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SITE CHARACTERIZATION PLAN
FORMER BROOKS AND PERKINS, INC. SITE
AAR MANUFACTURING, INC.
LIVONIA, MICHIGAN
June 1995

— B. KOH & ASSOCIATES, INC. —

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1.0 INTRODUCTION

This document presents a Site Characterization Plan (SCP) for the former Brooks and Perkins, Inc. site, including buildings and associated open land areas located in Livonia, Michigan. This site characterization effort and the subsequent remediation of the site will be carried out under the responsibility of the current owner of the site, AAR Manufacturing, Inc (AAR). The site characterization effort will be performed in a manner consistent with the sampling and analytical guidelines contained in this plan, as well as applicable AAR, federal, state and local requirements and/or regulations.

The purpose of this plan is to outline programs intended to determine the nature and extent of the onsite contamination and to provide sufficient information to develop remedial action plans if necessary. This plan has been prepared consistent with the guidance provided in the NRC Draft Branch Technical Position on Site Characterization for Decommissioning Sites (NRC, July 1992). In addition, consistent with the guidance and direction of Draft NUREG/CR-5849, Manual for Conducting Radiological Surveys in Support of License Termination (NRC, June 1991), this plan establishes the initial database to support the final radiological termination surveys of the former Brooks and Perkins, Inc. site.

1.1 Program Objectives

The primary program objectives of this SCP are to:

(1) Collect sufficient data to properly evaluate the AAR site impacts and identify potential receptors.

(2) Formulate remedial actions for the AAR site.

(3) Serve as the initial step in establishing the documented approach for the final termination surveys of the AAR site.

1.1.1 General Objectives

General objectives have been identified for the AAR site characterization. These objectives apply to buildings, and to the open land areas. The general objectives are outlined as follows:

(1) Determine whether the concentrations and quantities of Thorium (Th-228 and Thorium-232) present at the site exceed applicable regulatory limits (10 pCi/g).

(2) Determine the extent (vertical and horizontal) of the Thorium present at the site including the extent of potential migration onsite and offsite.

(3) Quantify environmental parameters that may significantly affect potential human exposure from existing and potential future Thorium contamination under unrestricted use conditions.

(4) Identify migration pathways and potential onsite and offsite receptors. Conduct pathway and risk analysis.

(5) Evaluate the need for further investigations or data collection to assess exposure, endangerment and risk associated with the Thorium contamination at the AAR site.

(6) Evaluate data and formulate any necessary remedial actions, including a preferred alternative, appropriate for the concentrations and quantities of Thorium at the AAR site.

(7) Identify past disposal practices at the site.

(8) Establishment of database for potential use in supporting final termination survey(s) of the site.

1.1.2 Comparison of Site Characterization Data

Collected data will meet specific characterization, quality assurance, and final termination survey objectives.

The data from air, surface water, groundwater, soil (surface and subsurface), sediment, and vegetation samples will be compared, as applicable, to established state and federal waste characterization guidelines. Background values will be compared to site values and statistical analysis will be applied to the data where appropriate.

Surface water and groundwater data will be compared to Drinking Water Standards, established background levels, downgradient levels, and NRC regulations, as appropriate. Surface, subsurface, and sediment sampling data will be compared to the Nuclear Regulatory Commission (NRC) and the Environmental Protection Agency's (EPA) recommended guidelines for evaluating cleanup and decontamination requirements.

The building radiological survey data will be compared to NRC surface contamination release criteria. After validation, analytical data will be examined to determine if the Thorium contamination present on the site poses any significant impacts to the environment and potential receptors.

1.1.3 Data Quality Objectives

Data collected from site characterization sampling and monitoring activities will be used to achieve the general objectives identified in Section 1.1.1. The most significant objectives are the determination of the magnitude and extent of contamination, the identification of the preferred remedial approach, and the design of the final radiological survey.

To ensure achievement of the general objectives, the following Data Quality Objectives (DQOs) have been developed. A lower limit of detection (LLD) of 0.5 pCi/l has been specified for liquid samples in order to ensure the 30 pCi/l (gross alpha) limit is obtainable; a LLD of 0.5 pCi/g has been specified for soil samples to ensure the 5 pCi/g Th-232 and 5 pCi/g Th-228 limit is obtainable; a LLD of 3E-15 μCi/ml has been specified for air sample analysis in order to ensure the 6E-15 μCi/ml limit is obtainable and a 10 mRem LLD has been specified for environmental exposure rate measurements to ensure the 100 mRem/yr limit is obtainable.

The DQOs have been developed for Thorium contamination at the AAR site and are listed in Table 1.1.3-1 along with the references for the specific limits.

1.2 Program Overview

The Site Characterization Plan is comprised of five major activities:

(1) Historical site review and literature search.

(2) Site investigation and sampling activities.

(3) Data management and analysis.

(4) Pathway and risk analysis modeling.

(5) Reports and deliverables.

1.3 Organization

The organizational chart of the management structure responsible for providing oversight to the development and implementation of the SCP is presented in Figure 1.3-1.

1.4 Applicable Regulations and Guidance

Radiological contamination assessment associated with Thorium is considered and addressed by this plan. The survey and sampling methodologies presented herein are consistent with the regulations and guidelines set forth in the following documents to the extent they are applicable to this type of activity.

Federal Regulations

- Code of Federal Regulations, Title 10, Part 20.

Nuclear Regulatory Commission (NRC) Guidance

- NRC Draft Branch Technical Position on Site Characterization for Decommissioning Sites (NRC, July 1992).
- Draft NUREG/CR-5849, Manual for Conducting Radiological Surveys in Support of License Termination (ORISE, June 1992).

- NRC Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By-Product Source or Special Nuclear Material (NRC, August 1987).

- NRC Branch Technical Position for the Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations (NRC, October 1981).

Environmental Protection Agency

- EPA Interim Primary Drinking Water Regulations, 40 CFR Part 141 (41 FR 38404: July 9, 1976).

- EPA Test Methods for Evaluating Solid Wastes, Third Edition, November 1986 (SW-846).

1.5 Revisions to This Plan

In the event that conditions other than those anticipated in developing this plan are encountered, the plan and/or affected field procedure(s) will be revised and submitted to the Project Manager (PM) for approval. Plan revisions or field changes are categorized into two types: major and minor.

In general, major field changes are changes which:

(1) Cause a potential safety or environmental impact.

(2) Adversely affect the quality of the data.

(3) Cause significant change in the cost of the field effort.

(4) Create a major change in the scope of the field effort.

(5) Cause significant delays in the schedule.

The PM, Senior Health Physicist, and Senior Site Radiation Technician approve major field changes.

Minor field changes are changes which do not affect the quality of the data, the rationale for the field procedures, plans or sampling locations. Examples of minor field changes include:

(1) Relocation of a planned sampling location within five feet of the original location to avoid obstruction.

(2) Modifying soil sampling intervals to avoid subsurface obstruction.

Minor field changes are approved by the Senior Health Physicist.

All plan revisions or field changes will be reviewed by the Project Manager or designee as to the change and whether the change is significant or not (major or minor).

Major plan revisions will be prepared and submitted to the Project Manager for approval. In addition, copies of the major plan revisions will be transmitted to the NRC for approval. Field changes are to be submitted within one day of the change and the review must be completed within two working days of the date of the change. Plan revisions will be reviewed and approved in the same manner as this original SCP. It is the responsibility of the Project Manager or his designee to obtain the necessary approvals, to advise the appropriate parties of work which is affected by the revisions, and to ensure the correct plan revision is being used at the work site.

Changes should be highlighted in the revision draft by marking a change bar in the right-hand margin with the revision number. Review of this revision draft should be limited to the revisions and their affect on program objectives. The revision number and date will appear at the top of

each page of an approved and revised plan. Copies of the SCP and any related changes/modifications will be maintained as part of the AAR Project Files.

It should be noted that the sampling locations, depths, type, and amounts presented in this document are based upon the best available information at the time of preparation of this SCP, and may be revised based on actual field conditions and interim findings as site characterization progresses.

TABLE 1.1.3-1
DATA QUALITY OBJECTIVES

MEDIA	LOWER LIMIT OF DETECTION (LLD)	SPECIFIED LIMITS
Liquid (surface water, groundwater)	0.5 pCi/l	30 pCi/l (gross alpha)[1] 88 pCi/l (Th-232)[1] 125 pCi/l (Th-228)[1]
Solids (soils, sediments, vegetation)	0.5 pCi/g	10 pCi/g Total (5 pCi/g Th-232 and 5 pCi/g Th-228)[2]
Air	3E-15 μCi/ml	6E-15 μCi/ml[3] (Th-232 Class Y)
Thermoluminescent Dosimeters (TLDs)	10 mRem	100 mRem/yr[4]

Sample results will be reported with an uncertainty at the 95% confidence level (2σ) for that value.

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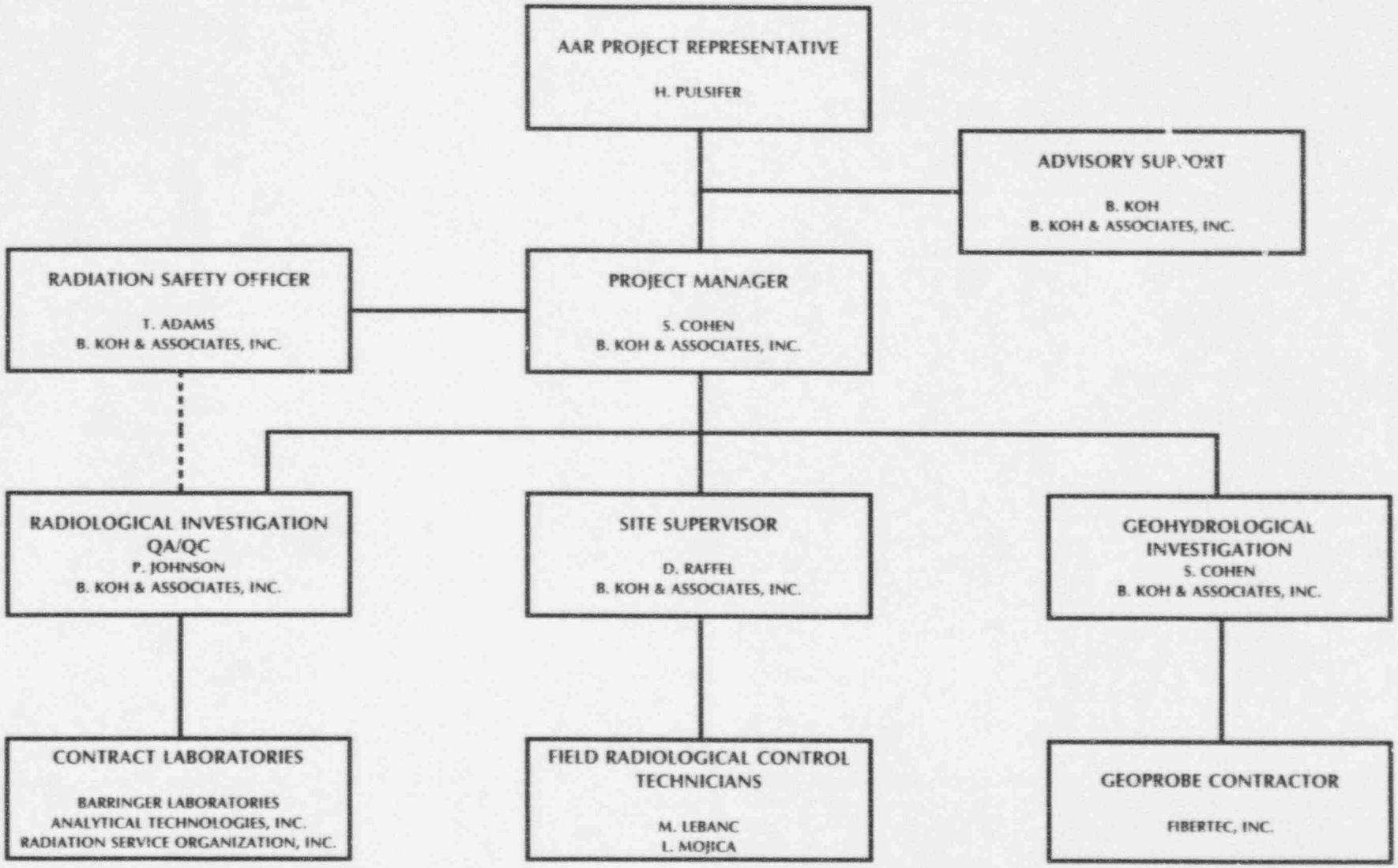
[1]Based on US EPA 40 CFR 141 "Proposed Primary Drinking Water Regulations"
[2]Based on US NRC Branch Technical Position "Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations (NRC, 1981).
[3]Based on US NRC 10 CFR 20 "Standards for Protection Against Radiation".
[4]Based on US NRC 10 CFR 20 "Standards for Protection Against Radiation", Public Dose Limit.

FIGURE 1.3-1
AAR PROJECT ORGANIZATION CHART



2.0 GENERAL INFORMATION

The following sections provide background information regarding the locations, history and operations and the related Thorium contamination at the site. In addition, these sections summarize previous site activities including site surveys and remedial efforts.

2.1 Site Background

2.1.1 Site Location and Description

The property is the former Brooks and Perkins, Inc. site which is currently owned by AAR. The former Brooks and Perkins, Inc. site is located at 12633 Inkster Road in Livonia, Wayne County, which is approximately 20 miles northwest of downtown Detroit, Michigan (Figure 2.1.1-1).

AAR acquired the property from the former Brooks and Perkins, Inc. in 1981. AAR currently operates a manufacturing plant that produces specialty items (aluminum cargo containers and related structural supports) for the aircraft industry. The major facilities on the former Brooks and Perkins, Inc. site include the Main Administration Building, the Fabrication Building, the Process Building and the Main Storage Building. A plot plan of the current buildings is shown in Figure 2.1.1-2. A plot plan of the site during the 1960s is shown in Figure 2.1.1-3.

The site is bordered on the north by light commercial developments, on the east by Inkster Road, on the south by a storm sewer/drainage swale and railroad tracks operated by the Chesse System Railroad, and on the west by undeveloped land. As a result of the NRC survey of the buildings and adjacent open land, evidence of Thorium contamination was found in a floor sump drain in the Pickling Room area, under the concrete floor of the new building, and in the storm sewer/drainage swale located along side the railroad tracks on the south side of the site (Figure 2.1.1-4).

2.1.2 Site History

2.1.2.1 Past Operations and Onsite Activities

Brooks and Perkins, Inc. owned and operated the Livonia Site from 1957 to 1981. During this period, Brooks and Perkins, Inc. manufactured products containing Thorium alloys. The process involved the Thorium entering the Plant as a master magnesium-Thorium alloy containing 40% Thorium, and leaving the Plant as the alloy products, HM21 (Ingots) containing approximately 2% Thorium and HK31 (sheets), containing approximately 3% Thorium. The master alloy was received and stored in closed drums until just prior to use. Chunks of the master alloy were placed on top of the melt furnace for 30 to 60 minutes, to dry and preheat. The chunks were then placed in baskets and lowered carefully below the level of the magnesium melt, where they were suspended until the chunks completely melted. This melting operation took about 45 minutes. The alloy melt was then poured into book shaped molds and allowed to cool for about three days. When the book molds were cool enough to work, the castings were removed, the heads were cut off, and the bodies were scalped. All of the metal scrap recovered from cutting and scalping operations was returned to the melt stage. The trimmed casting was then heated in a furnace to 930 °F for 16 hours in preparation for rolling.

The heated casting was divided into thirds and broken down to sheets about 1/2-inch thick during the first day's rolling. These sheets were trimmed and subjected to a second day's rolling, which produced sheets of the thickness desired by the customer. The sheets were annealed at 900°F for eight hours, cooled and pickled in an acid bath. The final preparation for shipping consisted of sanding, grinding and brushing.

A summary of the significant historical activities conducted at the former Brooks and Perkins, Inc. site throughout the past 37 years are outlined below.

- License STB-362 issued in 1959 by the Atomic Energy Commission (AEC), authorized the Brooks and Perkins, Inc. to possess and use 15,000 pounds of Thorium as contained in 40% Thorium master alloy and Thorium magnesium alloy containing not more than 3% Thorium. Licensed activities included rolling, melting, casting, forming, cutting, sanding and welding manufactured products containing licensed Thorium source material.

- During the years 1957 to 1971, the license was amended and/or renewed to incorporate increases in amounts of Thorium that could be possessed and used or changed in manufacturing operations.

- The AEC issued Brooks and Perkins, Inc. a license amendment for the incineration of the Thorium material on July 28, 1966.

- Brooks and Perkins, Inc. requested termination of License STB-362 on February 5, 1971.

- Brooks and Perkins, Inc. License STB-362 was terminated by the NRC Region III on May 17, 1971.

- AAR acquires the Brooks and Perkins, Inc. property in 1981.

2.1.2.2 Past Characterization and Remedial Actions

As discussed in Section 2.1.2.1, the Thorium magnesium manufacturing process began in the Melt Room Area (MRA). Sources of Thorium exposure from the MRA operations included airborne particles to the work area and to the environment due to venting of contaminated air exhaust. Sources of contaminated liquid effluent resulted from the discharge of water used for the cleaning of the melting pots. This water was discharged into a runoff ditch located along the east side of the MRA.

Maximum airborne Thorium concentration measured in the MRA was 7.2 E-12 μCi/ml. Maximum public airborne Thorium concentration measured as a result of operations in the MRA was 2.4 E-12 μCi/ml. The maximum liquid effluent Thorium concentration released from the MRA was 5.0 E-07 μCi/ml.

The next step of the process involved milling the sheets to specified thicknesses and pickling in an acid bath. These operations were performed in the Mill Area/Pickling Room (MA/PR) located adjacent to the MRA.

Sources of exposure from the MA/PR operation included release of airborne particles to the work area and to the environment due to venting of contaminated air and from liquid effluents originating from the discharge pickling wash water and pickling solution.

The maximum airborne Thorium concentrations measured in the MA/PR were 4.2 E-11 μCi/ml. Public airborne maximum concentrations of 1.1 E-12 μCi/ml were measured. Liquids (pickling wash water and solution) resulted in maximum levels of 8.0 E-04 μCi/ml.

Sources of exposure from the Finishing Room (FR) operation included releases of airborne particles to the work area and the environment from venting of contaminated air and liquid effluents from the Rotoclone liquid effluent pipe discharge.

The maximum airborne Thorium concentrations measured in the FR were 1.9 E-11 μCi/ml to the work area and to the environment 3.9 E-11 μCi/ml. Analyses of liquid effluents from the FR Rotoclone effluent resulted in maximum concentrations of 1.0 E-05 μCi/ml.

The locations of the various processing areas and rooms are presented in Figure 2.1.1-3.

For comparison with the concentrations presented above, the radiological concentration limits at the time Brooks and Perkins, Inc. was operational were specified by the AEC (10 CFR 20) and were

as follows, for the worker, airborne Thorium concentrations averaged over 40 hours must not exceed 5E-11 μCi/ml (10 CFR 20.101-b); for the environment (public), airborne Thorium concentrations averaged over one year must not exceed 1.7 E-12 μCi/ml (10 CFR 20.103-a) and for the environment (public) liquid effluent concentrations when diluted by average daily sewage must not exceed 1.5 E-6 μCi/ml nor may a total of more than one-half millicurie per day be released, whichever is larger (10 CFR 20.303). Airborne concentration measured for environment (public) exposure were collected at the site perimeter.

On November 19, 1970, a radiological survey was performed by Brooks and Perkins, Inc. in support of termination of License No. STB-362.

The levels of Thorium contamination found in the various process areas and rooms were generally well below the AEC guidelines for unrestricted use. The AEC limits in effect at this time specified that the level of alpha contamination may not exceed 10,000 dpm/100 cm^2 total and 1,000 dpm/100 cm^2 removable.

The alpha contamination levels in the process areas and rooms ranged from <500 dpm/100 cm^2 total to 1,000 dpm/100 cm^2 total except for one area, the MRA walkway. The walkway outside of the MRA had alpha contamination levels ranging from 9,000 dpm/100 cm^2 total to 15,000 dpm/100 cm^2 total. In all process areas surveyed, the removable contamination levels ranged from 1.1 dpm/100 cm^2 to 17 dpm/100 cm^2.

The radiological termination survey also identified a considerable amount of Thorium bearing waste found outside of the east walls of the old Melting and Scalping Rooms.

It was recommended by the Brooks and Perkins, Inc. representative who performed the termination survey that the contaminated material from the walkway outside of the MRA be remediated and buried onsite per the provisions of the AEC regulation 10 CFR 20.304. The burial of this material

onsite was performed. The location of this burial is not known and will be addressed in the evaluation outlined as part of the SCP.

2.1.2.3 Current Operations and Onsite Activities

Currently AAR manufactures specialty items (aluminum cargo containers and related structural supports) for the aircraft industry. The company has approximately 100 employees who work at the site.

2.1.2.3.1 Current Characterization and Remedial Actions

The following information was gathered during an NRC inspection conducted on February 23, 1994 (NRC, 1994).

The NRC conducted an inspection of the former Brooks and Perkins Company Site in and around the former manufacturing, processing and storage areas in the building. The areas surveyed included restrooms, hallways, offices, former manufacturing areas, parking lots, building down spouts and drainage ditches. The NRC inspector's survey of the building and adjacent property identified three areas where radiation levels were above natural background. An open area located (south) next to the parking lot (a former drainage ditch) showed elevated radiation levels of 450 μR/h on contact and a floor drain inside the building showed 70-200 μR/h. One area on the floor inside the newer portion of the building showed 120 μR/h (approximately twelve times background levels of 7 - 15 μR/h) on contact with the concrete floor and 40 - 50 μR/h at three feet (Figure 2.1.1-4).

A sample of the contaminated material from the floor drain and drainage ditch was collected for further analysis in the NRC Region III laboratory. The analysis of the floor drain sample showed

that the radioactive material is Thorium and the concentration of Thorium was approximately 580 picocuries/gram (pCi/g) which exceeds the NRC release criteria of 10 pCi/g. The analysis of the soil sample taken from the drainage ditch showed that the radioactive material is Thorium and the concentration of Thorium in soil was approximately 316 pCi/g which exceeds the NRC release criteria of 10 pCi/g.

Several smear tests for removable activity were taken at random locations within the building. These smear tests were analyzed for gross alpha and beta activity. The results for gross alpha and beta activity were both less than 5 dpm/100 cm^2 which is below the NRC limit of 200 dpm/100 cm^2.

No remedial activities are currently being performed at the former Brooks and Perkins, Inc. site.

2.1.2.4 Historical Site Review

A site's history contains important information for determining the contamination boundaries in both the vertical and horizontal directions. In many cases, where soil contamination is due to spillage or natural migration mechanisms, it is easier to estimate the extent of horizontal and vertical contamination. However, for situations in which material is buried in pockets or deposited in layers, the extent and location of the contamination is not easily determined and necessitates a more concise and comprehensive methodology than otherwise required.

To support the site characterization activities and to address any unknown subsurface site conditions, a detailed historical review of the former Brooks and Perkins, Inc. site will be conducted. The review will include, but will not be limited to, researching past disposal practices at the site, evaluating aerial photography of the area to help identify fill limits on the site, and interviewing individuals who have knowledge of past disposal or operational procedures at the site.

2.2 General Physical Setting

A summary of the general physical setting of the former Brooks and Perkins, Inc. site, including general physical characteristics of the site and its proximity to individuals that potentially could be affected by the existing Thorium contamination or required remediation activities will be provided.

2.2.1 Physical Site Characteristics

A summary of the physical characteristics regarding the former Brooks and Perkins, Inc. site will be provided. These characteristics include, as appropriate:

- Climate (e.g., temperature, precipitation)
- Geologic Setting (e.g., unconsolidated deposits and bedrock strata).
- Vegetation (e.g., unvegetated, forested, grassy).
- Soil (e.g., composition, thickness, chemistry).
- Groundwater (e.g., depth, quality, uses, and direction and rate of flow).
- Location and description of surface water (e.g., type, flow rates, quality and uses).

2.2.2 General Information on Exposed Individuals

A summary description of the general characteristics of the potentially exposed populations, both onsite and offsite, will be provided. The summary will include:

- General distribution and number of people on and near the site.
- Current land use(s) adjacent to the site.
- Anticipated future land use(s) on and adjacent to the site.
- Location and characteristics of any subgroup of special concern.

2.3 Preliminary Evaluation of Thorium Contamination

Based on review of available historic operational data, records of past and current surveys, records of waste disposal and effluent releases (air, water), and direct observation via site visits, the following preliminary evaluation of the Thorium contamination can be made.

Thorium contamination identified by the NRC in the buildings and open land areas does not appear to be widespread. Contamination does exist under the new building, in the sump drain in the old building, and in the storm sewer/drainage swale which runs along the railroad tracks on the south side of the site. In addition, there may exist a location somewhere in the site where soil contamination has resulted from the incineration of Thorium sweepings and the disposal of remediated Thorium contaminated soil from the MRA walkway and adjacent runoff ditch. More importantly, however, there does not appear to be any health and safety impacts to the onsite worker or to the general public due to the identified Thorium contamination.

The information obtained from available records and site visits have been used in designing the site characterization activities outlined in this SCP. These include radiation surveys of the buildings and lands, surface and subsurface contamination of the structures, soils, surface water and sediment and groundwater, as appropriate. Review of newly available records will be conducted as part of the site characterization effort. Rooftops and roof drains of buildings in existence at the time of

incineration activities may be contaminated. The rooftops in existence at the time of incineration may have subsequently been repaired or replaced. Therefore, contamination may be trapped between the old roof and the replacement roof. If during the site characterization activities it is determined that old rooftops (existing at the time of incineration) have been covered with replacement roofs, survey and sampling of these old rooftops will be performed. The additional survey and sampling will be performed as part of the survey and sampling of the existing rooftop. Specific details of the site characterization efforts are described in Section 5.0.

In addition, the review has confirmed that the principal radionuclide of concern is Thorium. Thus, the applicable cleanup criteria are as follows:

Soil - 5 pCi/g Th-232 and 5 pCi/g Th-228, as specified in the NRC Branch Technical Position "Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations" (NRC, 1981)

Surface Water - 30 pCi/l gross alpha, 88 pCi/l (Th-232) and 125 pCi/l (Th-228) as specified in 40 CFR 141 "Interim Primary Drinking Water Regulations"

Groundwater - 30 pCi/l gross alpha, 88 pCi/l (Th-232) and 125 pCi/l (Th-228) as specified in 40 CFR 141 "Proposed Primary Drinking Water Regulations"

Surface Contamination - 200 dpm/100 cm^2 α,β-γ removable activity
1,000 dpm/100 cm^2 α,β-γ average over 1 m^2
3,000 dpm/100 cm^2 α,β-γ maximum over 100 cm^2

"Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of License for Byproduct, Source, or Special Nuclear Materials" (NRC, August 1987).

Exposure Rates

Structures - $\leq 5\mu$R/hr above background (measured at 1 m above floor)

Open Land - $\leq 10\ \mu$R/hr (average) above background (measured at 1 m above the ground surface), average over 100 m^2 grid areas

- $\leq 20\ \mu$R/hr (maximum) above background (measured at 1 m above the ground surface), over discrete area of $< 100\ m^2$

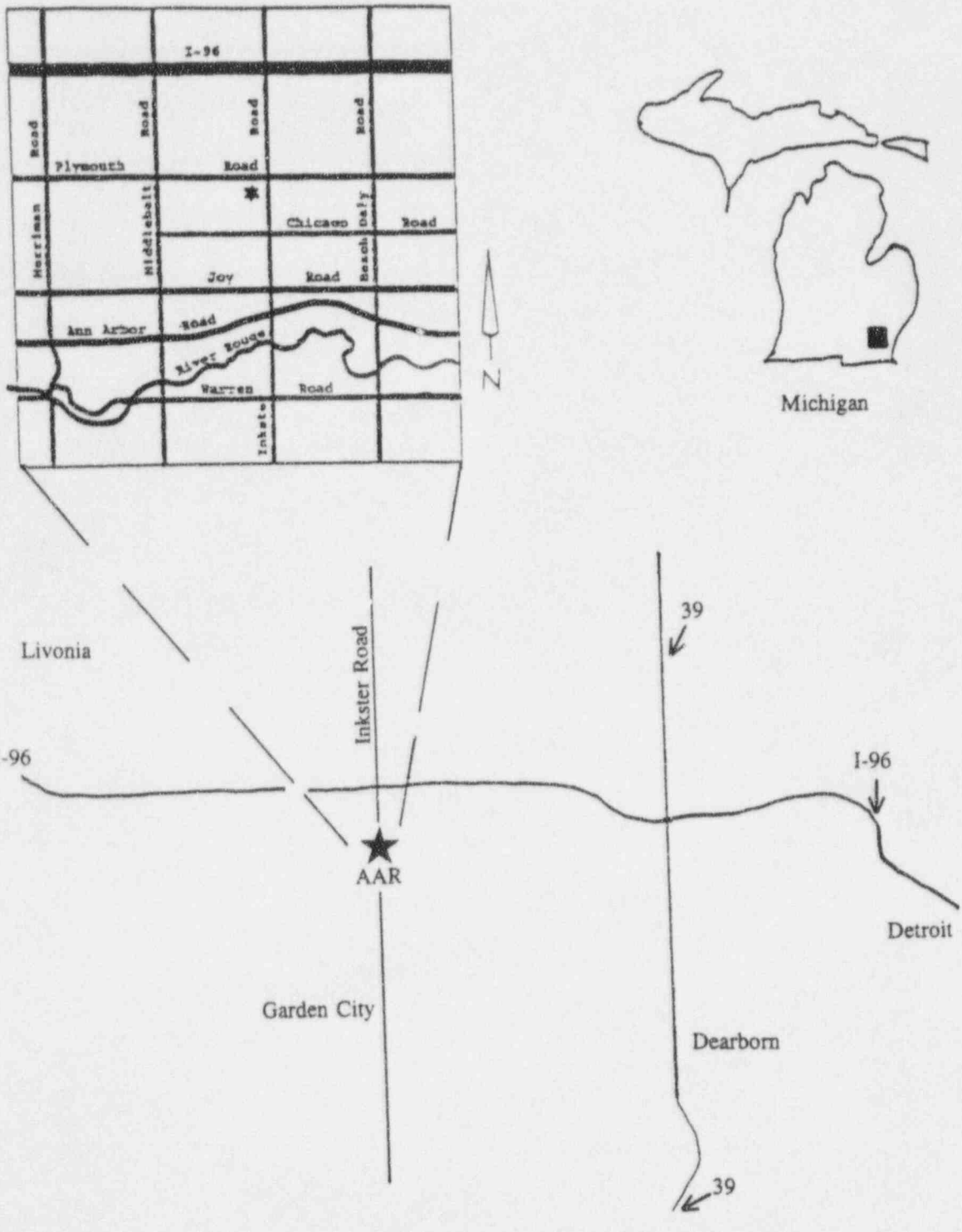


FIGURE 2.1.1-1

SITE LOCATION MAP

B. KOH & ASSOCIATES, INC.

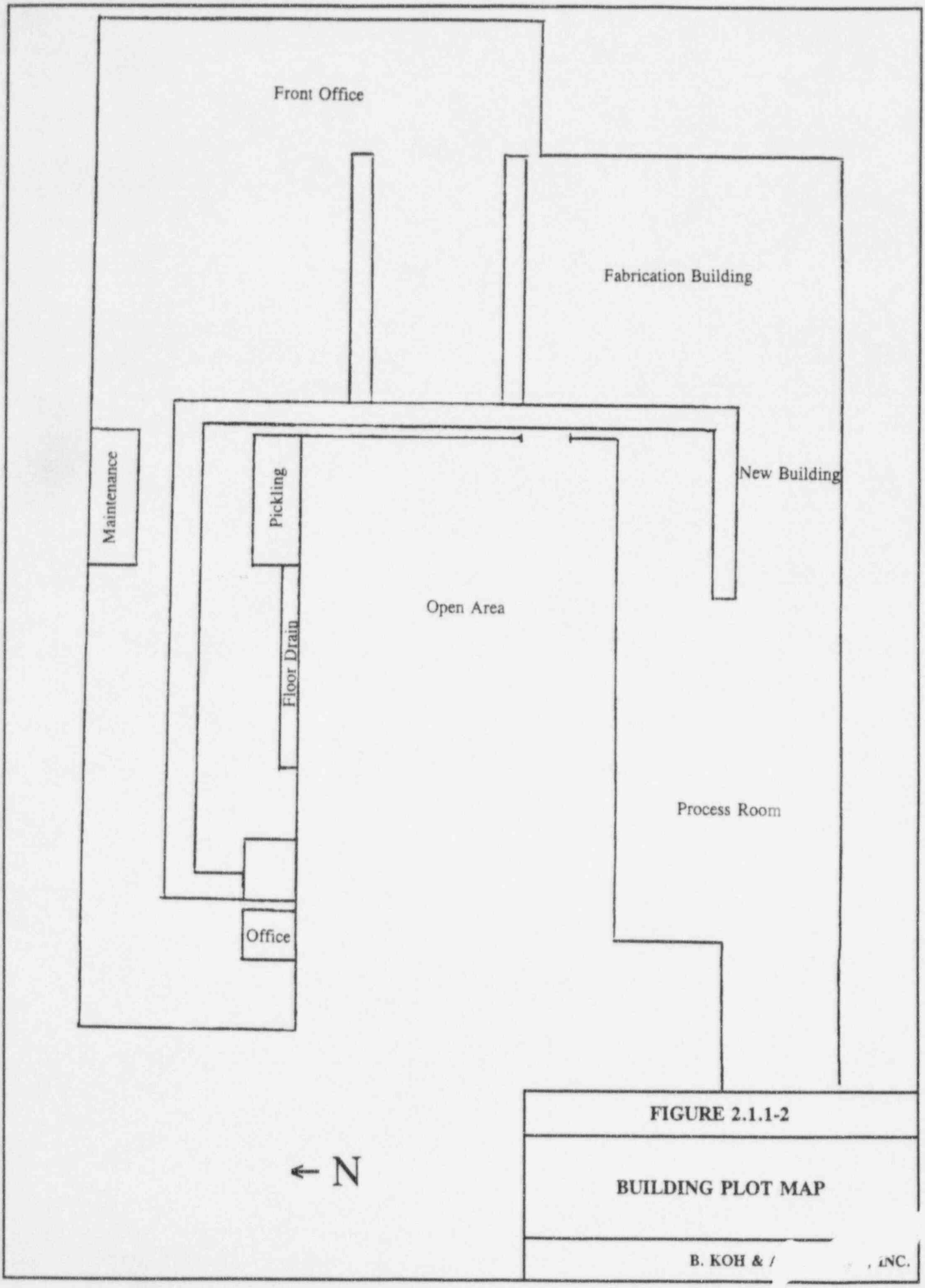
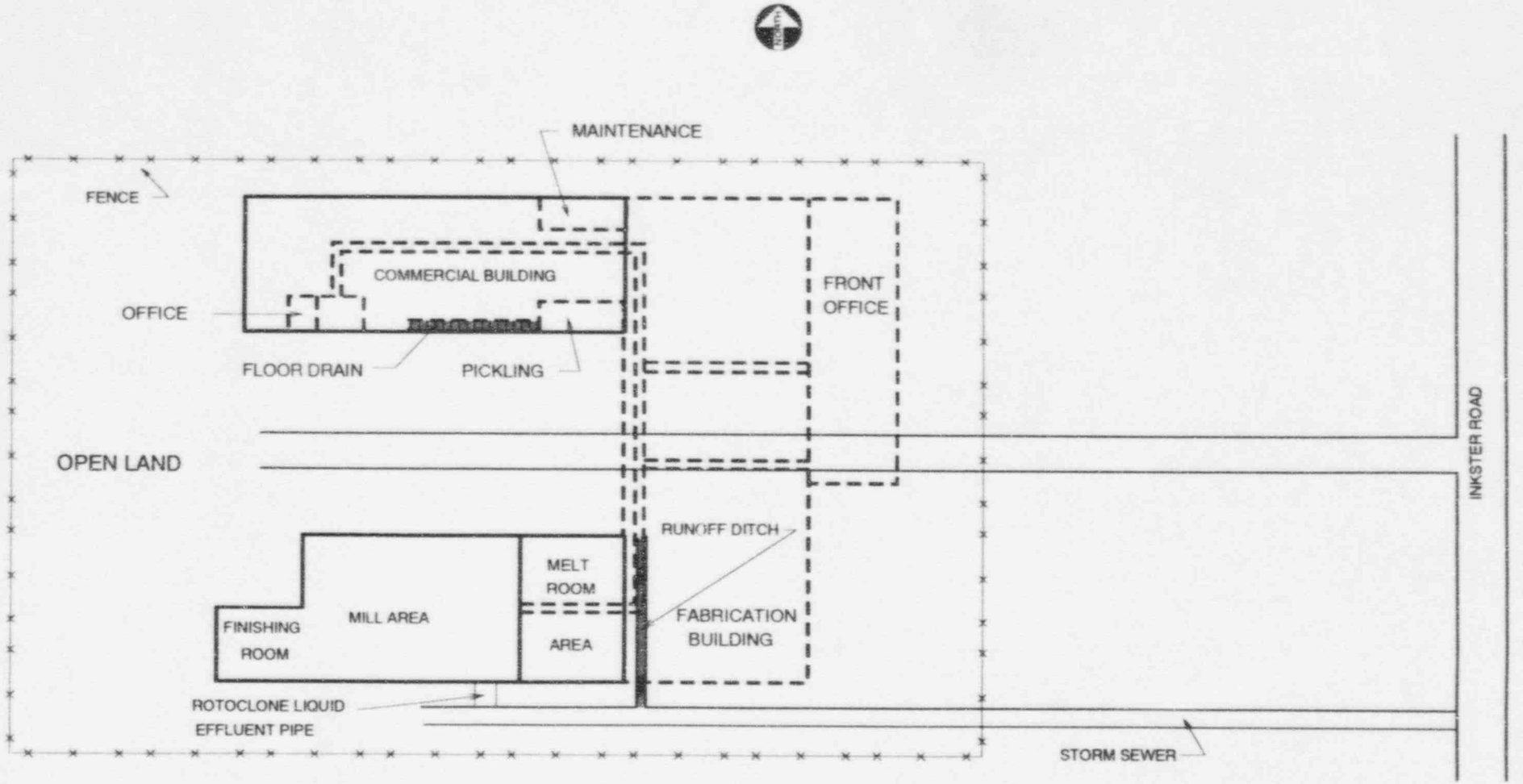


FIGURE 2.1.1-2

BUILDING PLOT MAP

B. KOH & / , INC.



LEGEND

- FOOTPRINT OF ADDITION
- FOOTPRINT OF BUILDINGS CIRCA 1960

B. KOH & ASSOCIATES, INC.

FIGURE 2.1.1-3
SITE PLOT PLAN
DATE: MARCH 23, 1995
NOT TO SCALE

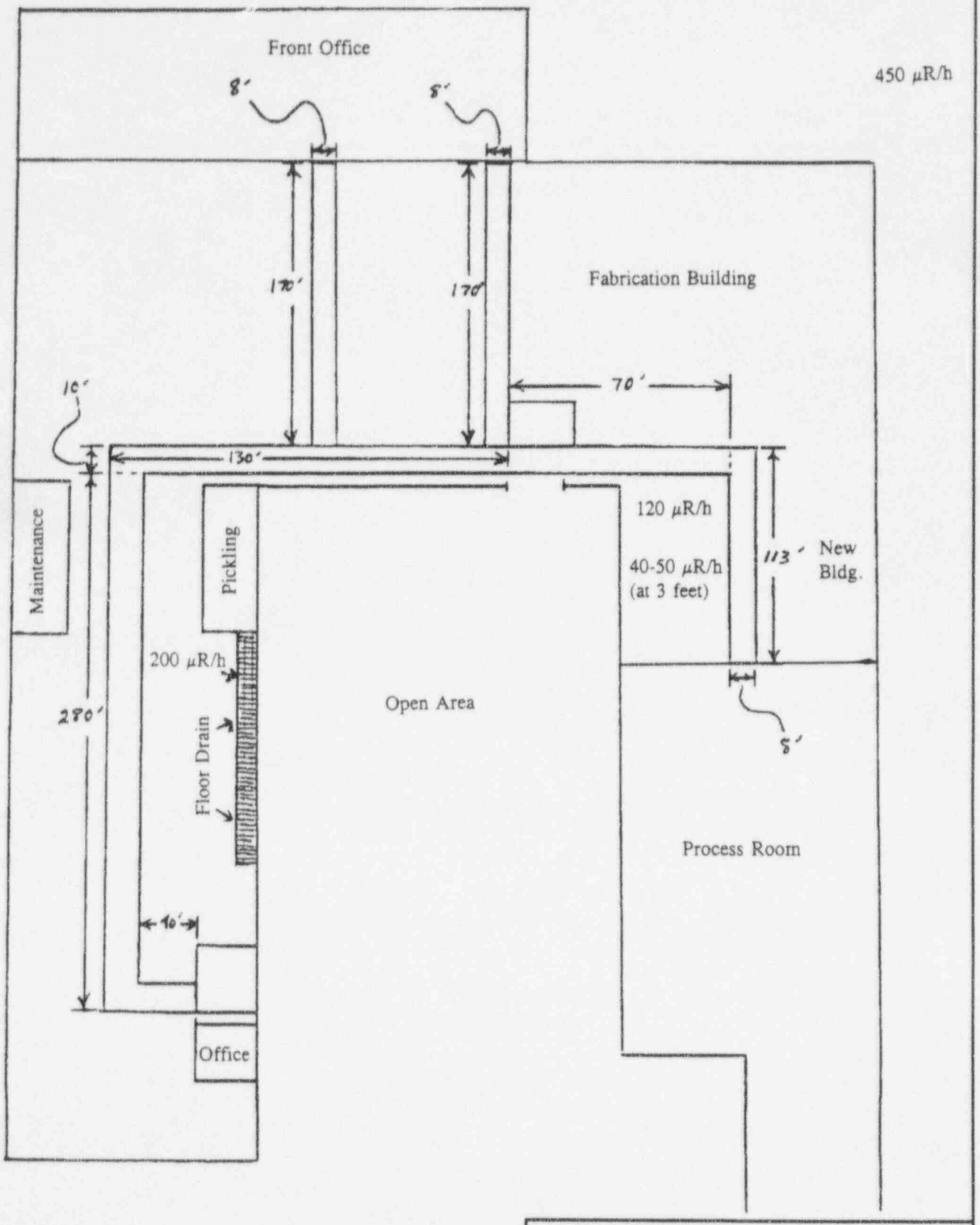


FIGURE 2.1.1-4

NRC SURVEY MAP

B. KOH & ASSOCIATES, INC.

3.0 DOSE ASSESSMENT

A radiological dose assessment is a method used for determining the amount of exposure to an individual or a population of individuals to a given radionuclide and the subsequent dose. Thus, dose assessment is a major activity of the site characterization process. The general process for conducting exposure and dose assessment includes the following components:

(1) Characterization of the exposure setting (physical setting and potentially exposed populations) at the former Brooks and Perkins, Inc. site.

(2) Identification of potential exposure pathways.

(3) Quantification of exposure hazard in terms of radionuclide (Thorium) concentrations or exposure rates (e.g., for direct gamma radiation).

(4) Estimation of radiological dose from the residual Thorium contamination using acceptable dose assessment codes.

3.1 Characterization of Exposure Setting and Potentially Exposed Population

The first step in the preliminary evaluation of potential doses is to assess the information known about the site, its physical characteristics, and extent of site Thorium contamination. The evaluation results will be used to identify potential exposure pathways and exposure points. Such information may also help in determining site characterization information needs.

3.2 Identification of Potential Exposure Pathways

The exposure pathway is the course through which a radiological constituent (Thorium) will be transported or conveyed from the source to the exposed individual. The exposure pathway analysis links the source(s), locations, and types of environmental releases with population locations and activity patterns to determine significant pathways of human exposure. An exposure pathway typically comprises four elements:

(1) A source and mechanism of radionuclide release;

(2) A retention or transport medium;

(3) A point of potential human contact with the contaminant; and

(4) Exposure route into the human (e.g., ingestion or direct radiation) at the contact point.

3.2.1 Sources and Receiving Media

Evidence of Thorium contamination of certain areas at the former Brooks and Perkins, Inc. site has been identified from review of available information on the site operational history and waste disposal practices. Thorium contamination may exist in buildings, structures, equipment, soil, waste disposal trenches, drain lines, plumbing, effluent discharge canals, surface water, and groundwater. Potential release and exposure mechanisms for the Thorium contaminated material include surface water runoff, infiltration, groundwater leaching and transport, wind erosion, or direct radiation. The assessment will also identify receiving media for Thorium contaminants from past and present operations and may include: surface water, groundwater, soil, sediments, and vegetation and air.

3.2.2 Fate and Transport of Contaminants

The purpose of fate and transport analysis at this stage is to identify media that are receiving or may receive Thorium and to assess the rate at which the Thorium may be transported through the media. Such analysis will address issues related to Thorium contamination occurring in the sources on or off the site and projected future locations and concentrations on or off the site. These analyses may be refined at the completion of site characterization on the basis of site-specific information and relevant reference studies.

The physical/chemical and environmental fate properties of Thorium will be obtained from general literature sources. The assessment will identify media that are currently contaminated and media that may reasonably become contaminated in the future.

3.2.3 Identification of Exposure Points and Exposure Routes

Exposure points are mainly identified by analyzing if and where any members of the potentially exposed population can contact contaminated media described above. Exposure points are typically located, or assumed to be located, at the location that the contamination can reasonably be contacted (e.g., where people live or work or where a domestic well is located).

Potential receptors at the site are considered to be limited to plant workers through direct contact or fugitive dusts. Workers at adjacent facilities, as well as the local population, are considered potential receptors through surface water, groundwater or fugitive dusts.

3.3 Quantification of Exposure

Exposure is typically quantified in two major steps. The first step involves estimation of exposure concentration; the second pertains to quantification of each pathway specific intake or exposure.

Exposure concentration is estimated either by direct determination of radionuclide concentration in the affected (e.g., soil, groundwater, and surfaces) or by using computational codes that model contaminant transport.

Appropriate dose conversion factors (e.g., Federal Guidance Report No. 11, EPA-520/1-88-20; September 1988) and dose assessment codes will be employed for estimation of dose received from each specific intake. For the radionuclide Thorium, the dose assessment calculations will be carried out for 1,000 years.

3.4 Estimation of Radiological Dose Using Dose Assessment Codes

The assessment will estimate radiation doses to potentially exposed individuals and critical population groups. Doses will be expressed in terms of effective dose equivalents (50-year committed dose) due to intakes of Thorium by inhalation, ingestion, or direct exposure. As stated above, appropriate dose conversion factors (e.g., Federal Guidance Report No. 11, EPA-520/1-88-20; September 1988) representing effective dose equivalent per unit radionuclide intake will be used in estimating doses. In the unlikely event that individual organ doses approach non-stochastic effect thresholds, the assessment will also present individual organ doses. The assessment will provide an estimate of the total individual doses from all pathways and each significant exposure pathway (e.g., ingestion, inhalation, direct exposure).

4.0 PHYSICAL CHARACTERISTICS OF THE SITE

4.1 Surface Features

4.1.1 Regional Topography

The surface features of Wayne County fall into two main divisions. The first division is the rough (morainic) area covering only the northwestern corner of the county. The second division is the broad, flat lake plain; which, were it not for subsequent stream, wave and wind action would appear to be remarkably even (Michigan, 1913)

In general, the topography of Wayne County is relatively flat. The highest point noted in the county is the extreme northwestern corner, 975 feet above mean sea level (msl).

4.1.1.1 Site Specific Topography

The former Brooks and Perkins, Inc. site is located on the southeastern corner of Wayne county in the flat lake plain region. Therefore, the land in which the site is located is flat with very little variation in topography.

4.2 Meteorology and Climatology

Meteorology and climatological data for the greater Detroit area recorded for the years 1951-1980 is presented below:

- The average annual maximum and minimum temperatures are 58.6 and 38.7 °F, respectively.
- The average annual rainfall is 31.65 inches.

- The annual snowfall is 38.5 inches.

The predominant wind direction is from the southwest (DOC, 1989).

4.2.1 Severe Weather Conditions

Summer precipitation comes mainly in the form of thundershowers. Annually, thundershowers will occur on an average of 36 days. Michigan is located on the northeast fringe of the tornado belt. The lower frequency of tornadoes occurring in Michigan may be, in part, the result of the colder water of Lake Michigan during the spring and early summer months, a prime period of tornado activity. During 1950-87, Michigan has averaged 15 tornadoes each year. During this same period, 23 tornadoes occurred within Wayne county (DOC, 1989).

4.3 Surface Water Hydrology

The oldest and largest drainage system to be developed within Wayne county is that of the Rouge River, with its Eastern, Middle and Lower branches which unite into a single trunk stream just to the east of Dearborn, Michigan (Michigan, 1913). This system drains into the Detroit River.

There is only one natural body of water in Wayne county that can be considered a lake. This unnamed lake is small, only about 840 feet by 1,170 feet (Michigan, 1913). It is surrounded by some swamp land and drains southwestward into the Middle Rouge.

Owing to the generally flat topography, portions of Wayne County are poorly drained and hence contain some extensive marshes throughout the area.

4.4 Geology

4.4.1 Regional Geology and Groundwater

Information regarding geology was obtained from the document entitled, "Report of Investigation No. 3, Geology for Land and Ground-Water Development in Wayne County, Michigan" by the State of Michigan, Department of Natural Resources and dated 1969.

4.4.2 Bedrock Geology

Michigan is located within a structural basin with beds of sedimentary rock dipping radially inward toward the central area of the Southern Peninsula. The bedrock surface of Michigan is a highly irregular surface. Major physical features of the bedrock surface consist of dissected uplands and lowlands. Uplands occur at elevations between 600 to more than 1,000 feet above mean sea level (msl). Lowlands occur between 400 and 600 feet msl. AAR, located in Wayne County, is situated in the Erie-Huron Lowland Physiographic Province along the southeast margin of the Michigan Basin.

Sedimentary rock strata underlying Wayne County are composed of materials deposited in ancient salty seas during the Paleozoic Era. The sequence of rock formations ranges from the Coldwater Shale of Mississippian Period (310-355 million years (MY) ago, youngest) to the Lake Superior Sandstone of Late Cambrian Period (475 MY ago, oldest). Paleozoic strata overlie Precambrian (> 570 MY ago) basement complex consisting of crystalline rocks of igneous and metamorphic origin.

Figure 4.4.2-1 presents the stratigraphic column for Paleozoic rocks in Michigan. As depicted in Figure 4.4.2-1, bedrock consists of alternating beds of sandstone, shale, limestone, dolomite some of which are interbedded with coal. Figure 4.4.2-1 also presents the approximate maximum thickness for each formation. The total maximum thickness as reported on the stratigraphic column

of the Paleozoic strata is 19,125 feet. This thickness is a maximum and assumes that all geologic units are present (which might not be true in some areas. Therefore, the actual thickness of the Paleozoic strata is most likely less than 19,125 feet.

Geologic formations mapped in Wayne County include the Mississippian Period Coldwater Shale, Sunbury Shale, Berea Sandstone, and Bedford Shale, the Devonian Period (345-410 MY ago) Antrim Shale, Traverse Group, Dundee Limestone, Detroit River Dolomite, and the Sylvania Sandstone. Coldwater Shales consist of micaceous, blue to blue-gray shale, becoming reddish and more sandy in the upper zones. Thin beds of dolomite, siltstone, and sandstone have been observed in Coldwater Shales. Sunbury Shales consist of hard, dark gray to black shales with traces of dolomite. Berea Sandstone consists of fine-grained, micaceous, white, gray, light drab to brown sandstone interbedded with gray to blue-gray shale. Bedford Shales consist of light gray, limy, or sandy shale with occasional dark gray shale beds. Antrim Shales consist of dark brown to black, bituminous shale containing large concretions and fossils. Traverse Group rocks consist of blue to blue-gray calcareous or dolomitic shale; light gray, gray, or gray-brown limestone; and gray to buff dolomite. Dundee Limestones consist of buff to light brown cherty limestone. Detroit River Group rock consists mostly of occasionally argillaceous and /or cherty dolomite and occasionally limestone. Sylvania Sandstone consists of white, fine to medium grained, high purity quartz sandstone.

4.4.3 Glacial Geology

The present topography of Wayne County was formed during the Wisconsin Stage (10,000 - 23,000 years ago, latest) of Pleistocene glaciation, as modified by subsequent erosion and deposition. Materials forming the present surface features do not necessarily extend downward to bedrock. The position and succession of glacial features found in Wayne County are related to the advance and withdrawal of the Erie-Huron Lobe.

In the northwest corner of the county, two northeast-southwest trending moraines are present. The Outer Defiance and Inner Defiance moraine separated by a narrow band of outwash and represent the southern extent of glacial advance. Sediments in Wayne County southeast of the moraine area consists of lacustrine and delta sands, lacustrine clays, and outwash deposits. Delta sands and outwash deposits originate from meltwaters from retreating glaciers. Lacustrine sands and clays originate from advance and retreat of glacial lake shorelines. Thickness of glacial deposits ranges from 20 - 30 feet in the southeast to a maximum of 390 feet in the northwest.

4.4.4 Site Specific Geology

No site specific geological information was obtained during development of this SCP. As part of site characterization activities, site specific geological information will be obtained and documented in the Site Characterization Report.

4.5 Hydrogeology

4.5.1 Regional Hydrogeology

Information regarding hydrogeology was obtained from the document entitled, "Report of Investigation No. 3, Geology for Land and Ground-Water Development in Wayne County, Michigan" by the State of Michigan, Department of Natural Resources and dated 1969. Groundwater in Wayne County occurs in the unconsolidated as well as consolidated geologic materials. Unconsolidated materials consist of the glacial drift and outwash deposits, alluvial deposits, and lacustrine deposits. A belt of glacial outwash and lacustrine sands trends through the middle of Wayne County from northeast to southwest. This area is most favorable for developing high-yield wells. Moraines and till plains are favorable for developing wells with small to medium yields. Glacial Lake Sediments (eastern Wayne County) are not favorable for developing wells with

moderate to high yields. Groundwater in the unconsolidated materials can occur in water table, semi-confined, or confined aquifers.

Consolidated materials consist of the bedrock formations underlying Wayne County. The best aquifer materials in this area are limestones and dolomites (when fractured) and sandstones. Sandstones may produce large quantities of water without extensive fracturing if sand grains are loosely cemented. Shales and siltstones generally exhibit low permeabilities, and, therefore, tend to act as confining layers.

Groundwater generally mimics topography in Wayne County. Therefore, groundwater will recharge in the morainic belts of western Wayne County and discharge to the Detroit River and other surface water bodies. Recharge to aquifers will also occur in the morainic belts. Groundwater will infiltrate the glacial moraines and migrate along groundwater gradients eastward to replenish the unconsolidated aquifers. Unconsolidated aquifers may also recharge from vertically migrating precipitation. General groundwater gradients for unconsolidated aquifers will be oriented west to east.

Wayne County is located on the eastern edge of the Michigan Basin. Bedrock dips toward the center of the state indicating that bedrock elevations are higher in Wayne County than in the center of the state. Wayne County, therefore, is a recharge area for the bedrock aquifers in the central Michigan. Regional groundwater gradients for bedrock aquifers will most likely be east to west.

4.5.2 Site Specific Hydrogeology

No site specific hydrogeological information was obtained during development of this SCP. As part of the site characterization activities, site specific hydrogeological information will be obtained and documented in the Site Characterization Report.

4.6 Demography and Land Use

4.6.1 Demography

Population data on the site and its surrounding areas will be collected to assess the potential health and safety and socio-economic impacts of the Thorium contamination at the former Brooks and Perkins, Inc. site.

The demographic data will include the residence inventory which will identify the locations and number of residents within a 2-km (1.2 miles) radius from the site boundary. Any sensitive population (e.g., medical institutions, nursing homes, etc.) will be identified within the designated radius.

4.6.2 Land Use

Land use information regarding the site and the surrounding vicinity will be collected and reviewed to assess potential impacts on the public health and safety from radiological releases from the contaminated areas of the site and the potential onsite exposure due to remediation.

STRATIGRAPHIC SUCCESSION IN MICHIGAN

PALEOZOIC THROUGH RECENT

MICHIGAN DEPARTMENT OF CONSERVATION
Ralph A. MacMullan, Director
GEOLOGICAL SURVEY
Gerald E. Eddy, State Geologist

ACKNOWLEDGEMENT: Compiled with the counsel of colleagues in the department, the U. S. Geological Survey, Michigan's universities, other state Geological Surveys, and geologists within Michigan's oil and gas industry. Dr. Aureal T. Cross, Department of Geology, Michigan State University, identified rocks of Mesozoic age and suggested provisional age assignments.

GEOLOGIC NAMES COMMITTEE
Garland D. Ells, Chairman; Robert W. Kelley, Secretary;
Harry J. Hardenberg, L. David Johnson, Harry O. Sorensen

PLEISTOCENE NOMENCLATURE

ERA	SYSTEM	SERIES	STAGE	
CENOZOIC	QUATERNARY	RECENT		
		PLEISTOCENE	Wisconsin Glaciation	Valders Stade
				Two Creeks Interstade
				Mankato Stade (Pt. Huron?)
				Cary Stade
				Tazewell Stade
			Sangamon Interglaciation	
			Illinoian Glaciation	

OUTCROP NOMENCLATURE

ERA (Geologic time)	PERIOD (Geologic time)	EPOCH (Geologic time)	SYSTEM (Time-stratigraphic)	SERIES (Time-stratigraphic)	GROUP (Rock-stratigraphic)	FORMATION (Rock-stratigraphic)	MEMBER (Rock-stratigraphic)
MESOZOIC	JURASSIC	LATE	JURASSIC	KIMERIDGIAN			
	PENNSYLVANIAN	LATE	PENNSYLVANIAN	CONEMAUGH		Grand River Fm.	Ionia, Eaton, and Woodville Sandstones
		EARLY		POTTSVILLE		Saginaw Fm.	Verne Ls.
	MISSISSIPPIAN	LATE	MISSISSIPPIAN	MERAMECIAN	GRAND RAPIDS	Bayport Ls.	
						Michigan Fm.	
		EARLY		OSAGIAN		Marshall Ss.	Napoleon Ss.
				KINDERHOOKIAN		Coldwater Sh.	
	MISSISSIPPIAN-DEVONIAN Unassigned					Ellsworth Sh. (Western Michigan)	
	DEVONIAN	LATE	DEVONIAN	CHAUTAUQUAN		Antrim Sh.	
				SENECAN		Squaw Bay Ls.	
		MIDDLE		ERIAN	TRAVERSE	Thunder Bay Ls.	
						Potter Farm Fm.	
						Norway Point Fm.	
						Four Mile Dam Fm.	
						Alpena Ls.	
						Newton Creek Ls.	
						Genshaw Fm.	Killians
						Ferron Point Fm.	
						Rockport Quarry Ls.	

DOMINANT LITHOLOGY

SUBSURFACE NOMENCLATURE

ROCK-STRATIGRAPHIC

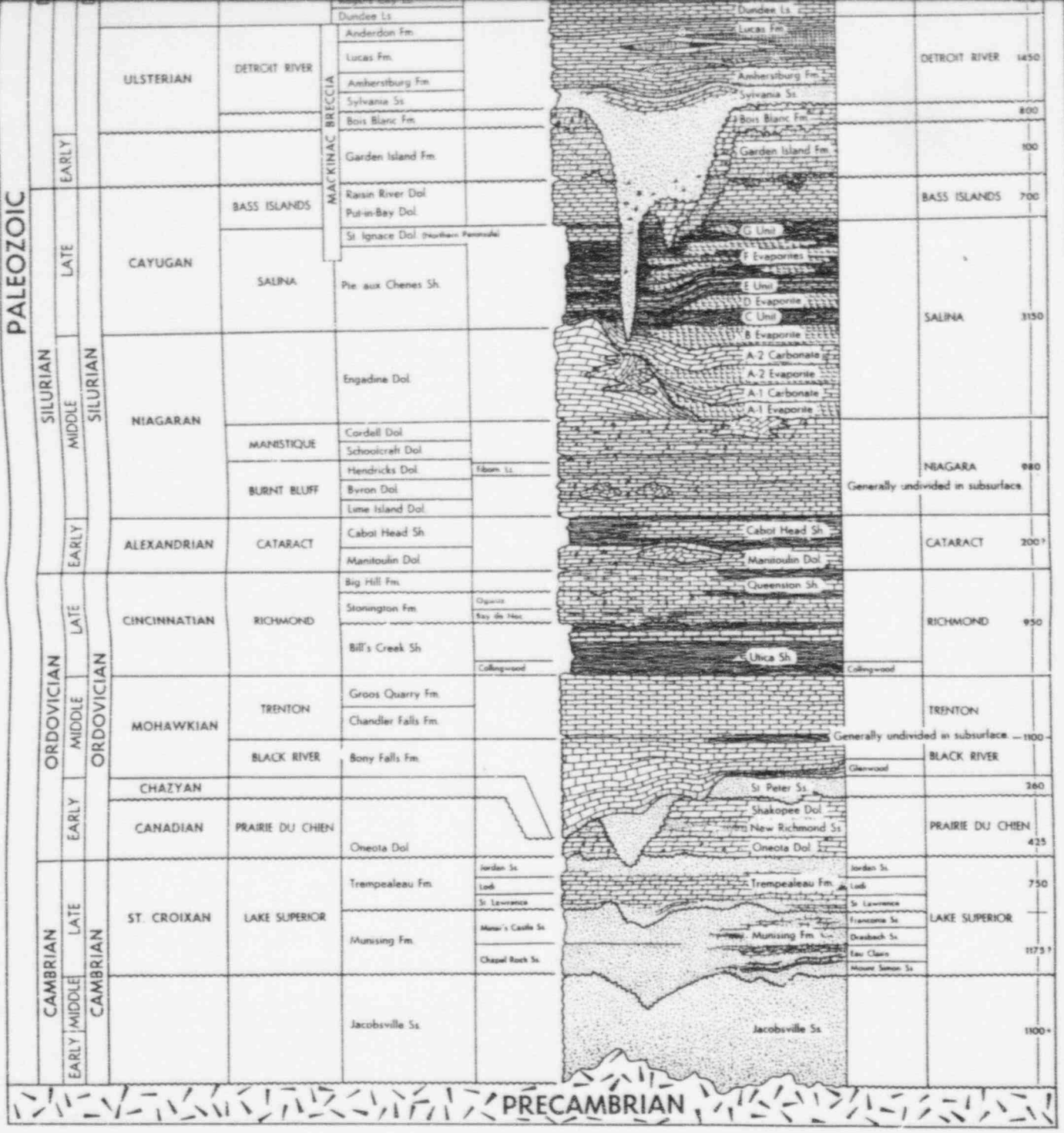
Approximate maximum thickness, in feet, of rock units in the subsurface. NO SCALE

FORMATION	MEMBER	GROUP	Thickness
"Red Beds" (unnamed)			220
Grand River Fm. / Saginaw Fm.			750
Bayport Ls.		GRAND RAPIDS	160
Michigan Fm.			600
Marshall Ss.	Napoleon Ss.		330
Coldwater Sh.			1300
Sunbury Sh.		(Eastern Michigan)	160
Berea Ss.			260
Bedford Sh.			240
Antrim Sh.			660
Squaw Bay Ls.			
Alpena Ls.		TRAVERSE Generally undivided in subsurface.	830

INFORMAL TERMS

Principal oil and gas pays, and informal terms used in petroleum exploration and applied to parts of formations or groups in the subsurface.

STRATIGRAPHIC POSITION	INFORMAL TERMS	PAYS
Basal sandstones of Saginaw Fm.	Parma sandstone	
In lower part of Michigan	triple gyp.	
	brown lime	
	stray-stray ss.	Gas
	stray dol.	
	stray ss.	Gas & Oil
Marshall Ss.		Gas & Oil
Coldwater Sh.	Coldwater lime	
	Weir sand	Gas
	Coldwater red-rock	
In upper part of Ellsworth Sh.	"Berea" (Western Michigan)	Oil & Gas
Berea Ss.	Berea sand (Eastern Michigan)	Oil & Gas
Squaw Bay Ls.	Squaw Bay	Oil & Gas
Upper part of Traverse Group in Western Michigan	Traverse formation	
	[illegible]verse lime	Oil & Gas
	[illegible] Lake zone	Oil & Gas
Rogers City Ls.		Oil & Gas
Dundee Ls.		Oil & Gas
Dundee Ls. (?), Upper part of Lucas Fm. (?)	Reed City zone	Oil & Gas
In Lucas Fm.	massive salt	
	big salt	
	sour zone	Oil & Gas
	massive anhydrite	
	big anhydrite	
	Richfield zone	Oil & Gas
Amherstburg Fm.	black lime	
Part of Salina Group E Unit	E zone (or Kintigh zone)	Oil
Divisions of A-2 Carbonate	A-2 dolomite	Gas



GEOLOGIC NAMES COMPILATIONS. Henry O. Sorensen, Cambrian and Ordovician; Robert W. Kelley, Early and Middle Silurian; Garland D. Elk, Late Silurian through Detroit River Group of Devonian age; Harry J. Hardenbergh, Dundee Limestone through Traverse Group of Devonian age; L. David Johnson, Antrim Shale through the Pennsylvanian System; F. Wells Terwilliger, glacial geology of the Canadian.

CHART 1

1964

FIGURE 4.4.2-1

5.0 EXTENT AND CONCENTRATION OF CONTAMINATION

5.1 Analysis and Review of Source and Contamination Characterization

The complexity and depth of detail of contamination characterization depends primarily on the extent and concentration of the contamination. Therefore, the first phase of the SCP in determining the extent of Thorium contamination within the buildings and open land areas of the former Brooks and Perkins, Inc. site is to analyze the type of facility and nature of the process(es) that may have caused the radiological contamination.

Specifically, this SCP will assess the Brooks and Perkins, Inc. process(es) to determine their effect on site Thorium contamination in terms of the following information:

- Physical and chemical properties of the Thorium.
- Quantities of Thorium used in the process(es).
- Types and quantities of reagents used in the process(es).
- Specific raw Thorium material composition used.
- Location of effluent discharges and releases.
- Relative throughput of activity and materials.
- Waste management practices.
- Material balance and inventory sheets.

- Other plant and operational records.
- Interviews with long-time employees (e.g., past, retired, present).
- Reports, accidents and incidents (e.g., fires, spills, unintentional releases and leakages).

In order to gather information necessary to address the above items, the following sources of information will be reviewed:

- Analyses of historical records on environmental monitoring.
- License applications, amendments and renewal.
- Operational permits.

Documented past data (Brooks and Perkins, Inc., May 1971) and more recent data (NRC, March 1994) indicate that certain locations within the former Brooks and Perkins, Inc. buildings and open land areas are contaminated with Thorium. In particular, the storm sewer/drainage swale located along side the parking lot and C&O railroad tracks on the south side of the site, the floor drainage sump located along the south wall of the former Commercial Building, and the elevated exposure readings (120 μR/hour) on contact with the concrete floor, inside a portion of the new building, all indicate Thorium contamination at the former Brooks and Perkins, Inc. site. Section 2.0 provides a more detailed discussion of the Brooks and Perkins, Inc. Final License Termination Survey performed in November 1970 (Brooks and Perkins, Inc., May 1971) and the NRC survey conducted of the site in February 1994 (NRC, March 1994).

Since surveys have been conducted which have confirmed Thorium contamination at the former Brooks and Perkins, Inc. site, the proposed characterization of the extent of the contamination, as outlined in this SCP, will include an assessment of the distribution of the Thorium in buildings and

structures, soils, surface water and sediments, and vegetation at the site. Thorium contamination of the groundwater will also be assessed.

The site characterization activities, as outlined in this section of the SCP, will include sufficient information on the Thorium radiological and physio-chemical analytical data to ensure their reliability and representativeness including sampling analysis methodology (Sections 5.0, 6.0 and 7.0) and quality assurance and quality control requirements (Section 8.0).

5.2 Design of Survey and Sampling of Contamination

The extent of the Thorium contamination at the former Brooks and Perkins, Inc. site will be determined using an appropriate combination of field survey, sampling techniques and laboratory analysis for each medium (e.g., water, soil).

The site characterization activities will be performed by qualified individuals using calibrated and maintained survey and sampling instrumentation/equipment. The activities will be conducted in accordance with approved plans and/or procedures. Furthermore, the site characterization activities including the design and conduct of the radiological surveys, as described in the subsequent section, have been developed consistent with the guidance contained in the NRC Draft Branch Technical Position on Site Characterization for Decommissioning Sites (NRC, July 1992) and in Draft NUREG/CR-5849, Guidance Manual for Conducting Radiological Surveys in Support of License Termination (NRC, June 1992).

5.2.1 Survey and Sampling Design

Based upon review of the available information regarding the former Brooks and Perkins, Inc. operations and the resultant Thorium contamination, it is apparent that all areas of the site do not

have the same potential for residual contamination. Consequently, these areas do not require the same level of survey/sampling coverage as the areas likely to be contaminated to achieve an acceptable level of confidence that the site satisfies the established release criteria for Thorium.

Therefore, the survey and sampling efforts outlined in this SCP have been designed such that site buildings and open land areas with higher potential for Thorium contamination will receive a higher degree of survey and sampling effort. This approach provides for a survey and sampling process which is both effective and efficient.

Consistent with Draft NUREG/CR-5849, the former Brooks and Perkins, Inc. site was subdivided into survey units and strata based on the potential for and the type of contamination. These subdivisions will be used as references for purposes of conducting site characterization activities and establishing the sampling and measurement frequency and pattern. Specifically the site was segregated into two classification areas; these are termed affected and unaffected areas. These classifications are defined as follows:

- Affected Areas

  Areas that have potential Thorium contamination (based on plant operating history) or known Thorium contamination (based on part of preliminary radiological surveillance). This would normally include areas where Thorium materials were used and stored, where records indicate spills or other unusual occurrences that could have resulted in spread of Thorium contamination and where Thorium materials were buried. Areas immediately surrounding or adjacent to locations where Thorium materials were used and stored, spilled or buried are included in this classification because of the potential for inadvertent spread of Thorium contamination.

- Unaffected Areas

  All areas not classified as affected. These areas are not expected to contain Thorium residual radioactivity, based on a knowledge of site history and previous survey information.

It is recognized that as site characterization and sampling efforts progress, an area's classification may require changing, based on collected survey and sampling data. Identification of soil activity levels in excess of 50% of this guideline, either by scans or measurements, will require further investigation to determine whether reclassification of an area to the "affected category" is necessary. The investigation will include the collection and analysis of additional soil samples within 5 meters of the elevated soil sample location. If the additional soil sample results are greater than or equal to 75 of the established limit, the area will be reclassified as "affected". The size of the "affected" area (survey unit) will depend on the extent of contamination.

To facilitate survey design and assure that the number of survey data points from an area (affected or unaffected) is sufficient to enable statistical evaluation, the areas (affected or unaffected) have been divided into survey units which have a common history or other characteristics naturally distinguishable from other portions of the site. The size of the survey and sampling unit was chosen to assure that the total number of data points and the spacing of the measurements/sampling satisfies the 95% confidence level for that survey unit.

Table 5.2.1-1 presents the classifications of the affected and unaffected areas of the former Brooks and Perkins, Inc. site. Figure 2.1.1-2 shows the locations of each of the identified survey units within the affected or unaffected area.

5.2.1.1 Affected Areas

5.2.1.1.1 Buildings

Affected areas specific to the onsite buildings include: subsurface soil under the newer addition to the Melt Room and the floor drain in the south side of the Old Commercial Building. A 10 meter x 5 meter grid will be established to investigate subsurface soil area under the new addition. A 2 meter x 2 meter grid will be established to investigate the floor drain.

5.2.1.1.2 Open Land

The affected area specific to the open land areas onsite include the old storm sewer/drainage swale located on the south side of the site, south of the building containing the Melt Room, Mill Area, Finishing Room along the railroad tracks. The open land area between the old commercial building and process building. Open areas along the north and west site perimeter. A 20 meter x 20 meter grid will be established for the affected area.

5.2.1.2 Unaffected Areas

5.2.1.2.1 Buildings

The unaffected building areas are essentially the remaining buildings (administrative offices). Grids will not be established for these buildings.

Based on the NRC survey conducted in February 1994, the sanitary sewer and drain lines will be initially classified as unaffected areas. If Thorium contamination is identified, these areas will be reclassified as affected and sampled/surveyed accordingly.

5.2.1.2.2 Open Land

For purposes of characterization there are no open areas classified as unaffected.

Because of the concern for locating the incineration and potential 20.304 burial area it is understood that the classification of these openland areas as affected is for purposes of characterization. Therefore, consistent with Section 5.2.1 the openland areas tentatively classified as affected may require changing, based on collected survey and sampling data.

5.2.1.3 Grid System

In accordance with the guidance presented in Draft NUREG/CR-5849, a grid system will be established to provide a traceable reference for survey measurements/sampling locations, to provide a convenient method for determining the average Thorium contamination levels, and for providing a reference for future relocation of survey and sampling points. The grid intervals will be based on the potential for residual Thorium contamination in the buildings and open land areas.

A 2 meter x 2 meter grid will be established for affected area buildings and structures identified in Section 5.2.1.1.1 except that a 10 m x 5 m grid will be established for the soil under the floor. A 20 meter x 20 meter grid will be established for affected and unaffected open land areas identified in Section 5.2.1.1.2. A grid system will not be established for unaffected area buildings and open land areas.

5.2.2 Sampling Methodology and Frequencies

The determination of the distribution and extent of the residual Thorium contamination in the selected affected area buildings and open land areas will be accomplished through the use of surface scans, surface activity measurements (direct and removable), exposure rate measurements and surface and subsurface soil sampling. In addition, surface water, vegetation and air sampling will be performed. Groundwater will also be sampled.

5.2.2.1 Surface Scans

Scanning of surfaces to identify locations of residual surface and near-surface Thorium activity will be performed according to the following protocol:

- Affected Area Surfaces

  100% scan will be conducted of the surface of the storm sewer/drainage swale and adjacent areas, the concrete floor surface in the new addition covering the melting pot runoff ditch, and the drainage sump and adjacent areas, along the south wall of the Old Commercial Building.

- Non-Contaminated Upper Surfaces in Affected Areas

  Scans will be performed in the immediate vicinity of the direct surface activity measurement (Section 5.2.2.2.1).

- Unaffected Area Surfaces

  10% of lower surface (buildings). Measurements will be made at approximately 40 randomly selected areas throughout the site.

Building interior and exterior surface scans will be conducted for beta-gamma radiations using a calibrated gas proportional flow counter with a 100 cm^2 probe area or a GM pancake probe coupled with a survey ratemeter or equivalent instrumentation. Open land soil surfaces will be scanned for gamma radiations only at 1 cm from ground surface using a calibrated 2 inch x 2 inch NaI (TI) gamma scintillation detector coupled with a ratemeter, Geiger Mueller (GM) pancake probe coupled with ratemeter, or equivalent instrumentation.

Instrumentation for scanning is listed in Table 5.2.2.1-1. The instruments having the lowest detection sensitivity will be used for the scans, wherever physical surface conditions and measurement locations permit.

Scanning speeds will be no greater than one detector width per second for beta gamma detection instruments and 0.5 m per second for gamma instruments. Audible indicators (headphones) will be used to identify locations, having elevated (2 to 3 times ambient) levels of direct radiation. All scanning results will be noted on standard field record forms.

Areas of elevated direct radiation (above the guideline limit) identified during scan surveys of structure or soil surfaces will be identified and documented. The results of the scan will satisfy the guideline limit at the 95% confidence level. Locations of elevated radiation will be identified for later investigation, biased soil sampling and remediation, if necessary.

5.2.2.2 Surface Activity Measurements

5.2.2.2.1 Direct Measurements

Direct measurements of beta-gamma surface activity will be performed at selected locations using instrumentation described in Table 5.2.2.1-1. Direct measurements of alpha surface activity will be performed on 10% of the beta-gamma direct measurements. Unless precluded by surface conditions or physical parameters, the most sensitive of the instruments listed for surface measurements will be used. Measurements will be conducted by integrating counts over a one minute period.

Because the scanning techniques using the gas proportional flow counter with a large probe area (100 cm^2) is capable of detecting residual Thorium activity at $<25\%$ of the guideline level, direct surface activity measurements will be systematically performed at 2 m intervals on floors and lower walls of affected areas and at the same intervals on upper surfaces that may have residual activities in excess of 25% of the guidelines.

On upper surfaces of affected areas which are not suspected of residual activity, measurements will be performed at a minimum of 30 locations each on vertical and horizontal surfaces and a scan of the immediate area around these locations will be performed. These locations will include surfaces where radioactive material would likely settle, and sufficient additional locations to provide coverage at a minimum average of one location per 20 m^2 of surface area.

On surfaces of unaffected areas, a minimum of 30 random measurements or an average measurement of one per 50 m^2 of building surface area, will be performed for each survey unit. These locations will include all building surfaces. Measurements will be biased toward areas/locations most likely to contain Thorium residual contamination (e.g., window sills, sumps, ventilation duct work and fans, structural members).

5.2.2.2.2 Removable Contamination Measurements

A smear for removable alpha and beta/gamma contamination will be performed at each direct surface activity measurement location.

5.2.2.3 Exposure Rate Measurements

Gamma exposure rates will be measured at contact and one meter above ground or floor surfaces, using a pressurized ionization chamber (PIC), a NaI (Tl), or a μR-meter or equivalent gamma scintillation instrument, that has been calibrated against a PIC at the site. Measurements will be uniformly spaced according to the following pattern:

Building Interiors

Affected Areas: 1 measurement per 4 m^2
Unaffected Areas: 1 measurement per 200 m^2

Open Land Areas

Affected Areas: 5 measurements per 100 m^2 grid block along storm sewer/drainage swale and any other locations where the radiation level measured at 1 cm exceeded twice background.

50 measurements at randomly selected locations and any other locations where the radiation level measured at one cm exceeded twice background.

5.2.2.4 Soil Sampling

5.2.2.4.1 Surface

5.2.2.4.1.1 Stormwater Sewer/Drainage Swale

Four surface (0-15 cm) soil samples (approximately 500 grams each) will be systematically collected from each 20 meter x 20 meter grid block at locations equidistant between the center and each of the four grid block corners. A fifth surface soil sample will be collected in the center of the grid block along with the collection of the subsurface soil sample.

Since there will be approximately nine 20 meter x 20 meter grid blocks established along the stormwater sewer/drainage swale, a total of 45 surface soil samples (9 grid blocks x 5 samples/grid block) will be collected from this affected area.

The surface soil samples will be analyzed for Thorium via alpha or gamma spectroscopy. Alpha spectroscopy will be performed on a selected number of soil samples to confirm the gamma spectroscopy results.

Surface (0-15 cm) soil samples will also be obtained from the geoprobe locations and approximately 23 random locations in areas within the site and site perimeter. At each surface sampling location, contact beta-gamma levels will be obtained prior to sampling to determine whether subsurface Thorium contamination may be present. The soil samples will be analyzed for Thorium via alpha or gamma spectroscopy.

5.2.2.4.2 Subsurface

Subsurface investigation will be performed within each identified affected area Table 5.2.1-1). Thirty five subsurface samples will be obtained by a geoprobe, hand auger, surface soil sampler, or the split spoon method (Figure 5.2.2.4-1). Sampling will be at the surface (0-15 cm) and at a continuous depth of every 0.6 m (2 feet) thereafter, until there is no evidence of Thorium contamination. A GM pancake probe coupled with a ratemeter will be used to field screen each sample to confirm the absence of Thorium contamination. Subsurface soil samples will be analyzed for Thorium-228 and Thorium-232 via alpha or gamma spectroscopy. The subsurface samples will be analyzed in two-foot increments using gamma spectroscopy. Approximately five samples will be analyzed for isotopic Thorium (Th-228 and Th-232). Once the isotopic ratios are determined for the five samples, the results of the gamma spectroscopy analyses can be correlated to the total Thorium concentration (Th-228 and Th-232).

Surface scans will be performed in the immediate vicinity of the geoprobe locations and in between sample locations, covering an area of approximately 100 m^2 between sample locations.

The subsurface sampling strategy for the stormwater sewer consists of one borehole in the center of each 40 meter x 20 meter grid block. Thus, a total of seven boreholes (seven 40 meter x 20 meter grid block x one borehole/grid block) will be drilled in this affected area.

The subsurface strategy for the soils under the new addition and the asphalt driveway is consistent with the strategy developed for surface soil sampling of these affected areas (Section 5.2.2.4). Thus, a total of seven subsurface soil samples and five subsurface soil samples will be collected from the soil under the new addition and the soil under the asphalt driveway, respectively.

5.2.2.5 Water

5.2.2.5.1 Surface

Six samples of surface water will be collected at various locations along the stormwater sewer/drainage swale to determine the impact of the Thorium contamination on local surface water regime. These samples will be analyzed for Thorium via gamma or alpha spectroscopy.

5.2.2.5.2 Groundwater

Ten of the 35 geoprobe borings discussed in Sections 5.2.2.4.2 and 5.2.2.4.3 will be drilled for the purpose of collecting groundwater samples. Figure 5.2.2.4-1 presents potential geoprobe boring locations. Groundwater sample locations were selected based on the estimated direction of groundwater flow, known areas of materials handling, and suspected areas of disposal. One upgradient location (BKGW-2) will be sampled to determine upgradient water quality and background Thorium, Radium and Uranium concentration in soil. Five geoprobe locations (BKGW-1, BH-3 through 5, and 10) are adjacent to materials handling areas and areas of significant dose measurements. Data from these boreholes will be used to evaluate groundwater quality near potential contaminant source areas. Boreholes BKGW-7 through 9 will be drilled along the downgradient side of the site to determine if contamination is migrating offsite. BKGW-6 will serve as a sampling point near a potential source and a downgradient sampling point.

Geoprobe sampling will be accomplished by driving 2-inch ID, 4-foot long, core barrels with a hydraulic hammer and withdrawing the core barrels to obtain soil samples. This type of sampling will be used to advance boreholes to the water table. B. Koh & Associates, Inc. (BKA) estimates that each groundwater sampling borehole will be drilled to 20 feet below grade. Once the proper depth is achieved, a groundwater sample will be extracted by lowering a small diameter well point into the borehole and purging with a sampling pump located on the geoprobe unit. Groundwater

samples will be collected as close to the water table surface as possible. Boreholes will be backfilled with cement/bentonite grout after sample collection.

Samples will be placed in 1-liter, plastic bottles supplied by the laboratory. Sample bottles will be placed in coolers, packed to reduce movement during shipment, and cooled with loose ice. Groundwater samples will be analyzed for gross alpha and gross beta. If alpha activity in the groundwater is measured in excess of the maximum or adjusted levels of 40 CFR 141.15, or if beta activity in the groundwater is measured in excess of the levels of 40 CFR 141.26 (b)(l)(i) and (ii), isotopic analysis will be required and groundwater will need to be resampled upgradient and down-gradient for the final termination and confirmatory surveys. All samples will be filtered with a 0.45 micron filter prior to analysis.

A BKA geologist will monitor geoprobe activities and log soil core samples. A BKA radiation technician will be onsite performing health and safety functions, such as monitoring the breathing zone for radionuclides and in field radiological screening of soil sample. All downhole equipment will be decontaminated to prevent cross contamination of soil and groundwater samples. Decontamination procedures include washing with a laboratory grade detergent and rinsing with distilled water.

Site specific groundwater flow directions and gradients will be calculated from field data collected during the site characterization activities, and will be presented in the site characterization report. To calculate flow direction and gradient, elevations of each groundwater sample location will be surveyed and the depth to water will be measured. This data will be plotted on a site map and contoured.

5.2.2.6 Sediments

Six sediment samples will be collected from the floor drain in the Old Commercial Building. Samples of sediments found in other stormwater drains or sanitary sewer lines will also be collected, if available. The actual number of sediment samples to be taken is not known at this time since the availability of the sediment in the lines is unknown. Sediment samples collected will be analyzed for Thorium via gamma or alpha spectroscopy.

5.2.2.7 Vegetation

Six samples of vegetation will be collected at various locations along the stormwater sewer/drainage swale to determine Thorium uptake, if any, in indigenous plant species. The vegetation samples will be analyzed for Thorium via gamma or alpha spectroscopy.

5.2.2.8 Air Sampling

Four air samples will be set up at the north, south, east and west site perimeter fence lines to confirm the absence of airborne Thorium. These samplers will be operated either on a daily or on a weekly basis during the period site characterization activities are being conducted, depending on the type of sampler used (high volume or low volume). At the end of each day or week (or sooner if dust loading of the filter paper dictates) the filter pad will be exchanged and analyzed for gross alpha and beta activity. All filters will be analyzed for gross alpha and gross beta activity. A select number (3) of the filter pads will be analyzed for Thorium activity to establish a correlation between gross alpha and gross beta and Thorium.

5.2.2.9 Environmental Exposure Rate Measurements

Four thermoluminescent dosimeters (TLDs) will be installed on the north, south, east, and west fence lines to measure the exposure rates to the public from onsite residual Thorium contamination. In addition, these TLDs will provide a baseline during site characterization activities and subsequent remediation activities. The TLDs will be exchanged on either a monthly or quarterly frequency.

5.2.2.10 Background Level Determinations

A total of nine surface soil samples will be collected from various locations within 0.5 to 10 km of the former Brooks and Perkins, Inc. site to establish background levels of Thorium in soil. These samples will be collected from locations which are geologically similar to the site and are unlikely to be affected by the contamination from the presence of any licensed material from any user. The background soil samples will be analyzed for Thorium contamination via alpha or gamma spectroscopy. In addition to soil samples, exposure rate levels will be measured at one meter above the ground surface at the same location that the background soil samples will be collected to establish background exposure rates.

A total of six surface water samples will be collected from the Rouge River or nearby stream(s) to establish background levels of Thorium in water.

A total of three vegetation samples will be collected from nearby areas to establish background levels of Thorium in indigenous plants.

5.3 Laboratory Analytical Work

Proposed analytical work for Thorium is gross alpha and gross beta activity and gamma and/or alpha spectroscopy. All laboratory analysis will be done by an AAR approved laboratory and will follow analysis methodology outlined in EPA 900.0 for gross alpha and gross beta activity, ESML-LV-0530 (or equivalent) for gamma spectroscopy, and ESML-LV-0539-17 (or equivalent) for alpha spectroscopy. Laboratory quality assurance and quality control procedures are to be provided by the laboratory and specific quality assurance procedures for contracted laboratory work will be provided in the contract laboratory Quality Assurance Program. Quality assurance/quality control requirements for site characterization activities are described in detail in Sections 7.0 and 8.0.

5.4 Data Management and Analysis

The preparation of the Site Characterization Plan (SCP) for the site included a preliminary review of radiological surveys and final reports prepared during previously conducted monitoring, remedial/decontamination efforts, and confirmatory surveys at the site. A complete review of available information and the correlation of this data with collected data will be conducted as part of the site characterization activities and during the preparation of remedial and decontamination options for affected areas.

Data collected and managed under the plan can be divided into field and technical data. Field data will consist of real-time measurements. Technical data will include field and laboratory analytical data, plus the results of field and laboratory quality control samples. Elements of field and laboratory documentation will include: recording of field data in notebook entries, data forms, and electronic media; recording or laboratory data; validation of data entry and data display, and analysis methods.

Data recording, reduction, validation, reporting and other recordkeeping/documentation associated with processing samples and data collected during the site characterization activities will be maintained by the Project Manager or designee.

TABLE 5.2.1-1

CLASSIFICATION OF FORMER BROOKS AND PERKINS, INC. SITE
BUILDINGS AND OPEN LAND AREAS ACCORDING TO CONTAMINATION POTENTIAL

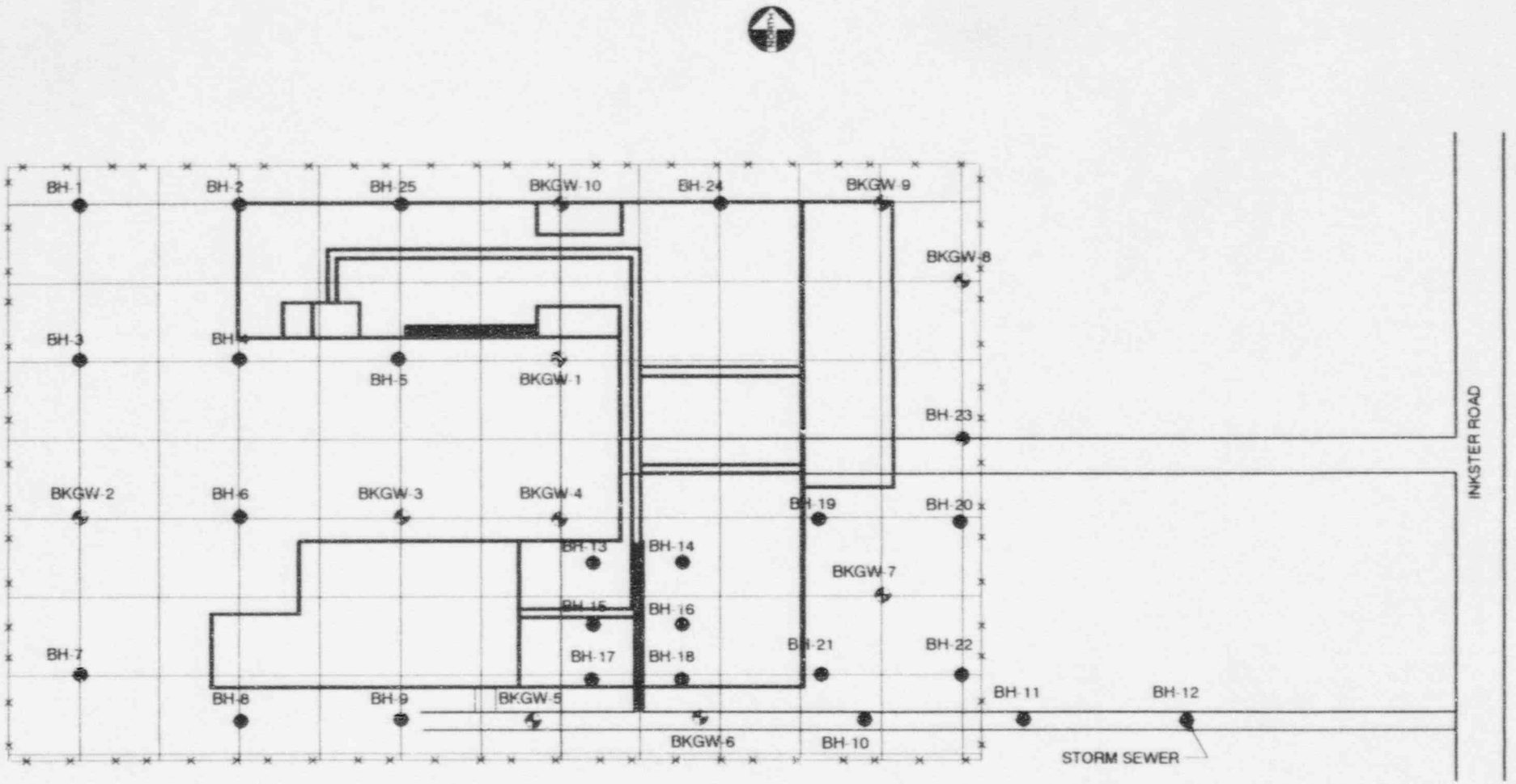
Plant Area	Building or Facility	Room or Area/Survey Unit	Classification of Contamination Potential	Remarks
	New Addition	Concrete floor above melting pot runoff ditch	Affected	Soil underneath concrete floor suspected to be contaminated. NRC survey indicated 120 μR/h spot.
	Old Commercial Building	Floor drain/sump along south wall	Affected	NRC survey indicated Th-232 contamination in slag of 580 pCi/g.
	Open Land	Storm sewer/drainage swale along C&O Railroad	Affected	NRC survey indicated Th-232 contamination in soil of 316 pCi/g.
	Open Land	Remaining open land areas Open area between Old Commercial Building and Process Building Open areas along north and west site perimeter	Affected	Survey for incinerator location and potential 20.304 burial area. Therefore consistent with Section 5.2.1, these areas may require changing to the Unaffected classification based on survey and sampling data.
	Old Commercial Building	Remaining rooms/areas (maintenance, office, pickling, storage, inspection)	Unaffected	[a]
	Fabrication Building	Fabrication Area	Unaffected	[a]
	New Addition	Remaining rooms/areas	Unaffected	[a]
	Process Building	Melt Room Area	Unaffected	[a]
		Mill Area/Pickling Area	Unaffected	[a]
		Finishing Room Area	Unaffected	[a]
	All	Sanitary Sewer and Drain Lines	Unaffected	Radiological contamination potential unknown if contamination identified, will reclassify as affected areas.

[a] Previous Brooks and Perkins, Inc. surveys and NRC surveys indicated no contamination of floors, walls, equipment.

TABLE 5.2.2.1-1

Instrumentation Specifications And Requirements For Radiological Surveys And Monitoring

Type of Measurement	Meter		Description	Detector		Description	BKG	EFF	Detector Sensitivity	Mode of Operation
	Make	Model		Make	Model					
Exposure rate measurements	Bicron	Micro Rem	Exposure rate analog display in units of μRem/hr	Bicron	N/A	Internally mounted tissue equivalent scintillator	7 μR	N/A	2 μR/hr	Analog display of exposure rate
Exposure rate measurements	Ludlum	19	Exposure rate analog display in units of μR/hr	Ludlum	N/A	Internal 1" x 1" NaI scintillation	7 μR	N/A	2 μR/hr	Analog display of exposure rate
Low level gamma scans, correlation with exposure rates or activity concentration	Ludlum	2221	LCD digital scaler/ratemeter with analog scaler	Ludlum	44-10	2" x 2" NaI scintillation	2000 cpm	About 500 cpm per μR/hr	2 μR/hr	Digital and analog display of count rate
Low level gamma scans, correlation with exposure rates or activity concentration	Ludlum	2241	LCD digital scaler/rateмeter	Ludlum	44-10	2" x 2" NaI scintillation	2000 cpm	About 500 cpm per μR/hr	2 μR/hr	Digital display of count rate
Exposure rate instrument	Ludlum	2241	Exposure rate digital display in units of μR/hr	Ludlum	44-10	2" x 2" NaI scintillation		N/A		Digital display of exposure rate
Exposure rate instrument	Ludlum	2241	Exposure rate digital display in units of mR/hr	Ludlum	44-9	15 cm^2 GM tube		N/A		Digital display of exposure rate
Exposure rate instrument	Ludlum	2241	Exposure rate digital display in units of R/hr	Ludlum	133 Series	GM tube		N/A		Digital display of exposure rate
Direct measurements for beta emitters	Ludlum	2221	LCD digital scaler/ratemeter with analog scaler	Ludlum	44-9	15 cm^2 GM tube	50 cpm	26%	77 cpm	Digital and analog display of count rate
Direct measurements for beta emitters	Ludlum	2241	LCD digital scaler/ratemeter with analog scaler	Ludlum	43-68	Gas flow proportional detector (100 cm^2 active area with thin aluminized mylar window (0.8 mg/cm^2)	300 cpm	37%	361 cpm	Digital display of count rate
Direct measurements for beta emitters	Ludlum	2221	LCD digital scaler/ratemeter with analog scaler	Ludlum	43-68	Gas flow proportional detector (100 cm^2 active area with thin aluminized mylar window (0.8 mg/cm^2)				
Direct measurements for alpha emitters	Ludlum	2241	LCD digital scaler/ratemeter with analog scaler	Ludlum	43-68	Gas flow proportional detector (100 cm^2 active area with thin aluminized mylar window (0.8 mg/cm^2)		60%		Digital display of count rate
Direct measurements for alpha emitters	Ludlum	2241	LCD digital scaler/ratemeter with analog scaler	Ludlum	43-68	Zinc sulfide probe, 50 cm^2 active area with .8 mg/cm^2 aluminized mylar				Digital display of count rate
Direct measurements for alpha emitters	Ludlum	2221	LCD digital scaler/ratemeter with analog scaler	Ludlum	43-5	Zinc sulfide probe, 50 cm^2 active area with .8 mg/cm^2 aluminized mylar	.5 cpm	11%	5.6 cpm	Digital and analog display of count rate
Portable contamination monitor	Ludlum	3	Count rate analog display	Ludlum	44-9	15 cm^2 GM tube	50 cpm	approx 23%	N/A	Analog display of count rate
Air samplers	Radeco	H-809V1	Variable flow rate sampler	N/A	N/A	N/A	N/A	N/A	N/A	Timed sample of no more than 15 min
Air samplers	Eberline	RAS-1	Flow rate sampler	N/A	N/A	N/A	N/A	N/A	N/A	Continuous
Air samplers	SKC	PCXR3	Variable flow rate sampler	N/A	N/A	N/A	N/A	N/A	N/A	Continuous
Air sample and smear counter scaler	Ludlum	2929	LCD digital alpha/beta scaler	Ludlum	43-10-1		60 cpm beta	27%	89 cpm	Digital display of count rate
							0.07 cpm alpha	30%	3.7 cpm	



LEGEND

- SUBSURFACE SOIL SAMPLE LOCATION
- SUBSURFACE SOIL AND GROUNDWATER SAMPLE LOCATION

FIGURE 5.2.2.4-1
SAMPLE LOCATION MAP
DATE: MARCH 23, 1995
SCALE: 0 20m

B. KOH & ASSOCIATES, INC.

6.0 TECHNICAL APPROACH

6.1 Sampling and Surveying Protocols

Several sampling and survey protocols are considered for collection of data required to characterize the buildings and open land areas of the site. Each of the potentially impacted media will be included in the evaluation, including soils, surface water and sediments, groundwater, and air quality, vegetation, and direct exposure. Collection of all samples will be conducted in accordance with accepted NRC or EPA guidelines, as outlined in referenced literature.

6.1.1 Soils

6.1.1.1 Surface

Surface samples will be collected using trowels, spoons, or shallow cores 0-15 cm (0-6"). No other special equipment or provisions are required.

6.1.1.2 Subsurface

Subsurface soil samples will be collected by hand augering surface soil sampler or by drilling and sampling using a split spoon soil sampler or geoprobe. Sample depths are estimated to range from 0.6 meters to 1.85 meters (2 feet to 6 feet) and will be continuously collected at 0.6 m (2 feet) intervals along the length of the borehole.

6.1.2 Surface Water and Sediments

Surface water samples will be collected using either direct fill methods (i.e., the sample will be collected directly into the sample container) or other acceptable procedures as outlined in EPA/SW-846. As an alternative, the sample jar may be fastened to an extension handle if required due to inaccessibility of sample location.

Sediment samples will be collected using a stainless steel spoon for shallow 0-15 cm (0-6") sediment samples or a sediment core for deeper 15-61 cm (6-24") samples.

6.1.3 Groundwater

At the present time, there is no evidence that would suggest that the local groundwater has been impacted by the residual Thorium contamination present on site. However, if site characterization data indicates that a potential for such impact exists, then a groundwater monitoring program will be developed. The program will include the number of wells, their location and depth, and the frequency of sampling.

All wells will be installed such that the top portion of the upper aquifer is screened. Actual well placement depths will be based on site hydrology and will be determined by the field hydrogeologist/geotechnical consultant. Groundwater will be sampled and analyzed for gross alpha, gross beta and thorium.

6.1.4 Air Quality

Air quality will be monitored for dust concentrations using particulate samplers. High volume samplers and/or low volume continuous samplers will be used to collect particulates on filters and

the filters subsequently analyzed for gross alpha and gross beta activity to determine the potential Thorium airborne contamination.

6.1.5 Vegetation

Samples will be taken of vegetation from onsite to determine possible uptake of Thorium. Grab samples of similar species of vegetation will be collected from various locations onsite and offsite. Sample locations and plant species will be documented.

6.1.6 Walkover Scans

Walkover scans of the site will be performed using a calibrated 2" x 2" NaI(Tl) probe (e.g., Ludlum Model 44-10) coupled with a ratemeter (e.g., Ludlum Model 12), a Geiger Mueller (GM) pancake probe (e.g., Ludlum Model 44-9) coupled with a ratemeter (e.g., Ludlum Model 12) or equivalent.

6.1.7 Contamination Survey Measurements

Contamination survey measurements will be performed throughout the site to determine the level of surface contamination (fixed and removable) on buildings, structures, equipment, floors and sidewalks, etc. Contamination surveys will consist of direct and smear measurements.

The direct measurements will be performed using a calibrated GM pancake probe (e.g., Ludlum Model 44-9 for β-γ and Model 44 for α) coupled with a survey ratemeter (e.g., Ludlum Model 12) or equivalent. Direct surveys will be performed for both α and β-γ contamination.

Smear measurements will be performed using an adhesive backed filter pad and applying moderate pressure. Smearing 100 cm^2 area. The smear will be counted for α and β/γ activities in a calibrated proportional counter (e.g., Ludlum Model 2929) or equivalent.

Table 5.2.2.1-1 presents the typical radiation survey instrumentation and equipment that will be used during characterization of the former Brooks and Perkins, Inc. site.

6.1.8 Radiation Exposure Measurements

Radiation level measurements (gamma radiation) will be obtained at various locations throughout the buildings and the open land areas. The radiation levels will be measured at 1 m (3 ft) above the ground surface using a calibrated $\mu R/hr$ (e.g., Ludlum Model 19) survey ratemeter or equivalent.

6.1.9 Environmental Exposure Monitoring

Thermoluminescent dosimeters (TLDs) may be used to measure the exposure rates to the general public at the site boundaries, if deemed appropriate. The TLDs will be obtained from a qualified vendor who participates in the National Voluntary Laboratory Accreditation Program (NAVLAP).

7.0 ANALYTICAL PROGRAM AND PROCEDURES

The analytical program for the field activities at the former Brooks and Perkins, Inc. site are described below. Laboratory analysis will consist of radiological analysis by alpha or gamma spectroscopy for Thorium.

Radiological analysis will be conducted by an offsite laboratory under contract to B. Koh & Associates, Inc. The required analyses will be performed by qualified individuals using approved and documented laboratory procedures. Laboratories will conduct internal quality assurance audits in accordance with their respective quality control program.

A summary of the types and number of samples to be analyzed is shown in Table 7-1. A summary of the types and number of samples to be analyzed for quality control purposes is shown in Table 7-2.

7.1 Testing Methods

Testing methods to be utilized for the analysis of water samples will be consistent within EPA methods and guidelines and are presented below.

Parameter	Container	Preservative	Holding Time	Analysis Method
Water Thorium	1 liter (P or G)	Nitric Acid	6 Months	EPA 901.1
Soil/Sediment Thorium	100g-500g (P)	None	N/A	EPA 901.1

P = Plastic, G = Glass

7.1.1 Testing Plan

Six surface water samples will be collected from the storm sewer/drainage swale. Additional samples may include samples of standing water from within the site. Water samples will be analyzed for gross alpha and gross beta activities and Thorium via alpha or gamma spectroscopy.

7.1.2 Quality Control Samples

Three field duplicates and an appropriate number of trip blanks will be submitted to the laboratories along with the surface water samples. In addition, Section 8.0 outlines the quality assurance/quality control requirements to be implemented for the site characterization activities.

7.2 Soil/Sediment Samples

Testing methods to be utilized for the analysis of soil/sediment samples during characterization activities will be consistent with ORISE methods.

7.2.1 Testing Plan

Sediment, surface, and subsurface soil samples are to be collected from within the former Brooks and Perkins, Inc. site. Based on existing data, approximately 100 soil and six sediment samples will be collected from within the site, as described in Section 5.0.

Radiological testing for Thorium via alpha or gamma spectroscopy will be completed on all surface/sediment and subsurface soil samples collected during site characterization.

7.2.2 Quality Control Samples

Quality control samples to be collected during soil/sediment sampling activities consist of the original samples collected and analyzed. Section 8.0 outlines the quality assurance/quality control protocols to be implemented for the site characterization activities.

As part of the quality assurance procedures, ten percent of the samples analyzed will be sent to an independent laboratory or to the NRC for verification analysis.

7.3 Vegetation Samples

Testing methods to be utilized for the analysis of vegetation during characterization activities will be consistent with EPA methods (EMSL-LV 0534-17, 0539-17) and guidelines. Samples will be collected in accordance with procedures described in this plan.

7.3.1 Testing Plan

Six vegetation samples will be taken by grab sampling from the storm sewer/drainage swale area. Also, three vegetation samples will be taken by grab sampling from outside the site.

7.3.2 Quality Control Samples

Two vegetation samples will be collected and split for quality control purposes.

7.4 Air Samples

Four air samples will be collected during the characterization activities in accordance with the protocol, as described in Section 5.2.2.8.

7.4.1 Testing Plan

The four air samples will be collected in accordance with the protocol, as described in Section 5.2.2.8.

7.4.2 Quality Control Samples

Two of the air particulate samples collected will be analyzed for gross alpha and gross beta activity and then sent to an independent laboratory for gross alpha, gross beta and Thorium analysis for quality control purposes. The air samplers will be calibrated in accordance with the manufacturer's specification.

7.5 Radiation Level Measurements

Gamma exposure rate measurements and TLD placement and removal performed during site characterization activities will be conducted in accordance with the protocol described in Sections 5.2.2.3 and 5.2.2.9. TLDs will be analyzed by a NAVLAP vendor.

7.5.1 Testing Plan

Approximately 100 gamma exposure rate measurements will be taken at the site. In addition, readings from the TLDs placed around the perimeter of the site will be obtained monthly or quarterly.

7.5.2 Quality Control Samples

Gamma exposure measurements will be taken with a portable ratemeter with a gamma scintillation detector. The ratemeter will be calibrated with a suitable and traceable source standard cross-calibrated with a Reuter-Stokes pressurized ionization chamber.

In addition, daily source checks will be conducted to ensure proper instrument operation.

TABLE 7-1

RADIOLOGICAL ANALYSIS SUMMARY
FORMER BROOKS AND PERKINS, INC. SITE

	Thorium	Gross Alpha	Gross Beta
Surface Water	6	6	6
Sediment	6	-	-
Soil	100	-	-
Groundwater	TBD	TBD	TBD
Vegetation	9	-	-
Air	6	6	6
TOTAL	127	12	12

TABLE 7-2

QUALITY CONTROL RADIOLOGICAL SAMPLE SUMMARY
FORMER BROOKS AND PERKINS, INC. SITE

	Thorium	Gross Alpha	Gross Beta
Surface Water	3	3	3
Sediment	2	-	-
Soil	10	-	-
Groundwater	TBD	TBD	TBD
Vegetation	2	-	-
Air	2	2	2
TOTAL	19	5	5

8.0 QUALITY ASSURANCE

Site characterization activities at the site will be conducted under a system of management and quality assurance (QA) controls to ensure the validity of data. The purpose of these controls is to ensure that technical data generated are accurate, representative, and will ultimately withstand regulatory agency scrutiny.

Quality Control (QC) consists of a system of checks on field sampling and laboratory analysis (through the use of field blanks, duplicates, documentation of sample movement, chain-of-custody records, etc.) to provide supporting information on the quality of the methods employed and on the data. QA consists of independent overview checking to certify that the QC procedures have been properly implemented to produce accurate data. The QA/QC manager will be independent of all other site activities and will report directly to the Project Manager.

The management and QA controls established for site characterization activities will incorporate the following activities:

- Sample collection, control, chain-of-custody, and analysis;
- Document control;
- Laboratory instrumentation, analysis, and control; and
- Review of project reports.

Analytical samples will be collected in the field utilizing approved field procedures consistent with EPA SW-846 and NUREG/CR-5849 and will be sent to the designated laboratory for analysis. Duplicates, replicates, and blank samples will be used, as appropriate, to develop estimates of the quality of the analytical data. Cross checks with NRC, ORISE or other outside independent laboratories will be used. Field surveillances will be conducted to document that proper sampling techniques and chain-of-custody procedures are followed. Field data compilation, tabulation, and analysis will be checked for accuracy. Calculations and other post-field tasks will be reviewed by

the Project Manager or designee. Equipment used to take field measurements will be maintained and calibrated in accordance with established procedures (see Section 8.0). Records of calibration and maintenance will be kept by assigned personnel. Field testing and data acquisition will be performed following guidelines presented in Sections 5.0, 6.0 and 7.0.

9.0 HEALTH AND SAFETY PLANS

A Health and Safety Plan will be developed which meets the objectives of the site characterization activities. Each contractor will have a designated Health and Safety Officer for the project who will be responsible for implementation of and compliance with the Site Health and Safety Plan. It is anticipated that characterization work will be performed in Modified Level D protection with shoe covers, disposable gloves and coveralls/Tyveks. TLDs will also be worn, other protective equipment include eye protection, hearing protection, hard hats and steel-toed safety shoes, as appropriate. Materials coming into contact with samples will be monitored for contamination and/or decontaminated prior to coming into contact with another sample. Air purifying respirators will be provided by each contractor if air monitoring indicates the need to do so.

On the basis of field monitoring, the level of protection may be downgraded or upgraded at the discretion of the contractor's Health and Safety Officer and concurrence of the Project Manager. Crew members will conduct onsite activities in pairs utilizing the "buddy system." Team members will stand upwind during the collection of samples, when possible.

Each contractor will remain an independent contractor with respect to all services performed and is responsible for complying with all federal, state, and local regulations regarding worker health and safety.

10.0 PROGRAM SCHEDULE

The characterization schedule presented in Table 10-1 outlines the proposed listing of activities for conducting the characterization of the former Brooks and Perkins, Inc. site.

TABLE 10-1

PROPOSED PROGRAM SCHEDULE
FORMER BROOKS AND PERKINS, INC. SITE

ACTIVITY	COMPLETION TIME
Grid Layout	1.5 Days
Surveying Affected and Unaffected Areas	5 Days
Surface Sampling including Background (soil, sediment, vegetation)	2 Days
Surface and Subsurface Soil and Water Sampling (including identification of the incineration area and properted disposal area)	3 Days
Review of Records and Interviews	1.5 Days
Lab Analyses	30 Days
Review Data and Prepare Report	10 Days

11.0 REPORTS AND DELIVERABLES

All field work will be carried out in accordance with this Site Characterization Plan, the Health and Safety Plan, and the management and QA controls.

11.1 Final Report (Phase I)

The Final Site Characterization Report (FSCR) will include sections addressing all of the subjects discussed in this Site Characterization Plan (SCP), including recommendations for specific tasks in the next phase of the site investigation, if required. Specifically, the FSCR will be developed consistent with the NRC "Branch Technical Position on Site Characterization for Decommissioning Sites" (NRC, July 1992) and will address results of the investigations of the site history, topography, geology, hydrology, geochemistry, climate, routes of migration, environmental fate modeling, and human health and environmental impacts as determined through dose and risk assessments.

Analytical data will be presented in summary tables within the text, as will water level, aquifer testing, climatic, and modeling data, and estimates of human health and environmental impacts.

Full data reports and analytical results will be presented in Appendices to the Final Site Characterization Report.

12.0 REFERENCES

Brooks and Perkins, Inc. May 6, 1971. Letter and Report of Radiological Survey from Brooks and Perkins to U.S. AEC dated February 5, 1971. Reference Docket #40-235.

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