MALCOLM PIRNIE

ARCS II

Contract No. 68-W9-0051
Work Assignment No. 004-2L67
SAP - Part II

FIELD SAMPLING PLAN

U.S. Radium Site
City of Orange
Essex county, New Jersey

Remedial Planning Activities at Selected Uncontrolled Hazardous Substance Disposal Sites USEPA Region II (NY, NJ, PR, VI)

Malcolm Pirnie, Inc.
2 Corporate Park Drive
White Plains, New York 10602

December 1990

MALCOLM PIRNIE

SAMPLING AND ANALYSIS PLAN, PART II

FIELD SAMPLING PLAN
FOR
REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

U.S. RADIUM CORPORATION SITE
CITY OF ORANGE
ESSEX COUNTY, NEW JERSEY

December 1990

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SAMPLING AND ANALYSIS PLAN

PART II

FIELD SAMPLING PLAN

FOR THE

U.S. RADIUM CORPORATION RI/FS

ORANGE, N.J.

MALCOLM PIRNIE

REVISED FIELD SAMPLING PLAN
(PART II)

DECEMBER 5, 1990

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1.0 INTRODUCTION

This Field Sampling Plan (FSP) was prepared as part of the Sampling and Analysis Plan (SAP) for the U.S. Radium Site, Orange, New Jersey, Remedial Investigation/Feasibility Study (RI/FS). The SAP is the controlling document for field activities under RI/FS Task 3 and ancillary tasks. The Revised Work Plan (RWP) for the U.S. Radium Site RI/FS contains descriptions of the RI/FS process and is the controlling document for the entire RI/FS.

The FSP describes field protocols for site work at:

- High and Alden Streets Properties
- Satellite Properties
- Vicinity Properties

A three phased approach will be utilized during the field investigations so that the sampling effort can be refined to address site specific conditions so that the spatial distribution of contamination can be determined. It is discussed in detail in Section 3.0.

2.0 TASK 3 FIELD INVESTIGATION OBJECTIVES

The objectives of the site investigation at the High and Alden Streets Properties are to:

1. Quantify the extent and type of radiological contamination in soils and buildings.

2. Determine the presence and characterize the type of radioactive material migrating in surface waters and groundwaters.

3. Characterize the nature and extent of Target Compound List/Target Analyte List (TCL/TAL) contamination.

4. Assess the effects of radium contamination and radon gas on air quality and screen for migration of airborne radioactive materials to the surrounding areas.

5. Develop preliminary remedial objectives, identify specific federal and state applicable or relevant and appropriate requirements (ARARs), and baseline risk assessment data to form the basis for the development of a Feasibility Study (FS).

The objectives of the Satellite and Vicinity Properties investigation are to:

1. Determine the presence and characterize the extent of radioactive materials in buildings and soils.

2. Develop preliminary remedial objectives to form the basis for the development of a FS.

Field radiological measurements conducted in support of the RI will be completed in strict compliance with the analytical procedures presented in this FSP.

Prior to the start of field investigation activities, it will be necessary to obtain property access from the property owners and tenants. Task 2, Community Relations Program, deals specifically with site access and community relations. No field investigations will be performed without a signed access agreement.

3.0 TASK 3 FIELD INVESTIGATIONS OVERVIEW

3.1 FIELD ASSIGNMENT BRIEFING MEETING

A preparatory briefing will be held in Malcolm Pirnie's office in Paramus, New Jersey prior to the start of the investigations. The purpose of the meeting is to:

- Discuss objectives of the investigation and work plan development
- Discuss major responsibilities of on-site personnel
- Discuss the Health and Safety Plan (HASP) procedures
- Conduct training in sampling and measurement protocols
- Review decontamination procedures.

Attendance at the briefing will be mandatory for the site manager and field personnel. Training will be conducted by the Site Health and Safety Officer/Site Health Physicist. Once field activities begin, briefing meetings generally will be held daily at the start of the work day. Each of the topics presented above will be discussed as applicable to the activities to be performed that work day.

3.2 MOBILIZATION/FIELD ACTIVITIES

Prior to initiating applicable field activities, the following preparatory activities must be completed:

- Select the subcontract laboratory to analyze radioactivity in water, soil, sediment and building samples which participates in the EPA Environmental Radioactivity Intercomparison Program. When the laboratory is selected, discussions will be held with the laboratory coordinator to finalize sampling protocols and shipping requirements.

- Select laboratory services to perform the appropriate chemical sample analyses.
- Select field survey services to perform Vicinity and Satellite Properties surveys.
- Finalize all sampling protocols, equipment needs, shipping requirements, and analytical methods.
- Ensure that field measuring equipment has been calibrated and has received appropriate quality control checks.
- Select qualified driller and surveyor following ARCS solicitation procedures.
- Obtain access permission for well-drilling and sampling activities.
- Establish that the well installations are performed in accordance with New Jersey Department of Environmental Protection (NJDEP) guidelines.
- Obtain trip blanks and field blank water from the Malcolm Pirnie laboratory.
- Locate the Federal Express, Emery, or other overnight delivery service nearest the site and note its hours of operation. Determine whether the office will provide sample pick-up service.
- Ensure that field personnel are trained to use personal protective equipment and are familiar with health and safety guidelines as specified in the HASP.

Equipment will be decontaminated at appropriate intervals during the field investigations (such as prior to initial use and prior to moving to a new sampling site). Several decontamination procedures will be implemented for various types of equipment. Decontamination stations will be established.

Radiological field monitoring equipment will be scanned for radionuclide contamination and will be decontaminated with a dry or water rinse as applicable.

Teflon and stainless steel sampling equipment used for sampling of chemical contaminants shall be precleaned or field cleaned prior to sampling. The decontamination procedures shall consist of the following steps:

1. Tap water and non-residual, low-phosphate detergent (Alconox) wash
2. Tap water rinse (three times)
3. 10 percent ultra pure grade nitric acid rinse
4. Tap water rinse
5. Acetone (pesticide grade) rinse or methanol followed by hexane (pesticide grade or better)
6. Deionized water rinse (demonstrated analyte free) (three to five volumes of the acetone rinse)
7. Air dry
8. Wrap in clean aluminum foil with the dull side against the equipment

Other field monitoring equipment that will be used for "contact" purposes will be cleaned at each sampling station prior to use. Cleaning procedures listed above shall be used where appropriate. An Alconox/water or a distilled water rinse shall be used for equipment such as conductivity meters, water-level indicators, and pH meters.

Personal protective equipment decontamination procedures are as follows:

- Immerse in cleaner/sanitizer
- Scrub gently with soft brush until clean
- Clean exhalation valve and other parts in contact with exhaled air
- Rinse three times in 120°F water
- Air dry

Drilling rigs will be decontaminated by steam cleaning. Some field monitoring equipment which contain plastic (i.e., geophysical logging equipment, pH meter, water-level indicators, conductivity probes) cannot be rinsed with

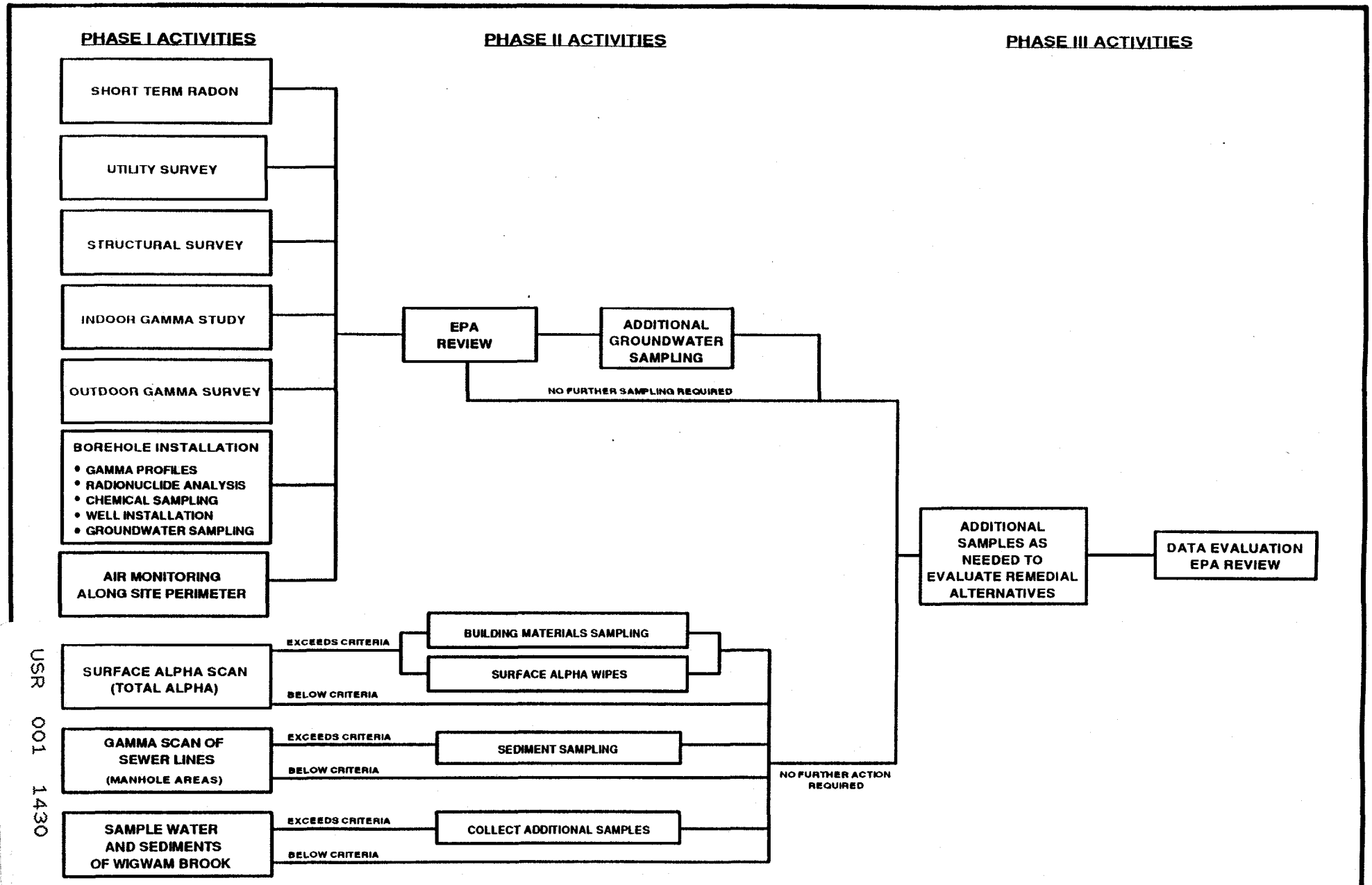
solvents because they may be harmed or rendered unusable. In these instances, a detergent rinse (Alconox) will be used. Other instruments can only be decontaminated using distilled water (e.g., conductivity meter probe, pH meter, etc.). Personnel clothing will be segregated and discarded in accordance with the guidelines presented in the HASP - Part IV.

3.3 OVERVIEW OF PROTOCOLS AT THE HIGH AND ALDEN STREETS PROPERTIES

The objective of this RI is to define the extent of radiological and chemical contamination and identify potentially hazardous conditions that could effect the public. The field investigations will characterize the locations of the radioactive material, examine the nature and extent of contamination within the surrounding the structures, and assess any migrate of radionuclides off-site. As discussed in the RWP, a three phased approach will be used during the RI of the High and Alden Street Properties. Sampling activities associated with each phase are summarized in Figure 3-1. Phase I investigations include preliminary screening and sampling of radiological and chemical contaminants in several media. Expanded chemical sampling may be warranted based on Phase I sample data. Phase II sampling will further refine estimates of contamination. Sample strategies may be modified based on screening data. Phase III investigations will only be implemented if more sampling is necessary to characterize the extent of contamination. The results from each activity will be used to formulate specific sampling strategy in subsequent phases.

Phase I

The Phase I investigations include preliminary screening activities as well as detailed characterization of the contamination in the soils, building structures, and surface water. Prior to the start of sampling activities, large trees and miscella-



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HIGH AND ALDEN STREET PROPERTIES
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FIGURE 3-1

neous debris will be cleared as needed. This effort will facilitate the establishment of survey grids and field operations. Exposure rates and short term indoor radon measurements will be taken at the outset for health and safety purposes. Structural surveys of the buildings will assess features impacting the technical feasibility and cost of potential remedial alternatives. Exposure rate surveys will be conducted both outdoors and indoors (where not done previously). Surface alpha measurements will be made. Soil (both surface and subsurface) and water will be measured for radionuclide and chemical content. Wells will be installed and the groundwater monitoring will be initiated. Ambient air monitoring will be conducted to determine any localized atmospheric impact of intrusive activities.

Phase II

Phase II sampling activities will be based on data generated during the Phase I program. They consist of wipe test to determine the levels of removable alpha contamination from indoor surfaces, radionuclide characterization of additional water and sediment samples of Wigwam Brook, radionuclide analyses of sediments taken from catch basins and manholes, and additional rounds of groundwater sampling.

Phase III

A review of all of the RI data will be conducted to determine if additional sampling is needed to evaluate remedial alternatives.

Site Entry

Prior to entering the site, the sampling team will review existing data, become familiar with the site layout and building plans, and identify potential hazards that might be encountered in the course of the work. Training will be conducted by the Site Health and Safety Supervisor and Health Physicist.

Personnel will become familiar with the location of entrances and exits from the buildings in case of an emergency evacuation. Indoor, outdoor, and subsurface investigations at the High and Alden Streets Properties will be completed in Level D protective clothing unless the Site Health and Safety Supervisor prescribes a change based on sampling results or pre-existing data. The radiation protection program will hold the whole body equivalent exposure to an administrative limit of 500 mrem/year.

Pre-existing data of samples collected within High and Alden Streets Properties buildings have been reviewed. Radon concentration levels in excess of the action levels shown in the Health and Safety Plan (HASP) have been measured in Buildings F and G. Therefore, full-face air purifying respirators (APRs) will be worn during sampling activities in these buildings. There are limited alpha contamination, exposure rate, and radon concentration data from Buildings B-E. Eight and 14 locations were sampled for alpha contamination and exposure rate, respectively, in Building A, although only one location was sampled for radon. Buildings F and G, however, were sampled extensively by previous investigators. All of these data are summarized in Appendix C of the Revised Work Plan (RWP). Sampling during this RI will be build on the data base, where one already exists.

Specifically, entry into any building on the High and Alden Streets Properties will proceed as follows:

- Assess structural integrity by visual examination.
- Review locations of entrances and exits.
- Review organization and team member duties (SAP, Part I).
- Place plastic sheets in the contamination reduction zone to be used during frisking and decontamination.
- Wear respiratory protective equipment as required by the Site Health and Safety Supervisor.
- Enter the facility at a designated entry.

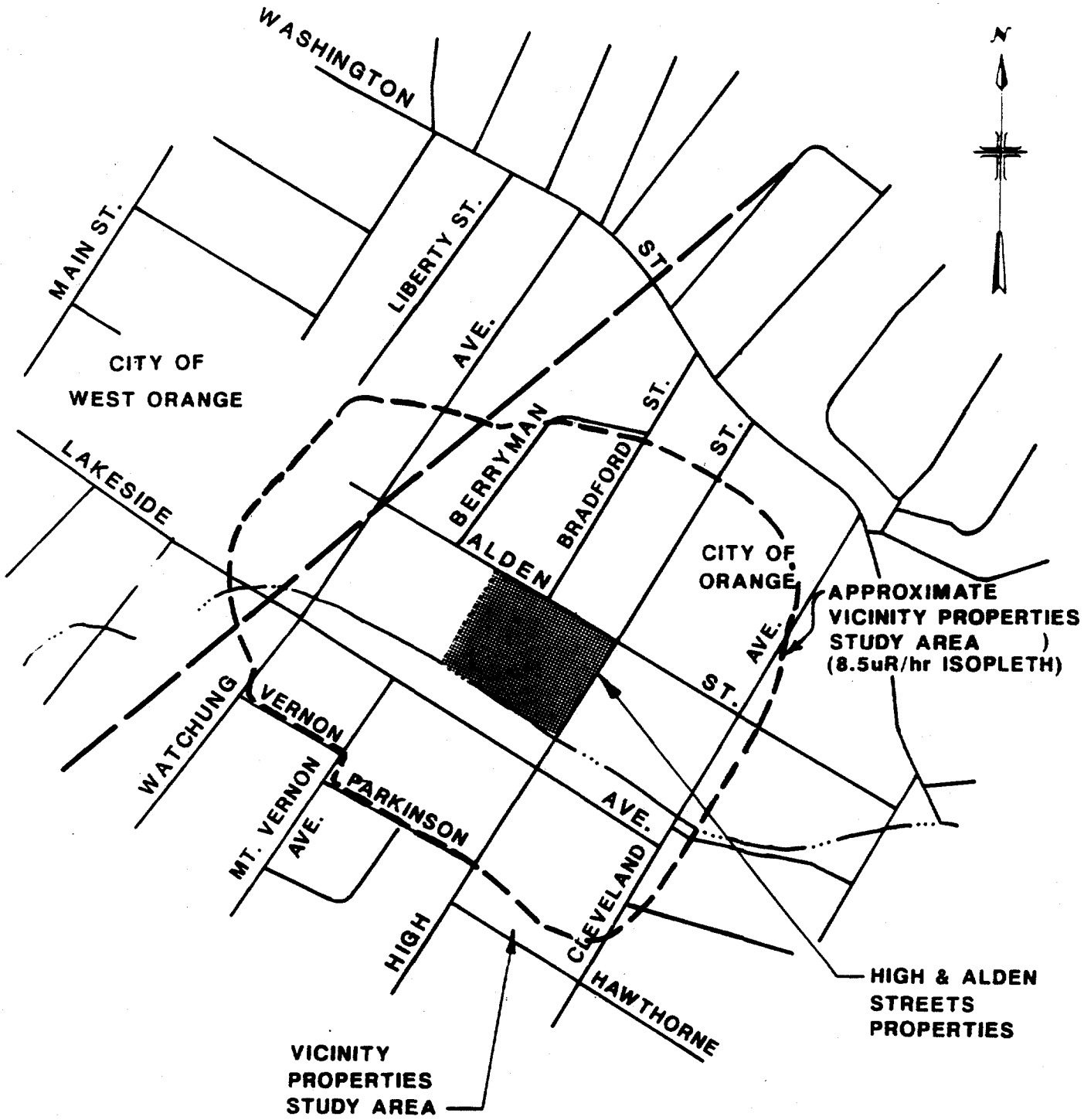
- Perform walk-through three foot high gamma radiation exposure scan.
- If the gamma surveys reveal levels in excess of 250 uR/hr, the Health Physicist will consider additional controls including limiting access.
- If radiation levels are within acceptable limits, work may continue according to the protocols outlined in Figure 3-1.
- After the completion of RI activities, the team members will simultaneously exit the facility through the designated entry.
- During decontamination, team members will be frisked using a Geiger-Mueller pancake probe. Decontamination will be performed according to the procedures described in the HASP.

3.4 OVERVIEW OF PROTOCOLS AT SATELLITE AND VICINITY PROPERTIES

The objective of these investigations is to determine the character and extent of radioactive contamination at the Satellite and Vicinity Properties. Satellite Properties consist of 22 structures identified from record searches as having associations with the U.S. Radium Corporation. The Vicinity Properties consist of approximately 300 structures identified in a 1981 EPA aerial gamma radiation survey which lie within an 8.5 uR/hr isopleth surrounding the High and Alden Streets Properties as shown in Figure 3-2.

During 1983 and 1984, NJDEP performed radiological investigations at nine of the Satellite Properties. In 1986, six additional Satellite Properties were screened by the EPA REM II contractor. These efforts resulted in the accumulation of some of the data necessary to characterize exposure to radioactive materials at these sites (Table 3-1). A discussion of these data can be found in Section 6.3.1 of the RWP. The goal of the current RI is to complete a data base which will provide the basis for decisions as to whether each property has been impacted by contamina-

During 1984, NJDEP performed an outdoor and indoor surface exposure rate survey at 31 Vicinity Properties immediately adjacent of the High and Alden



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U.S. RADIUM SITE
ORANGE, NEW JERSEY
VICINITY PROPERTIES AREA MAP

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FIGURE 3-2

TABLE 3-1
SUMMARY OF RADIOLOGICAL DATA
SATELLITE PROPERTIES

	ADDRESS	INVESTIGATOR	GAMMA (uR/hr)		TOTAL ALPHA (dpm/100 sq cm)	REMOVABLE ALPHA (dpm/100 sq cm)	RADON (pCi/l +/-s) or RANGE	RADON DECAY PRODUCTS (WL +/- s) or RANGE
			INDOOR	OUTDOOR				
1		NJDEP, 1984	15 – 2000	NM	NM	NM	0.6 – 6.9	0.0073 – 0.0159
2		NJDEP, 1983	16.7 – 178	NM	0 – 22,700	NM	4.7 – 10.6	NM
3		NJDEP, 1983	7.0 – 120	7 – 70	NM	NM	NM	NM
4		NJDEP (*)	10.0	10 – 60	NM	NM	1.6 – 4.0	NM
5		NJDEP (*)	12.0	13 – 46	NM	NM	1.7 – 3.4	NM
6		NJDEP (*)	10.0 – 12	12 – 70	NM	NM	2.0 – 3.6	NM
7		NJDEP (*)	10.0 – 12	15 – 110	NM	NM	1.6 – 4.0	NM
8		NJDEP (*)	10.0 – 14	10 – 50	NM	NM	0.5 – 2.5	NM
9		NJDEP (*)	12.0	10 – 30	NM	NM	2.8 – 4.5	NM
10		EPA, 1986	13 – 290	NM	160 – 880	2.4 – 9.7	6.15 +/- 1.30	0.0094 +/- 0.0020
11		EPA, 1986	11 – 121	NM	240 – 800	1.8 – 8.8	1.33 +/- 0.81	0.0061 +/- 0.0012
12		EPA, 1986	12 – 16	NM	250 – 500	4.2 – 4.9	0.56 +/- 0.79	0.0009 +/- 0.0006
13		EPA, 1986	10 – 27	NM	91 – 727	8.8 – 18.5	0.19 +/- 0.45	0.0019 +/- 0.0010
13A		EPA, 1986	13 – 16	NM	NM	NM	NM	NM
13B		EPA, 1986	14	NM	NM	NM	NM	NM
14		NI	–	–	–	–	–	–
15		NI	–	–	–	–	–	–
16		NI	–	–	–	–	–	–
17		NI	–	–	–	–	–	–
18		NI	–	–	–	–	–	–
19		NI	–	–	–	–	–	–
20		NI	–	–	–	–	–	–

NOTES: NM = NO MEASUREMENTS MADE
(*) = YEAR OF INVESTIGATION NOT KNOWN
NI = PROPERTY NOT INVESTIGATED
SATELLITE LOCATIONS ARE SHOWN IN FIGURE 1-1

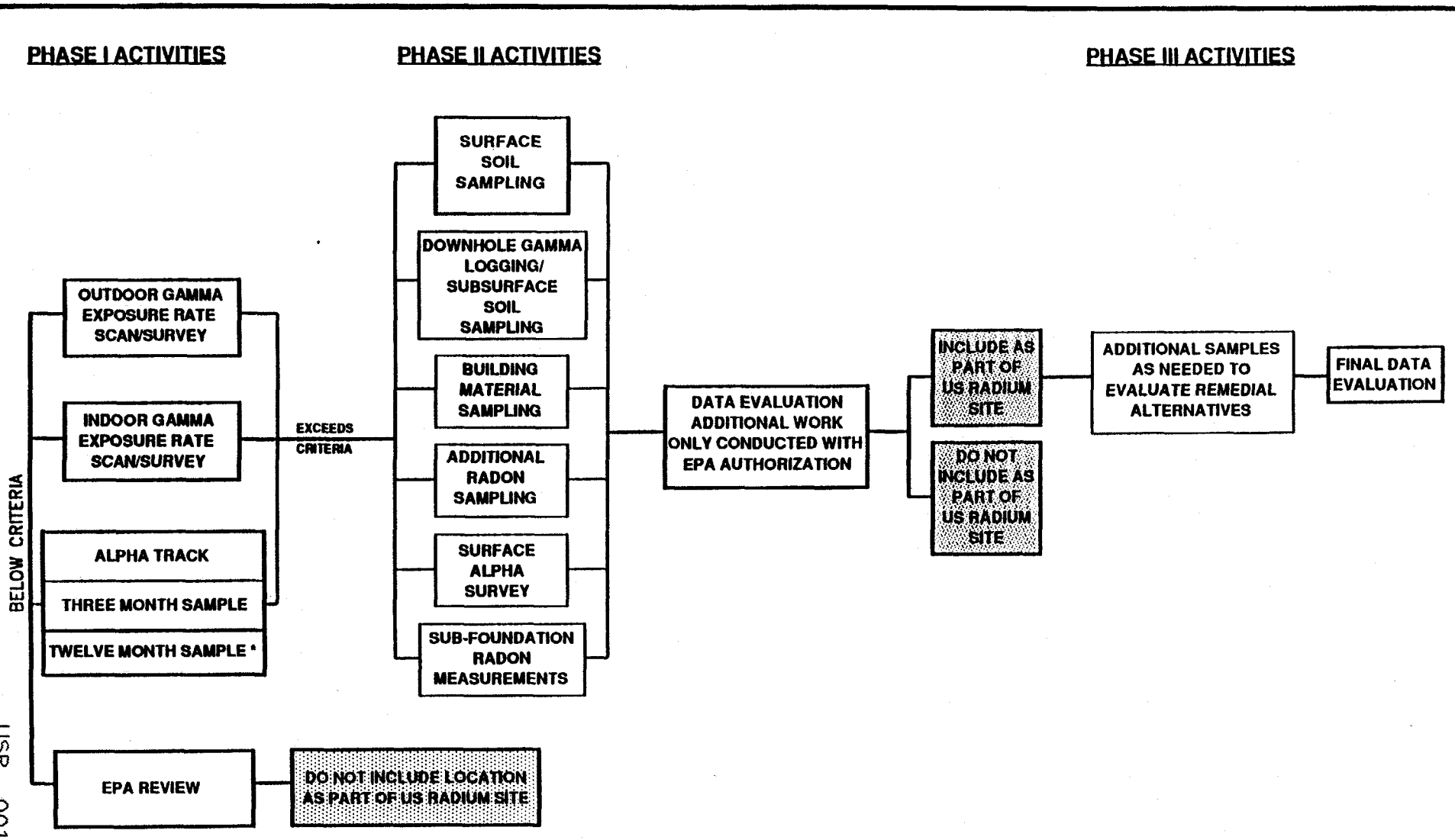
Streets Properties. Six of the 31 properties were found to exhibit elevated outdoor exposure rates.

A phased approach will be used to investigate the Satellite and Vicinity Properties (Figure 3-3). Prior to the onset of Phase I data collection, historical records and site histories will be reviewed and arrangements will be made to gain access to the properties.

Initially, investigations will be limited to 21 Satellite Properties and approximately 130 of the potential 300 Vicinity Properties. This will include the investigation of all Satellite Properties not previously investigated, Vicinity Properties adjacent to the High and Alden Street Properties and those Vicinity Properties built after 1915. The remaining Vicinity Properties will only be investigated if justified based on the review of data from the initial investigation.

Several sampling protocols will combine to make up Phase I, including indoor and outdoor gamma exposure rate surveys and indoor radon measurements. Certain sample types may be eliminated if suitable data exist from the aforementioned NJDEP and EPA investigations.

Upon arrival at a property, field crews will perform exposure rate scans to provide a basis for health and safety (e.g., ALARA) decisions. A complete gamma survey of the property will be conducted by taking near surface readings at intersecting points of a five foot grid inside the structure and a ten foot grid outside the structure. Alpha track etch detectors will be deployed in the lowest level of the building for a duration of three months. An additional 12 month detector will be deployed at any property when the sampling period commences between February 1 and October 1. The location will be selected by the field crew to comply with recommendations in EPA's Indoor Radon and Radon Decay Product Measurement Protocols (EPA 520-1/89-009). The detectors will be sent to a laboratory which has successfully participated in EPA's Radon Measurements Proficiency Program for analysis.



* Twelve month alpha tracks will only be placed on properties investigated between February 1 and October 1.

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VICINITY AND SATELLITE PROPERTIES
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FIGURE 3-3

Data evaluation (in conjunction with EPA) will be used to determine which of the activities described in Phases II and III will be implemented. Only a limited number of properties are expected to require investigations beyond the Phase I level. Phase II activities may include one or more of the following: surface alpha measurements, additional radon measurements, building materials sampling, and borehole gamma logging and soil sampling.

Total surface alpha measurements will be taken indoors at selected locations including original or unpainted surfaces, dusty ledges and shelves, areas which may have been used to contain contaminated material, such as sinks, and areas exhibiting elevated exposure rates. Wipe samples will also be taken to determine the removable alpha contamination.

If contaminated material is found within a structure, radon monitoring may be necessary in non-ground level areas. Also, long-term radon detectors may be deployed. Sub-foundation radon measurements may be necessary to characterize contaminated material beneath a structure.

Materials from floors, walls, or ceilings in areas with elevated exposure rates will be collected and analyzed via gamma spectrometry. These data will be useful in the evaluation of demolition or decontamination alternatives during the FS.

The vertical extent of contamination may be delineated by drilling shallow boreholes, measuring exposure rates at depth, and analyzing the radionuclide content of subsurface soils. An estimated five boreholes will be needed per property, ranging from five to 20 feet in depth.

Phase III investigation activities will be performed on particular properties as needed. These activities will be dependent on the results from Phases I and II.

4.0 FIELD INVESTIGATIONS PROTOCOLS

Protocols for each RI activity are presented in the following sections. The protocols are summarized on Table 4-1.

4.1 AERIAL LAND SURVEY

Objective: To produce planimetric maps of the area surrounding the High and Alden Streets Properties and Vicinity Properties and to establish a rectangular grid system on the High and Alden Streets Properties which will enable location of gamma radiation measurements, boreholes and sampling points to be reproduced on-site. These protocols will generally be followed if grids are required on the Satellite Properties and Vicinity Properties. The survey will also establish the vertical and horizontal controls for boring and monitoring locations.

Preparatory Activities

- Select qualified subcontractor for base mapping.
- Select qualified subcontractor for land surveying

Health and Safety Guidelines

Personnel will wear protective equipment as described in the HASP and will carry ARCS identification.

Field Equipment and Supplies

The equipment needed to conduct this field activity will be typical of land surveying operations.

TABLE 4-1
STUDY AREA PROTOCOL REQUIREMENTS

Protocol	High and Alden Street Site			Satellite and Vicinity Properties		
	Phase I	Phase II	Phase III	Phase I	Phase II	Phase III
Land Survey	Y	N	N	Y	N	N
Utility Survey	Y	N	N	N	N	N
Time Integrated Radon Sampling	Y	N	Y	Y	D	D
Indoor Gamma Scan	Y	N	N	Y	N	N
Indoor Gamma Survey	Y	N	N	Y	N	N
Outdoor Gamma Scan	Y	N	N	Y	N	N
Outdoor Gamma Survey	Y	N	N	Y	N	N
Surface Alpha Measurements (Total)	Y	N	N	N	Y	D
Surface Alpha Measurements (Removable)	N	Y	N	N	Y	D
Surface Water And Sediment Investigations	Y	Y	N	N	N	N
Sewer Investigations	N	Y	N	N	N	N
Radon Grab Sampling	N	N	N	N	D	D
Building Materials Sampling	N	Y	N	N	D	D
Monitoring Well Installation	N	N	Y	N	N	N
Monitoring Well Development	N	N	Y	N	N	N
Monitoring Well Cuttings Management	N	N	Y	N	N	N
Drawdown Tests On Monitoring Wells	N	N	Y	N	N	N
Field Permeability Tests	N	N	Y	N	N	N
Monitoring Well Sampling	N	N	Y	N	N	N
Surface Soil Investigation	Y	N	N	N	D	D
Borehole Installation And Subsurface Soil Investigation	Y	Y	N	N	D	D
Downhole Gamma Logging	Y	Y	N	N	D	D
Air Particulates Monitoring	Y	Y	Y	N	N	N

Notes: Y = Yes
N = No
D = Dependent on data collected during previous phases.

Approach - Mapping

A New Jersey licensed aerial surveyor will be contacted to produce a planimetric map of the High and Alden Streets Properties. The rectangular maps produced will be used for plotting data generated during the RI.

Procedures - Mapping

1. Planimetric mapping will be produced at a scale of one inch equals 50 feet using computerized stereo-plotting equipment.

2. Maps will show visually identifiable permanent site features and will be ground checked.

3. Property lines will be drafted on maps using data from most recent tax maps for the City of Orange.

4. Area along Wigwam Brook will be produced on a scale of one inch equals 100 feet using computerized stereo-plotting equipment. The length of the brook will be mapped from the boundary of the Vicinity Properties into Watsessing Park.

5. New Jersey licenses surveyor will establish reference points for a rectangular grid coordinate system within the streets fronting the High and Alden Streets Properties.

Approach - Grid Lines

On an as needed basis; a licensed surveyor will be contracted to establish grids within the study area.

Procedures - Grid Lines

1. Grid-lines shall intersect at 90° angles.

2. Grid system will be surveyed and four points on a grid will be keyed to the nearest U.S. Geological Survey monument.

3. Reference each grid point to three fixed points so that they may be reestablished should they be destroyed.

4. Compute New Jersey Plane coordinates for each grid point established and determine the elevation (National Geodetic Vertical Datum) of a sufficient number of grid points for planimetric mapping purposes.

5. Establish a 10 x 10 foot grid for surface radiological measurements and a 75 x 75 foot grid for borehole installation over entire outdoor portion of High and Alden Streets Properties.

4.2 UTILITY SURVEY

Objective: To determine the presence and locations of underground storage tanks, utilities, pipelines and building foundations on High and Alden Streets Properties in order to aid in the selection of borehole and subsurface sampling locations and to protect field personnel and equipment during drilling activities.

Preparatory Activities

- Obtain permission for property access.
- Review available site plans from the U.S. Radium Corporation files, aerial photographs, utility maps from the municipal office and maps of underground structures in use by prior and current occupants. Prior to the initiation of utility surveys, a grid system with 10-foot spacing will be established by Malcolm Pirnie personnel and referenced to the grid system established for the land survey by a New Jersey licensed surveyor. This grid system will also be utilized during the radiological surveys.
- Contract local utilities to mark out known underground utility lines.
- (Optional) Select utilities surveyor subcontractor.

Health and Safety Guidelines

Personnel will wear protective equipment as described in the HASP and will carry ARCS identification.

Approach

Site plans, photographs and utility maps will be reviewed and the utility "hotline" consulted to determine the location of underground structures and utilities which may affect RI activities. If necessary, a utility survey may be conducted using electromagnetic conductivity, GPR, or other appropriate equipment.

4.3 TIME INTEGRATED RADON SAMPLING

Objective: To measure the concentrations of radon in the air and to determine where additional sampling will be necessary during the RI.

Sample Type, Method and Code

- Sample type: air
- Sample method: continuous
- Sample code: CC

Health and Safety Guidelines

Personnel will wear protective equipment as described in the HASP and will carry ARCS identification.

Field Equipment and Supplies

The following equipment or its equivalent will be needed to conduct this field activity:

- Electret ion chambers (EIC) and readout instrumentation.
- Nuclear track etch detectors.

High and Alden Streets Properties

Two EICs will be placed in each structure on the High and Alden Streets Properties for two days and analyzed with an Electret-Passive Environmental Radon Monitor (E-PERM) system to determine radon concentrations in air. These samples will be taken prior to any other indoor RI activities. The data will provide essential health and safety information as well as indicate areas where long-term data are needed.

Procedures

1. Select sampling locations in accordance with EPA's sampling protocol (EPA 520/1-86-04) using the following guidelines and rationale:

   - Locations should be selected in rooms which are least influenced by doors, windows or ventilation or heating ducts.

   - Samples will be collected at either the ground level or in the basement.

2. Place EICs at a minimum of two different locations in each building for two days. Place a duplicate EIC at five percent of the sampling locations. Place a blank EIC at five percent of the sampling locations.

3. Determine the Rn-222 concentration in the field with the E-PERM instrumentation.

4. If the radon concentration in the air is greater than 4.0 pCi/l, then a long-term EIC will be deployed in the particular structure. If the concentration is greater than 30 pCi/L, workers will be required to wear respirators as specified in the HASP.

Satellite and Vicinity Properties

Preparatory Activities

- Obtain permission for property access.
- Instruct residents that structure must remain closed for 12 hours before scheduled test.

Nuclear track etch detectors (i.e., alpha track detectors) will be deployed in the lowest habitable floor of each property. The detectors will be retrieved after a three month period. An additional 12 months detector will be deployed at any property when the sampling period commences between February 1 and October 1. Analysis will be done by a laboratory that is a successful participant in EPA's

Radon Measurement Proficiency Program (RMPP). Blanks and duplicates will be placed at five percent of the sampling locations.

During later phases of the RI, radon sniffing with a continuous flow radon monitor may be conducted to locate isolated deposits of contaminated subsurface soil.

The frequency of radon measurements is summarized on Table 4-2.

TABLE 4-2

RADON MEASUREMENT FREQUENCY

HIGH AND ALDEN STREETS PROPETIES

	PHASE I				PHASE II AND III			
ANALYSIS	NO. OF SAMPLES	DUPLICATES	BLANKS	TOTAL	NO. OF SAMPLES	DUPLICATES	BLANKS	TOTAL
ELECTRET ION CHAMBERS	20	1	1	22	D	D	D	D

SATELLITE AND VICINITIES PROPERTIES

	PHASE I				PHASE II AND III (1)			
ANALYSIS	NO. OF SAMPLES	DUPLICATES	BLANKS	TOTAL	NO. OF SAMPLES	DUPLICATES	BLANKS	TOTAL
ALPHA TRACK ETCH DETECTORS	320	16	16	352	D	D	D	D

NOTES: D = NUMBER OF SAMPLES COLLECTED IS DEPENDENT ON THE RESULTS OF THE PHASE I INVESTIGATIONS.

4.4 GAMMA SCAN AND SURVEY

Objective: To characterize the level of gamma radiation and the spatial distribution with respect to a reproducible grid system (in some cases). Note: the term "scan" is used here to mean a walk-through by a competent technician using a radiation detection instrument at waist level in order to quickly locate radiation sources. The term "survey" is used here to mean a series of near surface readings taken on a defined, reproducible grid.

Preparatory Activities

- Obtain permission for property access. Person entering property must have a signed copy of site access agreement and will carry ARCS identification.

Health and Safety Guidelines

Personnel will wear protective equipment as described in the HASP and will carry ARCS identification.

Field Equipment and Supplies

The following equipment or its equivalent will be needed to conduct this field activity:

- Ludlum Model 12S micro-R meter or equivalent
- Ludlum Model 44-2 1" x 1" sodium iodide detector or equivalent
- Ludlum Model 12 portable scaler or equivalent
- Gamma check source
- Eberline Pic 6-A Pressurized Ion Chamber (POC) or equivalent
- Field logbook
- Measuring tapes

Approach

High and Alden Street Properties: A gamma scan will be done on each floor of the buildings. If exposure rates in excess of twice background are measured, a five foot gridded survey will follow. Areas with elevated exposure rates will be marked as locations for surface alpha measurements. An outdoor gamma survey will be done over the entire site using a 10 foot grid. Isopleth maps will be developed for the entire site from the survey data. Five percent of survey measurements will be reproduced with a PIC, providing an alternate method of comparison and an in-field calibration check of the gamma scintillometers.

Satellite and Vicinity Properties: An indoor gamma scan will be performed on each floor of each structure. A five foot gridded gamma survey will then be performed over any floor of the structure which has been found to have exposure rates which exceed background by a factor of two. Outdoor property will be initially scanned, followed by a survey utilizing a 10 foot grid. Cross calibration of gamma scintillation detectors to PICs will be included in the surveys.

Procedures - Preliminary

1. In a non-contamination area, switch the scintillometer on and check the battery for adequate power. Switch to the highest scale, and perform an operational check of the instrument using the gamma check source. Switching to lower scales, as necessary. Document the source check (Figure 4-1).

Procedures - Indoor Gamma Scan and Survey

1. Perform a preliminary three-foot high exposure scan with a micro-R meter or scintillometer to identify areas of elevated exposure rate. Record readings and range on Figure 4-2 (or equivalent data sheet).

2. If the scan indicates exposure rates which exceed twice the background, proceed with the following. Layout a five-foot indoor grid

134649

METER : _____ | DETECTOR: _____

SERIAL NUMBER : _____ | SERIAL NUMBER: _____

DATE	TIME	HV SET	SOURCE			BACKGROUND	SOURCE	OK	INITIALS
			TYPE	SERIAL NO.	ACTIVITY	COUNTS/MINUTE	COUNTS/MINUTE		

USR 001 1450

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DAILY CHECK SOURCE FORM

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FIGURE 4-1

SITE: _____ DATE: _____

LOCATION _____ TIME: _____

INVESTIGATOR: _____

COORDINATES		RANGE	REMARKS
X	Y		

COORDINATES		RANGE	COMMENTS
X	Y		

EQUIPMENT	MODEL #	SERIAL #
SCALER		
PROBE		

BACKGROUND	

CONVERSION FACTOR

COMMENTS: _____

_____ \ \

SIGNATURE DATE

USR 001 1451

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WALKOVER GAMMA SCAN DATA SHEET

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FIGURE 4-2

and reference to permanent features within structure. Also grid walls to a height reachable by the field crew.

3. Measure indoor exposure by near surface contact at the floor surface at each grid intersection within building boundaries and along perimeter of floor. Also survey walls to a height reachable by the field team members. Record readings on Figure 4-3.

4. In areas of elevated gamma radiation, make additional scintillometer readings between grid points to define the extent of radiological contamination. Monitor the meter output on a continuous basis to identify peak readings, and record these readings.

5. Record locations and levels where elevated readings were found on an interior map.

6. Plot the gridded measurements on a scaled map of the floor with lines of equal exposure between grid measurements drawn by interpolation.

7. Note structural features such as floor materials (concrete, wood, dirt), brick slate, or Belgium block structures which may influence readings.

Procedures for Outdoor Gamma Scan and Survey

1. Perform procedures as stated above over a 10-foot outdoor grid when the gamma scan indicates exposure rates at Satellite and Vicinity Properties which exceed background by a factor of two. The entire outdoor portion of the High and Alden Streets Properties will be surveyed.

2. Plot the isopleths on a site plan and note structural features such as sidewalks, driveways, courtyards, etc., which may influence readings.

NEAR SURFACE EXPOSURE RATE RADIATION SURVEY

SITE: ______________________ DATE: __________

LOCATION ______________________ TIME: __________

INVESTIGATOR: ______________________

COORDINATES		uR/h	COORDINATES		uR/h	COORDINATES		uR/h	COORDINATES		uR/h
X	Y		X	Y		X	Y		X	Y	

EQUIPMENT	MODEL #	SERIAL #
SCALER		
DETECTOR		
PIC		

COUNT TIME	
BACKGROUND	
CPM	

CONVERSION FACTOR	
CPM	uR/h

COMMENTS: ____

____

____

SIGNATURE ______________________ DATE \ \

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NEAR SURFACE EXPOSURE RATE RADIATION SURVEY

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FIGURE 4-3

4.5 SURFACE ALPHA MEASUREMENTS

Objective: To determine levels of total and removable alpha particle contamination on walls, floors, beams and other surfaces.

Health and Safety Guidelines

Personnel will wear protective equipment as described in the HASP and will carry ARCS identification.

Field Equipment and Supplies

The following equipment or its equivalent will be needed to conduct this field activity:

- Ludlum Model 43-5 alpha scintillation probe, or equivalent.
- Ludlum Model 12S scaler or equivalent.
- Ludlum Model 43-10 sample counter, or equivalent.
- Ludlum Model 2221, portable scaler-ratemeter, or equivalent.
- Smear sample papers (with 1 5/8 inch diameter) and envelopes.
- Am-241 or Th-230 alpha check source.

Approach

Surface alpha measurements survey will be performed to determine total and removable contamination within structures. Sampling locations will include a variety of areas where contaminants may have accumulated.

At the High and Alden Streets Properties, total alpha measurements will be taken as part of the Phase I activities. Removable alpha measurements will be taken during Phase II at locations with greater than 100 dpm/100 cm^2 and at

25 percent of locations with total alpha levels ranging from 20 dpm-100 dpm/ 100 cm^2.

At the Satellite and Vicinity Properties, total and removable measurements are options under Phases II and III. Decisions to perform these samples will be made based on Phase I data.

Total Surface Alpha Measurements Procedures

Use the surface alpha contamination data form and the following procedure to record contamination data:

1. List surveyor's name, date of survey, and identification number of the monitoring instrument and detector.

2. Switch the scaler on, check the batteries for adequate power, and perform a daily field check of the alpha scintillation detector. Record the instrument efficiency in the appropriate column under the Total Alpha Survey Results section on Form (Figure 4-4). Surface alpha sampling locations will be selected from those areas of the building interior showing the following characteristics:

   - Original or unpainted surfaces, or areas with chipped or peeling paint.

   - Locations apt to accumulate dust, such as window and door ledges, shelves, surface irregularities, cracks or corners.

   - Areas when handling or spillage or radioactive materials may have occurred, such as counters, original furniture, shelving or cabinets.

   - Rooms or other areas suspected of having been used for storage of radium compounds or radium contaminated equipment.

   - Areas exhibiting elevated gamma exposure rates.

3. Monitor potentially contaminated surfaces by passing the probe face along each surface at a rate of five cm per second or less. The probe face should not be more than about two cm away from the

DATE: _____
SURVEYORS NAME: _____
SCALER MODEL: _____
SERIAL NUMBER: _____
PROBE MODEL: _____
SERIAL NUMBER: _____

PROPERTY/AREA: _____
SURVEY NO.: _____
CALIBRATION DATE: _____
EFFICIENCY: _____ %
BACKGROUND: _____ cpm
MDA: _____ dpm/100 sq cm

LOCATION	TOTAL ALPHA	
	NET COUNTS/MINUTE	DPM/100 sq cm.

NOTE: DPM = DISINTEGRATIONS PER MINUTE

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TOTAL SURFACE ALPHA CONTAMINATION DATA FORM

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FIGURE 4-4

14884

surface. The probe should be held steady at any area which appears to indicate an elevated reading. Record the highest one-minute reading for each location.

4. Calculate the Minimum Detectable Activity (MDA) according to the equations in Section 3.3 of the Quality Assurance Project Plan (QAPjP).

Removable Surface Alpha Measurements Procedure

1. Rub a dry filter paper across an area of approximately 100 cm^2. Record the date, location of the sample, and the name of the person collecting the sample on the filter paper cover sheet.

2. Remove the sample to the analysis area.

3. Perform a daily calibration of the alpha sample counter.

4. Place the sample in a planchete, and place in an alpha sample counter. Count the sample for one minute. Record the results on the Removable Surface Alpha Contamination Data Form (Figure 4-5).

5. After a minimum four-hour delay period, (which allows for complete decay of radon decay products), count the sample again and calculate the level of removable contamination. Record this value as the actual level of contamination present.

6. Calculate the MDA according to the equations in Section 3.3 of the QAPjP.

DATE: _____
SURVEYORS NAME: _____
SCALER MODEL: _____
SERIAL NUMBER: _____
PROBE MODEL: _____
SERIAL NUMBER: _____

PROPERTY/AREA: _____
SURVEY NO.: _____
CALIBRATION DATE: _____
EFFICIENCY: _____ %
BACKGROUND: _____ cpm
MDA: _____ dpm/100 sq cm

LOCATION	WIPE NUMBER	REMOVABLE ALPHA	
		NET COUNTS/MINUTE	DPM/100 sq cm

NOTE: DPM = DISINTEGRATIONS PER MINUTE

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ORANGE, NEW JERSEY

REMOVABLE SURFACE ALPHA CONTAMINATION DATA FORM

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FIGURE 4-5

USR 001 1458

140884

4.6 SURFACE WATER AND SEDIMENT INVESTIGATION

Objective: To characterize the nature and extent of radiological contamination in the surface water and sediment of Wigwam Brook and areas of site runoff.

Sample Type, Method and Code

- Sample type: surface water - sediments
- Sample method: grab - grab
- Sample code: SW - SD

Preparatory Activities

- Prepare necessary equipment and sample containers prior to sampling as described in Section 3.2. Notify the Department of Public Works engineer one day prior to sampling.
- Schedule CLP analysis under SAS program or prepare an IFB and select radiological laboratory subcontractor.

Health and Safety Guidelines

Personnel will wear protective equipment as described in the HASP and will carry ARCS identification.

Field Equipment and Supplies

The following equipment or its equivalent will be needed to conduct this field activity:

Water Sampling Equipment

- Field notebook
- Paper towels
- Two indelible ink markers

- Analyte free water
- YSI model 33 conductivity meter
- Model 57 dissolved oxygen meter including probe, detachable cables, and membrane mounting kit
- Accument 150 portable pH meter
- pH paper
- Thermometer
- Ice chests
- Vermiculite
- Yardstick
- Tape measure
- Sample bottles or jars with teflon lined phenolic caps
- 10-foot telescoping stainless steel rod (optional)
- Four stainless steel hose clamps (optional)
- Trip blanks and deionized water for field blanks
- Chain-of-custody documents
- Plastic buckets
- Nitric acid
- Sodium hydroxide

Sediment Sampling Equipment

- Field notebook
- Paper towels
- Two waterproof pens
- 10-foot telescoping stainless steel rod (optional)
- Four stainless steel hose clamps (optional)
- Sample jars with teflon lined phenolic caps
- 500 mL nalgene sample jars
- Dedicated sampling trowels

- Chain-of-custody documents
- Camera
- Buckets
- Ice chests
- Vermiculite

Approach

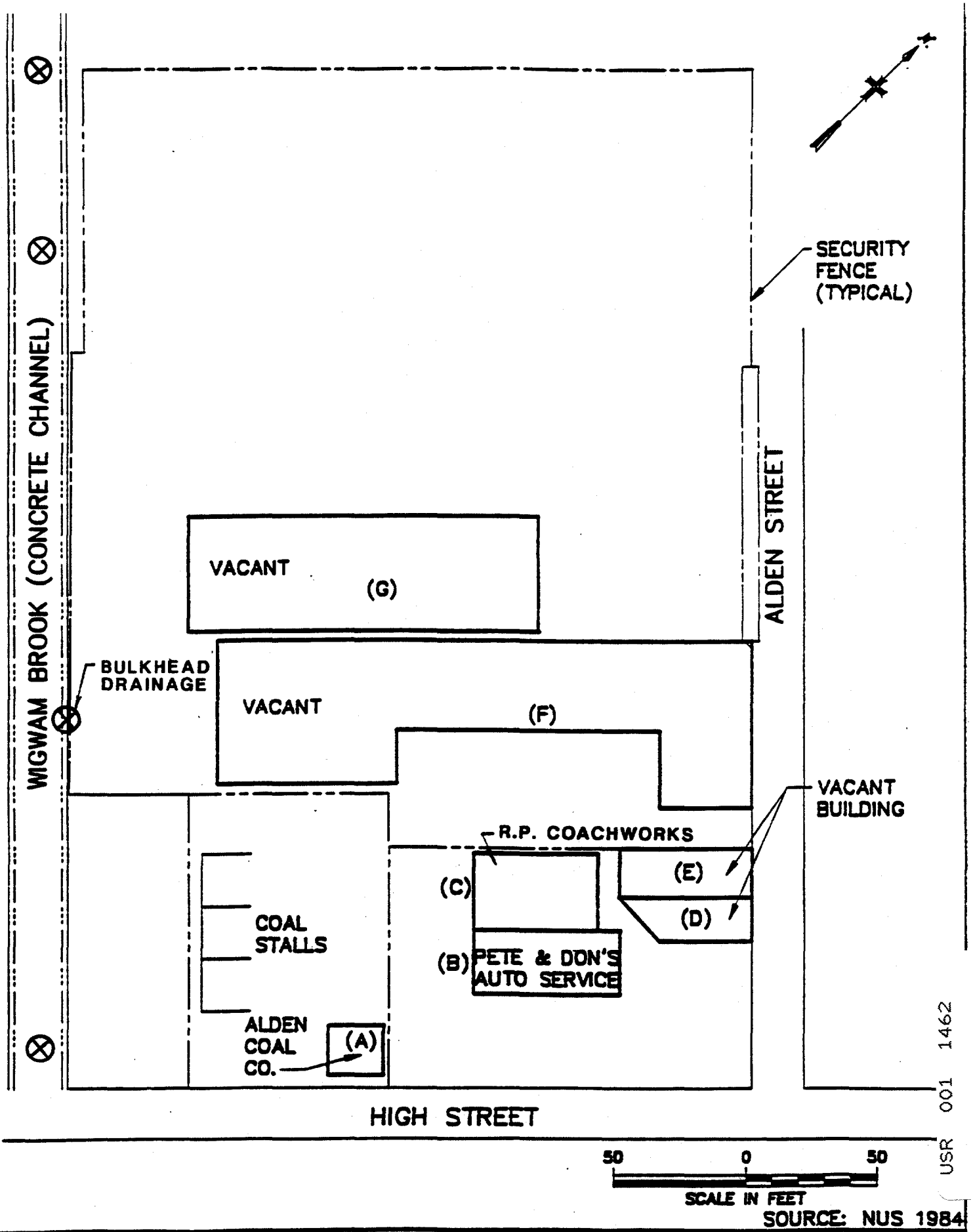
Water and sediment samples will be collected at locations to be determined in Wigwam Brook at the High and Alden Streets Properties to determine if radionuclides and/or vanadium are migrating via surface water. Samples will be analyzed for Ra-226 and Th-232 on site. Off-site analysis at a subcontract laboratory will include Th-230 and U-238 in addition to Ra-226 and Th-232. Up to four sediment and water samples may be collected during the Phase I investigation. In addition, background samples (water and sediment) will be taken upstream of the U.S. Radium Site. If necessary, up to five samples during the Phase II investigation may be collected to further define contaminated areas (Table 4-3).

Procedure Surface Water

1. Surface water and storm water runoff samples will be taken at up to four stations during the Phase I investigation and up to five stations during the Phase II investigation. Potential sampling locations are shown in Figure 4-6. Samples will be tested for the radionuclides on Table 4-3.

2. Approach sampling station in Wigwam Brook from downstream in order to minimize bottom disturbance.

3. If possible take samples in a low-energy area (i.e., little or no water movement).



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U.S. RADIUM SITE
ORANGE, NEW JERSEY
HIGH AND ALDEN STREET PROPERTIES
WIGWAM BROOK SEDIMENT
AND WATER SAMPLING LOCATIONS

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FIGURE 4-6

TABLE 4-3
SURFACE WATER AND SEDIMENT SAMPLES

WIGWAM BROOK AREA SEDIMENT SAMPLES

	PHASE I						PHASE II					
ANALYSES	NO. OF SAMPLES	DUPLICATES	SPLITS	TRIP BLANK	FIELD BLANK	TOTAL	SAMPLES	DUPLICATES	SPLITS	TRIP BLANK	FIELD BLANK	TOTAL
IN-FIELD GAMMA SPECTROMETRY Ra-226, Th-232	4	0	0	0	0	4+	4	0	0	0	0	4
OFF-SITE LABORATORY ANALYSIS U-238, Ra-226, Th-230, 232;	1	0	0	0	0	1+	1	0	0	0	0	1
VANADIUM	5	1	0	0	1	7	5	1	0	0	0	6

WIGWAM BROOK WATERS

	PHASE I						PHASE II					
ANALYSES	NO. OF SAMPLES	DUPLICATES	SPLITS	TRIP BLANK	FIELD BLANK	TOTAL	SAMPLES	DUPLICATES	SPLITS	TRIP BLANK	FIELD BLANK	TOTAL
IN-FIELD GAMMA SPECTROMETRY Ra-226, Th-232	4	1	0	0	0	5+	4	0	0	0	0	4
OFF-SITE LABORATORY ANALYSIS U-238, Ra-226, Th-230, 232;	1	0	0	0	0	1+	1	0	0	0	0	1
VANADIUM	5	1	0	0	1	7	5	1	0	0	1	7

NOTE : (+) ONE BACKGROUND SAMPLE WILL ALSO BE COLLECTED UPSTREAM OF THE SITE.

4. Immerse an uncapped sample bottle in the water and fill until the bottle begins to taper inward. Remove from the water and cap tightly.

5. Perform a gamma scan adjacent to each sampling location. Extend the scan no more than 10 feet from the sampling location, unless elevated radiation levels are detected.

6. Indicate the sampling location on a site map for future reference. Use landmarks or natural features as reference points.

7. Rinse all monitoring equipment with deionized water after each use and screen for residual radioactivity.

8. Record the following information in the field logbook:

   - Field team members, level of protection worn by each and task performed by each
   - Sample location, identification number, date, and time
   - Water temperature
   - pH (Do not immerse electrodes in samples to be sent to the laboratory; either obtain duplicate sample or measure on-site).
   - Specific conductance
   - Dissolved oxygen
   - Depth and width of stream
   - Visual description of flow rate, velocity, ad other stream characteristics (fast running verses stagnant)
   - Weather conditions
   - Observable physical characteristics (odor, color, turbidity, multiphase layering, precipitates)

9. Prepare a label for each sampling indicating the location number or identification number, sample number, depth of collection, date/time. and analysis to be conducted. Prepare a chain-of-custody control form and traffic report.

10. Package chemical sample bottles in coolers, add ice and vermiculite, and seal for shipment. Samples collected for chemical analysis will be sent to the appropriate laboratory within 24 hours.

11. If necessary, collect additional water samples during the Phase II investigations.

Procedures - Sediment Sampling

1. Take sediment samples from the same locations as the surface water and runoff samples during Phase I and Phase II field investigations. Samples will be tested for the radiolonuclides indicated on Table 4-3.

2. Always obtain surface water samples prior to sediment samples.

3. At each location, record appropriate data in field logbook (refer to Water Sampling Section, Number 8). If necessary, lower an uncapped sample bottle attached to the end of a telescoping stainless steel rod, auger, dredge or other appropriate sampling device through the water column until contact is made with the bottom. (Nalgene sample jars are used for radionuclide samples.)

4. Slowly slide the opening of the bottle across the sediments below the runoff area or fill bottle utilizing appropriate sampling device (i.e., trowels, auger). Repeat until the bottle is at least two-thirds full. The sample should represent the upper one or two inches of sediment.

5. Avoid collection of plant material and material greater than one cm in size. Care should be exercised to avoid losing the fine material which tend to disperse when disturbed.

6. Upon retrieving the sediment sample, do not remove water on top of the final sample. Secure cap tightly onto each jar.

7. Indicate the sampling location on a site map for future reference. Use landmarks or natural features as reference points.

8. Screen each piece of equipment for residual radiological contamination and decontaminate if necessary.

9. Record time, location, date, depth and physical description of soil sample.

10. Record field team members, level of protection worn by each and task performed by each.

4.7 SEWER INVESTIGATION

Objective: To characterize radiological conditions in sewers near the High and Alden Streets Properties.

Sample Type, Method and Code

- Sample type: soil logging
- Sample method: continuous
- Sample code: SG

Preparatory Activities

- Locate existing manholes by reviewing existing site plans and visually inspecting site grounds.
- Notify municipal authorities of planned sampling activities.

Health and Safety Guidelines

Personnel will wear protective equipment as described in the HASP and will carry ARCS identification.

Field Equipment and Supplies

The following equipment or its equivalent will be needed to conduct this field activity:

- Ludlum model 12S micro-R meter or equivalent
- Ludlum model 44-2 1" x 1" sodium iodide detector equivalent
- Field logbook
- Gamma check source
- Organic vapor analyzer Model GC 128 or equivalent
- 500 mL nalgene sample jars

- Sample jars with teflon lined phenolic caps
- Emergency flashes
- Traffic cones
- Crow bars

Approach

The exposure rate in manholes on and along the city sewer line immediately downstream of the High and Alden Streets Properties will be measured. If levels are detected above background, samples may be collected and analyzed for Ra-226 via gamma spectrometry. Sewers will be scanned and sampled during periods of low flow.

Procedures - Preliminary

1. Switch the scintillometer on before entering the site and check the battery for adequate power. Use the highest scale to perform an operational check of the instrument with the gamma check source and switch to lower scales as necessary. Calibration will be performed in accordance with the QAPjP.

2. Switch on and calibrate the organic vapor analyzer in accordance with the QAPjP.

Procedures - Gamma Scan

1. Remove manhole cover or catch basin grate and check for organic vapors.

2. Lower a gamma scintillometer down the manhole to the water level. Caution: be sure the scintillometer probe does not enter the water.

3. Record the gamma exposure rate immediately above the bottom of the manhole at each location in the field logbook.

Procedures - Sewer Sediment Sampling

1. Collect sediment samples from manholes which have been identified as having elevated exposure. Up to five samples will be collected in nalgene sample jars and analyzed for Ra-226 in the field using gamma spectrometry. The radionuclide content of one of the samples will be measured by the subcontract laboratory as shown on Table 4-4. An additional five samples will be collected in sample jars with teflon lined caps and sent to a laboratory for vanadium analyses.

2. Collect samples using a dredge, auger, or other appropriate sampling device. Place the sediment in a sample jar and label according to quality assurance guidelines.

3. Record the date, time, sample number, depth, sample characteristics and sample location in the field logbook.

TABLE 4-4
SEWER SEDIMENT SAMPLE SPECIFICATIONS

ANALYSES	NUMBER OF SAMPLES	DUPLICATES	SPLITS	TRIP BLANKS	FIELD BLANKS	TOTAL
IN-FIELD GAMMA SEPCTROMETRY Ra-226, Th-232	4	0	1	0	0	5
OFF-SITE LABORATORY ANALYSIS U-238 Th-230, 232 Ra-226	1	0	0	0	0	1
VANADIUM	5	1	0	0	1	7

4.8 REAL-TIME RADON SAMPLING

Objective: If necessary, determine the instantaneous concentration of atmospheric radon gas inside structures and underneath the basement floors of structures.

Preparatory Activities

- Instruct residents that the structure must remain closed for 12 hours before scheduled test, if applicable.

Health and Safety Guidelines

Personnel will wear protective equipment as described in the HASP and carry ARCS identification.

Field Equipment and Supplies

The following equipment or its equivalent will be needed to conduct this field activity:

- Pylon Model AB-5 portable radiation monitor, or equivalent, C/W battery, and battery charger
- Model LCA -2 lucas cell adaptor
- Model 300 scintillation cells
- Model 3150 radon calibration standard
- Model PPT-1 portable printer
- Accessory kit P/N 205410
- VFA-22BV flow meter
- Hammer drill with 1/2" carbide bit
- Hand operated vacuum pump
- Concrete (if necessary for repair of basement floors)

Approach

If necessary, air samples will be collected within buildings and underneath basement floors at Satellite and Vicinity Properties to determine instantaneous radon gas concentrations. Sampling will only be performed if further characterization of a property is necessary.

Procedures - Grab Sample Radon Monitoring

1) If applicable, drill a 1/2 inch diameter hole in the basement floor to allow for the insertion of a soil gas probe.

2) Using the hand operated vacuum pump, draw a filtered sample of air through the scintillation cell.

3) If a Lucas cell is used, attach to the scintillation cell utilizing a Lucas cell adapter.

4) Record the radon gas decay in counts per minute (cpm).

5) Calculate radon concentration as follows:

$$\text{Radon (pCi/L)} = \frac{\text{cpm}}{2.22 \times \text{Eff} \times V}$$

Where V = volume of the cell
Eff = detection efficiency

6) Repair hole in basement floor with concrete.

4.9 BUILDING MATERIALS SAMPLING

Objective: To identify and determine the concentration of radioactive contaminants in building materials.

Sample Type, Method and Code

- Sample type: Building material samples
- Sample method: grab
- Sample code: BM

Health and Safety Guidelines

Personnel will wear protective equipment as described in the HASP and will carry ARCS identification.

Field Equipment and Supplies

The following equipment or its equivalent, at the minimum, will be needed to conduct this field activity:

- Decontamination equipment
- Concrete saw
- Sample bags and labels
- Coolers
- Vermiculite
- Sample bottles, bags

Approach

If building materials are suspected of containing radioactive materials following the gamma scan and/or survey, samples of the materials may be collected and analyzed for radionuclides.

Procedures

1. Obtain building material samples using a concrete saw, chisel, or other appropriate sampling device. If necessary, cut the hole large enough to accommodate the auger bits for subsequent drilling.

2. Homogenize samples of uniform site size using a pulverize and homogenize multiple pulverized samples from each location before placing in sample containers.

3. In cases where flooring or foundations are encountered beneath existing floor grades, collect an additional sample.

4. Remove samples, package, and send to the radiological laboratory for analyses (Table 4-5).

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TABLE 4-5
BUILDING MATERIALS SAMPLES

HIGH AND ALDEN STREETS PROPERTIES

	LABORATORY SAMPLES		
ANALYSIS	NO. OF SAMPLES	DUPLICATES	TOTAL
BUILDING MATERIALS	30 *	0	30

SATELLITE PROPERTIES

	LABORATORY SAMPLES		
ANALYSIS	NO. OF SAMPLES	DUPLICATES	TOTAL
BUILDING MATERIALS	5 *	0	5

VICINITY PROPERTIES

	LABORATORY SAMPLES		
ANALYSIS	NO. OF SAMPLES	DUPLICATES	TOTAL
BUILDING MATERIALS	10 *	0	10

NOTES: * Estimated sample numbers.

4.10 MONITORING WELL INSTALLATION

Objective: The purpose of the wells is to evaluate the groundwater for the potential for chemical and radiological contamination, the direction of groundwater movement, and the vertical hydraulic gradient. A single overburden well will be installed at three locations. These wells will be screened for radioactivity and TCL/TAL parameters. A fourth well will be added as part of a cluster with one of the original three. This well will provide a monitoring point below that provided by the three water table wells. Potential monitoring well locations are shown in Figure 4-7.

Data from the groundwater samples taken from these wells will determine the need for additional wells and groundwater investigation. If necessary, it is assumed that a minimum of two additional monitoring well clusters would be installed.

Preparatory Activities

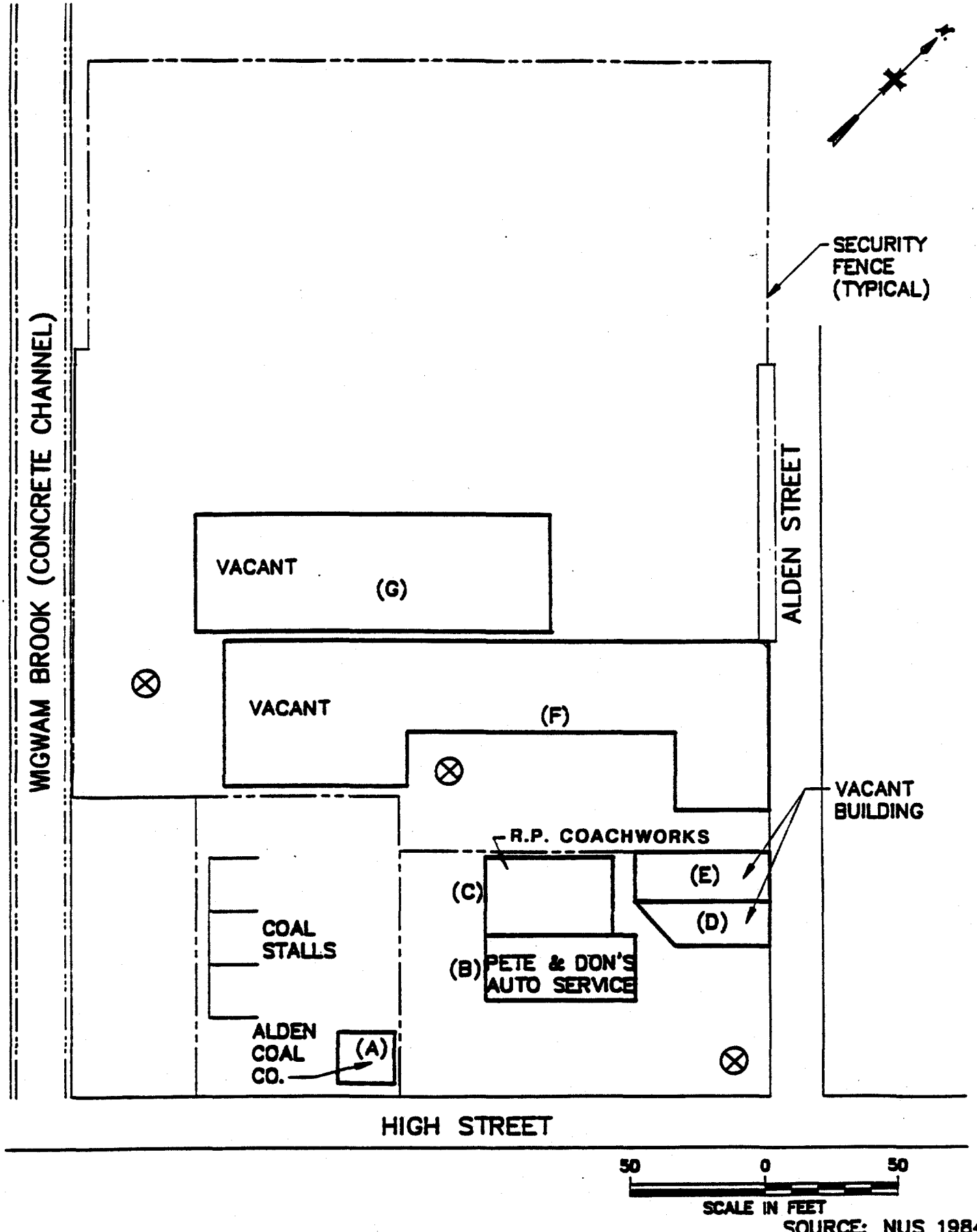
- Prepare IFB, procure well drilling subcontractor.
- Obtain permission for property access, if necessary.
- Locate and mark well locations.
- The well drilling subcontractor shall be responsible for obtaining necessary permits.

Health and Safety Guidelines

Personnel will wear protective equipment as described in the HASP and will carry ARCS identification.

Field Equipment and Supplies

The following equipment or its equivalent will be needed to conduct this field activity:



SOURCE: NUS 1984

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U.S. RADIUM SITE
ORANGE, NEW JERSEY
HIGH AND ALDEN STREET PROPERTIES
POTENTIAL MONITORING WELL LOCATIONS

MALCOLM PIRNIE, INC.

FIGURE 4-6

- Ludlum Model 12S micro-R meter or equivalent
- Pancake Geiger-Mueller detector
- Organic vapor analyzer Model GC 128 or equivalent
- Field logbooks
- Munsell soil and rock color charts
- Two indelible ink markers
- Portable field table
- Polyethylene plastic sheet
- 250-foot steel tape (engineers scale)
- Stainless steel knife
- Personnel decontamination equipment and expendables
- Camera
- Temperature bath/thermometer/water

Drilling equipment, tools, sampling supplies, and decontamination equipment will be supplied by the drilling subcontractor. Typically, this equipment will include:

- Truck-mounted hollow stem auger drilling rig or mud rotary and rock coring drilling rig
- Four-inch diameter stainless steel threaded pipe or black steel threaded pipe, with threaded cap
- Four-inch diameter stainless steel screen. Slot diameters will be determined following of visual observation of soil conditions.
- Four-inch diameter black steel casing with locking cap (if necessary)
- No. 1 sand
- Bentonite pellets
- Bentonite-cement grout

- Six-inch diameter protective steel casing with locking cap
- Glass jars for archiving samples

Equipment will be steam cleaned prior to the installation of each monitoring well.

Prior to initiating any field activities, the field team will review and discuss the HASP. Monitoring and protective equipment should be checked thoroughly at this time. The Bentonite-cement grouting may contain naturally occurring radionuclides. Samples will be taken and analyzed for Ra-226 and Th-232 via gamma spectroscopy prior to installation of the wells.

Approach

During the Phase I investigation on the High and Alden Streets Properties, wells will be installed and groundwater will be screened for radioactivity and TCL/TAL compounds.

If necessary after the first round of sample data are evaluated, two on-site locations will be redeveloped as monitoring well cluster locations as part of Phase II. Additionally, as necessary, up to two off-site locations will be chosen for well clusters. One well in the cluster will be screened across the water table. If the saturated overburden is at least 15 feet thick at the cluster location, a second overburden well will be installed, from five to 10 feet below the water table well. If a sufficient thickness of saturated overburden is not available, a well will be installed in the upper 10 feet of the bedrock.

Procedures

1. Shallow monitoring well drilling and installation will generally be as follows:

Drill each overburden monitoring well using a truck-mounted hollow stem auger drill rig. Foundations may need to be broken and opened to provide access to the underlying soil. Complete each well with a four-inch inner diameter stainless steel screen, 0.010 inch slots, and four-inch inner diameter stainless steel threaded casing.

Where a cluster of two monitoring wells are to be installed, install the deeper well first. Collect continuous split-spoon samples from the ground surface to 15 feet, following the procedures described in Section 4-17. At the two locations where single wells are to be installed, collect continuous split-spoon samples to five feet below the water table. Manage the drill cuttings in the manner described in Section 4.12.

Open the split-spoon sample and lay out on a piece of plastic. Examine the core, and screen for organic vapors by passing the probe of an organic vapor analyzer over the length of the core. Screen for gamma radiation with a gamma scintillometer. Take at least one photograph, with a scale for comparison, of the core. Include a card showing the site name, sample identification number, date, and initials of the sampling team on the photograph. Label the glass jars with the job name, date, and boring and sampling identification number. One-half hour after the soil samples have been collected, measure the head space in the jar for organic vapors with the HNu.

Drill the shallow well in the one monitoring well cluster adjacent to the deeper well by augering down to five feet below the water table. Do not collect soil samples.

For each boring, assemble the well screen, base plate and casing and lower inside the hollow stem auger. In the shallow wells, the well screen will bridge the water table with five feet set below the water table and the remaining five feet set in the vadose zone. In the deep well, place the top of the five-foot screen between five and 10 feet below the bottom of the shallow well screen. Slowly raise the auger flytes and hydraulically tremie sand to two feet above the top of the screen. Place a two foot bentonite seal above the gravel pack. Fill the remaining annular space with a cement-bentonite slurry. Complete each well with a five-foot length of six-inch diameter black steel protective casing and locking cap. Cement the protective casing into place, with approximately three feet below grade and two

Drill each overburden monitoring well using a truck-mounted hollow stem auger drill rig. Foundations may need to be broken and opened to provide access to the underlying soil. Complete each well with a four-inch inner diameter stainless steel screen, 0.010 inch slots, and four-inch inner diameter stainless steel threaded casing.

Where a cluster of two monitoring wells are to be installed, install the deeper well first. Collect continuous split-spoon samples from the ground surface to 15 feet, following the procedures described in Section 4-17. At the two locations where single wells are to be installed, collect continuous split-spoon samples to five feet below the water table. Manage the drill cuttings in the manner described in Section 4.12.

Open the split-spoon sample and lay out on a piece of plastic. Examine the core, and screen for organic vapors by passing the probe of an organic vapor analyzer over the length of the core. Screen for gamma radiation with a gamma scintillometer. Take at least one photograph, with a scale for comparison, of the core. Include a card showing the site name, sample identification number, date, and initials of the sampling team on the photograph. Label the glass jars with the job name, date, and boring and sampling identification number. One-half hour after the soil samples have been collected, measure the head space in the jar for organic vapors with the HNu.

Drill the shallow well in the one monitoring well cluster adjacent to the deeper well by augering down to five feet below the water table. Do not collect soil samples.

For each boring, assemble the well screen, base plate and casing and lower inside the hollow stem auger. In the shallow wells, the well screen will bridge the water table with five feet set below the water table and the remaining five feet set in the vadose zone. In the deep well, place the top of the five-foot screen between five and 10 feet below the bottom of the shallow well screen. Slowly raise the auger flytes and hydraulically tremie sand to two feet above the top of the screen. Place a two foot bentonite seal above the gravel pack. Fill the remaining annular space with a cement-bentonite slurry. Complete each well with a five-foot length of six-inch diameter black steel protective casing and locking cap. Cement the protective casing into place, with approximately three feet below grade and two

feet above the surface. In some cases, a flush mount may be necessary. Construct a cement collar at the surface around the protective casing, which will slope away from the casing to prevent surface water from entering the well.

2. General Bedrock Monitoring Well Drilling and Installation.

Construct a bedrock monitoring well if the saturated thickness of unconsolidated material is less than 15 feet. Determine the thickness of the material when attempting to install a deep overburden well as described previously. Since samples will be collected as part of that installation attempt, no samples will be collected when installing the bedrock well. If possible, the borehole drilled for the attempted deep overburden well will be used for the bedrock well. If this is not possible, the attempted borehole will be abandoned by pumping full of cement-bentonite grout and the bedrock well will be drilled within ten feet of the abandoned borehole.

At the bedrock monitoring well location, drill an eight-inch diameter boring into competent bedrock, using the hydraulic mud rotary method. The drilling mud will be a bentonite mixture with no additives. Mix the mud with potable water. Weld lengths of four-inch diameter black steel casing together and lower to the bottom of the hole. Three feet of casing will remain above ground surface. Grout the casing in place by filling the annular space with a cement-bentonite grout. The grout will be hydraulically tremied into place by beginning at the base of the hole and working upward.

After the grout has set for a period of at least 24 hours, drill an open borehole into ten feet if competent bedrock below the base of the black steel casing, using an "N" sized diamond core barrel. Manage the drill cuttings as described in Section 4.12.

Equip the four-inch diameter black steel casing with a locking cap. Construct a cement collar at the surface around the protective casing, which will slope away from the casing to prevent surface water from entering the well.

3. Well Drilling Records

The geologist or field operations supervisor shall prepare a well drilling record for each well. It shall include but not be limited to the following:

- Site name, boring or well location and number
- Drilling log indicating depths of strata changes
- Method of drilling and sample acquisition
- Soil and/or rock classification including color, texture, moisture content, and other observation
- Sample depths and number
- Organic gas and gamma radiation levels
- Number of blows required for each six-inch penetration of the split-spoon sampler, weight of drop hammer and height of drop.
- Percent recovery of split-spoon core.
- Depth water was encountered and any changes in water level or drilling rate noted.
- Seal type and depth and interval
- Grout depth and interval
- Total depth of borehole and annular fill interval
- Screen type, size and interval
- Riser pipe or casing type, size and interval
- Depths and intervals of jointed pipe
- Date and time of the start and completion of each well.
- Photograph numbers

4.11 MONITORING WELL DEVELOPMENT

Objective: To improve the hydraulic communication between the water-bearing formation and monitoring wells and ensure that groundwater samples are representative of the formation waters.

Preparatory Activities

- Install monitoring well

Health and Safety Guidelines

Personnel will wear protective equipment as described in the HASP and will carry ARCS identification.

Field Equipment and Supplies

Typically, the following equipment or its equivalent will be needed to conduct this field activity:

- Electric water-level indicator
- Specific conductance meter
- Marsh funnel (optional)
- Plastic buckets (one-, three-, and five-gallon capacity)
- Keys for well locks and site gate locks
- Submersible pump
- Field logbook
- Bottled spring water
- Detergent (Alconox)
- Distilled water
- Bailers (stainless steel)
- 100-ft steel tape with plunker

- Electric water level indicator
- 55 gallon drums
- Stainless steel sash-chain
- Check valves (Teflon)
- Scrub brush

Approach

The subcontractors will be required to develop monitoring wells to ensure that the groundwater samples are representative of formation waters.

Procedures

1. Steam clean development equipment prior to use.

2. Promptly following the installation of a monitoring well, develop each well by surging, compressed air, interrupted overpumping, or other approved methods. Continue development until the purged water is clear or for a maximum of one hour.

4.12 BORINGS, CUTTINGS AND WELL WATER MANAGEMENT

Objective: To determine the ultimate disposal requirements for cuttings, development waters, and purge waters.

Health and Safety Guidelines

Personnel will wear protective equipment as described in the HASP and will carry ARCS identification.

Field Equipment and Supplies

The following equipment or its equivalent will be needed to conduct this field activity:

- Ludlum Model 12S micro-R meter or equivalent
- NaI (Tl) Gamma Spectroscopy System
- 55-gallon drums with sealed removable covers

Approach

Borings and monitoring well cuttings, well development water, and purge water will be scanned and segregated according to radioactivity levels to assure proper disposal.

Procedures

1. Drum cuttings and water for temporary or permanent storage at the High and Alden Streets Properties.

2. Collect representative 300 g samples and determine Ra-226 concentrations by counting with the NaI gamma spectroscopy system. Segregate into the following groups:

   - Average Ra-226 levels greater than 5 pCi/g.
   - Average Ra-226 levels lower than 5 pCi/g.

3. Place soil and water into labeled drums. Spray paint to identify the monitoring well or borehole from which the material originated, the depth range and the date.

4. If Ra-226 levels are greater than 5 pCi/g, label as low-level radioactive waste. Make arrangements for drum transportation and disposal at an appropriate low level radioactive waste disposal facility unless it is determined that the High and Alden Streets Properties can be used to store material for an indefinite time.

4.13 DRAWDOWN TEST ON MONITORING WELLS (OPTIONAL)

Objective: Measure the drawdown of each monitoring well during a two-hour pumping period. Drawdown tests will only be performed, if necessary, during the Phase III investigations.

Preparatory Activities

- Develop each well
- Intrusive field equipment will be decontaminated prior to introduction into a well

Health and Safety Guidelines

Personnel will wear protective equipment as described in the HASP and will carry ARCS identification.

Field Equipment and Supplies

The following equipment or its equivalent will be needed to conduct this field activity:

- Stainless steel water-level measuring tape (100 feet)
- Electric water-level indicator
- Five gallon capacity plastic bucket calibrated in one gallon increments or calibrated 55 gallon drum
- Stopwatch
- Field book and semilog graph paper
- Key to well locks
- Submersible pump (3/4 HP)
- Hose clamps (3/4 inch), six
- 300 feet of 3/4-inch diameter polyethylene hose
- 220-volt, 8-amp generator

- 3/4 inch gate valves (two)
- 300 feet cable
- electrical line clamps (stay ties)
- Acetone (pesticide grade)
- Decontamination detergent
- Distilled water
- Camera with film
- Gasoline can with gasoline
- Braided polypropylene rope
- Rope clamp and hex wrench
- Hexane

Approach

A drawdown test will be performed on each monitoring well which can be pumped successfully and from which relevant data may be obtained. Data collected during the test will be analyzed to determine the hydraulic conductivity of the unconsolidated material in the vicinity of the well.

Procedures

1. Review and discuss the HASP prior to initiating any field activities. Check monitoring and protective equipment thoroughly at this time.

2. Determine the water level in each well by direct measurement using an electric sounding device and record the depth to water in the field book.

3. Assemble the submersible pump and attach the discharge hose and polypropylene safety line. Lower the pump in the monitoring well.

4. Measure the depth to water and allow water to recover to a static level. Use this static level measurement as the original water level.

5. Start generator and pump the well at an appropriate constant rate discharging into 55 gallon drums.

6. Take water level measurements once every 30 seconds for the initial five minutes, once every minute for the next 10 minutes, once every five minutes for the next 45 minutes, and every 10 minutes after one hour until an equilibrium has been reached.

7. Record both the time and drawdown in the field notebook for each water level measurement.

8. Plot the time versus drawdown on semi-logarithmic graph paper. The time (in minutes since the start of pumping) should be plotted on the log scale and the drawdown (in feet) plotted on the linear scale.

9. When the pumping level stabilizes, calculate the well's specific capacity by dividing the discharge rate (Q) by the drawdown. If after two hours the pumping level has not stabilized, estimate the 24 hour drawdown by extrapolating the time-drawdown plot. Use the predicted drawdown to calculate the well's specific capacity.

10. After two hours stop pumping the well and take water level measurements at the same intervals used during pumping until the well has recovered to 90 percent of its static level.

11. Record recovery data in the field notebook and plot time versus drawdown on the semilog paper. Compare recovery and pump data to verify that specific capacity calculations were correct.

12. Remove and decontaminate pumping and test equipment. Lock each well upon completion of the test.

13. Analyze the test data using an appropriate method.

4.14 FIELD PERMEABILITY TESTS (OPTIONAL)

Objective: To measure, record and evaluate rising and falling head data from each shallow and intermediate well for the purpose of estimating the hydraulic conductivity of the unconsolidated aquifer.

Preparatory Activities

- Develop each well
- Calculate gravel pack porosity (where applicable)
- Intrusive field equipment will be decontaminated prior to introduction into a well

Health and Safety Guidelines

Personnel will wear protective equipment as described in the HASP and will carry ARCS identification.

Field Equipment and Supplies

The following equipment or its equivalent will be needed to conduct this field activity:

- Electronic water level indicator
- Pressure transducers (five pounds per square inch (psi), 10 psi)
- Dedicated field notebook and semi-log graph paper
- Enviro-labs data logger Model DL-120-MCP or equivalent
- Cylindrical slug (solid), 3.5 inch O.D., 60 inch long
- Alconox detergent
- Deionized water
- Scrub brush
- Disposable 3/8 inch cord

Approach

Slug tests well be performed at each well by the subcontractor in accordance with the procedure outlined below.

Procedures

1. Measure the water level in the well using the electronic water-level indicator and record the data in the field logbook.

2. Complete the system setup procedure by setting the internal clock in the data logger, input transducer scale factors, and selecting appropriate logging sequence for each well. Lower transducer into well to a depth of eight feet beneath static water level to reduce the possibility of damage to the transducer by the slug. Allow transducer to stabilize, and record initial head reading in feet. Input the logging sequence in preparation of slug test.

3. Lower slug into well, stopping at a pre-determined depth immediately above the static water level in the well.

4. Instantaneously introduce the slug into the water so that the entire slug is submersed, keeping the bottom of the slug from touching the pressure transducer. Once the well has recovered to 90 percent or greater of its original level, store data in unit memory as falling head measurement.

5. Reset the data logger to standby mode.

6. Leaving the logging sequence the same as for the falling head test, instantaneously remove the slug from the water. Tie off cord and leave the slug in the wall suspended above the water surface.

7. Once the well has recovered to 90 percent or greater of its original level, store data in unit memory as rising head measurement.

8. Output data in memory to a printer upon the completion of the test at each well.

9. Calculate estimates of aquifer hydraulic conductivity and transmissivity according to the method of Bower and Rice, 1976 as outlined

in "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells."

4.15 MONITORING WELL SAMPLING

Objective: To determine the presence and degree of groundwater contamination around the High and Alden Streets Properties.

Sample Type, Method and Code

- Sample type: groundwater sample
- Sample method: grab
- Sample Code: GW

Preparatory Activities

- Install and develop monitoring wells at least two weeks prior to sampling.
- Schedule CLP analysis or prepare IFB; select radiological laboratory subcontractor.
- Intrusive field equipment will be decontaminated prior to introduction into a well.

Health and Safety Guidelines

Personnel will wear protective equipment as described in the HASP and will carry ARCS identification.

Field Equipment and Supplies

The following equipment or its equivalent will be needed to conduct this field activity:

- Stainless steel water-level measuring tape (100 feet)
- Electric water-level indicator
- Five-gallon capacity plastic bucket calibrated in one gallon increments

- Stopwatch
- Field logbook
- Key to well locks
- Submersible pump (3/4 HP)
- Hose clamps (3/4 inch), six
- 3/4-inch diameter polyethylene hose
- Teflon or stainless steel bailers (decontaminated)
- 300-feet cable
- Electrical line clamps (stay ties)
- Polyethylene drop cloth
- Acetone (pesticide grade)
- Decontamination detergent
- 10 percent nitric acid
- Distilled water
- Laboratory prepared Volatile Organic Analysis (VOA) sample bottles
- Nalgene sample bottles
- Braided polypropylene rope
- Teflon-coated leader cord
- pH meter
- Temperature and specific conductivity meter
- Organic vapor analyzer

Approach

Three rounds of groundwater sampling will be conducted during the Phase I investigations for radionuclides, TCL/TAL compounds, sulfate, chloride, and nitrate at the four monitoring wells installed on the High and Alden Streets Properties, as discussed in Section 4.0. The first round of sampllng will be conducted following development of the wells followed by a second round of sampling approximately

30-40 days later. Finally, a third round of sampling will be conducted after an additional three months. If contamination is found in groundwater samples collected from any of the wells, additional wells may be necessary to fully characterize the nature of the contamination as part of Phase II. The number, depth, and location of these wells would be determined after analyses of the initial sample data.

The objective of the additional groundwater sampling (Phase II) would be better define the degree and extent of groundwater contamination resulting from site operations. Therefore, groundwater samples will be analyzed for the same radionuclide and chemical species as detected in the Phase I groundwater samples. The scope of groundwater sampling beyond the first three rounds of sampling will be determined by the data needs of the FS. Data from the chemical analysis of groundwater would be evaluated against the chemical contamination, if found, in the High and Alden Streets Properties soil samples. The decision to continue collecting groundwater samples for chemical analysis will be made after this evaluation and upon EPA approval. The earlier review of municipal records for the REM II contractor indicates that regional chemical contamination may exist as evidenced by the shutdown of the municipal (bedrock) well at Gist Place.

Groundwater samples are tabulated on Table 4-6.

Procedures

1. Remove the well cap and measure the concentration of volatile organic vapors by placing the organic vapors analyzer above the well casing. Calibrate the analyzer before the start of each day and if the instrument is turned off during the day, recalibrate before reuse.

2. Determine the water level in each well by direct measurement using an electronic water level indicator.

3. Once the depth to groundwater is established, calculate the volume of standing water in the well.

TABLE 4-6
GROUNDWATER SAMPLE SAMPLES

FOUR WELLS ON HIGH AND ALDEN STREETS PROPERTIES - THREE ROUNDS OF SAMPLING.(1)

	SAMPLES PER ROUND					TOTAL(THREE ROUNDS)				
ANALYSIS	NO. OF SAMPLES	DUPLICATES	TRIP BLANKS	FIELD BLANKS	TOTAL	NO. OF SAMPLES	DUPLICATES	TRIP BLANKS	FIELD BLANKS	TOTAL
CHEMICAL										
TCL/TAL COMPOUNDS	4	1	1	1	7	12	3	3	3	21
SULFATE	4	1	0	1	6	12	3	0	3	18
CHLORIDE	4	1	0	1	6	12	3	0	3	18
NITRATE	4	1	0	1	6	12	3	0	3	18
RADIOLOGICAL										
LABORATORY ANALYSIS: U-238; Th-230, 232; Ra-226.	4	1	0	0	5	12	3	0	0	15
IN-FIELD GAMMA SPECTROMETRY: Ra-226; Th-232.	4	1	0	0	5	12	3	0	0	15

NOTES: SAMPLE NUMBERS ARE ESTIMATES.

(1) THREE ROUNDS OF SAMPLING INCLU ROUND ONE - FOLLOWING WELL DEVELOPMENT
ROUND TWO - APPROXIMATELY 40 DAYS AFTER ROUND ONE SAMPLING
ROUND THREE - THREE MONTHS FOLLOWING ROUND TWO SAMPLING

THE NEED FOR ADDITIONAL ANALYSES FOR CHEMICAL AND RADIOLGICAL CONTAMINANTS WILL BE BASED ON THE INITIAL THREE ROUNDS OF DATA COLLECTED FROM THE HIGH AND ALDEN STREETS PROPERTIES WELLS.

4. Store decontaminated equipment on clean polyethylene sheeting; it should not touch the ground adjacent to the well.

5. Lower the pump into the well. During evacuation, do not set the pump intake greater than six feet below the dynamic water level. This requires that the pump be lowered as purging continues and the water level drops.

6. Start pumping and record time. Discharge evacuation water to the ground surface if NJDEP and EPA determine that no sampling is required, and allow run-off and/or percolation.

7. Initially, purge each well until three to five volumes of standing water are evacuated or until the well is pumped dry. The volume of water removed from each well that is not pumped dry is dependent upon field measurements of pH, temperature, and specific conductivity. When each of these parameters has stabilized, record the volume of water and sample the well. If the parameters do not stabilize, continue purging until three to five volumes of water are removed.

8. Sample the well as soon as a sufficient volume recovers or within three hours of purging.

9. Wearing a clean pair of gloves, remove the bailer from the wrapping.

10. Attach the dedicated polypropylene rope to five-foot teflon-coated leader on the bailer and play enough line to submerge the bailer.

11. For chemical contaminant samples, when collected:

    - Commencing with the first bailer, pour the bailer contents into the VOA sample bottles. Use sample containers and preservatives as specified in this section. Care must be taken to ensure no air bubbles are included.

    - Repeat the procedure for the remaining sampling parameters described on Table 4-6. These bottles should only be filled to where the bottles begin to taper inward.

12. For radiological samples, pour water into Nalgene sample bottles.

13. Cap and lock the well.

14. Prepare a label for each sample indicating the location number or identification number, sample number, depth of collection, date/time, and analysis to be conducted. A chain-of-custody control form and traffic reports will also be prepared.

15. Carefully package sample bottles in their respective coolers, add ice and vermiculite, and seal for shipment. Samples collected for chemical analysis will be supplied to the CLP laboratory within 24 hours.

16. Data to be recorded in the field logbook will include the following:

- Name and location of job
- Well and sample identification numbers
- Date of sample collection
- Method of purging and sample acquisition
- Depth of water
- Volume of water removed during purging
- pH, temperature and specific conductivity measurements
- Organic gas levels

4.16 SURFACE SOIL INVESTIGATION

Objective: To identify radioactive isotopes which could link contamination to a potentially responsible party and to determine concentrations present in the soils of the High and Alden Streets Properties, Satellite Properties and Vicinity Properties.

Sample Type, Method and Code

- Sample type: surface soil
- Sample method: grab
- Sample code: SO

Preparatory Activities

- Obtain permission for property access
- Mobilize necessary equipment and sample containers prior to day of sampling
- Locate and stake locations prior to sampling, when appropriate
- Select radiological and chemical laboratory subcontractors for samples collected at the High and Alden Streets Properties

Health and Safety Guidelines

Personnel will wear protective equipment as described in the HASP and will carry ARCS identification.

Equipment, team organization and responsibilities and procedures will vary on sampling location as described below.

4.16.1 High and Alden Streets Properties:

The following equipment or its equivalent will be needed to conduct this activity:

- Field logbook
- Dedicated stainless steel spoons, knives or trowels
- Nalgene sample jars
- Sample jars with teflon lined phenolic caps, sample cans, sample bags
- Stainless steel pan
- Decontamination equipment
- Plastic buckets
- Chain-of-custody documents
- Paper towels
- Organic vapor analyzer (OVA) model GC128 or equivalent
- HNu Photoionizer with 10.2 or 11.7 eV source
- Polyethylene plastic sheeting
- Plywood and sawhorse portable field table
- Portable steam cleaner
- Stakes with colored flags
- Ice chests
- Vermiculite

Approach

Surface soil samples will be collected at the High and Alden Streets Properties from approximately 30 boreholes and sampled in accordance with Section 4.17. A separate protocol is presented since the sampling activity for surface samples may vary slightly from subsurface sample collection. Samples will be analyzed in the field using via gamma spectrometry for Ra-226 and Th-232. Additional samples will be analyzed by a certified laboratory for additional

radionuclides. A limited number of samples will be tested for chemical parameters. Samples estimates are shown on Table 4-7.

Procedures

1. Collect approximately 30 surface soil samples with a trowel at a depth of zero to six inches at the borehole locations determined via the procedure described in Section 4.17.1.

2. At each surface sampling location, collect soil in a garden trowel and homogenize as follows:

   a. Remove rocks, twigs, leaves, etc. while the sample is still in the trowel.

   b. Place soil in a stainless steel pan and mix thoroughly with a stainless steel spoon.

   c. Quarter the sample and move to the four corners of the pan.

   d. Individually mix each quarter of the sample.

   e. Combine the four quarters and mix thoroughly.

Place approximately 300 g of soil in the sample jar and secure cap tightly.

3. When collecting split samples, manually homogenize soil as described above prior to placing in sampling jars.

4. Enter a concise physical description of the soil at the sampling location, including any stain or unusual characteristics, into the field logbook. Scan each sample with an HNu.

5. Photograph the sample and sample location. Enter the sample number, frame number, and time of collection into the field logbook. Complete the Field Sample Collection Form shown in Figure 4-8.

6. Following sample collection, screen the containers and trowels for residual radiological contamination and return to the decontamination

TABLE 4-7
HIGH AND ALDEN STREET PROPERTIES
SURFACE SOIL SAMPLES

ANALYSIS	NO. OF SAMPLES	DUPLICATES	SPLITS	TRIP BLANKS	FIELD BLANKS	TOTAL
CHEMICAL						
TCL/TAL COMPOUNDS	10	1	0	5	5	21
SULFATE	10	1	0	0	5	16
CHLORIDE	10	1	0	0	5	16
NITRATE	10	1	0	0	5	16
RADIOLOGICAL						
LABORATORY ANALYSIS: U-238; Th-230, 232; Ra-226.	3	0	1	0	0	4
IN-FIELD GAMMA SPECTROMETRY: Ra-226; Th-232.	30	0	3	0	0	33

FIELD SAMPLE C LECTION FORM

SITE NAME _____

SAMPLE IDENTIFICATION	TYPE(1)	GRID LOCATION (X,Y)(2)	COLL. DATE	DEPTH (FT)	REQUIRED ANALYSES(3)	COMMENTS

(1) SAMPLE TYPE
SURFACE SOIL SS
SUBSURFACE SOIL SS
SEDIMENT SD
VEGETATION VE
GROUNDWATER GW
SURFACE WATER SW
AIR FILTER AF
BUILDING MATERIALS BM
OTHER OT

(2) GRID LOCATIONS
+X = EAST
-X = WEST
Y = NORTH
Y = SOUTH

(3) REQUIRED ANALYSES
TOTAL URANIUM U
URANIUM-238 U-238
THORIUM-230 TH-230
THORIUM-232 TH-232
RADIUM-226 RA-226

COLLECTED BY _____

DATE _____

TOTAL NO. SAMPLES _____

MALCOLM PIRNIE

U.S RADIUM CORPORATION
ORANGE, NEW JERSEY

FIELD SAMPLE COLLECTION FORM

MALCOLM PIRNIE, INC.

FIGURE 4-8

station. To remove any gross contamination from the outside of the sample container, wash samples for chemical analysis with a solution of Alconox (an EPA-approved surfactant) and water, and rinse with clean water. Do not submerge the containers at any time during decontamination. Wipe outside of radiological samples with a damp cloth.

7. Preserve samples for chemical analysis in a cooler with ice until they are analyzed in the field or shipped to a laboratory.

8. Place a wooden stake bearing the sample number, in waterproof ink, in the ground at the sample location.

9. Record field team members, level of protection worn by each and task performed by each.

10. Record serial numbers and calibration dates of equipment used.

11. Prepare a label for each sample indicating the location number or identification number, sample number, depth of collection, date/time, and analysis to be conducted. A chain-of-custody control form and traffic reports will also be prepared.

12. Carefully package sample bottles for chemical analysis in their respective coolers, add ice and vermiculite, and seal for shipment. Samples collected for chemical analysis will be supplied to the CLP laboratory within 24 hours.

13. Package samples for off-site radiological analysis appropriately for shipment.

14. Remove samples for in-field gamma spectrometry to the location of detection system.

4.16.2 Satellite and Vicinity Properties

Equipment

- Field logbook
- Garden trowel
- Nalgene samples jars

- Dedicated stainless steel spoons, knives or trowels
- Number 10 sieve
- Decontamination equipment
- Plastic buckets
- Chain-of-custody documents
- Paper towels
- Pancake Geiger-Mueller detector
- Gamma scintillator

Approach

Approximately five surface soil samples will be collected per property, when necessary, at the Satellite locations. Samples will be analyzed as shown on Table 4-8. An estimated maximum of 50 samples will be collected from Vicinity Properties and analyzed in the same manner as samples taken at the Satellite Properties. The actual number of samples collected at the Satellite and Vicinity Properties will depend on the data obtained during the Phase I investigation.

Procedures

1. Take approximately five surface soil samples at each property which requires sampling.

2. An estimated maximum of 50 and 25 surface soil samples will be taken from the Vicinity Properties and Satellite Properties, respectively.

3. Homogenize soil as described in Section 4.16.1 and collect approximately 300 g samples at selected representative locations of property with maximum outdoor gamma exposure rates.

4. To sample, use a garden trowel and collect the top six inches of soil.

5. Use a pancake probe or micro-R meter to scan the sample and record the exposure rate in the field notebook.

TABLE 4-8
SATELLITE AND VICINITY PROPERTIES
SURFACE SOIL SAMPLES

SATELLITE PROPERTIES

	LABORATORY SAMPLES				
ANALYSIS	NO. OF SAMPLES	SPLITS	TRIP BLANKS	FIELD BLANKS	TOTAL
U-238, Th-230,232; Ra-226	25	3	0	0	28

VICINITY PROPERTIES

	LABORATORY SAMPLES				
ANALYSIS	NO. OF SAMPLES	SPLITS	TRIP BLANKS	FIELD BLANKS	TOTAL
U-238, Th-230,232; Ra-226	50	5	0	0	55

6. When collecting split samples, pass soil through a sieve prior to placing soil in sampling jars.

7. Record time, location, date, depth, and physical description of soil sample. Also record serial numbers and calibration dates of equipment used.

8. Record field team members, level of protection worn by each and task performed by each.

9. Screen each piece of equipment for residual radiological contamination and decontaminate, if necessary.

4.17 BOREHOLE INSTALLATION AND SUBSURFACE SOIL INVESTIGATION

Objective: To estimate quantities of contaminated soil and to determine the physical characteristics of the overburden.

Sample Type, Method and Code

- Sample type: subsurface soil
- Sample method: grab
- Sample Code: SS

Preparatory Activities

- Obtain permission for property access.
- Mobilize necessary equipment and sample containers prior to day of sampling.
- When appropriate, identify and stake locations before sampling begins.
- Select radiological and chemical laboratory subcontractors.
- Prepare IFB for drilling, select subcontractor.

Health and Safety Guidelines

Personnel will wear protective equipment as described in the HASP and will carry ARCS identification.

4.17.1 High and Alden Streets Properties

Generally, the following equipment or its equivalent will be needed to conduct this field activity:

- Track mounted auger rig or tripod rig
- Field logbook

- Split spoon sampler
- Dedicated stainless steel spoons, knives, containers, and trowels
- Nalgene sample jars
- Sample jars with teflon lined phenolic caps, sample cans, sample bags and labels
- Decontamination equipment
- Chain-of-custody documents
- Paper towels
- Organic vapor analyzer (OVA) model GC128 or equivalent
- HNu Photoionizer w/10.2 or 11.7 eV source
- Extension rods
- Stainless steel buckets
- Plastic buckets

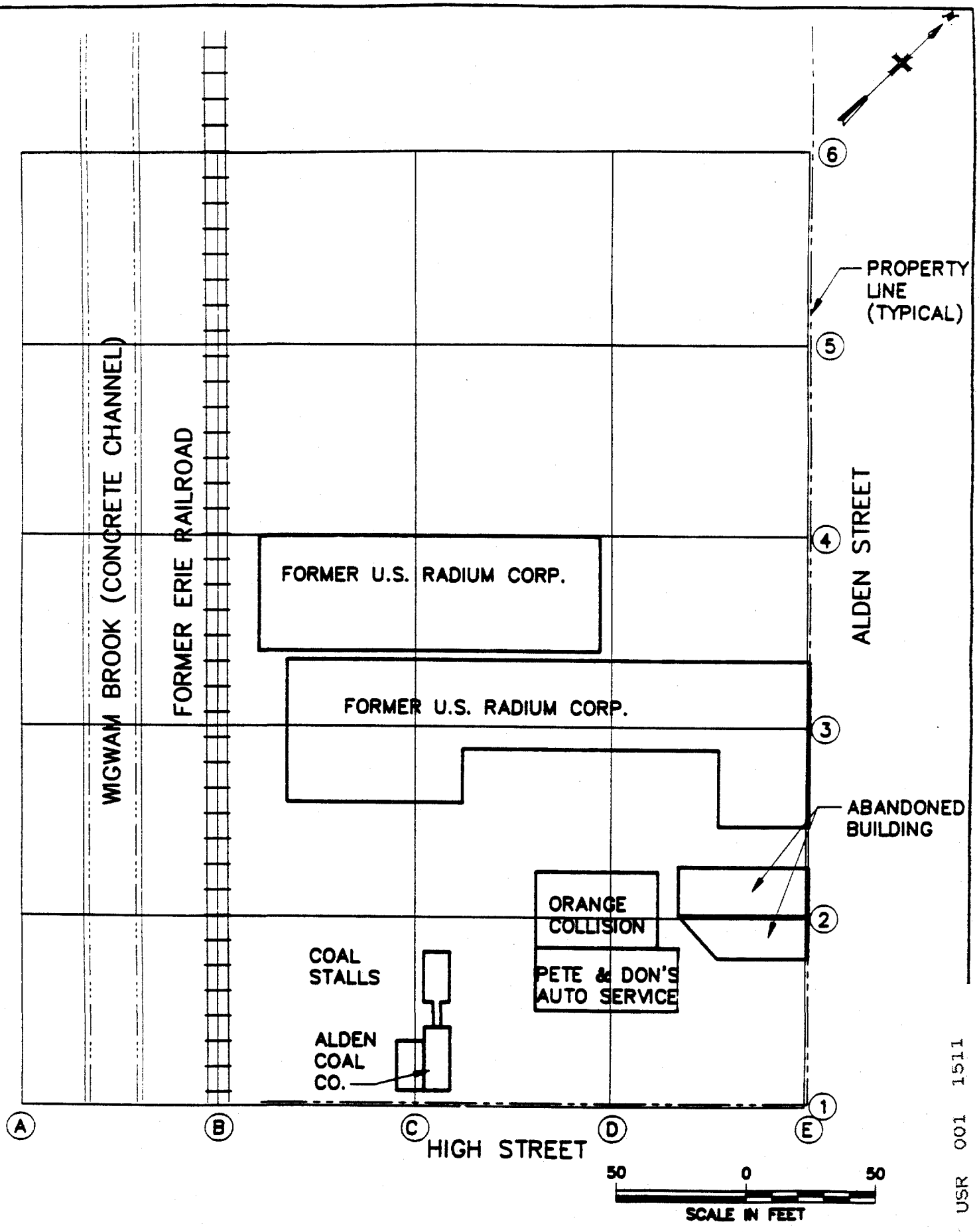
Approach

A grid system will be utilized to randomly distribute borehole locations at the High and Alden Streets Properties. A grid consisting of 75 x 75 foot grid squares will be superimposed over the site. One borehole location will be selected at random within each grid square resulting in the installation of approximately 20 boreholes. Once the random samples are collected, biased sampling will be used to locate an additional 10 boreholes.

Procedures - Borehole Installation

1. Survey a 75 x 75 foot grid within the site perimeter and establish one random sampling location within each grid square. Install boreholes utilizing the superimposed grid (Figure 4-9). Install additional boreholes at biased sampling locations which exhibit elevated surface exposure rates.

2. Select the borehole locations by generating random numbers. The numbers generated will represent the number of feet along either the



USR 001 1511

MALCOLM PIRNIE

U.S. RADIUM CORPORATION
ORANGE, NEW JERSEY
SAMPLING GRID

MALCOLM PIRNIE, INC.

FIGURE 4-9

X or Y axis to the specific point in the grid where the borehole is to be installed. Thus, if the X and Y random numbers are two and 43 feet, respectively, the station will be located two feet in along the X axis and 43 feet along the Y axis. Note the starting point must be consistent within each grid square (e.g. south grid corner).

3. Measure the borehole locations from the surveyed rectangular grid system and determine the borehole elevations from contour lines on the planimetric map.

4. Install additional boreholes at biased locations as needed including adjacent to Wigwam Brook to define the limits of contamination.

5. Stake and record locations on site plan.

6. Install boreholes to 15 feet using hollow or solid-stem drilling equipment. If contamination is found to extend below 15 feet during the downhole gamma logging activity (see Section 4.18), extend the borehole to bedrock.

7. Advance a boring to a depth of 15 feet collecting split-spoon samples at two-foot intervals continuously. Collect deeper samples if elevated exposure rates are measured at a depth of 15 feet.

8. Place spoon on a clean piece of plastic, and remove the threaded end caps.

9. Open the spoon by prying the spoon apart.

10. Measure the amount of material inside the spoon and note the percent recovery (Example - 24-inch spoon length with 12 inch of soil = 50 percent recovery).

11. Reassemble the split spoon after decontamination or cleaning.

Sampling Intervals

Samples will be collected at approximately two foot intervals, beginning with the surface. Approximately 300 g (wet) aliquots of soil samples collect from the surface (representing the zero to two foot interval), four to six foot, eight to ten

foot, and 12 - 14 foot depth intervals will be analyzed for Ra-226 and Th-232 with the in-field gamma spectrometry system. Approximately 10 percent of the samples will be sent off-site for radiological laboratory analysis. A profile of the relative distribution of radionuclides among the various particle size fractions will be established. In addition, wet and dry soil measurements will be made, enabling a soil moisture correction factor to be applied to soil mass. Additional intervals will be sampled if elevated radiation levels are detected during gamma logging at depth. Chemical analysis will also be performed on approximately 10 percent of the samples. Table 4-9 lists the subsurface soils expected to be taken at the High and Alden Streets Properties.

Procedures - Screening

1. Screen every split spoon sample entirely with an HNu and Nal scintillometer for organic vapors and gamma activity.

2. Record the station location, depth interval, time, date and observed readings in the field logbook.

Procedures - Chemical Sampling

1. Designate 10 percent of the samples for chemical analysis.

2. Only a limited number of chemical samples are to be collected. Therefore, the field investigator will base the decision to collect samples for chemical analysis on the following information:

   - Results of initial screening for organic vapors
   - Discoloration, odor or obvious differences in physical characteristics
   - Location of known waste disposal areas

3. Homogenize soil as described in Section 4.16.1 prior to sample collection.

TABLE 4-9
HIGH AND ALDEN STREETS PROPERTIES
SUBSURFACE SOIL SAMPLES

ANALYSIS	NO. OF SAMPLES	DUPLICATES	SPLITS	TRIP BLANKS	FIELD BLANKS	TOTAL
CHEMICAL						
TCL/TAL COMPOUNDS	10	1	0	5	5	21
SULFATE	10	1	0	0	5	16
CHLORIDE	10	1	0	0	5	16
NITRATE	10	1	0	0	5	16
RADIOLOGICAL						
LABORATORY ANALYSIS: U-238; Th-230, 232; Ra-226.	9	0	1	0	0	10
IN-FIELD GAMMA SPECTROMETRY: Ra-226; Th-232.	90	0	9	0	0	99

4. Record relevant information such as boring number, depth interval, physical characteristics and organic vapor concentrations in parts per million in a bound field notebook.

5. Analyze samples for TCL/TAL compounds, sulfate, chloride, and nitrate. Prior to shipment to the subcontract laboratory, count samples on the in-field gamma spectrometer to test for potential mixed wastes.

Post Sampling Activities

1. Prepare a label for each sample indicating the location number identification number, sample number, depth of collection, date/time, and analysis to be conducted. Prepare a chain-of-custody control form and a traffic report.

2. Carefully package chemical sample bottles in their respective coolers, add ice and vermiculite, and seal for shipment. Supply samples collected for chemical analysis to the CLP laboratory within 24 hours.

3. Discard any extra material in the split spoon with the cuttings.

4. Wipe the outside of the sample containers with a solution of Alconox (an EPA-approved surfactant) and water, and rinse with clean water to remove any gross contamination. Do not submerge the containers in the decon solution.

5. Place the cuttings back in the borehole in stratigraphic order at the conclusion of sampling activities at each borehole.

6. Steam the auger, rig, and split spoon prior to initiation of drilling/sampling activities at the next borehole location.

7. Mark the borehole locations with wood stakes bearing the borehole number in waterproof ink at the conclusion of test boring and sampling activities.

Radiological Sampling

1. Collect two foot segments at equal depth intervals (therefore, depth of each sample will be dependent on overall borehole depth) unless the gamma logging or visual inspection indicates a need for biased sample selection.

2. Collect up to four homogenized samples (300 g) from each borehole. Homogenize as described in Section 4.16.1.

3. Collect split samples as directed in the QAPjP. Place two separate aliquots of approximately the same size (300 g) in Nalgene sample jars.

4. Label samples.

5. Analyze each sample in the field using a gamma spectrometer for Ra-226 and Th-232. In addition, transport one sample from each borehole to a laboratory for a more thorough characterization of the radionuclide content of the soils.

4.17.2 Satellite and Vicinity Properties

The following equipment or its equivalent will be needed for this field activity:

- Field logbook
- Portable auger
- Ludlum Model 125 micro-R meter or equivalent
- Sample jars

Approach

Boreholes will only be installed on the Satellite and Vicinity Properties if further characterization of site conditions is necessary. Boreholes will be installed to a depth of five feet. Sampling locations will be based on the information obtained during the Phase I investigation. Estimates of sample numbers appear on Table 4-10.

TABLE 4-10
SATELLITE AND VICINITY PROPERTIES
SUBSURFACE SOIL SAMPLES

SATELLITE PROPERTIES

ANALYSIS	NO. OF SAMPLES	DUPLICATES	SPLITS	TRIP BLANKS	FIELD BLANKS	TOTAL
U-238; Ra-226; Th-230, 232.	10	0	1	0	0	10

VICINITY PROPERTIES

ANALYSIS	NO. OF SAMPLES	DUPLICATES	SPLITS	TRIP BLANKS	FIELD BLANKS	TOTAL
U-238; Ra-226; Th-230, 232.	25	0	3	0	0	28

Procedures

1. An estimated 25 boreholes will be installed on Satellite Properties and an estimated 50 boreholes will be installed on Vicinity Properties during the Phase II investigation. These estimates are subject to change, based on the data collected during Phase I. Each borehole will be approximately five feet deep. Select borehole locations after a review of available surface gamma radiation measurement data and field judgement.

2. Advance boring to five feet collecting two foot split spoons continuously. Place materials collected on split spoon on polyethylene plastic sheeting.

3. If contamination is found to extend below five feet during the gamma logging activity, extend the borehole to approximately 10 feet.

4. Collect approximately 300 g homogenized samples in sample jars.

5. Replace the remaining cuttings in the borehole in the order in which they were removed. Drum excess cuttings.

6. Record time, location, date, depth of borehole, and physical description of soil. Also record serial numbers and calibration dates of equipment used.

7. Record location of borehole on property map and key it to natural features of the property for reference.

8. Record field team members, level of protection worn by each, and task performed by each.

4.18 DOWNHOLE GAMMA LOGGING

Objective: To obtain gamma radiation logs of boreholes so that an accurate estimate can be made of the depths and quantities of contamination.

Sample Type, Method and Code

- Sample type: soil logging
- Sample method: continuous
- Sample code: BL

Preparatory Activities

- Install boreholes according to Section 4.17.

Health and Safety Guidelines

Personnel will wear protective equipment as described in the HASP and will carry ARCS identification.

Field Equipment and Supplies

The following equipment or its equivalent will be needed to conduct this field activity:

- PVC or stainless steel casing
- Ludlum Model 2221 Ratemeter or equivalent
- Ludlum Model 44-10 2"x 2" sodium iodide detector or equivalent
- Field logbook
- Gamma check source

Procedures - Preliminary

1. Switch the scintillometer on before entering the site and check the battery for adequate power. Use the highest scale to perform an

operational check of the instrument with the gamma check source and switch to lower scales as necessary.

2. After the borehole is completed, insert a PVC or stainless steel pipe into borehole to prevent collapse, if needed.

Procedures - Gamma Logging

1. Lower a gamma probe down the borehole and record the one-minute gamma exposure rates of six-inch intervals, from the ground surface to the total depth of the boring.

2. If contamination extends beyond five feet at the Satellite Properties or the Vicinity Properties, extend the borehole and casing to the depth of 10 feet and record additional gamma exposure rates at six-inch intervals.

3. If contamination extends beyond 15 feet at the High and Alden Streets Properties, extend the borehole and casing to bedrock and record additional gamma exposure rates at six-inch intervals.

4. Remove the pipe from the borehole and decontaminate the pipe and the radiation detector as required to background before proceeding to the next borehole.

4.19 AIR PARTICULATES MONITORING

Objective To evaluate the potential impact on gross alpha levels in air surrounding the High and Alden Streets Properties during borehole and monitoring well installation activities.

Sample Type, Method and Code

- Sample type: air
- Sample method: continuous
- Sample code: AS

Preparatory Activities

- Select upwind and downwind locations from existing meteorological data.
- Calibrate air samplers.
- Distribute, install and check the operation of air sampling pumps.

Health and Safety Guidelines

Personnel will wear protective equipment as described in the HASP and will carry ARCS identification.

Field Equipment and Supplies

The following field equipment or its equivalent will be needed to conduct this field activity:

- Hand-held wind speed direction indicator
- Four Gast Model RAS-1 high-volume air sampling pumps or equivalent with an adjustable flow rate of 2 to 50 liters per minute
- Ludlum Model 43-10 alpha sample counter or equivalent
- Ludlum Model 2221 Ratemeter or equivalent

- Filters to sample total particulates and those particulates in the respirable dust range (less than 10 microns in diameter)
- Air sampler calibration equipment

Approach

Four air particulate samplers will be installed along the perimeter of the High and Alden Streets Properties during borehole and monitoring well installation. Air particulate samples will be collected twice per week. On site analysis will be done to determine gross alpha particle concentration. In the unlikely event that site activities result in elevated levels, filters will be sent to a contract laboratory for radionuclide analyses.

Procedures

1. Assemble 4 RAS-1 air samplers with 47 mm glass fiber filters having a minimum retention of 99.7 percent for 0.3 um dioctyl phthalate (DOP). One unit will be assembled with particle sizing equipment in advance of the filter.

2. Calibrate four units with collection media in place using a large bubble tube, wet test meter, or equivalent device. Units will be calibrated at usable flow rates, i.e. 20 to 60 liter per minute (l/m). Document this calibration.

3. Review existing meteorological data and select one upwind and one downwind site perimeter location. Select two additional locations with due consideration for planned on-site RI activities. Make every effort to bracket the site in the four major compass quadrants.

4. Operate samplers on a continuous basis (24 hours per day, seven days per week) at a nominal flow rate of 30-35 l/m. Schedule filter changes on Monday mornings and Friday evenings resulting in a minimum of eight samples per week. Other work schedules or non-routine conditions may result in unscheduled filter changes. Operate samplers throughout the invasive task period (Table 4-11).

TABLE 4-11
HIGH AND ALDEN STREETS PROPERTIES
AIR PARTICULATE SAMPLES

ANALYSIS	NUMBER OF SAMPLES	DUPLICATES	FILTER BLANKS	TOTAL
TOTAL ALPHA	32	8	2	42

5. Determine the corrected sample volume at Standard Temperature and Pressure (STP) by the following formula:

$$Vstp = V \times \frac{\text{Barometer Pressure}}{760 \text{ mm Hg}} \times \frac{298°K}{T + 273°K}$$

Where: V_{stp} = Sample volume at standard conditions (L)
V = Actual sample volume (L)
T = Air temperature (°F)

6. After a 24 hour delay to allow for decay of the short-lived radon decay products, count the samples in the on-site lab by alpha scintillation. Recount again after four to five day decay to account for any contribution from thoron progeny.

7. Calculate the long-lived gross alpha concentration in air:

$$uCi/ml = \frac{\text{Net cpm}}{(V)\ (Eff)}$$

Where: Net cpm = Net counts per minute
V = sample volume at STP (ml)
Eff = scintillator efficiency (cpm/uCi)

8. Submit samples with alpha levels in excess of two standard deviations of the ambient background concentration to a contract laboratory for radionuclide analyses.