FINAL

SAMPLING PLAN
For
TASK 3: COAL ASH DETERMINATION

NAVAL STATION GREAT LAKES
RADIOLOGICAL REMEDIATION
GREAT LAKES, ILLINOIS

Navy Control Number 2006-009
Contract number DAAA09-02-D-0024/30

Prepared for:
DEPARTMENT OF THE ARMY
HEADQUARTERS, JOINT MUNITIONS COMMAND
ROCK ISLAND, IL

Prepared by:

CABRERA SERVICES
RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION

103 E. Mount Royal Ave., Suite 2B
Baltimore, Maryland

December 2006

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

AEC	U.S. Atomic Energy Commission
Army	U.S. Army
bgs	below ground surface
CABRERA	Cabrera Services, Inc.
cm	centimeter
COC	chain of custody
CHSM	Corporate Health and Safety Manager
CRSM	Corporate Radiation Safety Manager
DCGL	derived concentration guideline level
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DRMO	Defense Reutilization and Marketing Office
EPA	U.S. Environmental Protection Agency
IDW	investigation-derived waste
JMC	Joint Munitions Command
m^2	square meters
MDC or MDC_{SCAN}	minimum detectable concentration
NRC	U.S. Nuclear Regulatory Commission
pCi/g	picocuries per gram
PM	project manager
POC	point of contact
PPE	personal protective equipment
ppm	parts per million
PPV	Public Private Venture
QA	Quality Assurance
QAC	Quality Assurance Coordinator
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCOPC	radionuclide contaminant of potential concern
SRSM	Site Radiation Safety Manager
USGS	U.S. Geological Survey
SSHP	Site Safety and Health Plan
^{232}Th	thorium-232
^{238}U	uranium-238
^{235}U	uranium-235
^{234}U	uranium-234

1.0 TASK 3 DESCRIPTION

The primary purpose of this task is to determine if radioactive contamination present in the areas of interest at Naval Station Great Lakes (hereafter referred to as the 'Site') is due to the presence of monazite sand or simply the result of other, non-licensed material, with similar naturally occurring radionuclides, such as coal fly ash. To accomplish this task, soil samples will be obtained from the following locations:

1. Non-Impacted Background Reference Area
2. Former Monazite Sand Storage Area (Area 18)
3. Public Private Venture Areas 3A, 3B, 3C, 3D, 3E and 3F

Soil samples collected will be submitted to an off-site laboratory for analysis to determine the concentration of the naturally occurring radionuclides present in both the background soils as well as the soils in the areas of interest.

1.1 Site History and Contaminants

1.1.1 Site History

In 1974 the Atomic Energy Commission (AEC) granted a license (license number STE-8179) to Engelhard Minerals & Chemicals to package and ship a strategic stockpile of monazite sand from the Site. This sand was reportedly shipped to Holland in 1974. In January 2000, the U.S. Nuclear Regulatory Commission (NRC) found residual monazite sand during a confirmatory survey of the previous AEC decommissioning of the Site. The NRC found elevated areas of gamma activity on the north side of the former monazite sand storage area along the fence near the Defense Reutilization and Marketing Office (DRMO) facility. In the spring of 2000, CABRERA Services, Inc. (CABRERA) performed a detailed site characterization that confirmed the NRC findings and identified several other areas of elevated concentrations of thorium-232 (^{232}Th). The final characterization report identified a monazite sand area of concern approximately 90,000 square meters in the tank farm area of the Site. The contractor also found a radium-containing device at the base of a large dirt pile in the northwest corner of the site. In the fall 2003, CABRERA remediated the large soil pile and the North fence area. As part of this effort, CABRERA collected some additional depth characterization data.

In the fall 2004, CABRERA performed an at depth characterization of the remainder of the site, with results published in a technical memorandum. It was estimated that an additional 1,526 cubic yards of material required remediation. As part of Phase III and Phase IV, CABRERA performed remediation in the North Fence Area, Recreation Area and Central Tank area of the monazite storage area. Final Status surveys by CABRERA and scoping surveys completed by the NRC showed additional areas of contamination above the current Derived Concentration Guideline Limit (DCGL) of 1 picocurie per gram (pCi/g) above background. These include some areas at the boundary of the original footprint remediated under Phase IV at a greater depth than anticipated, also a larger areal extent than previously identified. Additionally, the NRC identified contamination at the headwall of a drainage pipe that empties into Skokie ditch. The headwall is east of the site with the ditch running north and south in the area. Contamination detected in this area is 20 pCi/g.

In the form of a Public Private Venture (PPV), Forest City LLC is conducting renovation and development of the Forrestal Village housing area. This program will develop housing available on a priority basis to Navy personnel but also to the public. As part of this program, MACTEC conducted radiological screening surveys in the proposed area of the PPV. MACTEC found six areas with elevated thorium contamination. One of these areas also shows radium contamination (MACTEC, 2006).

1.1.2 Radiological Contaminants of Potential Concern

The radiological contaminants of potential concern (RCOPCs) associated with monazite sand are natural thorium and natural uranium. Since the monazite sand was stored in its natural, unprocessed form at the Site, the decay products associated with natural thorium and natural uranium remain in the same concentrations as would be found in locations where these sands occur in nature. Therefore, the decay or daughter products for both natural thorium and natural uranium would remain in secular equilibrium with the parent radionuclides.

The parent radionuclide in the natural thorium decay chain, ^{232}Th, and the parent radionuclides in the two decay chains that comprise natural uranium, uranium-238 (^{238}U) and uranium-235 (^{235}U), emit alpha particles. The daughter products in the natural thorium and natural uranium decay

chains decay by emission of alpha or beta particles, some with accompanying emission of gamma rays. The decay schemes for both natural thorium and the natural uranium decay chains are provided in Figures 1-1, 1-2 and 1-3.

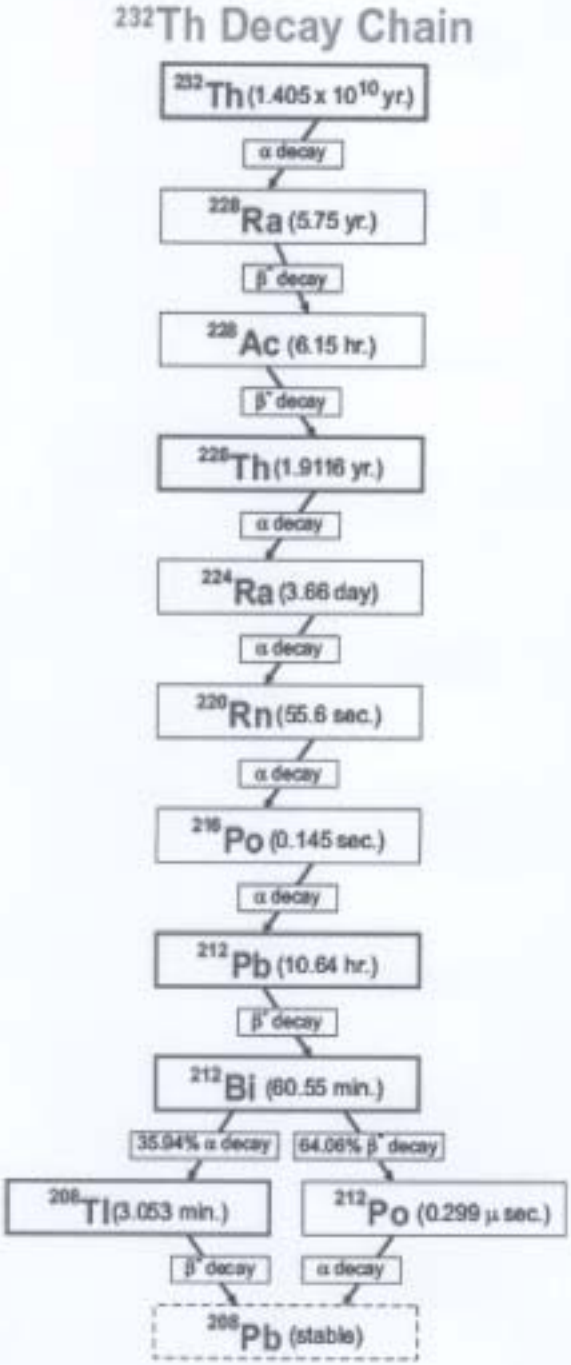

FIGURE 1-1: THORIUM 232 DECAY CHAIN

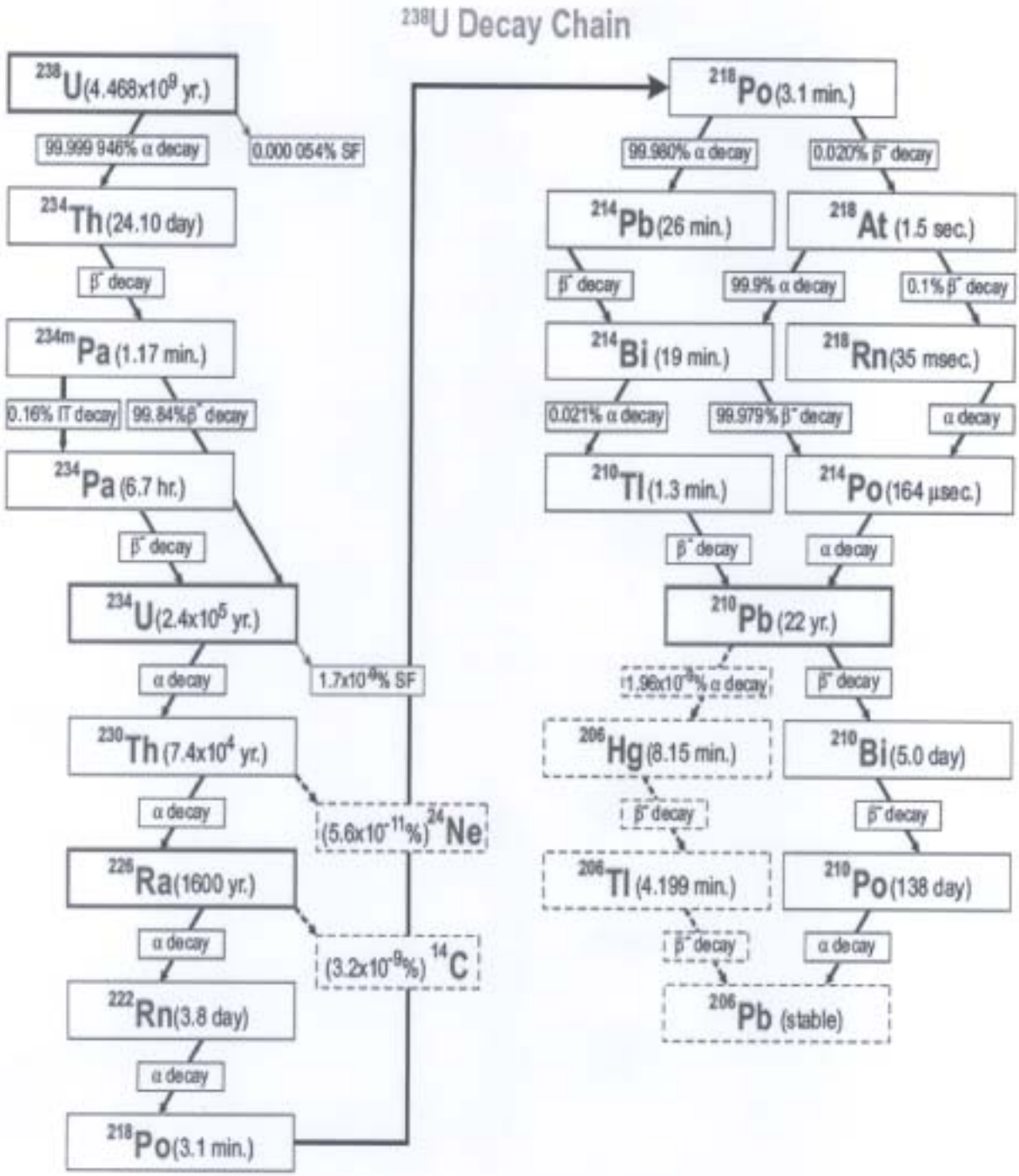

FIGURE 1-2: URANIUM 238 DECAY CHAIN

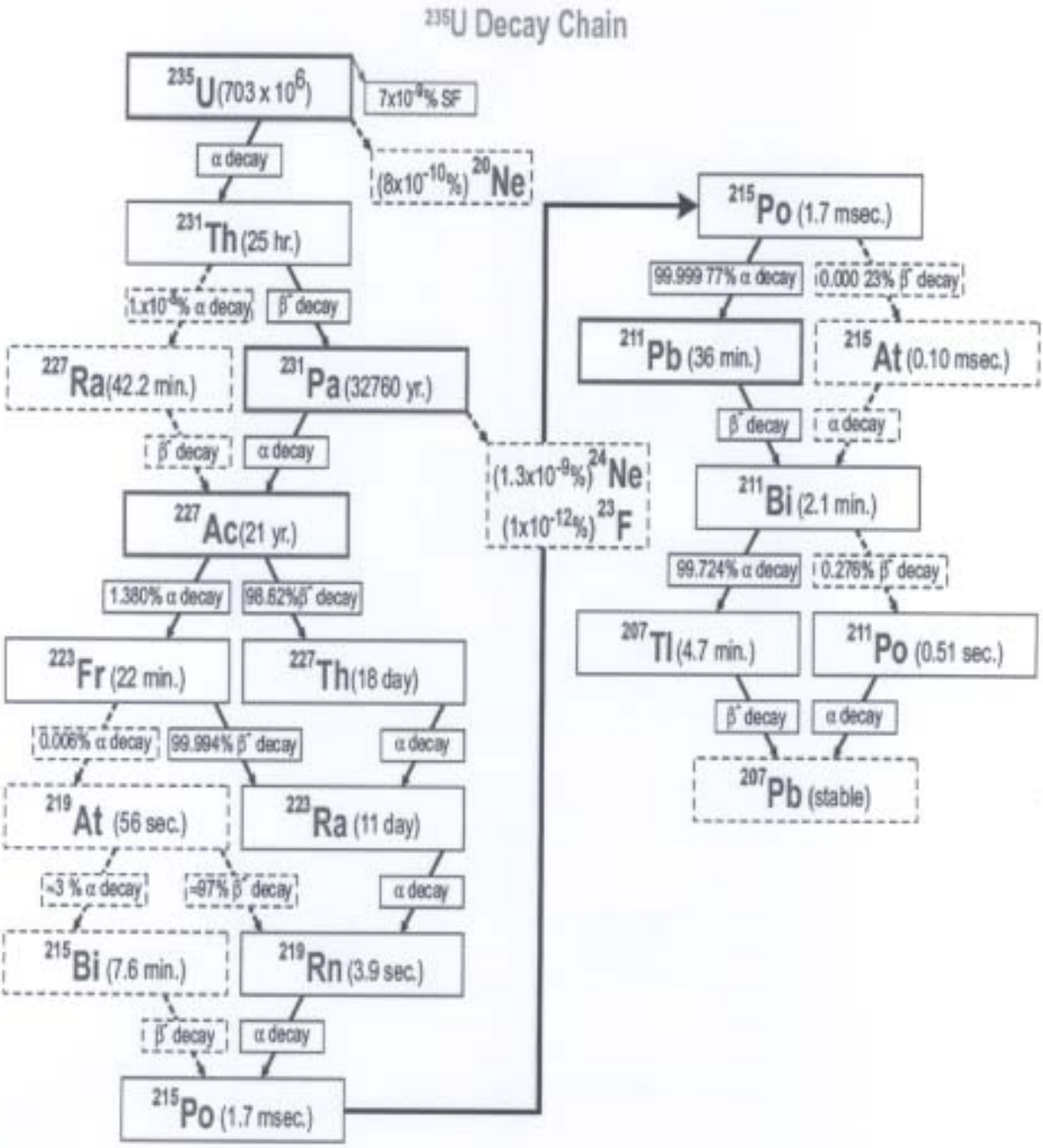

FIGURE 1-3: URANIUM 235 DECAY CHAIN

1.1.3 Determination of Natural Thorium Ratios[1]

Uranium and thorium are naturally occurring radioactive elements commonly found in very small amounts in rocks, soil, sand, water, plants and animals, including humans. The radioactivity of thorium and uranium in the environment is typically very low and contributes to low levels of natural background radiation. A higher concentration of natural thorium (^{232}Th) is found in certain sands, such as monazite sand. Table 1-1 provides the specific activity and radiological half-life of ^{232}Th.

TABLE 1-1: THORIUM 232 RADIOLOGICAL INFORMATION

Specific Activity (Ci/g)	Half-life (years)
1.10E-07	1.405E10

Monazite sand also contains a small amount of natural uranium. The three primary uranium isotopes present in natural uranium are ^{238}U, ^{235}U, and ^{234}U. Table 1-2 provides the percentages of the uranium isotopes found in nature, as well as the specific activity and half-lives of the three isotopes of interest.

TABLE 1-2: NATURAL URANIUM RADIOLOGICAL INFORMATION

Radionuclide	Abundance (%)	Specific Activity (Ci/g)	Half-life (years)	Activity per Gram Natural Uranium (µCi/g)
U-238	99.28	3.30E-07	4.47E9	3.28E-1
U-235	0.72	2.10E-06	7.04E8	1.51E-2
U-234	0.0055	6.20E-03	2.44E5	3.41E-1

[1] Throughout this section, natural thorium refers to ^{232}Th and natural uranium refers to the sum of the three uranium radionuclides (^{238}U, ^{235}U, and ^{234}U).

Monazite sand differs from most other environmental media in that it contains much higher concentrations of natural thorium, specifically ^{232}Th. The percentage of ^{232}Th in monazite sand has a range of 3 to 10%. The natural uranium content in the sand is typically much lower, in the range of 0.2 to 0.5 percent. This higher concentration of ^{232}Th compared to natural uranium in monazite sand can be used as a mechanism to screen soil samples to determine if the radioactivity fractions are representative of this material. By comparing the ratio of ^{232}Th to natural uranium, or more simply comparing the ratio of ^{232}Th to ^{238}U, it can be determined whether the contaminants are due to monazite sand or another source of naturally occurring radioactivity.

Tables 1-3 and 1-4 provide examples of the ^{232}Th to natural uranium and ^{232}Th to ^{238}U activity ratios using the range of ^{232}Th and natural uranium abundance percentages provided above for monazite sands.

TABLE 1-3: MONAZITE SAND RADIOACTIVITY RATIOS (10% ^{232}Th, 0.2% NATURAL URANIUM)

Radionuclide	Radionuclide Activity per Gram Monazite Sand (µCi/g)	^{232}Th:Radionuclide Ratio
Natural U	1.4E-03	8:1
U-238	6.5E-04	17:1
Th-232	1.1E-02	1:1

TABLE 1-4: MONAZITE SAND RADIOACTIVITY RATIOS (3% ^{232}Th, 0.5% NATURAL URANIUM)

Radionuclide	Radionuclide Activity per Gram Monazite Sand (µCi/g)	^{232}Th:Radionuclide Ratio
Natural U	3.4E-03	1:1
U-238	1.6E-03	2:1
Th-232	3.3E-03	1:1

For comparison, the average ^{232}Th to ^{238}U activity ratio in soil in the United States is 1:1 and the average ^{232}Th to natural uranium (includes ^{238}U, ^{235}U and ^{234}U) activity ratio is 0.5:1 (NRC, 1994).

The natural radioactivity in coal ash (fly ash) varies significantly (a direct result of the variability in coal). Quoting figures provided by the U.S. Environmental Protection Agency (EPA), a 1993 report states that the concentrations of natural thorium (^{232}Th) and natural uranium in coal ash is 3.2 parts per million (ppm) and 1.3 ppm, respectively (Gabbard, 1993). This equates to 3.2E-06 grams of thorium per gram of ash and 1.3E-06 grams natural uranium per gram of ash, resulting in a ^{232}Th to ^{238}U activity ratio of 0.8:1 and a ^{232}Th to natural uranium activity ratio of 0.4:1. The United States Geological Survey (USGS) states that the concentration of thorium and natural uranium in coal is approximately equal (USGS, 1997). This report also indicates that the thorium and natural uranium concentrations in coal ash, although increased by a factor of ten from the concentrations in coal, are similar. This results in a ^{232}Th to ^{238}U activity ratio of 0.3:1 and a ^{232}Th to natural uranium activity ratio of 0.2:1. The NRC reports that the natural uranium concentration in coal ash exceeds the ^{232}Th concentration by a factor of two to three (NRC,

2001). The U.S. Department of Energy (DOE) also reports that the natural uranium concentration in coal ash exceeds the ^{232}Th concentration by a factor of three (DOE, 1996). To summarize the information provided in these reports, the uranium radioactivity in coal ash exceeds that of ^{232}Th which results in activity ratios less than 1.

Additionally, many building materials may exhibit higher concentrations of naturally occurring radioactivity and these concentrations may vary greatly. For example, concrete contains natural thorium and natural uranium primarily due to the aggregate used in the concrete, of which sand is a primary component. The average ^{232}Th to ^{238}U activity ratio in concrete used in the Chicago, IL area is 0.4:1, with an average ^{232}Th to natural uranium activity ratio of 0.2:1 (NRC, 1994).

As indicated in the previous paragraphs, the natural thorium and natural uranium concentrations used in the determination of the ratios presented are based on averages. It is important to note that the natural radioactivity in these materials varies greatly within the U.S and around the world. However, the higher ^{232}Th concentration found in monazite sand distinguishes this material from most other environmental media and the ratios of ^{232}Th to ^{238}U and/or ^{232}Th to natural uranium may serve as a useful screening tool to determine if the radioactivity in soil at the Site is due to the presence of monazite sand or the result of other environmental (natural or a byproduct material, such as coal ash) media.

To minimize the impact of the variability of natural radioactivity concentrations in the media of interest (soil), this sampling plan requires collection of surface soil samples from a location within the Site that has no known history of containing monazite sand (reference area). Additional surface soil samples will also be collected from an area of the site known to have contained monazite sand (previously impacted area). These samples will be analyzed for natural thorium and natural uranium to determine the concentrations of the radionuclides of interest, as well as determine the ^{232}Th to ^{238}U and ^{232}Th to natural uranium activity ratios in non-impacted soil and soil samples obtained from a location known to contain monazite sand. The background concentrations of natural thorium and natural uranium in soil samples from the reference area will be used to correct the concentrations of these radionuclides in soil samples from the remaining six (6) areas of interest, as well as generate activity ratios of natural thorium to natural

uranium in native, non-impacted soil. This information will then be used to select an appropriate ratio threshold, above which can be concluded that the concentrations of natural radioactivity in soil is likely due to the presence of monazite sand or the result of these same radionuclides of concern in other environmental media.

Care must be exercised when evaluating soil sample results and resulting radioactivity ratios. This approach assumes the contaminant is homogenously distributed within the volume of soil sampled. Although a high ^{232}Th to ^{238}U or ^{232}Th to natural uranium activity ratio does provide reasonable assurance the contaminants are the result of monazite sand, low ratios need to be examined. For example, a low ratio may be the result of monazite sand deposited in a thin layer, with activity ratios more indicative of soil rather than monazite sand (resulting from dilution in the sample). This may be resolved by a simple visual examination of the soil sample as it's obtained, with examination results recorded in the field log book for each sample for future reference, if needed.

Following collection of samples and evaluation of analytical data, other methods for differentiating monazite sand from other sources may be proposed, if appropriate. These additional methods, if any, as well as the results of the soil sampling effort, activity ratio determination, conclusions and recommendations will be discussed in the sampling report provided by CABRERA.

2.0 CABRERA PROJECT ORGANIZATION AND RESPONSIBILITIES

The CABRERA Services, Inc. project organization with key responsibilities for each key position is presented below. Contact information is provided in Table 2-1.

- **CABRERA Managing Principal** – Dave Watters is responsible for overall project objectives, scope, budget, and quality of submittals. He will ensure that adequate corporate resources are made available to the Project Manager. Mr. Watters will also provide senior technical review and support.
- **CABRERA Project Manager** – John Eberlin is responsible for planning, coordinating, integrating, monitoring, and managing project activities. He is also responsible for day-to-day management and monitoring of the project budget, schedule, and scope. He will work with the CABRERA Quality Assurance Coordinator to ensure procedural compliance for all tasks. Mr. Eberlin is CABRERA'S primary point of contact (POC).
- **Corporate Health and Safety Manager (CHSM)** - Paul Schwartz is a Certified Industrial Hygienist and Certified Safety Professional. He is responsible for the development and overall implementation of the Site Safety and Health Plan (SSHP) (Cabrera, 2006), in accordance with CABRERA's Corporate Health and Safety Program and JMC's safety protocol. He is also responsible for implementing any appropriate medical monitoring programs for this project.
- **Corporate Radiation Safety Manager (CRSM)** - Henry Siegrist is responsible for the overall implementation of the SSHP with regard to radiological issues. He is also responsible for the implementation of CABRERA's Corporate Radiation Protection Program. He will work closely with the CHSM to ensure the adequacy and appropriateness of radiation safety measures during field activities.
- **Quality Assurance Coordinator** – Kim Nelson is the Quality Assurance Coordinator (QAC) for this project and is responsible for the overall implementation of quality control (QC) measures in sampling plan design and sampling activities, including the planning documents and the accuracy and precision of field-generated data.
- **Site Radiation Safety Manager (SRSM)** – The SRSM (TBD) is responsible for supervising all radiation safety and other safety protocols on this project. He/she is responsible for field implementation of any medical monitoring programs under the direction of the CHSM. He/she is also responsible for the calibration and operation of radiological safety monitoring equipment. He will work in concert with the CRSM, Project Health Physicist, and CHSM to

ensure that field activities are conducted in accordance with project plans and applicable procedures and regulations.

- **Field Site Manager** - The Field Site Manager (TBD) is responsible for organization, scheduling, and implementation of field activities for this project. He/she will be in frequent communication with the Project Manager and will be the Contractor's primary onsite POC for other Project Team personnel. He/she will be responsible for the activities of field sampling personnel, as well as working with other team members with Quality Assurance (QA) responsibility to ensure that all field activities are completed in a safe and efficient manner, in accordance with applicable procedures.
- **Project Health Physicist** – The project health physicist is responsible for all radiological field activities and has authority to direct such activities, to stop and restart work if necessary, and to take appropriate actions, as required, to address radiological emergency situations. He will work directly with the Field Site Manager, the CRSM, and the SRSM to ensure that radiological sampling procedures are properly implemented and followed.

TABLE 2-1: CABRERA CONTACT INFORMATION

Title	Name	Phone Number	E-mail address
Managing Principal	Dave Watters	860.569.0095	dwatters@cabreraservices.com
Project Manager	John Eberlin	314.703.6784	jeberlin@cabreraservices.com
Corporate H&S Manager	Paul Schwartz	860.569.0095	pschwartz@cabreraservices.com
Corporate Radiation Safety Manager	Henry Siegrist	860.569.0095	hsiegrist@cabreraservices.com
Quality Assurance Coordinator	Kim Nelson	410.332.8177	knelson@cabreraservices.com
Project Health Physicist	Mike Lambert	443.404.1687	mwljm@aol.com

3.0 SAMPLING DESIGN

The design of this sampling plan incorporates the methods and locations for the performance of sampling and direct measurements in order to assess the nature and extent of RCOPCs.

3.1 Sampling Tasks

Sampling and analysis will be performed to measure and quantify the RCOPCs present at the specified areas within the Site. Sampling and analysis of these media will provide the quantification of natural radioactivity in the media, used to determine the likely source of the contaminants (monazite sand or other) and the concentrations present. The sampling and analysis will include the following activities.

3.1.1 Task 1 - Mobilization

Mobilization includes preparation, travel to the site, and establishment of onsite support facilities, as necessary, for soil sample collection and analysis.

3.1.2 Task 2 – Sampling Activities

Soil sampling will be performed in a background reference area, an area known to contain (or previously contained) monazite sand, and six (6) areas of interest at the Site.

3.1.3 Task 3 – Investigation-Derived Waste Management/Disposal

This task involves packaging, removal, disposal, and general management of any investigation-derived waste generated during the sampling process, typically generated as a result of decontaminating sampling equipment prior to sampling and at the conclusion of all sampling.

3.1.4 Task 4 - Sampling Results

The results of the sampling effort will be compiled and presented by CABRERA. The sample results will be submitted in the form of a sampling report for this task. The report will detail the amount, type, and location of RCOPC found during the field effort, the likely source of the contaminants (monazite sand or other source), and the rationale for the decision.

3.2 Rationale

The sampling effort is intended to identify the concentrations of naturally occurring radioactivity in soil at the Site, specific to the locations in the following sections, and evaluate these concentrations to provide reasonable conclusions regarding the probable source of the contaminants (monazite sand or other source).

This sampling plan provides for:

- Determination of the concentrations of natural radioactivity (natural thorium and natural uranium) in soil from non-impacted areas of the Great Lakes Naval Station (reference area background concentrations),
- Sufficient data to establish activity ratios for ^{232}Th to ^{238}U and ^{232}Th to natural uranium to select an appropriate activity ratio threshold above which the source can be concluded to be monazite sand,
- Analysis of soil samples obtained from an area of the Site known to contain or have previously contained monazite sand to verify appropriate selection of the threshold activity ratio(s); and
- Collection and analysis of soil samples from the six (6) areas of interest and comparison of the analysis results, including activity ratios to the activity ratio threshold established to determine the probable source of contaminants (monazite sand or other source).

4.0 FIELD ACTIVITIES

Field sampling activities will be performed within the Site areas specified in the following sections. Surface soil samples from the six (6) PPV areas of interest will be collected at biased locations identified from previous survey efforts. Surface soil samples will typically be collected by hand.

4.1 Reference Background Area

The existing Reference Area used during the Area 18 remediation will be used for this study. Five (5) surface soil samples (0 to 30 centimeters below ground surface) will be obtained from the reference area collected from random locations selected by the sampling team. These locations should be selected from portions of the area that are relatively flat. Locations that should be avoided include lower portions of downward sloping soil, as well as ditches and the base of creek banks where contaminants typically concentrate.

4.2 Known Monazite Sand Contaminated Area

Monazite sand was previously stored at a location in the northwestern section of the Site (Area 18). Therefore, twenty (20) surface soil samples [0 to 30 centimeters below ground surface (bgs)] will be obtained from this area, collected from locations selected by the sampling team. The sampling team may use handheld radiological instrumentation to identify locations within this area that exhibit elevated radioactivity for selection of biased sample locations.

4.3 Six Areas of Interest (PPV Areas)

4.3.1 Area 3A

This area is in the vicinity of a 4 unit housing complex. The radiological contour map generated from a previous survey indicates two areas of elevated radioactivity in soil (refer to Figure 4-1), one area of approximately 200 square meters (m^2) on the north side of the housing unit and a smaller area of approximately 100 m^2 on the east side of the same housing unit, in the vicinity of a carport. Five (5) surface soil samples will be collected from these two locations in Area 3A. Locations may be selected using the five highest survey locations previously identified.

4.3.2 Area 3B

This area is in the vicinity of a ball field. The radiological contour map generated from a previous survey indicates a large area of approximately 1500 m^2 with elevated radioactivity in

soil (refer to Figure 4-1). The most significant radioactivity was found on the northwest side of the ball field in an area where a creek borders the survey area. Five (5) surface soil samples will be collected from Area 3B. Locations may be selected using the five highest survey locations previously identified.

4.3.3 Area 3C

This area is on the east and west sides of Great Lakes Drive. The radiological contour map generated from a previous survey indicates three (3) locations of elevated radioactivity on the west side of Great Lakes Drive, between the pavement and sidewalk (refer to Figure 4-1). Collectively, these areas cover approximately 100 m^2. A second, smaller area of elevated radioactivity, approximately 25 m^2, is found on the east side of the street. Five (5) surface soil samples will be collected from the three (3) locations of elevated radioactivity in Area 3C. Locations may be selected using the five highest survey locations previously identified.

4.3.4 Area 3D

This is an area surrounding a duplex housing unit. The radiological contour map generated from a previous survey indicates an area of elevated radioactivity exists on the southwest side of the structure, approximately 50 m^2 in size (refer to Figure 4-1). Five (5) surface soil samples will be collected from the location of elevated radioactivity in Area 3D. Locations may be selected using the five highest survey locations previously identified.

4.3.5 Area 3E

This area is in the southeast corner of the housing area property boundary. The radiological contour map generated from a previous survey indicates an area of elevated radioactivity, approximately 200 m^2 in size, exists on the downward slope of this area (refer to Figure 4-1). Five (5) surface soil samples will be collected from the location of elevated radioactivity in Area 3E. Locations may be selected using the five highest survey locations previously identified.

4.3.6 Area 3F

This area is on the west side of a creek, south of the area identified in Area 3B. The radiological contour map generated from a previous survey indicates this area of elevated radioactivity covers approximately 400 m^2 (refer to Figure 4-1). Five (5) surface soil samples will be collected from the location of elevated radioactivity in Area 3F. Locations may be selected using the five highest survey locations previously identified.

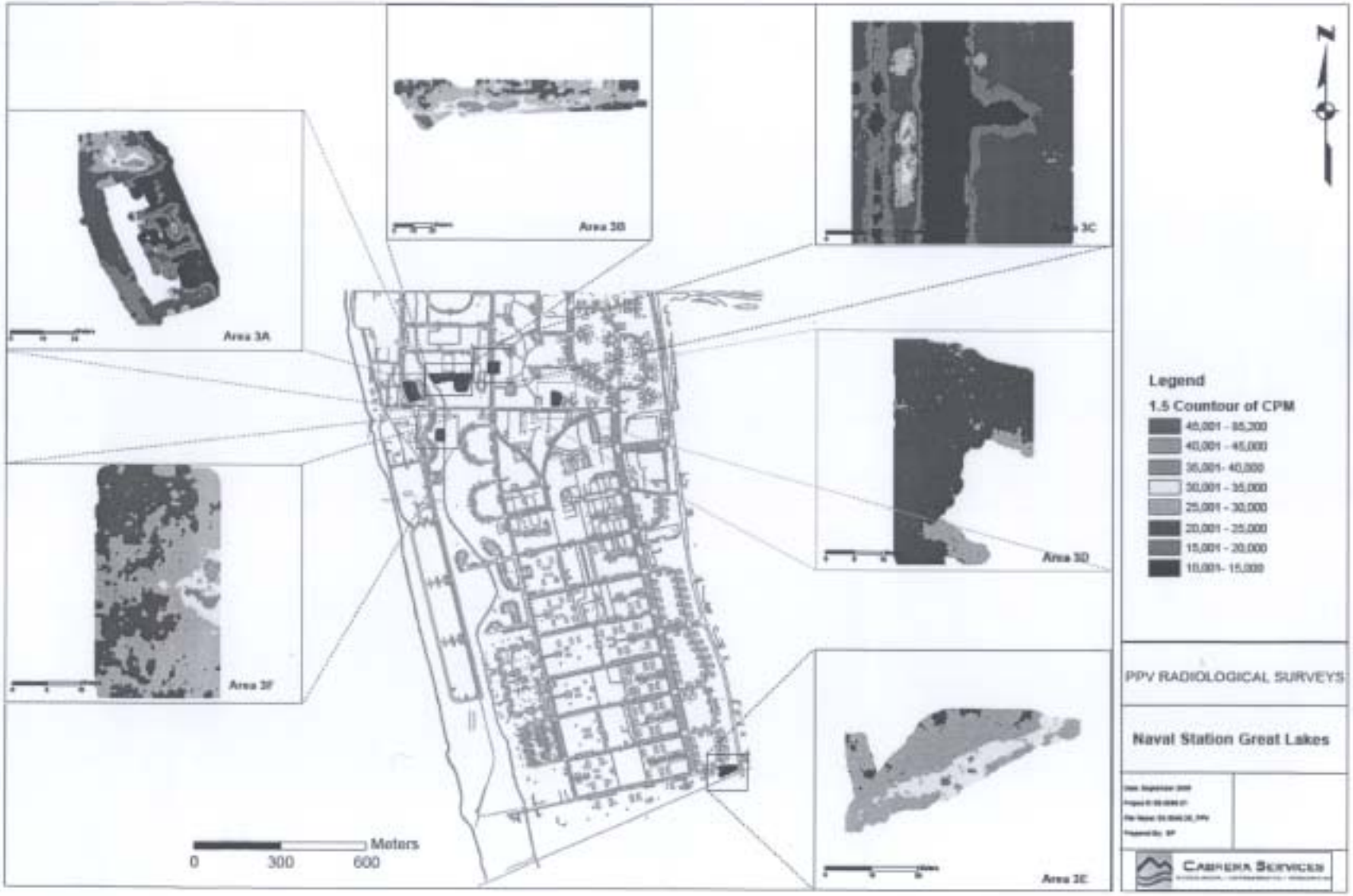

FIGURE 4-1: PPV AREAS OF INTEREST

5.0 SAMPLING PROTOCOL

The purpose of this section is to describe sampling methodologies to be used for surface soil sample collection. Specific sampling requirements are discussed in Section 4.0. Discrete surface soil sampling and offsite laboratory analyses will be performed to measure radioactivity concentrations of RCOPCs in surface soil. Soil sampling equipment will be decontaminated and/or surveyed to minimize cross-contamination of samples.

5.1 Volumetric Sample Collection and Analysis

Volumetric samples of soil will be collected and analyzed at an off-site laboratory. During the collection of soil samples, large twigs, stones and other similar items will be removed. Chain of custody (COC) forms will be maintained in accordance with CABRERA SOPs.

5.1.1 Volumetric Surface Soil for RCOPCs

Surface soil samples will be collected from 0 to 30 centimeters bgs. The following equipment (or equivalent) will be required for this task.

- Hand auger, hand trowel or other proper sampling method;
- Large stainless steel mixing bowl;
- Stainless steel utensil for removal of soil core from soil core rod or hand auger after sample is retrieved and for mixing and packaging samples in containers;
- Sample containers and COC forms/seals.

Sample results will be used to quantify surface soil contaminant concentrations at discrete locations. All surface soil samples will be analyzed for RCOPCs at an off-site laboratory. At approximately 5% of all sample locations, CABRERA will collect duplicate samples for QC considerations.

A minimum of 750 grams of soil will be obtained for each discrete sample. Personnel collecting samples will ensure each sample is placed into a clean, unused container. For each related batch of samples, a sample COC form will be filled out. The samples will be either individually listed or batch listed (by chain of custody form number) in the Project Logbook. Samples awaiting shipment to the contract offsite laboratory will be stored in a designated, secure location.

Soil samples will be prepared and packaged to meet laboratory requirements and, if Class 7 radioactive material, to meet U.S. Department of Transportation (DOT) regulations for transportation.

Soil samples will be analyzed by an off-site laboratory via alpha spectroscopy using an industry standard analytical method, e.g. HASL-300, or equivalent. Analytical parameters shall be sufficient to achieve a minimum detectable concentration (MDC) of 0.5 pCi/g or less.

5.2 Sample Chain of Custody/Documentation

5.2.1 Field Log

Project data will be recorded in a Field Data Logbook (or other equivalent method of data record) and subsequently transferred to an electronic format. Field Data Logbook records will be sufficient to allow data transactions to be reconstructed after the project is completed. The CABRERA project manager (PM), or designee, is responsible to ensure logbook(s) entries are completed appropriately. The CABRERA designee will review the Project Logbook periodically and will report significant issues to the CABRERA PM.

Field Data Logbooks will be permanently bound and the pages will be numbered. Pages may not be removed from logbooks under any circumstances. All entries are to be made in blue or black ink. Entries will be legible, factual, detailed, and complete and should be signed and dated by the individual(s) making the entries. If a mistake is made, the error will be denoted by placing a single line through the erroneous entry and initialing the deletion. Under no circumstances will any previously entered information be completely obliterated. Use of whiteout in data logbooks is not permitted for any reason.

5.2.2 Sample Documentation

When samples are collected for radiological analysis, documentation such as sample labels, COC forms (if they are to be sent offsite for analysis), and field logbooks will be completed. This information enables the maintenance of sample integrity from the time of the sample collection through transport to the laboratory. All documentation will be completed with indelible ink.

5.2.2.1 Sample Labels and/or Tags

Sample labels should include the following items:

- Client name
- Project name
- Sample location
- Date/time
- Sample collector
- Sample identification
- Preservation
- Analyses requested

5.2.2.2 Chain of Custody Records

A COC form will be completed and will accompany the samples being sent offsite. The following information should be provided on the COC:

- Site name
- Laboratory name and contact.
- Turnaround time (only if site-specific conditions require non-standard turnaround time).
- Sample ID, matrix, sample date, and collection time.
- Parameters, analytical methods, bottle type, bottle volume, sample type, and preservative.
- Signed release on bottom of COC.

5.2.2.3 Receipt for Sample Forms

The analytical services laboratories should analyze the condition of the samples upon receipt. This information will be recorded on a form. The form will include the date, client's name, cooler number, temperature of samples, etc. The laboratory sample custodian or manager will sign and date the form. The form should be returned to the Project Manager with the results package for each laboratory work order.

5.3 Sample Packaging and Shipping

5.3.1 Sample Handling

The Field Site Manager will arrange for delivery of all coolers, labels, and sample containers prior to conducting field sampling activities. Sample containers will be labeled using preprinted labels. The labels should include the project name and number, unique sample ID, sample date and time of collection, sample procedure (i.e., composite, grab), preservative used, analysis requested, and sampler's initials. All samples should be screened to determine if the

concentration and total activity in a conveyance requires shipment as Class 7 radioactive material. If so, the samples shall be packaged, labeled, if necessary, marked, and transported in accordance with U.S. DOT regulations.

5.3.2 Sample Transport

Samples should be shipped to the laboratory via overnight carrier, or, if possible, the laboratory may arrange for sample pickup at the site. The Field Site Manager will coordinate the transport of samples.

6.0 INVESTIGATION-DERIVED WASTE

Investigation-derived waste (IDW) is expected to be minimal as a result of this investigation. IDW will be generated from the use of PPE, disposable sampling equipment, and decontamination fluids during field investigation activities, and possibly from excess soil during sampling activities. IDW will be containerized and staged at the site until sample results are received from the laboratory and the final disposition of the waste is determined. IDW will be stored in Type 7A steel drums placed on pallets (or other standard and appropriate containers). The containers will be labeled with the type and volume of the contents, date, and contact information. Depending on the constituents of concern, fencing or other special marking may be required. The containers will be inspected on a routine basis to ensure that they are properly sealed and intact, and that markings remain clearly visible.

IDW that has not come in contact with significant contamination such as paper towels, and packaging will be collected on an as-needed basis to maintain the site in a clean and orderly manner. This waste will be containerized and transported to a designated collection bin. Acceptable containers will be sealed boxes or plastic garbage bags.

7.0 REFERENCES

(DOE, 1996) *Naturally Occurring and Accelerator Produced Radioactive Material*, U.S. Department of Energy, Office of Environmental Management, dated 1996.

(Gabbard, 1993) Oak Ridge National Laboratory Review, *Coal Combustion: Nuclear Resource or Danger*, report by Mr. Alex Gabbard, dated July, 1993.

(MACTEC, 2006) *Forrestal Village Phased-Approach Radiological Survey Report In Support of the Phase II Environmental Assessment, NAVSTA Great Lakes, Naval Region Midwest Family Housing Privatization*, MACTEC, dated February, 2006.

(NRC, 1994) NUREG-1501, *Background as a Residual Radioactivity Criterion for Decommissioning, Draft Report*, U.S. Nuclear Regulatory Commission, dated August, 1994.

(NRC, 2001) NRC SECY-01-0057, Policy Issue, *Partial Response to SRM COMEXM-00-0002 – "Expansion of NRC Statutory Authority Over Medical Use of Naturally Occurring and Accelerator-Produced Radioactive Material (NARM)"*, U.S. Nuclear Regulatory Commission, dated March, 2001.

(USGS, 1997) *Radioactive Elements in Coal and Fly Ash: Abundance, Forms, and Environmental Significance*, dated October, 1997.