DRAFT REPORT

# CONFIRMATORY SURVEY OF THE V-1 POND SITE BP CHEMICALS, INC. LIMA, OHIO

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Prepared for the
Division of Low-Level Waste Management and Decommissioning
U.S. Nuclear Regulatory Commission



ORISE

OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

Environmental Survey and Site Assessment Program
Energy/Environment Systems Division

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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| ANI | Acrylonitrile Plant No. 1 |
| ANII | Acrylonitrile Plant No. 2 |
| ASME | American Society of Mechanical Engineers |
| BPC | BP Chemicals, Inc. |
| cm | centimeter |
| CNES | Chem-Nuclear Environmental Services |
| EML | Environmental Measurements Laboratory |
| EPA | Environmental Protection Agency |
| ESSAP | Environmental Survey and Site Assessment Program |
| ft | foot |
| km | kilometer |
| kg | kilogram |
| $m^2$ | square meter |
| MeV | million electron volts |
| NaI | sodium iodide |
| NIST | National Institute of Standards and Technology |
| NRC | Nuclear Regulatory Commission |
| $\mu$R/h | microroentgens per hour |
| ORAU | Oak Ridge Associated Universities |
| ORISE | Oak Ridge Institute for Science and Education |
| pCi/g | picocuries per gram |
| PIC | pressurized ionization chamber |
| RCRA | Resource Conservation and Recovery Act |

# CONFIRMATORY SURVEY
# OF THE V-1 POND SITE
# BP CHEMICALS, INC.
# LIMA, OHIO

## INTRODUCTION AND SITE HISTORY

BP Chemicals, Inc. (BPC) owns and operates a chemical production facility in Lima, Ohio. The facility, formerly owned by the Vistron Corporation, manufactures chemical products for industrial and agricultural use. One of the chemical products produced is acrylonitrile, a raw material used in the plastics industry. From 1963 to 1971, Vistron's acrylonitrile production process used a catalyst which contained uranium depleted in uranium-234 and uranium-235. The catalyst was produced in the Catalyst Plant then transferred to Acrylonitrile Plants No. 1 and No. 2 (ANI and ANII) for acrylonitrile production. The resulting process wastes, which contained both depleted uranium and RCRA hazardous wastes, were transferred to on-site impoundments for storage. The manufacture, use, storage, and distribution of the uranium source material were authorized under Atomic Energy Commission, predecessor agency to the Nuclear Regulatory Commission (NRC), licenses SUB-756 and SUB-908.

In 1971, the plant was converted to produce and use a non-radioactive catalyst. As a result of the uranium catalyst use, portions of the plant equipment and grounds became radiologically contaminated. Vistron initiated site characterization in 1977 by contracting Radiation Management Corporation to survey and assess the radiological status of the site. Site assessment was followed by remediation of those areas identified as having major contamination, and in 1980 the last containers of licensable material were removed from the site.

In 1982, the NRC requested the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE), formerly the Radiological Site Assessment Program of Oak Ridge Associated Universities (ORAU), to conduct a radiological survey of the Vistron site. The results of that survey indicated that areas of the plant, which had been associated with the uranium catalyst, had residual contamination on surfaces and in soil in excess of the NRC guidelines established for release to unrestricted use.[1] Specifically, these

areas included soils and structures associated with the ANI and ANII, the Thermal Oxidizer area, the Central Warehouse, and in the surface impoundments known as the V-1, Deep Well, Burn, and Celite Ponds, all of which are located in the eastern portion of the plant.

In 1987, BPC, who had acquired the site, renewed site decontamination efforts in order to terminate the remaining NRC Source Material License No. SUB-908. BPC contracted Nuclear Engineering Services to perform additional radiological surveys and decontamination beginning with the Catalyst Plant. Remedial actions were completed on the Catalyst Plant and ESSAP performed a confirmatory radiological survey during April 1988.[2]

BPC next addressed ANII (specifically, Reactor Vessels A and B), the Central Warehouse, ANI, and contaminated soils. Chem-Nuclear Environmental Services (CNES), under contract to BPC, performed radiological surveys and decontamination activities of these areas during 1991. ESSAP performed confirmatory surveys for these areas.[3]

BPC is currently conducting closure operations for the four mixed waste ponds as part of this site-wide decontamination and decommissioning program. Remediation of the first pond, the V-1 Pond, included removal and treatment of water followed by excavation, transfer, and temporary storage of the contaminated sludges and soils. A test fill pad had been established within the excavation to demonstrate that engineering requirements could be met for the closure cell that will be constructed for the permanent disposal of the mixed wastes. Prior to cell construction, BPC performed radiological surveys to demonstrate that the pond bottom satisfies the NRC guidelines for release from licensing restrictions. The Nuclear Regulatory Commission, Decommissioning and Regulatory Issues Branch, Low-Level Waste Management and Decommissioning Division requested that ESSAP perform a confirmatory radiological survey of the V-1 Pond Site.

## SITE DESCRIPTION

The BPC site is located on Fort Amanda Road, approximately 1.5 km southwest of Lima, Ohio (Figure 1). The V-1 pond is located in the northeast quadrant of the plant as illustrated in

Figure 2. The 6,000 $m^2$ excavated area contains no structures or inside features other than the 730 $m^2$ test fill pad. Depth of the excavation is approximately 6 meters. Sides are steeply sloped with an access ramp cut into the contours.

## OBJECTIVES

The objectives of the confirmatory process are to provide independent document reviews and radiological data, for use by the NRC in evaluating the adequacy of the licensee's radiological status report, relative to the established guidelines.

## DOCUMENT REVIEW

ESSAP reviewed the licensee's radiological status survey report.[4] Procedures and methods utilized by the licensee were reviewed for adequacy and appropriateness. The post-remedial action data were reviewed for accuracy, completeness, and compliance with guidelines.

## PROCEDURES

During the period February 23 through 25, 1994, ESSAP personnel conducted on-site measurement and sampling survey activities. These activities were in accordance with a site-specific survey plan which was submitted to and approved by the NRC.[5] Additional information pertaining to survey and analytical instrumentation and procedures may be found in Appendices A and B.

## REFERENCE GRID

The licensee established a reference grid consisting of 100 $m^2$ grid blocks which ESSAP used for referencing measurement and sampling locations (Figure 3).

## SURFACE SCANS

Surface scans were conducted for gamma activity at 1 to 2 meter intervals over 50% of the excavated area using NaI detectors coupled to ratemeters with audible indicators. Two areas with standing water were not surveyed due to inaccessibility; one was the drainage trench surrounding the Test Fill Pad and the other a dewatering sump located in the northwest portion of the pond (Figure 3).

## SOIL SAMPLING

ESSAP collected background soil samples from the Lima, OH area during the previous 1991 survey.[3] Surface soil samples (0-15 cm) were collected from 29 randomly selected grid blocks. Two of these samples were collected from beneath the test fill pad. The licensee provided a drilling contractor to assist ESSAP with the collection of the two samples from beneath the test pad. Figure 4 shows soil sampling locations.

## EXPOSURE RATE MEASUREMENTS

Background exposure rate measurements, also performed by ESSAP during the 1991 survey in the Lima, Ohio area, were used for comparison purposes. Exposure rate measurements at 1 meter above the surface were performed at 18 soil sampling locations using a pressurized ionization chamber (PIC). The remaining sampling locations were inaccessible to the PIC due to steep or uneven terrain. Figure 5 shows exposure rate measurement locations.

## SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to ESSAP's laboratory in Oak Ridge, Tennessee for analysis and interpretation. Soil samples were analyzed by solid state gamma spectrometry. The radionuclide of interest is uranium-238; however, spectra were reviewed for other identifiable photopeaks. Total uranium was estimated based on a uranium-238 to total uranium activity ratio

of 1:1.3. Soil sample results were reported in units of pCi/g. Exposure rates were reported in units of $\mu$R/h.

## FINDINGS AND RESULTS

### DOCUMENT REVIEW

ESSAP's review of the licensee's documentation indicated that the overall radiological status of the V-1 Pond bottom had been adequately documented in accordance with appropriate guidelines, with the exception of the apparent underestimation of reported exposure rates. Comments on the document were provided to the NRC in a February 2, 1994 correspondence.[6]

### SURFACE SCANS

Surface scans of the area did not identify any locations of elevated direct gamma radiation.

### RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES

Table 1 provides a summary of the uranium concentrations in soil. The concentration of U-238 ranged from 1.0 to 4.6 pCi/g. The total uranium levels were 1.3 to 6.0 pCi/g. Background levels for the Lima, Ohio area ranged from 1.6 to 2.7 pCi/g and 3.2 to 5.4 pCi/g with average concentrations of 2.2 and 4.4 pCi/g for uranium-238 and total uranium, respectively.

### EXPOSURE RATES

The corresponding exposure rates are also provided in Table 1. Gross exposure rates within the excavation ranged from 10 to 13 $\mu$R/h. Background exposure rates ranged from 7 to 9 $\mu$R/h.

## COMPARISON OF RESULTS WITH GUIDELINES

The confirmatory survey data were compared with the NRC's Branch Technical Position Option 1 concentration level for depleted uranium in soil of 35 pCi/g and the exposure rate guideline of 10 $\mu$R/h above background. These guidelines are presented in Appendix C.[7]

Confirmatory soil samples all contained total uranium levels below the 35 pCi/g guideline. The maximum level identified was 6.0 pCi/g. Exposure rates were also within guideline levels ranging from 4 to 6 $\mu$R/h above the background range.

## SUMMARY

The Environmental Survey and Site Assessment Program of the Oak Ridge Institute for Science and Education performed confirmatory activities for the V-1 pond closure at the BP Chemical, Inc. site in Lima, Ohio. These activities included independent document review and during the period February 23 through 25, 1994, confirmatory soil samples and exposure rate measurements were collected.

The review of the radiological status survey report indicates that the licensee has adequately documented the radiological condition of the V-1 Pond area. The confirmatory survey provides data which support the licensee's conclusion that the uranium concentrations in soil and exposure rates are less than the NRC's guidelines for release to unrestricted use.

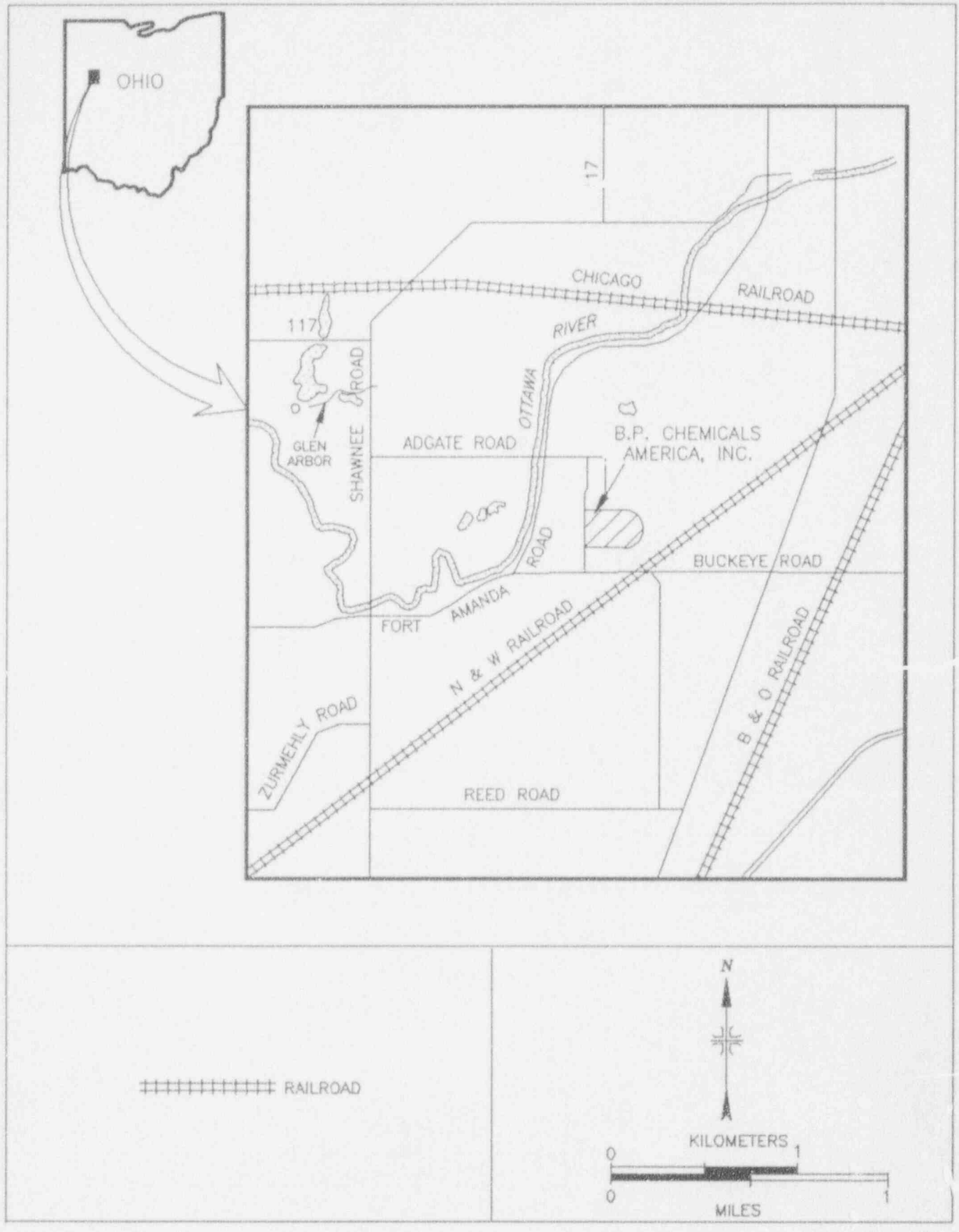


FIGURE 1: Lima, Ohio Area Map – Location of BP Chemicals America, Inc.

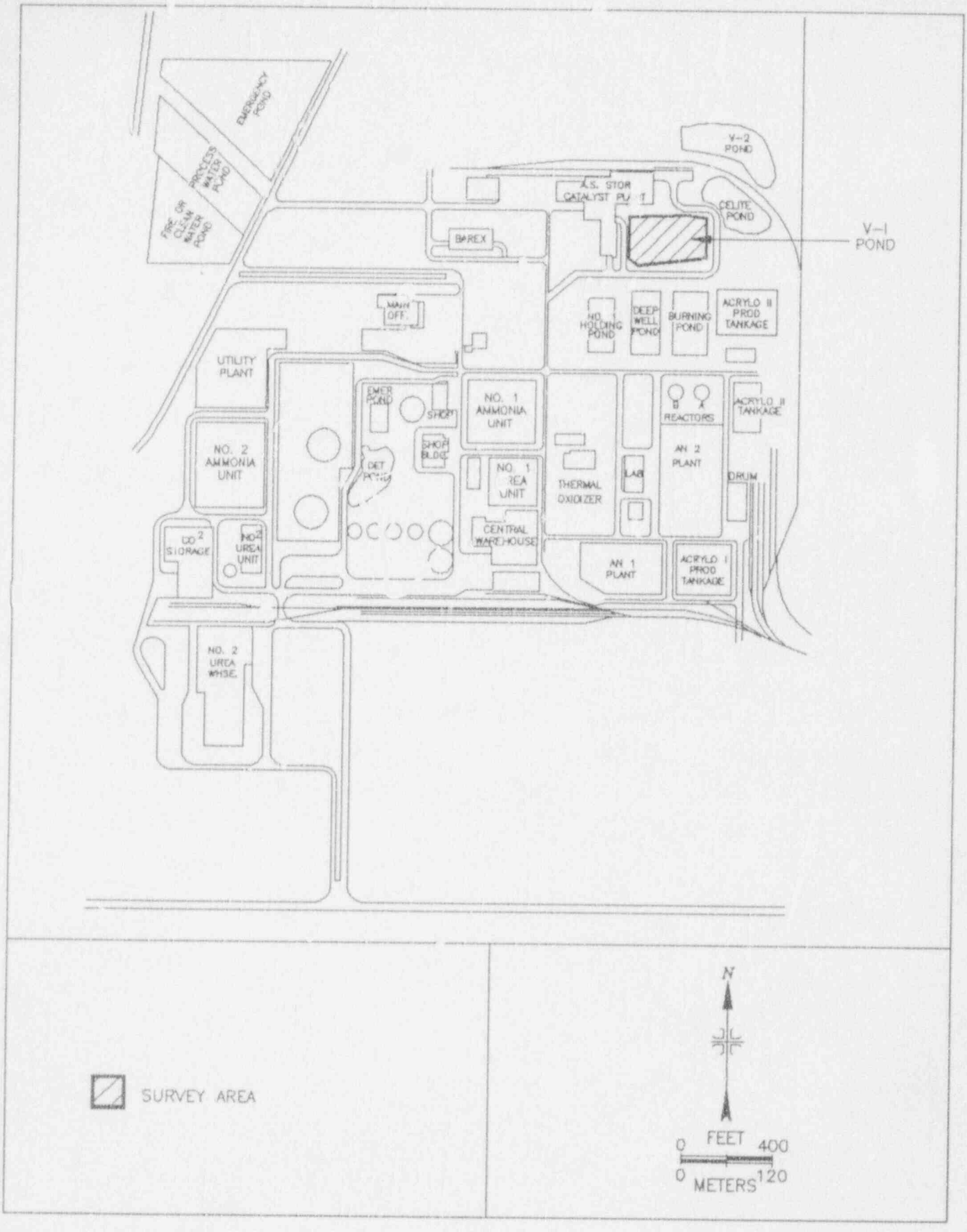


FIGURE 2: BP Chemical, Inc. Plant Layout – Location of V–1 Pond

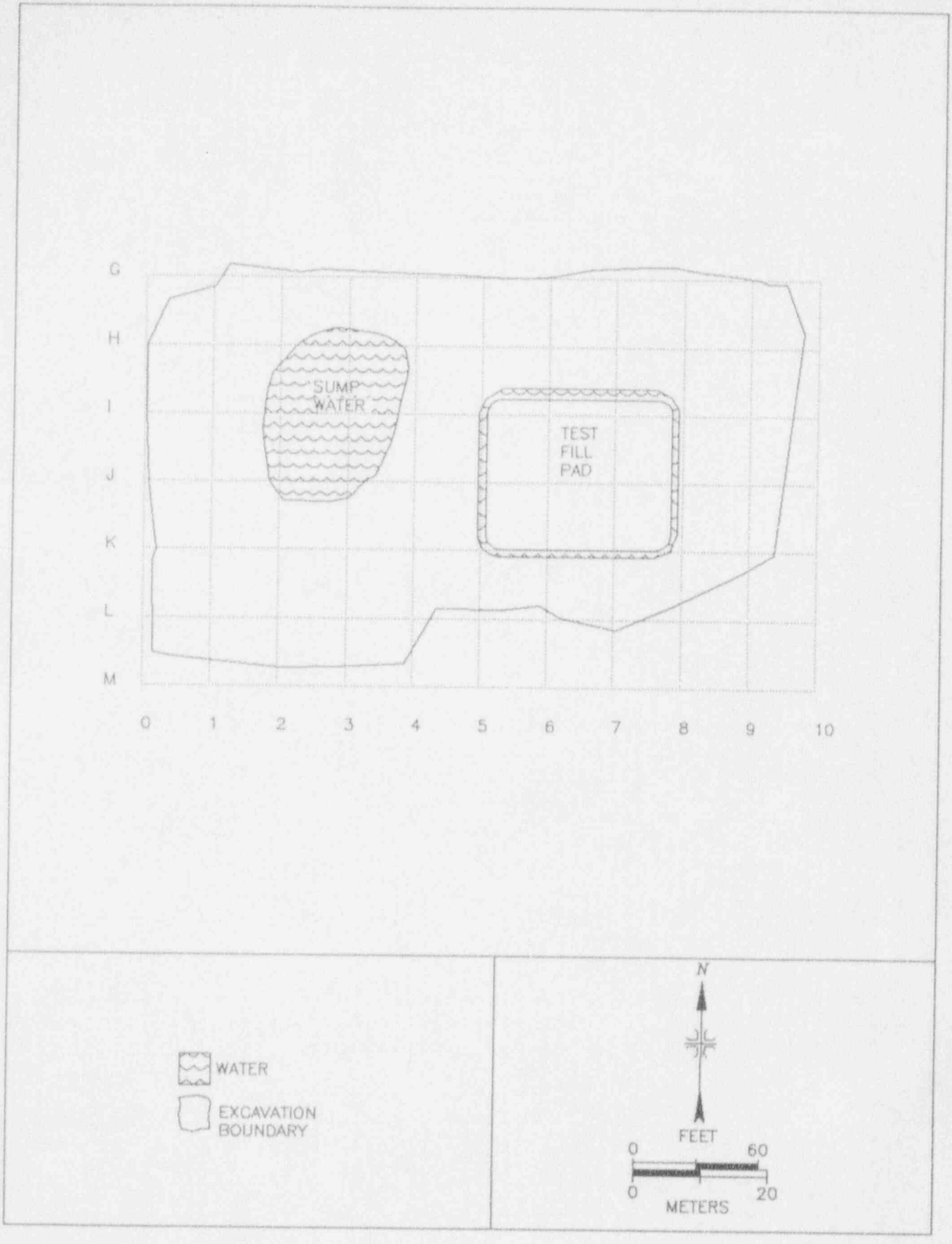


FIGURE 3: BP Chemicals, Inc. – V-1 Pond Excavation and Reference Grid

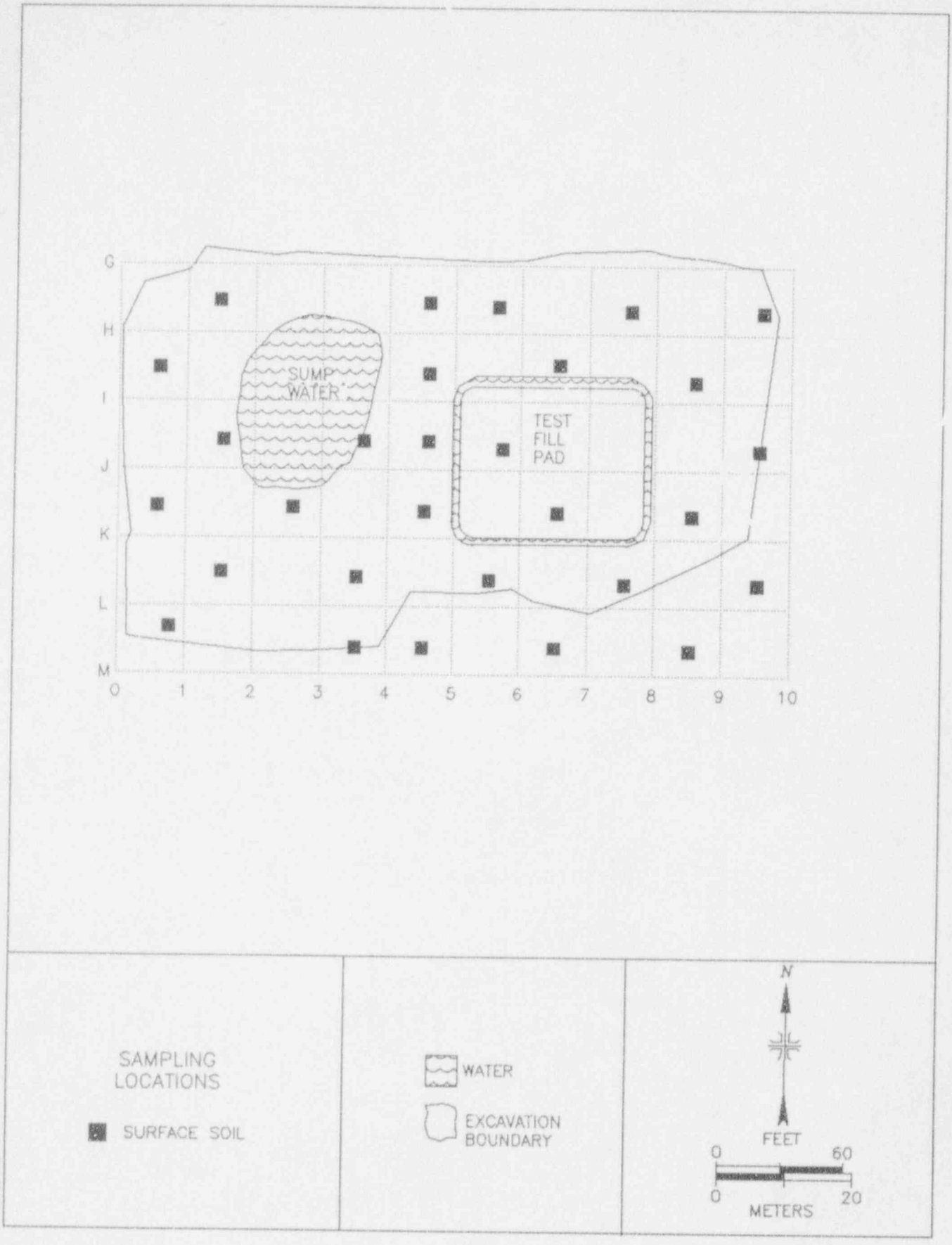


FIGURE 4: V-1 Pond - Sampling Locations

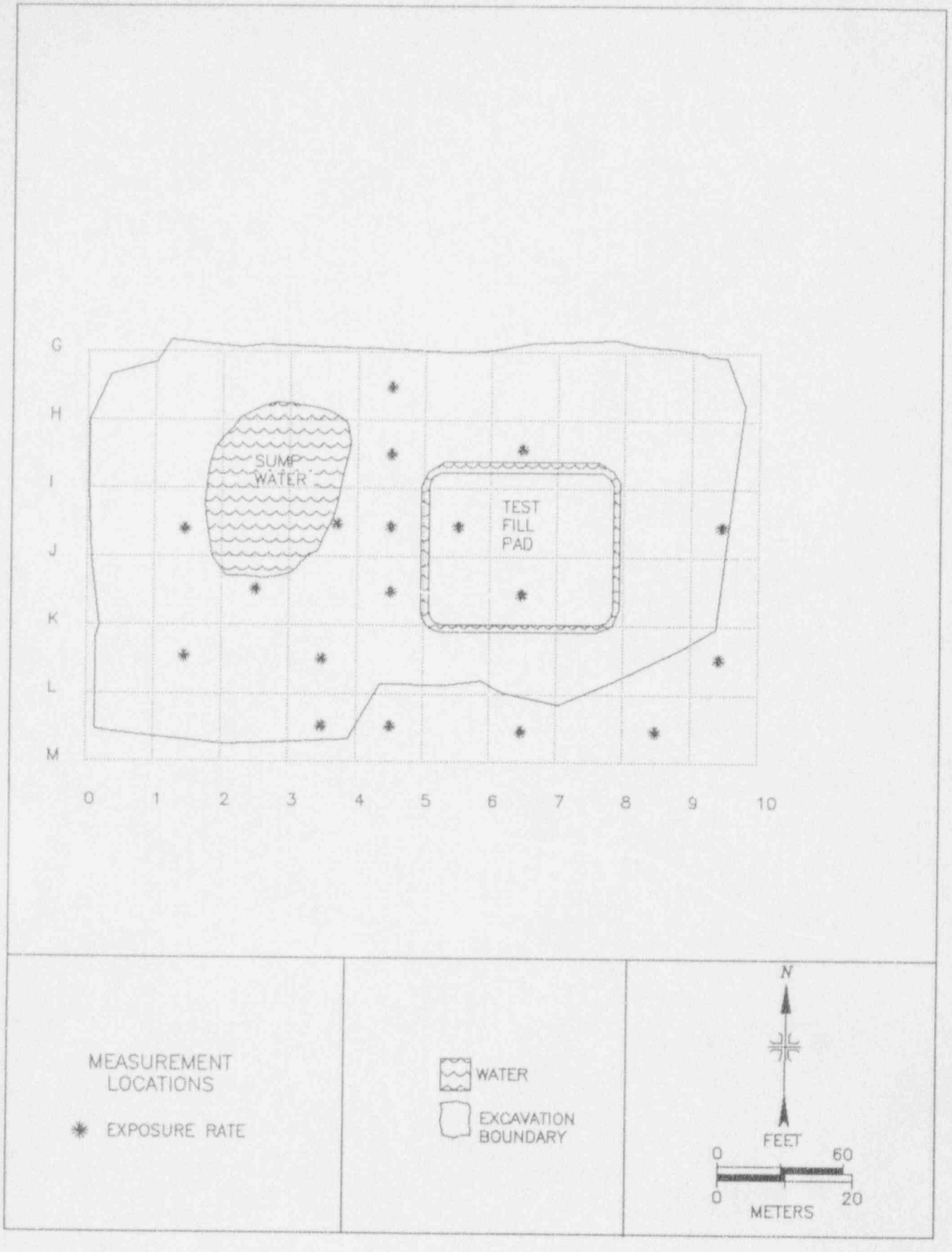


FIGURE 5: V-1 Pond – Measurement Locations

TABLE 1

EXPOSURE RATES AND
URANIUM CONCENTRATIONS IN SOIL
V-1 POND SITE
BP CHEMICALS, INC.
LIMA, OHIO

| Location[a] | Exposure Rate at 1 m ($\mu$R/h) | Radionuclide Concentration (pCi/g) | |
|---|---|---|---|
| | | U-238 | Total U |
| H,1 | --[b] | 1.0 ± 0.8[c] | 1.3 |
| H,4 | 12 | 1.4 ± 1.3 | 1.8 |
| H,5 | -- | 1.4 ± 1.2 | 1.8 |
| H,7 | -- | 1.8 ± 1.1 | 2.3 |
| H,9 | -- | 1.7 ± 1.4 | 2.2 |
| I,0 | -- | 2.4 ± 1.4 | 3.1 |
| I,4 | 13 | 2.1 ± 1.3 | 2.7 |
| I,6 | 12 | 2.6 ± 1.3 | 3.4 |
| I,8 | -- | 1.7 ± 1.3 | 2.2 |
| J,1 | 12 | 1.4 ± 1.1 | 1.8 |
| J,3 | 12 | 2.4 ± 1.1 | 3.1 |
| J,4 | 13 | 1.9 ± 1.1 | 2.5 |
| J,5 | 12 | 1.2 ± 1.1 | 1.6 |
| J,9 | 10 | 4.4 ± 1.6 | 5.7 |
| K,0 | -- | 1.5 ± 1.5 | 2.0 |
| K,2 | 13 | 2.4 ± 1.2 | 3.1 |
| K,4 | 13 | 2.1 ± 1.1 | 2.7 |
| K,6 | 13 | 2.6 ± 1.5 | 3.4 |
| K,8 | -- | 1.7 ± 1.2 | 2.2 |
| L,1 | 13 | 2.3 ± 1.6 | 3.0 |
| L,3 | 13 | 2.1 ± 1.2 | 2.7 |
| L,5 | -- | 1.5 ± 1.4 | 2.0 |
| L,7 | -- | 1.7 ± 1.0 | 2.2 |
| L,9 | 10 | 1.6 ± 1.2 | 2.1 |
| M,0 | -- | 1.6 ± 1.2 | 2.1 |
| M,3 | 12 | 4.6 ± 2.0 | 6.0 |
| M,4 | 11 | 2.3 ± 1.6 | 3.0 |
| M,6 | 11 | 1.0 ± 1.2 | 1.3 |
| M,8 | 11 | 3.2 ± 1.6 | 4.2 |

[a]Refer to Figures 4 and 5.
[b]-- = Measurement was not performed.
[c]Uncertainties represent the 95% confidence level, based only on counting statistics.

## REFERENCES


1. B.P. Rocco, Oak Ridge Associated Universities, "Radiological Survey of Vistron Corporation, Lima, Ohio," August 1983.

2. M.R. Landis, Oak Ridge Associated Universities, "Confirmatory Survey of the Catalyst Plant, BP Chemical, Inc., Lima, Ohio," July 1988.

3. T.J. Vitkus, ORISE, "Draft Report—Confirmatory Survey of Portions of the BP Chemical, Inc. Site, Lima, Ohio", In preparation.

4. B.P. Chemicals, Inc. "Radiological Status Survey of the V-1 Pond Site, Mixed Waste Pond Closure Project," January 21, 1994.

5. Letter from T. J. Vitkus, ORISE to S. Nalluswami, U.S. Nuclear Regulatory Commission, Subject—"Revised Confirmatory Survey Plan for the V-1 Pond Site, BP Chemical, Inc., Lima, OH [Docket No. 040-07604]," February 16, 1994.

6. Letter from A. Ansari, ORISE to S. Nalluswami, U.S. Nuclear Regulatory Commission, "Radiological Status Survey of the V-1 Pond Site, BP Chemicals, Inc., Lima, Ohio [Docket No. 040-7604]," February 2, 1994.

7. U.S. Nuclear Regulatory Commission, "Branch Technical Position on the Disposal of Residual Thorium or Uranium," October 1981.

# APPENDIX A

# MAJOR INSTRUMENTATION

# APPENDIX A

## MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the authors or their employer.

### DIRECT RADIATION MEASUREMENT

Eberline Pulse Ratemeter
Model PRM-6
(Eberline, Santa Fe, NM)
Victoreen NaI Scintillation Detector

Victoreen NaI Scintillation Detector
Model 489-55
3.2 cm x 3.8 cm Crystal
(Victoreen, Cleveland, OH)

Reuter-Stokes Pressurized Ionization Chamber
Model RSS-111
(Reuter-Stokes, Cleveland, OH)

### LABORATORY ANALYTICAL INSTRUMENTATION

High Purity Extended Range Intrinsic Detectors
Model No: ERVDS30-25195
(Tennelec, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-11
(Nuclear Lead, Oak Ridge, TN) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

High-Purity Germanium Detector
Model GMX-23195-S, 23% Eff.
(EG&G ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Gamma Products, Palos Hills, IL) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

# APPENDIX B

# SURVEY AND ANALYTICAL PROCEDURES

# APPENDIX B

# SURVEY AND ANALYTICAL PROCEDURES

## SURVEY PROCEDURES

### Surface Scans

Surface scans were performed by passing the probes slowly over the surface; the distance between the probe and the surface was maintained at a minimum - nominally about 1 cm. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument. Combinations of detectors and instruments used for the scans were:

Gamma — NaI scintillation detector with ratemeter

### Exposure Rate Measurements

Measurements of gamma exposure rates were performed using a pressurized ionization chamber (PIC). The instrument is adjusted to one meter (3.3 ft) above the surface and allowed to stabilize. The measurement is read directly in ($\mu$R/h).

### Soil Sampling

Approximately 1 kg of soil was collected at each sample location. Collected samples were placed in a plastic bag, sealed, and labeled in accordance with ESSAP survey procedures.

## ANALYTICAL PROCEDURES

The samples of soil were dried and crushed, and a portion sealed in 0.5-liter Marinelli beaker. The quantity placed in the beaker was chosen to reproduce the calibrated counting geometry.

Net material weights were determined and the samples counted using intrinsic germanium detectors coupled to a pulse height analyzer system. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. All photopeaks associated with the radionuclides of concern were reviewed for consistency of activity. Energy peaks used for determining the activities of radionuclides of concerns were:

U-238 0.063 and 0.093 MeV from Th-234* (or 1.001 MeV from Pa-234 m)*

*Secular equilibrium assumed.

Spectra were also reviewed for other identifiable photopeaks.

## UNCERTAINTIES AND DETECTION LIMITS

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels. Additional uncertainties, associated with sampling and measurement procedures, have not been propagated into the data presented in this report.

## CALIBRATION AND QUALITY ASSURANCE

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the Environmental Survey and Site Assessment Program:

- Survey Procedures Manual, Revision 8 (December 1993)
- Laboratory Procedures Manual, Revision 8 (August 1993)
- Quality Assurance Manual, Revision 6 (July 1993)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 5700.6C and ASME NQA-1 for Quality Assurance and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in EPA and EML laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

# APPENDIX C

## GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE OR SPECIAL NUCLEAR MATERIAL

## AND

## GUIDELINES FOR RESIDUAL CONCENTRATIONS OF THORIUM AND URANIUM WASTES IN SOIL

# GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE, OR SPECIAL NUCLEAR MATERIAL

U. S. Nuclear Regulatory Commission
Division of Fuel Cycle & Material Safety
Washington, D.C. 20555

August 1987

The instructions in this guide, in conjunction with Table 1, specify the radionuclides and radiation exposure rate limits which should be used in decontamination and survey of surfaces or premises and equipment prior to abandonment or release for unrestricted use. The limits in Table 1 do not apply to premises, equipment, or scrap containing induced radioactivity for which the radiological considerations pertinent to their use may be different. The release of such facilities or items from regulatory control is considered on a case-by-case basis.

1. The licensee shall make a reasonable effort to eliminate residual contamination.

2. Radioactivity on equipment or surfaces shall not be covered by paint, plating, or other covering material unless contamination levels, as determined by a survey and documented, are below the limits specified in Table 1 prior to the application of the covering. A reasonable effort must be made to minimize the contamination prior to use of any covering.

3. The radioactivity on the interior surfaces of pipes, drain lines, or ductwork shall be determined by making measurements at all traps, and other appropriate access points, provided that contamination at these locations is likely to be representative of contamination on the interior of the pipes, drain lines, or ductwork. Surfaces or premises, equipment, or scrap which are likely to be contaminated, but are of such size, construction, or location as to make the surface inaccessible for purposes of measurement, shall be presumed to be contaminated in excess of the limits.

4. Upon request, the Commission may authorize a licensee to relinquish possession or control of premises, equipment, or scrap having surfaces contaminated with materials in excess of the limits specified. This may include, but would not be limited to special circumstances such as razing of buildings, transfer from premises to another organization continuing work with radioactive materials, or conversion of facilities to a long-term storage or standby status. Such requests must:

   a. Provide detailed, specific information describing the premises, equipment or scrap, radioactive contaminants, and the nature, extent, and degree of residual surface contamination.

   b. Provide a detailed health and safety analysis which reflects that the residual amounts of materials on surface areas, together with other considerations such as prospective use of the premises, equipment, or scrap, are unlikely to result in an unreasonable risk to the health and safety of the public.

5. Prior to release of premises for unrestricted use, the licensee shall make a comprehensive radiation survey which establishes that contamination is within the limits specified in Table 1. A copy of the survey report shall be filed with the Division of Fuel Cycle, Medical, Academic, and Commercial Use Safety, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, and also the Administrator of the NRC Regional Office having jurisdiction. The report should be filed at least 30 days prior to the planned date of abandonment. The survey report shall:

   a. Identify the premises.

   b. Show that reasonable effort has been made to eliminate residual contamination.

   c. Describe the scope of the survey and general procedures followed.

   d. State the findings of the survey in units specified in the instruction.

   Following review of the report, the NRC will consider visiting the facilities to confirm the survey.

TABLE 1
ACCEPTABLE SURFACE CONTAMINATION LEVELS

| Nuclides[a] | Average[b,c,f] | Maximum[b,d,f] | Removable[b,e,f] |
|---|---|---|---|
| U-nat, U-235, U-238, and associated decay products | 5,000 dpm $\alpha$/100 cm$^2$ | 15,000 dpm $\alpha$/100 cm$^2$ | 1,000 dpm $\alpha$/100 cm$^2$ |
| Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129 | 100 dpm/100 cm$^2$ | 300 dpm/100 cm$^2$ | 20 dpm/100 cm$^2$ |
| Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133 | 1,000 dpm/100 cm$^2$ | 3,000 dpm/100 cm$^2$ | 200 dpm/100 cm$^2$ |
| Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above. | 5,000 dpm $\beta\gamma$/100 cm$^2$ | 15,000 dpm $\beta\gamma$/100 cm$^2$ | 1,000 dpm $\beta\gamma$/100 cm$^2$ |

[a] Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

[d] The maximum contamination level applies to an area of not more than 100 cm$^2$.

[e] The amount of removable radioactive material per 100 cm$^2$ of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

[f] The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h at 1 cm and 1.0 mrad/h at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

## Guidelines for Residual Concentrations of Thorium and Uranium Wastes in Soil

On October 23, 1981, the Nuclear Regulatory Commission published in the Federal Register a notice of Branch Technical Position on "Disposal or Onsite Storage of Thorium and Uranium Wastes from Past Operations." This document establishes guidelines for concentrations of uranium and thorium in soil, that will limit maximum radiation received by the public under various conditions of future land usage. These concentrations are as follows:

| Material | Maximum Concentrations (pCi/g) for various options | | | |
|---|---|---|---|---|
| | 1[a] | 2[b] | 3[c] | 4[d] |
| Natural Thorium (Th-232 + Th-228) with daughters present and in equilibrium | 10 | 50 | --- | 500 |
| Natural Uranium (U-238 + U-234) with daughters present and in equilibrium | 10 | -- | 40 | 200 |
| Depleted Uranium: | | | | |
| Soluble | 35 | 100 | --- | 1,000 |
| Insoluble | 35 | 300 | --- | 3,000 |
| Enriched Uranium: | | | | |
| Soluble | 30 | 100 | --- | 1,000 |
| Insoluble | 30 | 250 | --- | 2,500 |

[a]Based on EPA cleanup standards which limit radiation to 1 mrad/yr to lung and 3 mrad/yr to bone from ingestion and inhalation and 10 $\mu$R/h above background from direct external exposure.

[b]Based on limiting individual dose to 170 mrem/yr.

[c]Based on limiting equivalent exposure to 0.02 working level or less.

[d]Based on limiting individual dose to 500 mrem/yr and in case of natural uranium, limiting exposure to 0.02 working level or less.