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"BECHTEL RADIOLOGICAL SURVEY REPORT"

1985

MANHATTAN PROJECT

DOE/OR/20722-22

RADIOLOGICAL SURVEY
OF THE
E. I. DUPONT DE NEMOURS AND COMPANY
CHAMBERS WORKS PLANT
DEEPWATER, NEW JERSEY

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ABSTRACT

During October and November 1983, a radiological survey was conducted in six separate areas of the DuPont Chambers Works Plant in Deepwater, New Jersey. The survey was performed as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), a U.S. Department of Energy effort to identify, clean up, or otherwise control sites where low-level radioactive contamination (exceeding current guidelines) remains from the early years of the nation's atomic energy program.

A 1977 radiological survey conducted by Oak Ridge National Laboratory had established that contamination existed at the site. The 1983 survey was necessary to define locations and boundaries of the contamination. The survey was conducted by the FUSRAP Program Management Contractor, Bechtel National, Inc., and its radiological subcontractor, Eberline Analytical Corporation (EAC).

Measurements taken during the 1983 radiological survey indicate that four of the six site areas surveyed are contaminated above current guidelines. In both soil and water samples, the major contaminant was found to be uranium-238. In some areas, contamination was found at depths greater than 3 m (9 ft), and in some cases contamination extended into the water table.

If remedial action were performed at the site, approximately 6300 m^3 (8200 yd^3) of contaminated materials would require removal to decontaminate exterior areas. One building would require surface decontamination [approximately 50 m^3 (70 yd^3) of material] or total demolition [approximately 2300 m^3 (3000 yd^3) of material]. However, in the areas of subsurface contamination, measures currently enforced by DuPont to protect against the site's chemical contaminants are adequate to protect personnel from the low-level radioactive contamination. DuPont does not permit excavation in areas of known chemical contamination and this prohibition extends to low-level radioactive contamination. Additionally, DuPont has positive access controls to the site.

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ABBREVIATIONS

cm	centimeter
cm^2	square centimeter
cpm	counts per minute
dpm/cm^2	disintegrations per minute per square centimeter
ft	foot
ha	hectare
l	liter
m	meter
µR/h	microroentgens per hour
mg	milligram
mrad/h	millirads per hour
pCi/g	picocuries per gram
pCi/l	picocuries per liter
yd^3	cubic yards

1.0 INTRODUCTION AND SUMMARY

This report describes the procedures, results, and significance of findings for a radiological survey conducted during October and November 1983 at the DuPont Chambers Works Plant in Deepwater, New Jersey. The survey was conducted as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP). FUSRAP is a U. S. Department of Energy (DOE) program to identify, clean up, or otherwise control sites where low-level radioactive contamination, at levels above current guidelines, remains from the early years of the nation's atomic energy program. Under contract to DOE, Bechtel National, Inc., (BNI) acts as the Program Management Contractor (PMC) for FUSRAP.

An earlier radiological survey, performed in 1977 by Oak Ridge National Laboratory (ORNL), established that contamination existed at the site and resulted in its designation as a FUSRAP site (Ref. 1). The 1983 radiological survey was necessary to define the locations and boundaries of the contamination identified in the ORNL survey, as a prelude to possible remedial action at the site. BNI and its radiological subcontractor, Eberline Analytical Corporation (EAC), conducted the 1983 survey.

Six separate areas were surveyed throughout the site: Building 845 (interior and exterior); Central Drainage Ditch; F Corral Parking Area; Building J-26 Area; East Burial Area and Lagoon A.

Surface and subsurface measurements in the J-26 and Lagoon A areas indicate the areas are not contaminated above guidelines and do not require remedial action. The remaining areas surveyed were contaminated above guidelines. In some areas, subsurface contamination exists at depths greater than 3 m (9 ft). Due to the high water table under the DuPont site, contamination at depths below the water line could not be quantified. The major on-site contaminant was found to be uranium-238, both in water and soil samples.

Groundwater uranium-238 concentrations collected from the F Corral Parking area ranged from background levels to over 105,105 pCi/l. Contamination in soil was found to exist in stratified layers down to the water table.

External-gamma radiation levels ranged from 11.2 to 27.8 µR/h. These levels are above the normal background level for the DuPont area; however, they are below the DOE guideline of 60 µR/h above background.

The survey also determined the extent of contamination present in Building 845. The building was surveyed for beta-gamma and alpha contamination; elevated dose rates and above-guideline alpha surface contamination were measured on all four levels of the building. First floor corehole loggings indicated areas of contamination beneath the building up to depths of 1.2 m (4 ft).

If remedial action were to be performed at the site, a total of approximately 6300 m^3 (8200 yd^3) of contaminated materials would have to be excavated from the site's exterior areas. In addition, surface decontamination of Building 845 would result in approximately 50 m^3 (70 yd^3) of contaminated material. Total demolition of Building 845 would result in approximately 2300 m^3 (3000 yd^3) of contaminated material. In areas of subsurface radioactive contamination, measures presently required by DuPont to protect against chemical contaminants are adequate to protect personnel from the low-level radioactive contamination. DuPont does not permit excavation in areas of known chemical contamination and this prohibition extends to low-level radioactive contamination. Additionally, DuPont has positive access controls to the site.

2.0 SITE DESCRIPTION AND HISTORY

2.1 LOCATION AND DESCRIPTION

The DuPont Chambers Works Plant is an active chemical plant which primarily manufactures organic chemicals. Products include fluorinated hydrocarbons (Freon), petroleum chemicals (tetraalkyl lead), elastomers (Viton and Hytrel), specialty chemicals (Zepel and organic titanates), and aromatics (phenylene diamines). The Chambers Works covers approximately 283 ha (700 acres) in Pennsville and Carneys Point townships on the southeast shore of the Delaware River, adjacent to the residential community of Deepwater, New Jersey. The site location is illustrated in Figure 2-1.

The following areas were investigated as part of the site radiological survey: Building 845 interior and exterior areas, F Corral (demolished Building 708, now a parking area), Building J-26 Area, East Burial Area, sections of the Central Drainage Ditch, and Lagoon A. These areas are shown in an aerial photograph of the site presented in Figure 2-2.

2.2 SITE HISTORY AND PREVIOUS RADIOLOGICAL SURVEYS

Operations involving uranium at the Chambers Works began in 1942. DuPont was conducting experiments with uranium hexafluoride under contract to the U. S. Office of Scientific Research and Development when the Manhattan Engineer District (MED) was established. As a part of its work on the MED program, DuPont worked on developing a process for converting uranium oxide to produce uranium tetrafluoride and small quantities of uranium metal. Other research activities were also performed.

All MED activities were transferred to the Atomic Energy Commission (AEC) when that agency was created by Congress in 1946. DuPont continued its research activities for AEC until late 1947.

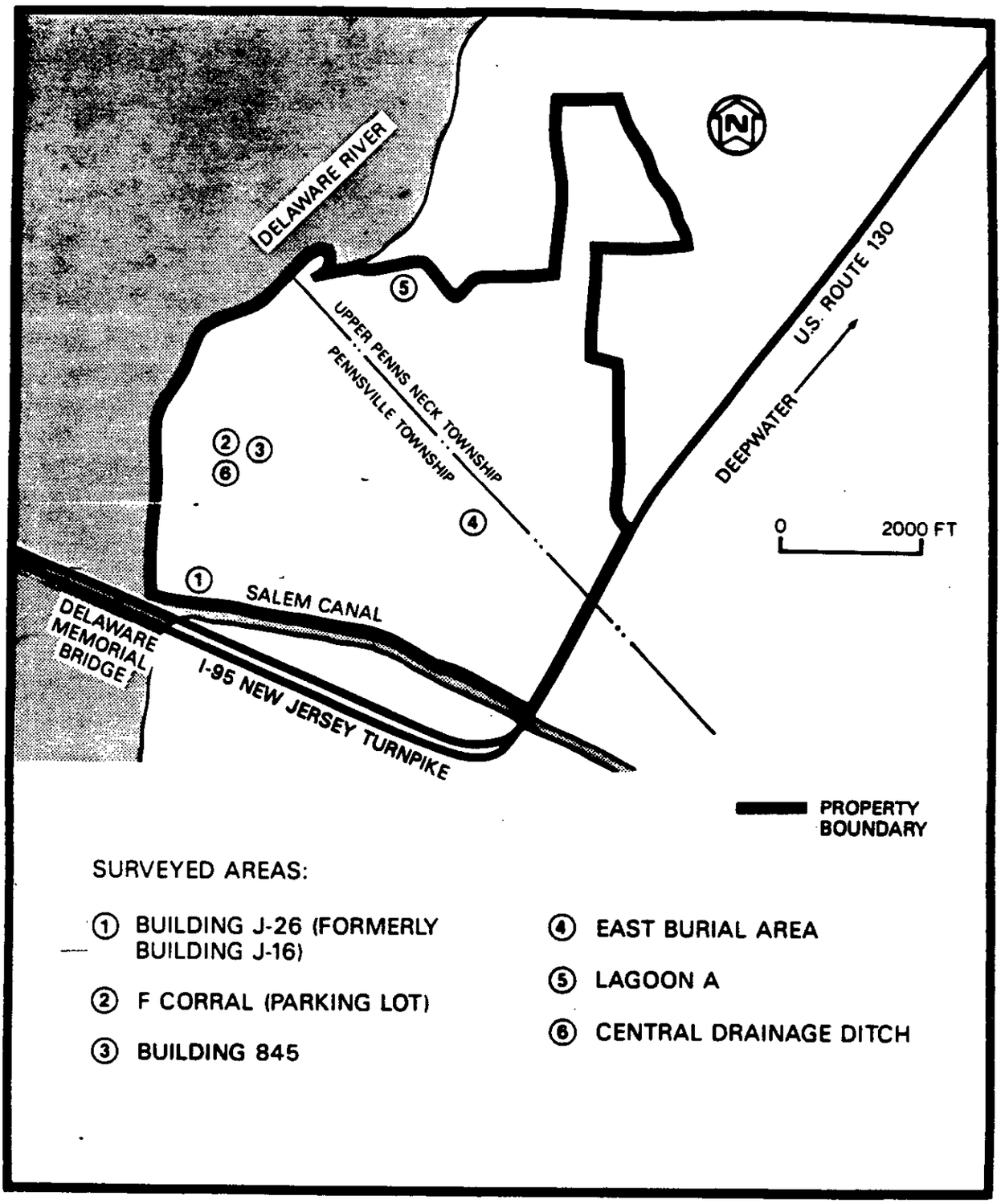

FIGURE 2-1 LOCATION OF THE DUPONT CHAMBERS WORKS PLANT

FIGURE 2-2 AERIAL VIEW OF THE DUPONT SITE

In 1948 and 1949, the AEC conducted radiological surveys and decontamination activities at the site. These activities included sandblasting, vacuuming, and washing building surfaces. Following a radiological survey based on then-existing criteria, AEC released the buildings back to DuPont in 1949.

In March 1977, another radiological survey of the site was conducted by ORNL as part of FUSRAP. The 1977 survey results indicated that elevated concentrations of uranium were present in rubble from the operations building and in some surface and subsurface soil samples. Alpha and beta-gamma contamination levels in some areas of Building 845 were above present federal guidelines (Ref. 1). The 1977 survey concluded that, under current conditions of site use, this contamination does not cause employees working at the site to receive radiation exposures appreciably different from those due to background radiation. However, under different conditions of use (e.g., actions which involved agitation or abrasion of dry contaminated surfaces), the potential for low-level radiation exposures to employees and the public could result.

Based on the 1977 survey results, the DOE Assistant Secretary for Environment determined that the DuPont site warranted remedial action under FUSRAP. In its role as PMC for FUSRAP, BNI conducted the 1983 survey to more accurately define the boundaries and depth of contamination at the site.

2.3 PRESENT SITE CONDITIONS

Of the three buildings used for MED activities, only Building 845 remains. Building 845 is presently used as a miscellaneous stores warehouse. The other two buildings were demolished from 1945 to 1953.

In 1945, part of Building 708 was demolished and removed from the site. In 1953, the remainder of Building 708 was removed along with several feet of underlying earth. Materials removed in 1953 were

disposed of in the Lagoon A area (Ref. 2). A parking facility, F Corral, is now located on the location of Building 708.

Following release of the site by the AEC in 1949, Building J-16 was demolished and disposed of in the Lagoon A area (Ref. 2). A new building, J-26, now stands at this location.

The East Burial Area contains some equipment from the demolition of Building 845. In addition, various chemical wastes and small amounts of New Jersey-approved low-level radioactive material have been stored in this area.

The Central Drainage Ditch is in approximately the same location as in the 1940s. The primary purpose of the ditch is to carry residual wastes from chemical operations. In the past, residual wastes from Building 845 were discharged into a wooden trough located east of the building. The trough dumped into the Central Drainage Ditch approximately 150 feet north of Building 845. The Central Drainage Ditch flows toward the northeast, adjacent to the northwest corner of Building 845, and drains out into the eastern corner of Lagoon A. The composite from Lagoon A is then pumped into the on-site water treatment facility for chemical processing of the waste.

3.0 HEALTH AND SAFETY PLAN

The presence of various chemicals used and manufactured at the site posed potential health hazards to employees involved in the sampling and handling of subsurface soil and water samples. These conditions necessitated the use of special measures to protect employees involved with the subsurface investigations and a Health and Safety Plan was designed by BNI.

The primary components of the Health and Safety Plan were: pre-work medical examinations; safety education in handling and sampling precautions; personal protective equipment consisting of gloves, shoe covers, disposable coveralls, eye protection, hard hats, and butyl-rubber air-supplied suits; urine sampling; and follow-up medical examinations performed upon completion of the survey. Controls required for chemical protection were reviewed and approved by DuPont. All drilling and soil sampling in the Central Drainage Ditch, Lagoon A, and East Burial Area, under direction from DuPont, were carried out with drillers and support personnel attired in one-piece, air-supplied butyl-rubber suits. In addition, two 30-minute self-contained breathing apparatus air cylinders were used during the sediment sampling conducted west and northwest of Building 845 along secondary drainage ditches.

During the radiological survey, the FUSRAP BNI Safety Supervisor was present and supervised operations. There were no recorded illnesses or injuries involving any person working on this survey. Medical examinations given at the conclusion of the survey showed no evidence of personnel having been exposed to hazardous chemicals.

4.0 SURVEY PROCEDURES

4.1 FIELD SURVEY PROCEDURES

The survey grid system for the site, exclusive of the grid for the interior of Building 845, was established by a civil surveyor during October 1983 and was based on the New Jersey state geological survey. The areas surveyed on a 15-m (50-ft) grid included Lagoon A, East Burial Area, Central Drainage Ditch, F Corral parking lot, areas around Building J-26, and areas around Building 845. The radiological measurements taken and the methods used for taking the measurements are described in the following subsections.

4.1.1 Measurements Taken and Methods Used

Within the grid blocks of all field areas, beta-gamma measurements were made on the ground surfaces at 6-m (20-ft) intervals. The measurements were made using a pancake geometry (Geiger-Mueller) probe coupled to a digital ratemeter/scaler [Eberline Instrument Corporation (EIC) models HP-210 and PRS-1, respectively.].

Near-surface gamma measurements were made 30 cm (12 in.) above the ground surface at 6-m (20-ft) intervals within the grid using a 5- x 5-cm (2- x 2-in.) sodium-iodide (NaI) detector. This detector (EIC model SPA-3) was mounted in a probe assembly surrounded with a conical lead shield to reduce the gamma intensity through the sides, thus producing a downward directional response.

Gamma exposure rates at 1 m (3 ft) above the ground were measured using a pressurized ionization chamber (PIC) with a response to gamma radiation that is proportional to exposure in roentgens. Readings were made at 15-m (50-ft) intervals above all open area surfaces in all gridded areas (gamma exposure rate measurements were not taken in the J-26 area).

Boreholes 15 cm (6 in.) in diameter were drilled in all areas. Material from the boreholes was returned to the holes. Drilling was conducted in accordance with safety precautions described in Section 3.0. The locations and number of holes in each area were based on near-surface gamma measurements made in the area and the historical data on the site. A section of 10-cm (4-in.) diameter PVC plastic pipe with a closed bottom was inserted into each hole as a temporary sleeve to allow gamma logging. A 5- x 5-cm (2- x 2-in.) NaI (Tl) gamma scintillation detector (SPA-3 NaI crystal in a modified probe used specifically for borehole logging), coupled with a PRS-1 ratemeter/scaler, was lowered into the pipe to obtain a profile of the depth of contamination. Timed gamma measurements were made at 15-cm (6-in.) vertical intervals. By calibrating these measurements with the results from laboratory analyses of soil samples, borehole loggings provide a reliable estimate of radionuclide concentrations in subsurface soils.

4.1.2 Sample Collection and Analyses

Building 845 (Exterior) Area

In the area surrounding Building 845, in addition to the boreholes drilled for gamma logging, undisturbed (Shelby tube) soil samples, water samples, and sediment samples were taken. The locations of the boreholes and of each type of sample taken are illustrated in Figure 4-1. In some cases, more than one type of sample was taken at the same location.

Based on the gamma logs, four Shelby tube soil samples were taken in areas which had revealed the most significant subsurface deposits of radioactivity. The soil samples extended to 30 cm (1 ft) below the depth of the radionuclide deposits as indicated by the gamma logging. Shelby tubes, 61 cm long and 7.6 cm in diameter (24 x 3 in.) were used to collect these soil samples. The soil in the tubes was extruded in 10-cm (4-in.) sections, placed in 500-ml plastic containers, identified, and packaged. The samples were

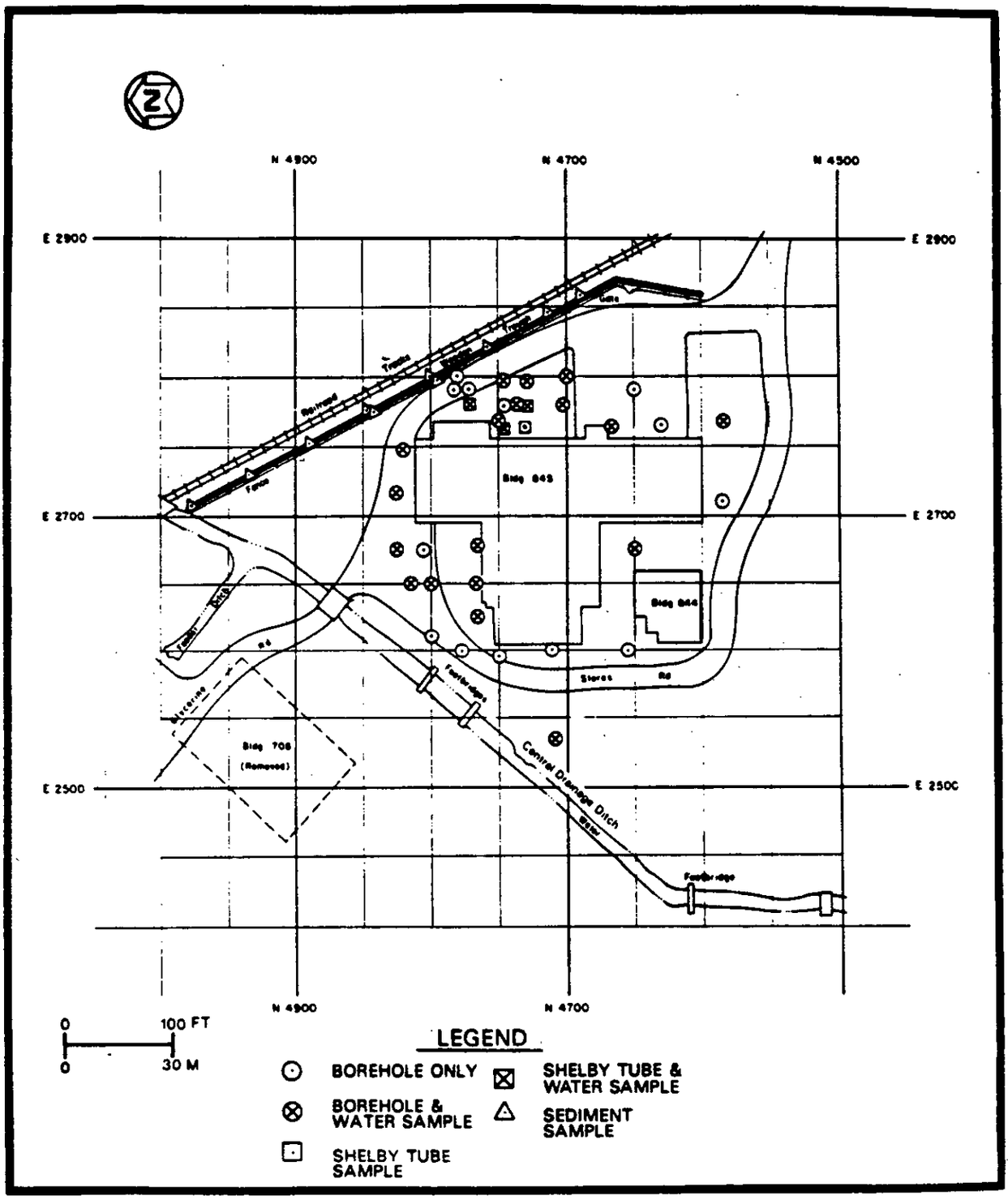

FIGURE 4-1 BOREHOLES AND SAMPLING LOCATIONS IN THE VICINITY OF BUILDING 845

shipped to DOE's Niagara Falls Storage Site where they were dried, pulverized, and homogenized before they were analyzed for uranium-238. The samples were analyzed by EAC personnel using the high resolution gamma spectrometry system in the FUSRAP in situ van (Ref. 3). Each sample was analyzed for 10 minutes using an intrinsic germanium detector housed in a lead counting cave lined with cadmium and copper. The detector is coupled to a computer base pulse height analyzer. Following the initial gamma spectrometry analysis of the soil samples, aliquots of selected samples were taken and sent to the EAC laboratory in Albuquerque, New Mexico, for radiochemical analysis. This analysis was performed to measure the concentrations of uranium-234 and uranium-235 in the samples and also to verify the uranium-238 analysis.

Water samples also were collected from all boreholes in the Building 845 area whenever the water table was reached. Water table depth proved to vary from 1 to 1.3 m (3 to 4 ft). Water samples were collected in 1-liter plastic sample bottles, clearly marked, and identified. (Chemical contamination of the water samples was evident through both odor and consistency of the liquid. For handling precautions, analytical laboratory personnel were advised of the possibility of chemical contamination.) All water samples collected were shipped to the EAC Albuquerque laboratory for analysis for uranium-234, uranium-235, and uranium-238 by radiochemical techniques.

Ten sediment samples were collected at 15-m (50-ft) intervals in the wooden drainage trough east of Building 845. Prior to analysis, all samples were heated on-site in an oven (at the in situ van) to 600°C (1112°F) to remove organics and eliminate possible chemical exposures during handling. Sediment samples then were analyzed using the same methods used for soil samples.

Central Drainage Ditch

Ten sediment samples were collected from the Central Drainage Ditch between grid location N4700-2485 and N5150-E3220. Sediment sampling

locations are shown in Figure 4-2. Sediment samples were collected primarily utilizing foot and traffic bridges and in areas of the ditch that were accessible during drilling operations.

Four sediment samples were collected at 15-m (50-ft) intervals from the Feeder Ditch. All sediment samples taken were heated to 600°C (1112°F) to remove organics and to eliminate possible chemical exposures during handling. Samples were then analyzed for radioactivity by the same methods used for soil samples.

F Corral Parking Area

Two Shelby tube soil samples were collected in the F Corral parking area. Samples were collected and analyzed in the same manner as described earlier. Water samples also were collected from boreholes in the F Corral when applicable. Water was collected and analyzed as described earlier. Sampling locations are shown in Figure 4-3.

Building J-26 Area (Formerly J-16)

Water samples were collected from boreholes, when possible, in the Building J-26 area. Boreholes and water sample locations are shown in Figure 4-4.

East Burial Area

In the East Burial Area, two locations were selected for Shelby tube soil samples. These samples were taken in the immediate vicinity of the two boreholes which revealed the most significant subsurface deposits of radioactivity. Water samples also were collected from boreholes when possible. Sampling locations are shown in Figure 4-5.

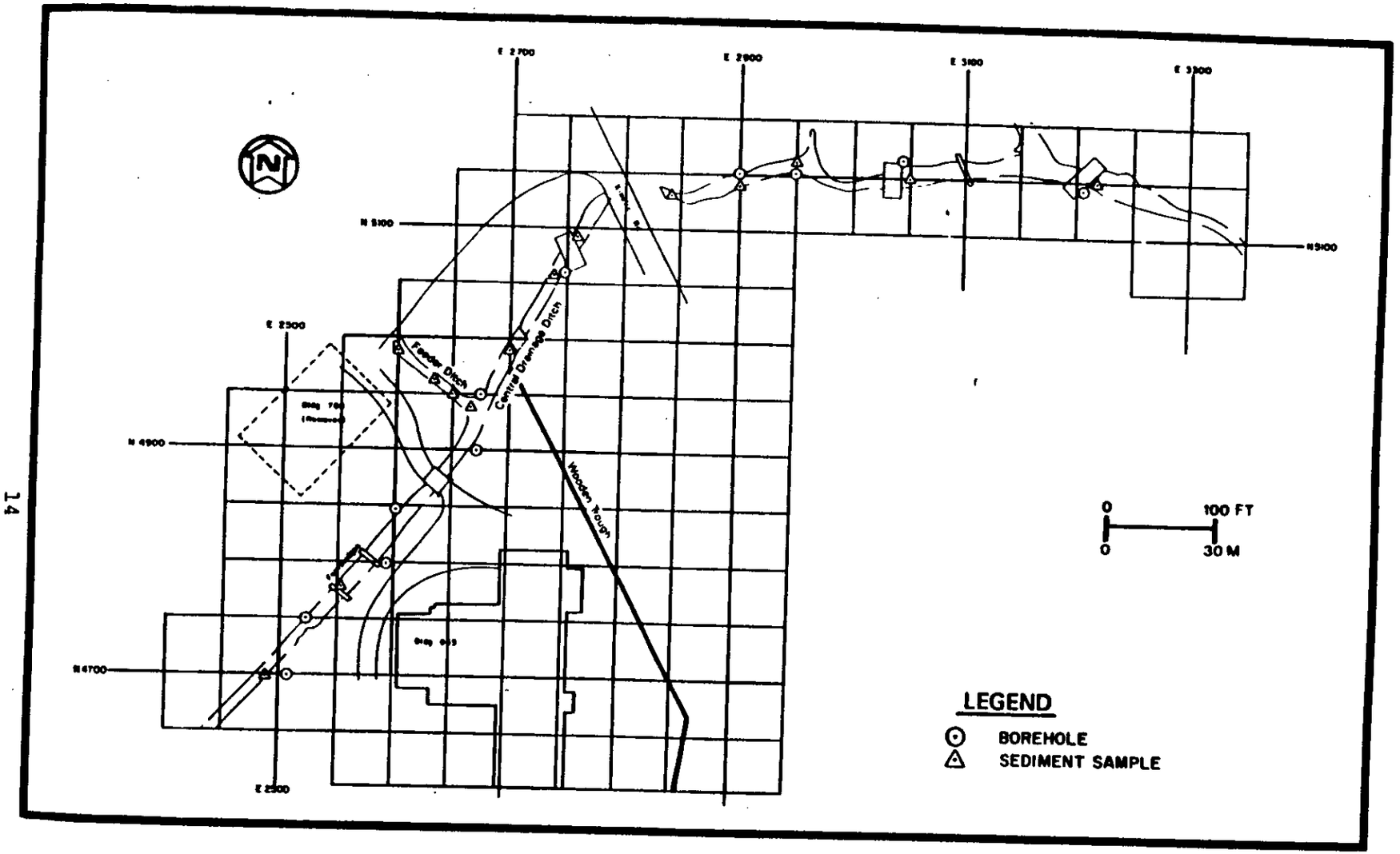

FIGURE 4-2 BOREHOLE AND SEDIMENT SAMPLE LOCATIONS, CENTRAL DRAINAGE DITCH AND FEEDER DITCH

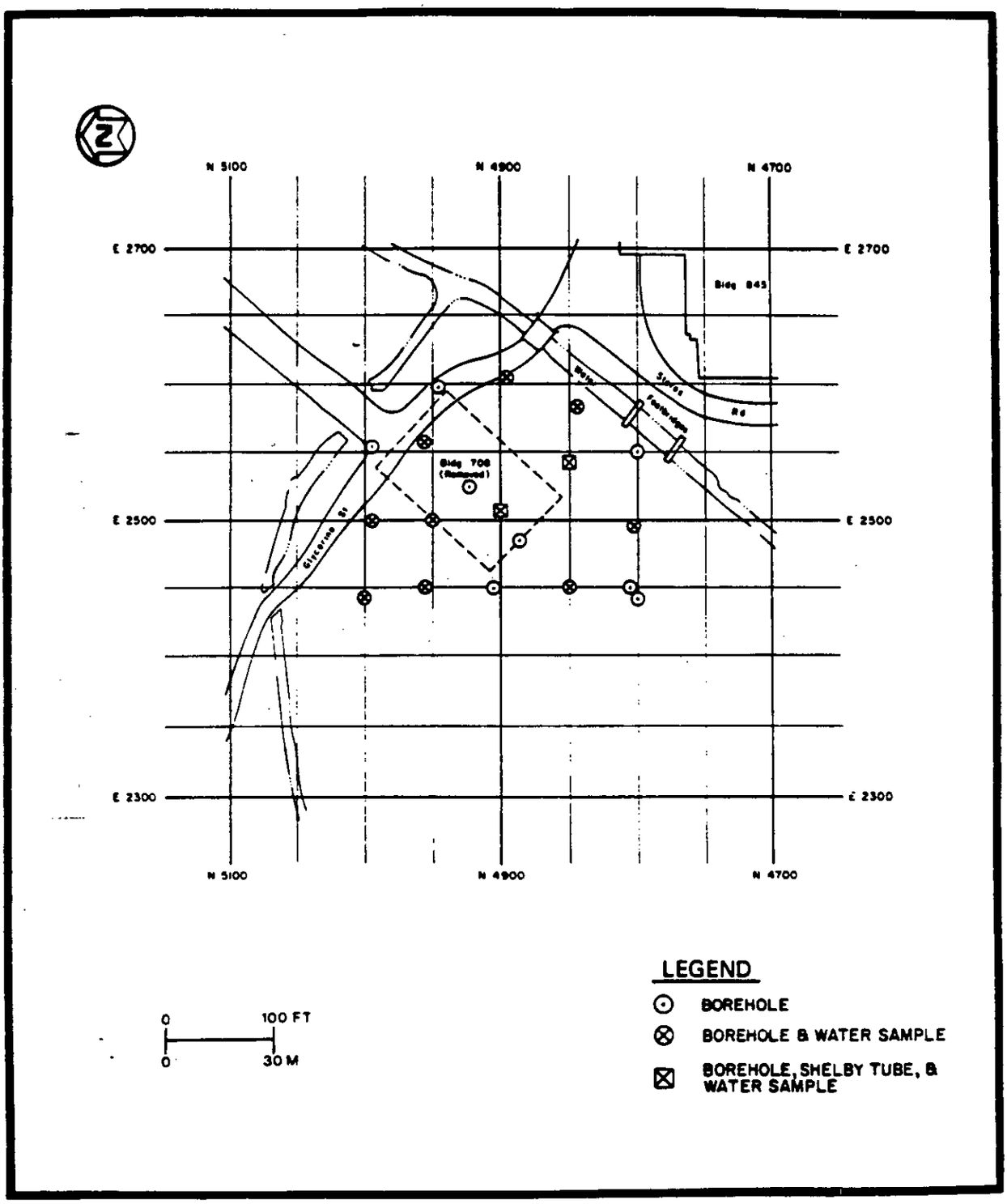

FIGURE 4-3 BOREHOLES AND SAMPLING LOCATIONS, F CORRAL AREA

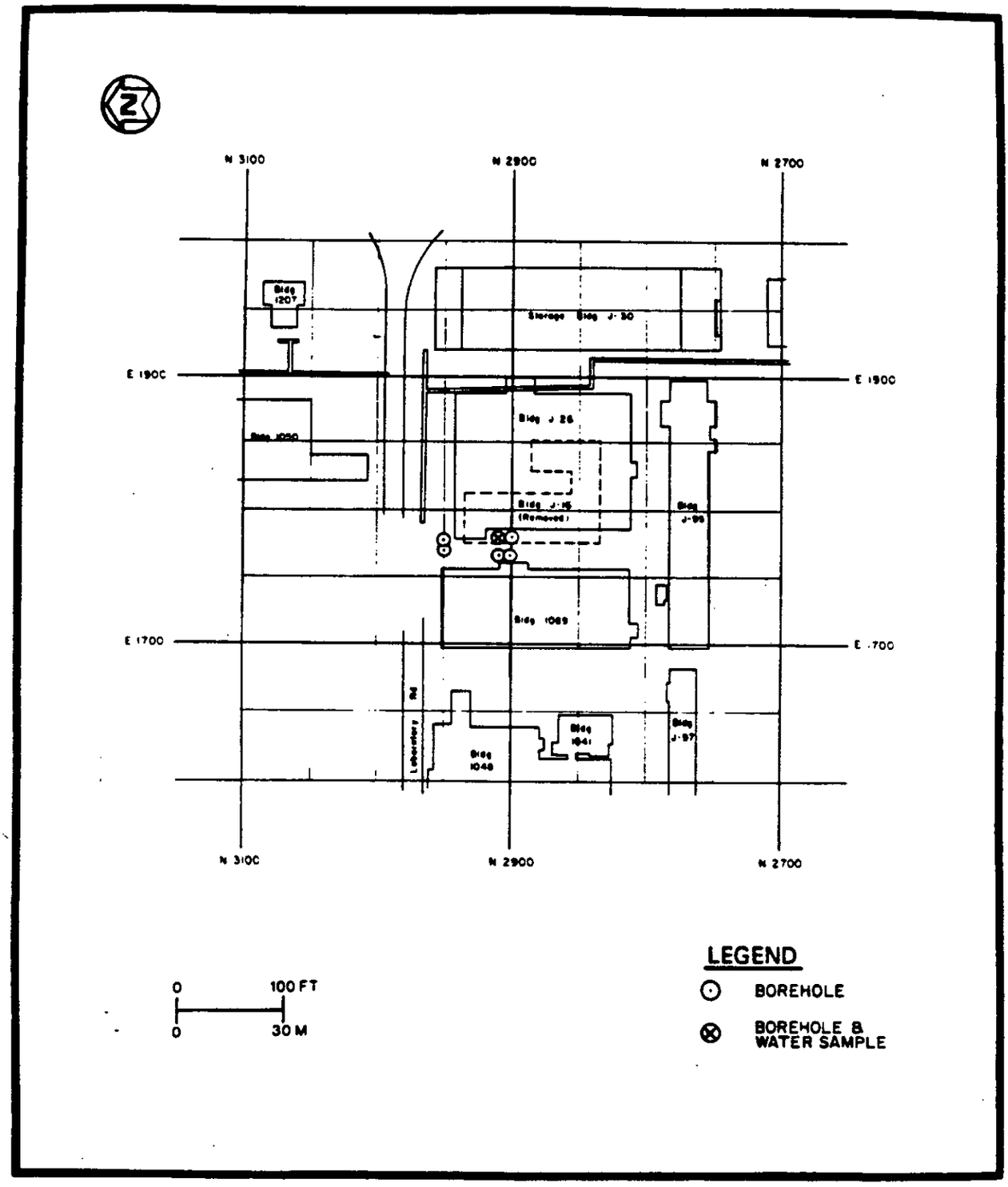

FIGURE 4-4 BOREHOLES AND WATER SAMPLING LOCATIONS, BUILDING J-26 AREA

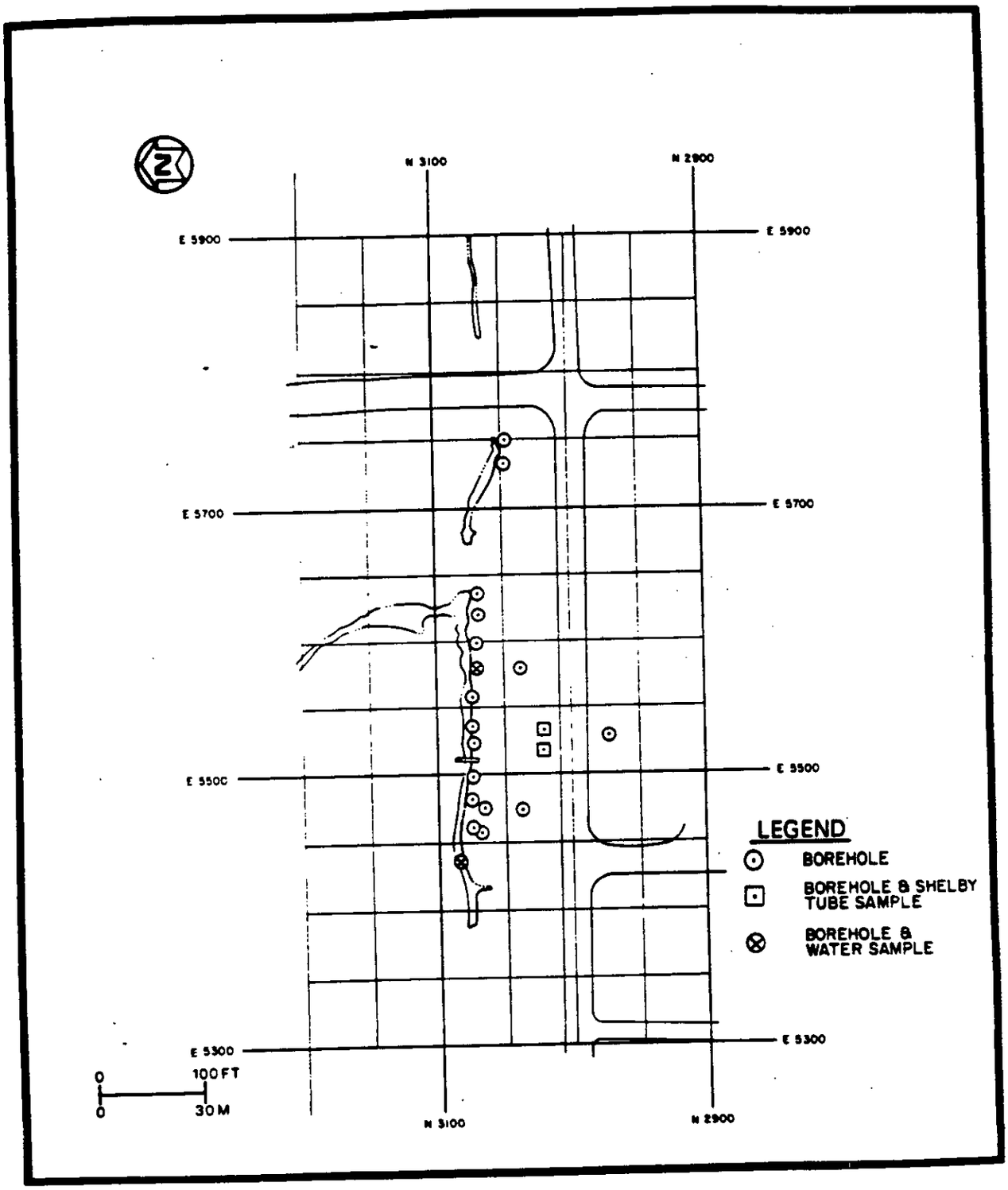

FIGURE 4-5 BOREHOLE AND SAMPLING LOCATIONS, EAST BURIAL AREA

Lagoon A

Two sediment samples were taken from Lagoon A and were processed using the same method used on the sediment samples taken from central drainage ditch. Sampling locations are shown in Figure 4-6.

4.2 BUILDING 845 SURVEY PROCEDURES

The grid system used for Building 845 consisted of a 1.8- x 1.8-m (6- x 6-ft) grid established on the walls, floors, and ceilings. Building 845 presently has four floors. During early plant operation this was not the case. The building contained equipment that reached from the ground floor to the upper parts of the building, and upper floors were only partial -- to varying extents. The present upper floors contain original flooring and recently added "new" flooring. For the purposes of this radiological survey, each floor of Building 845 was gridded independently and random measurements were made on the new floor areas to verify that these areas were not contaminated.

4.2.1 Measurements Taken and Methods Used

The surface of each floor of Building 845 was monitored for beta-gamma radiation, with a total of five measurements made in each grid segment on the original floor areas and random measurements made on the new floor areas. Measurements were made with a thin window (7 mg/cm^2) Geiger-Mueller detector with digital readout (EIC model HP-210/PRS-1). The HP-210 detector was in contact with floor surfaces. Five 30-second counts were obtained and recorded in each grid block. Measurements were made along the floor/wall intersection and along new and old floor joints at 3-ft intervals.

Wall surface measurements were obtained in the same manner as floor surface measurements. A 1.8-m (6-ft) grid was used from the floor to a height of 1.8 m (6 ft) above the floor. For upper walls the

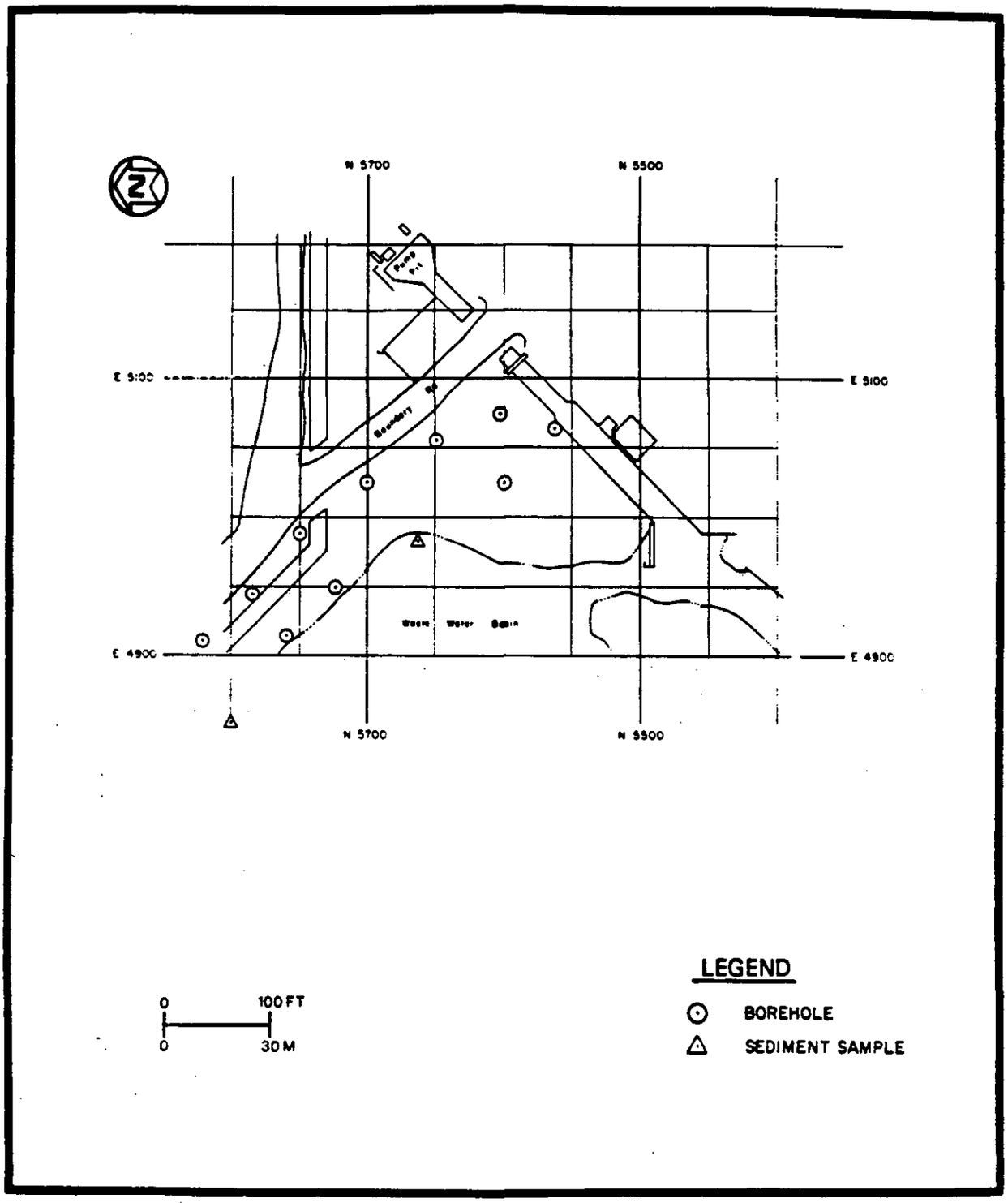

FIGURE 4-6 BOREHOLE AND SEDIMENT SAMPLING LOCATIONS, LAGOON A

grid was increased to 5 m (16 ft). All horizontal surfaces, such as window sills, also were scanned and radiation levels were recorded. All wall measurements are referenced to the floor grid numbering system.

Ceilings were monitored in the same manner as floors and walls. Measurement points were selected on horizontal and vertical surfaces such as beams, pipes, and ledges in each building unit (rooms, halls). All ceiling measurements were referenced to the floor grid numbering system.

Alpha radiation measurements were made at the same locations as beta-gamma measurements, using a 59-cm^2 zinc sulfide (ZnS) scintillation detector with digital readout (EIC models AC-3/PRS-1).

Based on results of the 1977 ORNL survey and surface beta-gamma measurements conducted during the 1983 building survey, 27 locations were identified for coring through the ground floor concrete slab. Locations are illustrated in Figure 4-7. Typical cores indicated the concrete slab was 10 to 15 cm (4 to 6 in.) thick, with a spread foundation footing 15 to 45 cm (6 to 18 in.) deep under columns.

A sealed drain trench was located in core boring number 4 (CB-4) and CB-6. The trench extended approximately 11 m (35 ft) south of CB-6 and was an average 45 cm (1.5 ft) deep. In CB-6, a 7.5-cm (3-in.) diameter steel drain pipe was located in the sealed trench at a depth of 22 to 30 cm (9 to 12 in.). This pipe contained elevated levels of radiological contamination in a dry, yellow powder form.

Augering techniques inside the building varied from methods used in the exterior areas of the plant due to limited overhead clearances. A 15-cm (6-in.) diameter hand auger was used to remove soil in 10-cm (4-in.) increments, allowing sufficient clearance for insertion of the PVC pipe for downhole gamma logging.

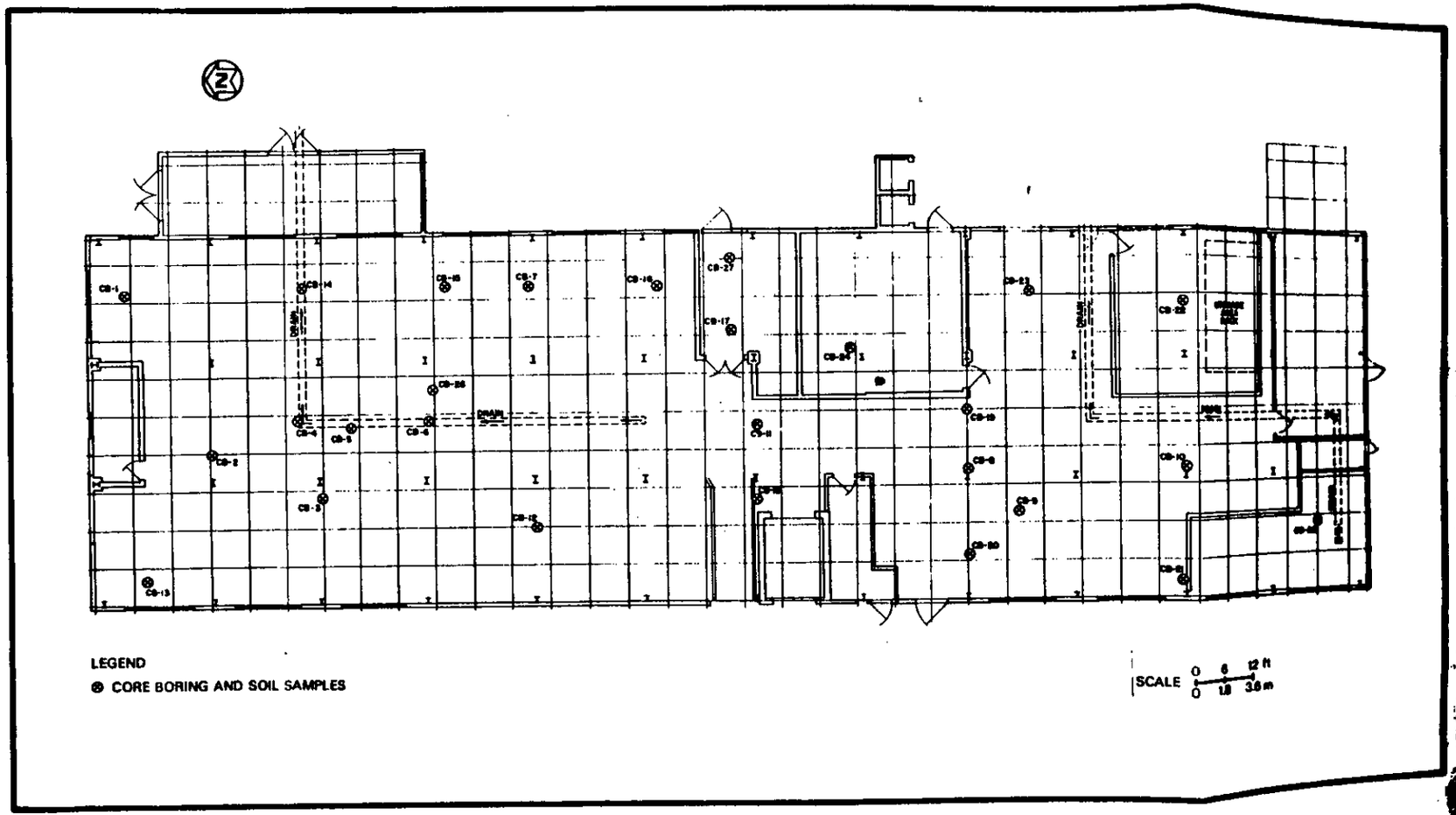

FIGURE 4-7 CORE BORINGS AND SOIL SAMPLE LOCATIONS, BUILDING 845 (GROUND FLOOR)

4.2.2 Sample Collection and Analysis

Shelby tube soil samples were collected inside Building 845 near all core boring locations. These samples were collected and analyzed using the same methods described in Subsection 4.1.2 of this report. Water samples also were taken from the borings when possible and processed as noted in Subsection 4.1.2.

During this radiological survey, four particulate air samplers (EIC Model RAS-1) were employed. These samplers, one on each floor, ran continuously and sampling filters were exchanged daily. Composite samples for each location were sent to the NFSS, where they were analyzed for gross alpha and beta-gamma.

Two composite dust samples also were collected from the first and fourth floors of Building 845. These samples were analyzed for uranium-238 and radium-226 at the EAC Albuquerque Laboratory.

5.0 SURVEY RESULTS

5.1 FIELD SURVEY RESULTS

All direct field measurements and laboratory results in this report represent gross readings; background measurements and concentrations have not been subtracted.

Background measurements were made in 1977 as part of the ORNL survey. At six locations on the DuPont property, at distances ranging from 300 to 1800 m (1000 to 6000 ft) from the nearest area in which radioactive materials were handled or stored, surface soil samples were taken to determine radionuclide concentrations. Concentrations of uranium-238 in the background soil samples ranged from 0.3 to 4.0 pCi/g and averaged 1.8 pCi/g.

External gamma measurements 1 m (3 ft) above the ground were made at the same six points. Background external gamma readings ranged from 3 to 6 μR/h and averaged 4.5 μR/h (Ref. 1). Background radiation rates and radionuclide concentrations in soil are summarized in Table 5-1, at the end of Section 5.0.

In addition to these background data, a series of additional external gamma exposure rate measurements were made throughout the state of New Jersey. The average statewide measurement was 6.1 μR/h (Ref. 4).

During the 1977 ORNL survey, three river water samples, which were assumed to represent background concentrations, were collected from the Delaware River. The results of these samples are presented in Table 5-2.

Background near-surface gamma measurements for the DuPont site were made during the 1983 BNI survey using an EIC SPA-3 detector. These measurements showed the site's near-surface gamma reading to be 2500 cpm.

Current DOE guidelines for radionuclide concentrations in soil, sediment and water are presented in Table 5-3.

In all field areas, measurements were taken for near-surface gamma, surface beta-gamma, and gamma exposure rates 1 m (3 ft) above the ground (gamma exposure rates were not measured in the J-26 area). Boreholes were drilled and gamma logging was performed, and undisturbed (Shelby tube) soil samples, water samples, and sediment samples were taken in each area as appropriate.

The results of near-surface gamma, surface beta-gamma, and gamma exposure rates are summarized in the following subsections. A summary table, Table 5-4, is presented at the end of Section 5.0. Analysis results for soil, sediment, and water samples also are summarized in the following sections, with specific results reported in Tables 5-5 (soil), 5-6 (sediment), and 5-7 (water) at the end of Section 5.0.

5.1.1 Building 845 Area

Near-surface gamma readings taken in the Building 845 area ranged from 1770 to 12,246 cpm. Only four surface areas east of Building 845 exhibited readings greater than twice background. All beta-gamma measurements were below the DOE guideline of 0.20 mrad/h dose rate averaged over one square meter.

Gamma exposure rates in the area ranged from 11.6 to 27.8 μR/h. As noted earlier, the overall site background rate measured by ORNL is 4.5 μR/h. The DOE criteria for continuous exposure to an individual in the general population is 60 μR/h above background.

Twenty-five boreholes, ranging in depth from 1.4 to 2.8 m (4.5 to 9 ft) were drilled in the area around Building 845. Borehole gamma logging then was performed to indicate general depth and concentrations of contamination. When possible, the borehole gamma loggings were correlated with undisturbed (Shelby tube) soil samples

analyses, relating the gamma detector's cpm response to the specific radionuclide concentration in picocuries per gram (pCi/g).

Due to the high water table encountered under the DuPont site, in many instances soil samples could not be collected. However, four Shelby tube soil samples were taken in the area east of Building 845 (refer to Figure 4-1). Specific analysis results are presented in Table 5-5, which lists the samples by coordinates and depth. The results indicate uranium is the major contaminant in the Building 845 exterior area, with levels ranging from 0.63 to 7398.0 pCi/g. The DOE remedial action guideline for uranium is 150 pCi/g.

Ten sediment samples were collected from the drainage trough located east of Building 845. Sampling locations are shown in Figure 4-1. All samples were analyzed for uranium-238, and concentrations ranged from 1.9 to 255.6 pCi/g. Selected samples also were analyzed for uranium-234, uranium-235, thorium-232, and radium-226. Results are given in Table 5-6. All results were below the DOE guidelines for these radionuclides (Ref. 5).

Twenty-one water samples were collected from boreholes in the area around Building 845. These samples were analyzed for total uranium. Results, given in Table 5-7, range from 1.5 to 11,712.0 pCi/l.

5.1.2 Central Drainage Ditch

Near-surface gamma measurements and beta-gamma measurements were made along both sides of the Central Drainage Ditch and the Feeder Ditch. Near-surface gamma readings ranged from 1806 to 14,532 cpm. Three measurements taken in the southwest portion of the Feeder Ditch had readings greater than twice background. All beta-gamma dose rates were below the DOE guideline.

Gamma exposure rates in the area of the Central Drainage Ditch ranged from 12.8 to 15.4 μR/h. These measurements are elevated above natural background but are below the DOE guideline of 60 μR/h.

Eleven boreholes were drilled 1.8 to 2.6 m (6 to 8.5 ft) deep along the sides of the Central Drainage Ditch (refer to Figure 4-2). Boreholes were gamma logged, and elevated measurements were detected along both sides of the ditch. All measurements were below but near the guideline limit.

Sediment samples were collected from 10 locations in the Central Drainage Ditch and 4 locations in the Feeder Ditch. These samples were analyzed for uranium-234, -235, and -238. Results ranged from 0.90 to 4.10 pCi/g for uranium-238, 1.20 to 1.90 pCi/g for uranium-234, and 0.04 to 0.15 pCi/g for uranium-235. Complete results are given in Table 5-6. All results were below the DOE guidelines.

5.1.3 F Corral Parking Area

Near-surface gamma measurements and beta-gamma measurements were made in the F Corral parking area at 6-m (20-ft) intervals. Near-surface gamma readings ranged from 1608 to 5020 cpm. All beta-gamma dose rates were below the DOE guideline. Gamma exposure rates in the F Corral parking area ranged from 11.6 to 13.8 μR/h.

Nineteen boreholes ranging from 0.6 to 2.7 m (2 to 9 ft) in depth were drilled in the F Corral area (refer to Figure 4-3). Based on gamma logs, subsurface contamination is indicated in layers to a depth greater than 2.7 m (9 ft).

Two Shelby tube soil samples were collected from the F Corral, and sample results are given in Table 5-5 by depth and coordinate. Uranium-238 was the major contaminant found in the parking area, with concentrations ranging from 0.90 to 4347 pCi/g.

Eleven water samples were collected from boreholes located in the F Corral. These samples were analyzed for total uranium. Results, given in Table 5-7, ranged from 1.50 to 105,105 pCi/l.

5.1.4 Building J-26 Area

In the Building J-26 area, near-surface gamma measurements ranged from 1568 to 4334 cpm. Beta-gamma dose rates were below the DOE guideline.

Six boreholes were drilled in the area around Building J-26 (refer to Figure 4-4), and one water sample was collected. The total uranium concentration of the sample was 13.51 pCi/l. Analysis results are given in Table 5-7.

5.1.5 East Burial Area

Near-surface gamma readings in the East Burial area ranged from 1212 to 17,878 cpm. Three measurements exceeded normal background levels. All beta-gamma dose rates were below the DOE guideline. Gamma exposure rates in the East Burial area ranged from 12.2 to 15.0 μR/h.

Twenty boreholes were drilled in the East Burial area (refer to Figure 4-5). Gamma loggings indicate contamination exists in layers to depths greater than 2.6 m (8.5 ft). Higher count rates were observed in the boreholes drilled adjacent to the road.

Two Shelby tube soil samples were collected in the East Burial area, and samples were analyzed for uranium-238, thorium-232, and radium-226. Uranium-238 was the major contaminant found, with concentrations ranging from 297 to 20,810 pCi/g. Both sampling locations also showed concentrations of radium-226 above the DOE guideline, with concentrations ranging from 0.19 to 27.8 pCi/g. All thorium-232 concentrations were below the DOE guideline. Complete results are given in Table 5-5. Due to the high water table, subsurface soil samples could not be collected below 1 m (3 ft).

Groundwater samples were collected from two locations at a depth of 90 cm (36 in.). Water samples were analyzed for total uranium. Both samples had uranium-238 concentrations below the DOE guideline.

5.1.6 Lagoon A

In the Lagoon A area, near-surface gamma measurements ranged from 1566 to 3436 cpm. All beta-gamma dose rates were below the DOE guideline. Gamma exposure rates ranged from 11.2 to 15.8 uR/h.

Ten boreholes were drilled in the Lagoon A area (refer to Figure 4-6). Gamma loggings exhibited readings above background but below the guideline.

A surface water sample was collected from Lagoon A. The total uranium concentration in the sample was 4.20 pCi/l. Results are given in Table 5-7.

5.2 BUILDING 845 SURVEY RESULTS

All building survey measurements in this report represent gross readings; background measurements have not been subtracted. Beta-gamma dose-rate measurements taken on the DuPont site in buildings that have not been contaminated with radioactive materials were less than 0.03 mrad/h (Ref. 1). DOE guidelines for the release of property for unrestricted use state that beta-gamma dose rates at 1 cm from the surface shall not exceed 0.2 mrad/h (averaged over one square meter) and 1.0 mrad/h maximum in an area not greater than 100 cm^2 (Ref. 5). The guidelines also state that alpha surface contamination levels shall not exceed 1000 dpm/100 cm^2 average and 3000 dpm/100 cm^2 maximum when natural uranium is known to be the contaminant.

Results of measurements for beta-gamma dose rates and alpha contamination taken in Building 845 are summarized in the following subsections. More detailed results are presented in summary form in Table 5-8. Results for soil and water samples are summarized in the following sections, with specific results reported in Tables 5-5 (soil) and 5-7 (water).

While work was being performed inside Building 845, air particulate samples were taken. All results were within the DOE guideline for gross alpha of 0.1 pCi/m^3 (for uncontrolled areas) (Ref. 6).

5.2.1 First Level

A total of five measurements were made for beta-gamma and alpha contamination in each floor grid block. Average and maximum values per grid block are recorded in this report. The floor beta-gamma dose rates per grid block ranged from 0 to 4.54 mrad/h. Alpha measurement averages ranged from 0 to 6819 dpm/100 cm^2, with a maximum reading of 26,544 dpm/100 cm^2.

Floor/wall intersections were surveyed in 1-m (3-ft) increments for beta-gamma and alpha contamination. Beta-gamma dose rate averages ranged from 0 to 6.05 mrad/h, with a maximum reading of 8.88 mrad/h. Alpha measurement averages ranged from 0 to 10,621 dpm/100 cm^2, with a maximum reading of 18,041 dpm/100 cm^2.

Beta-gamma dose rates measured on the ceiling ranged from 0 to 4.78 mrad/h. Alpha measurements ranged from 0 to 5568 dpm/ 100 cm^2. Beta-gamma and alpha measurement results are summarized in Table 5-8.

Twenty-seven corenoles were drilled through the first floor of Building 845. Locations are shown in Figure 4-7. In several locations, the auger hit the spread footings of the building's foundation. Thus, the corehole depths ranged from 0.5 to 2 m (1.5 to 6.0 ft). Eighteen boreholes indicated elevated gamma readings.

Soil samples were collected at all corenole locations and were analyzed for uranium-238, thorium-232, and radium-226. The major contaminant was uranium-238, with concentrations ranging from 0.70 to 8334 pCi/g. Thorium-232 and radium-226 concentrations were below the DOE criteria limit. Several samples were selected for uranium-234 and uranium-235 analysis, and concentrations were below guidelines. Results are given in Table 5-5.

One water sample was collected from CB-13 at a depth of 105 cm (42 in.), and the sample was analyzed for total uranium. The analysis results given in Table 5-7 indicate 7508 pCi/l of total uranium.

During building coring operations, two coreholes were drilled into the drainage trench used during MED operations. Two soil samples were collected from the drain and analyzed for uranium-238, thorium-232, and radium-226. All analysis results were below DOE guideline.

The building's elevator shaft could not be surveyed because of flooding conditions in the shaft. During the ORNL survey, the walls of the shaft were surveyed and one sediment sample was taken and analyzed. The sediment sample showed radium-226 concentrations above guideline (35 pCi/g), while all surface readings were below guidelines (Ref. 1).

Two composite dust samples were collected from first floor beams and horizontal surfaces. Both samples were analyzed by gamma spectrometry for uranium-238, and one sample was analyzed for radium-226. Uranium results ranged from 489 to 1625 pCi/g. The radium-226 result was 2.8 pCi/g. These results can be compared with surface-soil guidelines for uranium-238 and radium-226 of 150 pCi/g and 5 pCi/g above background, respectively.

5.2.2 Second Level

Beta-gamma and alpha measurements were taken on the old floor area of the second level. The new floor area was spot checked for contamination. Beta-gamma dose rate averages ranged from 0 to 2.85 mrad/h, with a maximum reading of 3.45 mrad/h. Alpha measurement averages ranged from 0 to 264 dpm/100 cm^2, with a maximum reading of 584 dpm/100 cm^2.

Beta-gamma and alpha measurements also were made on accessible lower wall areas during the survey. Beta-gamma dose rates ranged from 0.05 to 10.92 mrad/h. Alpha measurements ranged from 0 to 9068 dpm/ 100 cm^2.

Floor/wall intersections and the new floor/old floor intersections also were also surveyed. Beta-gamma dose rate averages ranged from 0.01 to 2.16 mrad/h, with a maximum reading of 2.77 mrad/h. All alpha measurements were below the guideline.

On the ceiling, beta-gamma dose rates ranged from 0.02 to 4.87 mrad/h. Alpha measurements ranged from 8 to 3992 dpm/100 cm^2.

Results of second level readings are summarized in Table 5-8.

5.2.3 Third Level

Beta-gamma and alpha measurements were taken on the old floor areas of the third level, and new floor areas were spot checked for contamination. Beta-gamma dose-rate averages ranged from 0 to 1.40 mrad/h, with a maximum reading of 2.38 mrad/h. Alpha measurement averages ranged from 0 to 1017 dpm/100 cm^2.

On the lower walls, beta-gamma dose rate averages ranged from 0.08 to 2.84 mrad/h, with a maximum reading of 2.84 mrad/h. Alpha measurements ranged from 37 to 3076 dpm/100 cm^2.

At floor/wall intersections and new floor/old floor intersections, beta-gamma dose rates ranged from 0 to 0.68 mrad/h, with a maximum reading of 0.98 mrad/h. Alpha measurements ranged from 0 to 1930 dpm/100 cm^2, with a maximum reading of 2599 dpm/100 cm^2.

On the third level ceiling, beta-gamma dose rate measurements ranged from 0.02 to 1.49 mrad/h, with a maximum reading of 7.05 mrad/h. Alpha measurement averages ranged from 8 to 1347 dpm/100 cm^2.

Beta-gamma and alpha measurement results for the third level are summarized in Table 5-8.

5.2.4 Fourth Level

On the old floor area of the fourth level, beta-gamma dose rate averages ranged from 0 to 1.0 mrad/h, with a maximum reading of 1.76 mrad/h. Alpha measurement averages ranged from 0 to 885 dpm/100 cm^2, with a maximum reading of 2561 dpm/100 cm^2.

On all accessible lower wall areas, beta-gamma dose rates ranged from 0.03 to 3.39 mrad/h. Alpha measurements ranged from 0 to 3487 dpm/100 cm^2.

On the ceiling, beta-gamma dose rates ranged from 0.05 to 4.34 mrad/h. Alpha measurement averages ranged from 76 to 2703 dpm/100 cm^2.

Beta-gamma and alpha measurement results for the fourth level are summarized in Table 5-8.

The fourth level ceiling heaters also were monitored for beta-gamma and alpha contamination. All measurements were below guideline. Two composite dust samples were collected from fourth level beams and horizontal surfaces. These samples were analyzed for total uranium-238, and results ranged from 1879 to 2984 pCi/g. These results can be compared to the uranium-238 guideline in soil of 150 pCi/g.

TABLE 5-1

BACKGROUND RADIATION RATES AND RADIONUCLIDE CONCENTRATIONS IN SOIL

Location	Gamma Exposure Rate at 1 m (μR/h)	Radionuclide Concentrations (pCi/g)			
		U-238	Ra-226	Ac-227	Th-232
1	4	1.5	0.8	not found	0.7
2	4	1.9	0.5	0.3	0.6
3	6	4.0	0.6	2.2	0.7
4	6	1.6	0.9	not found	1.0
5	3	0.3	0.2	not found	0.3
6	4	1.8	0.8	not found	0.8
Averages	4.5	1.8	0.6	0.4	0.7

Source: ORNL (Ref. 1)

TABLE 5-2

RADIONUCLIDE CONCENTRATIONS IN THE DELAWARE RIVER

Location	Radionuclide Concentrations (pCi/ml)			
	U-238	Ra-226	Th-230	Pb-210
W-1	1.5×10^{-3}	9×10^{-6}	1.7×10^{-5}	9×10^{-4}
W-2	1.1×10^{-3}	9×10^{-6}	1.5×10^{-5}	9×10^{-4}
W-3	4.3×10^{-4}	2.3×10^{-5}	3.2×10^{-5}	4.5×10^{-4}

Source: ORNL (Ref. 1)

TABLE 5-3

RESIDUAL CONTAMINATION GUIDELINES AND CRITERIA FOR FUSRAP SITES

Soil and Sediment[a,b]	Guidelines		
Uranium-238[c]	150 pCi/g above background		
Uranium-235[c]	140 pCi/g above background		
Uranium-234[c]	150 pCi/g above background		
Radium-226 and Thorium-232	5 pCi/g above background when averaged over the first 15 cm of soil below the surface; 15 pCi/g above background when averaged over 15-cm thick soil layers more than 15 cm below the surface and less than 1.5 m below the surface		
Radionuclides in Water	**Criteria**		
Total Uranium	600 pCi/l		
Surface Contamination	**Average[d]**	**Maximum[e]**	**Units**
Beta-gamma dose rates	0.2	1.0	mrad/h
Alpha surface for U-natural, U-238, U-235, and associated decay products	5000	15000	dpm/100 cm^2
External Gamma	60 μR/h above background		
Air Particulate	0.1 pCi/m^3		

[a]Except for radium-226, these criteria represent unrestricted-use concentrations above background, averaged across any 15-cm layer to any depth and over any contiguous 100-m^2 surface area. The same conditions prevail for radium-226 except for soil layers beneath 1.5 m. The allowable radium-226 concentration may be affected by site-specific conditions and must be evaluated accordingly.

[b]Localized concentrations in excess of these limits are allowable provided that the average over 100 m^2 is not exceeded.

[c]Assumes that no other uranium isotopes are present.

[d]Measurements of average contamination are averaged over areas of no greater than 1 m^2.

[e]The maximum contamination levels apply to areas of not more than 100 cm^2.

Sources: DOE (Ref. 5 and 6)

TABLE 5-4

DUPONT CHAMBERS WORKS SITE: PRE-REMEDIAL ACTION

SUMMARY OF OUTDOOR MEASUREMENT RESULTS

Measurement Location and Type[a]	Units	Number of Measurements Made	Range	Normal Background (BKG)
Building 845 Area				
Near-surface gamma	cpm	142	1770-12246	2,500
Beta-gamma dose rates	mrad/h	142	BKG - 0.08	0.02
External gamma exposure rates	µR/h	31	11.6 - 27.8	4.5
Feeder Ditch and Central Drainage Ditch				
Near-surface gamma	cpm	73	1806-14532	2,500
Beta-gamma dose rates	mrad/h	73	BKG-0.13	0.02
External gamma exposure rates	µR/h	12	12.8 - 15.4	4.5
F Corral Parking Area				
Near-surface gamma	cpm	203	1608-5020	2,500
Beta-gamma dose rates	mrad/h	203	BKG-0.14	0.02
External gamma exposure rates	µR/h	27	11.6 - 13.8	4.5
Building J-26 Area				
Near-surface gamma	cpm	41	1568-4334	2,500
Beta-gamma dose rates	mrad/h	41	BKG-0.05	0.02
East Burial Area				
Near-surface gamma	cpm	89	1212-17878	2,500
Beta-gamma dose rates	mrad/h	89	BKG-0.04	0.02
External gamma exposure rates	µR/h	15	12.2-15.0	4.5
Lagoon A				
Near-surface gamma	cpm	64	1566-3436	2,500
Beta-gamma dose rates	mrad/h	64	BKG-0.05	0.02
External gamma exposure rates	µR/h	4	11.2-15.8	4.5

[a]Near-surface gamma measurements were made with a SPA-3 coupled with a PRS-1. Beta-gamma dose rates were measured with an HP-210 and PRS-1. Gamma exposure rates were measured with a PIC.

TABLE 5-5

DUPONT CHAMBERS WORKS SITE: GAMMA SPECTROMETRY OF SOIL SAMPLES

Sampling Location		Depth (inches)	Radionuclide Concentrations (pCi/g +/- 2 Sigma)				
			Uranium-238	Radium-226	Thorium-232	Uranium-234	Uranium-235
Building 845 Area:							
Grid E	Grid N						
2761	4730	6-10	581.20 ± 11.80	1.83 ± .28	.96 ± .55	---	---
2761	4730	10-14	427.60 ± 9.68	1.07 ± .20	1.51 ± .56	---	---
2761	4730	14-18	164.80 ± 5.34	.38 ± .13	---	---	---
2761	4730	18-22	61.92 ± 21.60	.33 ± .22	.86 ± .29	---	---
2761	4730	22-26	4.92 ± 1.47	.28 ± .23	.62 ± .26	---	---
2761	4745	0-4	7398.00 ± 32.70	4.06 ± .77	---	---	---
2761	4745	6-10	720.10 ± 9.50	.67 ± .20	.66 ± .23	---	---
2761	4745	42-45	321.80 ± 7.74	.78 ± .19	.46 ± .26	---	---
2761	4745	46-50	358.40 ± 11.14	.69 ± .21	---	---	---
2761	4745	50-54	269.50 ± 6.88	.36 ± .17	.40 ± .42	---	---
2761	4745	54-58	94.98 ± 5.88	.37 ± .29	---	---	---
2761	4745	58-62	152.40 ± 9.25	.86 ± .20	---	---	---
2761	4745	62-66	.63 ± 1.54	.63 ± .14	.94 ± .28	---	---
2780	4771	6-10	10.61 ± 6.69	---	---	---	---
2780	4771	10-14	25.61 ± 5.12	---	---	---	---
2780	4771	14-18	159.30 ± 10.19	.90 ± .29	---	---	---
2780	4771	36-40	40.87 ± 3.39	.92 ± .15	.97 ± .49	---	---
2782	4730	2-3	4355.00 ± 68.70	5.12 ± 2.17	---	---	---
2782	4730	3-7	561.40 ± 11.12	1.99 ± .27	---	---	---
2782	4730	7-11	58.06 ± 2.93	.82 ± .16	---	---	---
2782	4730	11-15	.80 ± .20	.63 ± .11	.58 ± .22	.70 ± .20	.09 ± .08
2782	4730	15-19	---	.53 ± .13	.48 ± .17	---	---
2782	4730	19-23	---	.42 ± .14	.23 ± .23	---	---
2782	4730	23-27	---	.46 ± .25	---	---	---
F Corral Parking Area:							
Grid E	Grid N						
2507	4900	13-17	323.70 ± 16.36	1.04 ± .42	---	---	---
2507	4900	17-21	1333.00 ± 41.20	8.58 ± .93	---	---	---
2507	4900	21-25	1768.00 ± 42.40	8.91 ± .86	---	---	---
2507	4900	25-29	863.30 ± 26.24	2.66 ± .50	---	---	---
2507	4900	29-33	3531.00 ± 25.90	2.11 ± .62	---	---	---
2507	4900	54-56	1629.00 ± 51.30	1.69 ± .86	---	---	---
2507	4900	56-60	4378.00 ± 25.29	1.16 ± .48	---	---	---
2507	4900	60-64	4247.00 ± 61.35	1.03 ± .71	---	---	---
2507	4900	64-68	1734.00 ± 44.40	.76 ± .56	---	---	---
2507	4900	68-72	662.30 ± 37.91	1.10 ± .58	---	---	---
2507	4900	72-76	536.20 ± 18.65	---	.79 ± .26	---	---
2540	4850	6-10	12.59 ± 2.21	.28 ± .16	---	---	---
2540	4850	10-14	1.40 ± .20	---	---	---	---
2540	4850	14-18	.90 ± .20	---	---	1.70 ± .20	.12 ± .05

TABLE 5-5

(continued)

Sampling Location	Depth (Inches)	Radionuclide Concentrations (pCi/g +/- 2 Sigma)				
		Uranium-238	Radium-226	Thorium-232	Uranium-234	Uranium-235
F Corral Parking Area:						
Grid E / Grid N						
2540 / 4850	18-22	3.90 ± 1.01	.15 ± .05	---	.80 ± .20	.05 ± .04
2540 / 4850	22-26	6.93 ± 1.46	.19 ± .12	.11 ± .12	---	---
2540 / 4850	26-30	281.20 ± 11.70	2.72 ± .33	.62 ± .18	---	---
2540 / 4850	36-42	1066.00 ± 12.11	6.51 ± .51	.84 ± .38	---	---
East Burial Area:						
Grid E / Grid N						
5518 / 3018	9-13	11210. ± 39.40	27.84 ± 2.28	---	---	---
5518 / 3018	13-17	20810. ± 54.38	25.98 ± 2.37	---	---	---
5518 / 3018	17-21	673.30 ± 9.59	1.27 ± .10	.69 ± .34	---	---
5518 / 3018	21-25	185.40 ± 4.94	1.04 ± .08	1.05 ± .24	---	---
5518 / 3018	25-29	296.90 ± 6.59	3.93 ± .32	---	---	---
5518 / 3018	29-33	375.40 ± 8.33	.19 ± .02	---	---	---
5518 / 3018	34-38	602.10 ± 13.30	5.02 ± .41	.64 ± .53	---	---
5533 / 3018	6-10	18670. ± 16.83	5.13 ± .42	---	---	---
5533 / 3018	10-14	6029.00 ± 30.04	16.02 ± 1.31	---	---	---
5533 / 3018	14-18	710.20 ± 9.75	5.45 ± .45	---	---	---
5533 / 3018	18-23	577.40 ± 11.39	3.73 ± .31	---	---	---
5533 / 3018	22-26	745.80 ± 9.92	1.87 ± .15	.48 ± .60	---	---
5533 / 3018	26-30	517.20 ± 8.04	.63 ± .22	---	---	---
5533 / 3018	30-32	530.10 ± 11.10	1.24 ± .39	.57 ± .58	---	---
Building 845 (Interior)						
Grid No. / Core No.						
9 / CB-1	6-9	2092.00 ± 3.31	1.44 ± .19	1.05 ± .40	---	---
9 / CB-1	9-13	21.82 ± 2.54	.80 ± .17	1.14 ± .30	---	---
11 / CB-13	15-19	3281.00 ± 28.45	---	---	---	---
11 / CB-13	19-24	1342.00 ± 13.80	.43 ± .28	---	---	---
11 / CB-13	24-29	130.10 ± 3.70	.90 ± .29	---	---	---
11 / CB-13	33-36	1351.00 ± 18.00	1.40 ± .46	---	---	---
11 / CB-13	39-43	18.35 ± 2.33	.70 ± .14	.73 ± .28	---	---
11 / CB-13	43-47	1.35 ± 1.49	1.30 ± .20	1.28 ± .25	---	---
11 / CB-13	47-51	---	.90 ± .45	---	---	---
11 / CB-13	51-55	---	1.07 ± .18	.97 ± .29	---	---
11 / CB-13	55-59	1.14 ± .93	.65 ± .14	---	---	---
11 / CB-13	59-63	4.09 ± 1.44	.43 ± .12	.28 ± .31	---	---
40 / CB-2	0-6	149.80 ± 8.21	1.13 ± .20	---	---	---
40 / CB-2	0-6	86.89 ± 5.00	.33 ± .16	.61 ± .17	---	---
40 / CB-2	12-16	166.40 ± 8.10	1.09 ± .38	.86 ± .45	---	---
40 / CB-2	12-16	36.24 ± 1.32	.48 ± .08	.62 ± .14	---	---
40 / CB-2	16-20	145.60 ± 10.47	---	---	---	---

TABLE 5-5

(continued)

Sampling Location		Depth (inches)	Radionuclide Concentrations (pCi/g +/- 2 Sigma)				
			Uranium-238	Radium-226	Thorium-232	Uranium-234	Uranium-235
Building 845 (Interior):							
Grid No.	Core No.						
40	CB-2	16-20	177.20 ± 8.04	.48 ± .31	.18 ± .50	---	---
40	CB-2	20-24	106.20 ± 8.36	.57 ± .22	---	---	---
40	CB-2	20-24	49.37 ± 4.26	.56 ± .24	.13 ± .45	---	---
40	CB-2	24-28	29.09 ± 3.70	.85 ± .37	---	---	---
40	CB-2	24-28	56.79 ± 4.63	.94 ± .28	.23 ± .39	---	---
40	CB-2	28-32	43.66 ± 6.30	---	---	---	---
40	CB-2	28-32	18.58 ± 5.29	---	---	---	---
65	CB-3	0-3	1256.00 ± 42.13	---	---	---	---
65	CB-3	3-7	484.70 ± 19.50	---	---	---	---
65	CB-3	7-11	569.90 ± 10.30	.35 ± .19	---	---	---
65	CB-3	11-15	427.80 ± 9.74	.22 ± .32	.99 ± .31	---	---
67	CB-4	23-27	45.87 ± 3.64	.77 ± .16	.62 ± .25	---	---
67	CB-4	27-31	790.10 ± 10.00	.66 ± .44	---	---	---
71	CB-14	20-23	39.12 ± 3.00	.74 ± .13	.42 ± .21	---	---
80	CB-5	21-30	72.63 ± 7.24	.84 ± .21	---	---	---
80	CB-5	30-39	10.09 ± 2.87	---	---	---	---
106	CB-6	22-27	9.82 ± 7.59	---	---	---	---
107	CB-26	6-10	43.14 ± 7.67	1.01 ± .25	---	---	---
107	CB-26	10-14	37.89 ± 2.64	.51 ± .20	.91 ± .32	---	---
107	CB-26	14-18	42.07 ± 3.13	.90 ± .13	.37 ± .22	---	---
107	CB-26	18-22	17.89 ± 2.19	.92 ± .14	.71 ± .16	---	---
123	CB-15	8-12	2014.00 ± 15.80	.78 ± .32	1.20 ± .41	---	---
123	CB-15	12-16	166.80 ± 5.78	.98 ± .18	1.22 ± .31	---	---
123	CB-15	16-20	71.34 ± 4.29	.36 ± .16	.75 ± .29	---	---
123	CB-15	20-24	12.52 ± 2.29	1.10 ± .20	1.15 ± .39	---	---
123	CB-15	24-28	1.00 ± .20	.99 ± .18	10.44 ± .25	1.00 ± .20	.04 ± 0.3
136	CB-12	7-12	38.16 ± 3.63	.85 ± .17	---	---	---
136	CB-12	12-18	56.41 ± 3.92	1.64 ± .28	.61 ± .28	---	---
136	CB-12	18-21	3.30 ± .30	---	---	3.40 ± .30	.11 ± .07
143	CB-7	6-10	991.20 ± 11.71	1.42 ± .21	---	---	---
143	CB-7	10-14	94.34 ± 4.39	.63 ± .15	1.16 ± .25	---	---
143	CB-7	14-18	1.24 ± 6.96	---	---	---	---
143	CB-7	18-22	1.53 ± 1.06	.44 ± .23	.56 ± .29	---	---
143	CB-7	22-26	1.69 ± 1.46	1.10 ± .15	.54 ± .31	---	---
173	CB-16	6-10	2785.00 ± 48.20	4.94 ± .82	---	---	---
173	CB-16	10-14	5839.00 ± 76.74	4.27 ± .90	---	---	---
173	CB-16	14-18	8057.00 ± 3.62	.83 ± .70	---	---	---
173	CB-16	18-22	6721.00 ± 31.70	---	---	---	---
173	CB-16	33-37	2083.00 ± 16.50	.80 ± .35	---	---	---
173	CB-16	37-41	843.20 ± 11.10	1.23 ± .34	.95 ± .33	---	---
173	CB-16	41-45	719.00 ± 10.30	1.10 ± .24	---	---	---

TABLE 5-5

(continued)

Sampling Location		Depth (inches)	Radionuclide Concentrations (pCi/g +/- 2 Sigma)				
			Uranium-238	Radium-226	Thorium-232	Uranium-234	Uranium-235
Building 845 (interior):							
Grid No.	Core No.						
173	C8-16	45-49	7.76 ± 3.90	.78 ± .17	---	---	---
173	C8-16	49-53	35.37 ± 3.43	.62 ± .22	.93 ± .32	---	---
192	C8-17	0-1	4699.00 ± 68.90	---	---	---	---
192	C8-17	6-10	2517.00 ± 18.63	.54 ± .38	---	---	---
192	C8-17	10-14	1471.00 ± 13.25	---	---	---	---
192	C8-17	14-18	151.90 ± 5.36	.49 ± .12	---	---	---
192	C8-17	18-22	197.10 ± 5.91	.35 ± .14	.34 ± .27	---	---
194	C8-27	6-10	32.62 ± 2.38	.32 ± .13	---	---	---
197	C8-18	6-10	187.90 ± 4.78	1.73 ± .20	---	---	---
199	C8-11	6-10	6334.00 ± 122.40	---	---	---	---
199	C8-11	10-14	3938.00 ± 31.60	.31 ± .77	---	---	---
199	C8-11	14-18	2168.00 ± 58.40	---	---	---	---
199	C8-11	18-22	409.90 ± 10.49	.48 ± .30	---	---	---
199	C8-11	22-26	302.10 ± 11.06	.72 ± .36	---	---	---
199	C8-11	26-30	59.62 ± 4.04	.58 ± .18	.56 ± .30	---	---
221	C8-24	0-4	2.30 ± .30	---	---	2.40 ± .30	.08 ± .05
221	C8-24	4-12	3.40 ± .30	---	---	3.40 ± .30	.11 ± .05
221	C8-24	4-12	6.89 ± 1.75	.67 ± .20	.71 ± .20	---	---
221	C8-24	12-16	7.00 ± 1.69	.58 ± .13	---	---	---
221	C8-24	12-16	3.23 ± 2.22	.55 ± .16	.72 ± .26	---	---
221	C8-24	16-20	6.23 ± 3.47	---	---	---	---
221	C8-24	16-20	5.66 ± 1.43	.76 ± .16	.41 ± .19	---	---
221	C8-24	20-24	3.61 ± 3.03	.31 ± .14	---	---	---
221	C8-24	20-24	3.00 ± 1.88	.70 ± .13	---	---	---
252	C8-8	6-8	268.90 ± 15.50	---	---	---	---
252	C8-8	8-12	29.24 ± 3.92	.26 ± .18	---	---	---
252	C8-8	12-16	23.54 ± 2.13	.38 ± .15	.33 ± .12	---	---
253	C8-19	35-36	1143.00 ± 53.20	---	---	---	---
253	C8-19	36-40	446.60 ± 9.70	.74 ± .25	.63 ± .20	---	---
253	C8-19	40-44	817.50 ± 27.91	---	---	---	---
253	C8-19	44-48	1113.00 ± 11.70	---	---	---	---
253	C8-19	48-52	12.83 ± 1.72	.55 ± .11	---	---	---
253	C8-19	52-56	---	.52 ± .13	.32 ± .22	---	---
253	C8-19	56-60	2.67 ± 1.32	.42 ± .12	.80 ± .18	---	---
260	C8-20	7-10	25.03 ± 4.17	.23 ± .10	---	---	---
260	C8-20	10-14	3.32 ± 1.23	.08 ± .12	---	---	---
260	C8-20	14-18	---	.41 ± .18	---	---	---
260	C8-20	18-22	---	.15 ± .12	.43 ± .13	---	---
260	C8-20	22-26	1.19 ± 1.54	.47 ± .16	.55 ± .30	---	---
260	C8-20	26-30	---	.47 ± .17	.86 ± .27	---	---
271	C8-9						
277	C8-23	6-10	.70 ± .10	.42 ± .15	.59 ± .19	.80 ± .10	.03 ± .03
277	C8-23	10-14	---	.52 ± .29	---	---	---
277	C8-23	14-18	---	.26 ± .10	.59 ± .19	---	---
277	C8-23	18-22	---	.49 ± .13	.55 ± .15	---	---

TABLE 5-5

(continued)

Sampling Location		Depth (inches)	Radionuclide Concentrations (pCi/g +/- 2 Sigma)				
			Uranium-238	Radium-226	Thorium-232	Uranium-234	Uranium-235
Building 845 (interior):							
Grid No.	Core No.						
277	CB-23	22-26	---	.67 ± .13	.82 ± .18	---	---
309	CB-21	6-10	17.29 ± 2.14	.47 ± .14	---	---	---
309	CB-21	10-14	3.16 ± .97	.26 ± .08	---	---	---
309	CB-21	14-18	10.61 ± 4.58	.25 ± .20	---	---	---
312	CB-10	6-7	305.50 ± 1.96	3.30 ± 1.96	---	---	---
312	CB-10	7-11	17.95 ± 1.94	.61 ± .10	.34 ± .26	---	---
316	CB-22	6-10	44.95 ± 6.20	1.01 ± .25	---	---	---
316	CB-22	10-14	11.50 ± 2.05	.60 ± .12	.46 ± .18	---	---
316	CB-22	14-18	---	.69 ± .28	---	---	---
316	CB-22	18-22	5.82 ± 1.17	.86 ± .15	---	---	---
316	CB-22	22-26	4.64 ± 2.07	1.53 ± .23	.98 ± .36	---	---
316	CB-22	26-30	---	.55 ± .29	---	---	---
360	CB-25	5-9	3.56 ± 1.19	.33 ± .14	---	---	---

TABLE 5-6

DUPONT CHAMBERS WORKS SITE: GAMMA SPECTROMETRY OF SEDIMENT SAMPLES

Sampling Location		Depth (inches)	Radionuclide Concentrations (pCi/g +/- 2 Sigma)				
			Uranium-238	Radium-226	Thorium-232	Uranium-234	Uranium-235
Wooden Trough East of Building 845:							
Grid E	Grid N						
2710	4980	0-6	42.03 ± 9.62	1.03 ± .70	---	---	---
2730	4935	0-6	255.60 ± 18.50	2.45 ± .65	1.86 ± 1.07	---	---
2755	4890	0-6	40.98 ± 6.11	1.27 ± .34	.47 ± .64	---	---
2775	4840	0-6	49.13 ± 6.74	.87 ± .28	---	---	---
2775	4848	0-6	10.99 ± 4.53	---	---	---	---
2795	4795	0-6	127.60 ± 11.90	1.67 ± .73	2.03 ± .12	---	---
2800	4845	0-6	1.90 ± .30	---	---	2.10 ± .30	.09 ± .06
2820	4755	0-6	31.99 ± 4.45	---	---	---	---
2845	4715	0-6	16.52 ± 6.29	---	---	---	---
2760	4690	0-6	21.81 ± 6.09	2.58 ± .46	---	---	---
Central Drainage Ditch and Feeder Ditch:							
Grid E	Grid N						
2485	4700	0-6	1.20 ± .20	---	---	1.40 ± .20	.05 ± .04
2485	4700	0-6	1.00 ± .20	---	---	1.20 ± .20	.08
2550	4770	0-6	1.70 ± .20	---	---	1.60 ± .20	.07 ± .04
2600	4990	0-6	4.10 ± 2.85	.50 ± .26	---	---	---
2630	4970	0-6	1.00 ± .20	---	---	1.20 ± .20	.04
2650	4950	0-6	.90 ± .20	.41 ± .21	---	1.80 ± .20	.13 ± .07
2670	4940	0-6	1.50 ± .20	---	---	1.80 ± .20	.15 ± .07
2700	4990	0-6	1.60 ± .20	---	---	1.70 ± .20	.10 ± .06
2740	5060	0-6	1.50 ± .20	---	---	1.60 ± .20	.08 ± .04
2805	4820	0-6	1.20 ± .20	---	---	1.20 ± .20	.08 ± .05
2840	5130	0-6	1.60 ± .20	---	---	1.50 ± .20	.07 ± .04
2900	5145	0-6	1.70 ± .20	---	---	1.60 ± .20	.06 ± .04
2950	5160	0-6	1.00 ± .20	---	---	1.30 ± .20	.04
3050	5150	0-6	2.10 ± .30	---	---	1.90 ± .30	.10 ± .06
3220	5150	0-6	1.90 ± .30	---	---	1.80 ± .30	.08 ± .05
Lagoon A:							
Grid E	Grid N						
4850	5800	0-6	.20 ± .10	---	---	.40 ± .10	.03 ± .02
4980	5665	0-6	1.60 ± .20	---	---	1.70 ± .20	.05 ± .05

TABLE 5-7

DUPONT CHAMBERS WORKS SITE:

RESULTS OF RADIOCHEMISTRY ANALYSIS OF WATER SAMPLES

Sampling Location		Depth (inches)	Total Uranium (pCi/l ± 2 sigma)
Inside Building 845:		42	7507.51
Building 845 Area:			
Grid E	Grid N		
2534	4710	60	12.01
2600	4655	48	10.51
2624	4766	40	18.02
2630	4766	50	15.32
2650	4798	50	1.80
2650	4816	51	2.70
2667	4600	40	1.50
2678	4829	48	1.50
2681	4765	46	1.50
2717	4824	32	5.11
2747	4822	48	2.10
2761	4745	54	1,381.38
2768	4586	52	60.06
2768	4750	39	660.66
2779	4738	34	246.25
2780	4702	30	150.15
2790	4771	34	11,712.00
2799	4701	60	10.21
2799	4730	26	132.13
2799	4748	54	150.15
2816	4670	30	1,001.80
F Corral:			
Grid E	Grid N		
2444	5000	48	6.01
2450	4850	43	105.11
2450	4954	42	1,621.62
2492	4802	52	156.16
2500	4950	56	2,852.85
2500	4995	46	4.50
2507	4900	44	105,105.00
2540	4850	36	16,817.00
2565	4958	54	264.26
2580	4844	56	7.51
2603	4897	54	1.50

TABLE 5-7
(continued)

Sampling Location		Depth (inches)	Total Uranium (pCi/l ± 2 sigma)
Building J-26 Area:			
Grid E	Grid N		
1765	2910	30	14
East Burial Area:			
Grid E	Grid N		
5440	3080	36	24
5580	3070	36	6
Lagoon A:		Surface	4

TABLE 5-8

DUPONT CHAMBERS WORKS SITE: PRE-REMEDIAL ACTION

SUMMARY OF BUILDING 845 MEASUREMENT RESULTS

Measurement Locations	Measurement Type[a]	Units[a]	No. of Readings Taken	Grid Block Average Range	Maximum Reading Observed
First Level					
Ceiling	Beta-Gamma Dose Rate	mrad/h	41	0-4.78	4.78
	Direct Alpha Activity	dpm/100 cm^2	41	0-5568	5568
Floor	Beta-Gamma Dose Rate	mrad/h	1850	0-4.54	5.78
	Direct Alpha Activity	dpm/100 cm^2	1850	0-6819	26544
East Wall	Beta-Gamma Dose Rate	mrad/h	120	0-10.34	10.34
	Direct Alpha Activity	dpm/100 cm^2	120	2-4169	6229
West Wall	Beta-Gamma Dose Rate	mrad/h	175	0-8.69	16.30
	Direct Alpha Activity	dpm/100 cm^2	175	8-2461	6110
North Wall	Beta-Gamma Dose Rate	mrad/h	105	0.04-3.29	3.65
	Direct Alpha Activity	dpm/100 cm^2	105	17-483	890
South Wall	Beta-Gamma Dose Rate	mrad/h	65	0.08-1.51	1.57
	Direct Alpha Activity	dpm/100 cm^2	65	29-102	161
Floor/Wall Intersection	Beta-Gamma Dose Rate	mrad/h	244	0-6.05	8.88
	Direct Alpha Activity	dpm/100 cm^2	244	0-10621	18041
Second Level					
Ceiling	Beta-Gamma Dose Rate	mrad/h	38	0.02-4.87	4.87
	Direct Alpha Activity	dpm/100 cm^2	38	8-3992	3992
Floor	Beta-Gamma Dose Rate	mrad/h	580	0-2.85	3.45
	Direct Alpha Activity	dpm/100 cm^2	580	0-264	564
East Wall	Beta-Gamma Dose Rate	mrad/h	20	0.09-10.92	10.92
	Direct Alpha Activity	dpm/100 cm^2	20	51-9068	9068
West Wall	Beta-Gamma Dose Rate	mrad/h	30	0.05-5.53	5.53
	Direct Alpha Activity	dpm/100 cm^2	30	0-3712	3712
North Wall	Beta-Gamma Dose Rate	mrad/h	60	0.07-0.96	1.19
	Direct Alpha Activity	dpm/100 cm^2	60	14-763	763
South Wall	Beta-Gamma Dose Rate	mrad/h	15	0.07-0.54	0.54
	Direct Alpha Activity	dpm/100 cm^2	15	34-44	85
Floor/Wall Intersection	Beta-Gamma Dose Rate	mrad/h	118	0.01-2.16	2.77
	Direct Alpha Activity	dpm/100 cm^2	118	0-1221	1516

TABLE 5-8

(Continued)

Measurement Locations	Measurement Type[a]	Units[a]	No. of Readings Taken	Grid Block Average Range	Maximum Reading Observed
Ceiling	Beta-Gamma Dose Rate	mrad/h	240	0.02-1.49	7.05
	Direct Alpha Activity	dpm/100 cm^2	240	8-1347	1347
Floor	Beta-Gamma Dose Rate	mrad/h	120	0-1.40	2.38
	Direct Alpha Activity	dpm/100 cm^2	120	0-1017	1281
East Wall	Beta-Gamma Dose Rate	mrad/h	24	0.09-2.84	2.84
	Direct Alpha Activity	dpm/100 cm^2	24	53-3976	3076
West Wall	Beta-Gamma Dose Rate	mrad/h	180	0.25-2.37	2.37
	Direct Alpha Activity	dpm/100 cm^2	180	42-1754	1754
North Wall	Beta-Gamma Dose Rate	mrad/h	36	0.08-0.61	0.65
	Direct Alpha Activity	dpm/100 cm^2	36	37-653	653
South Wall	Beta-Gamma Dose Rate	mrad/h	10	0.08-0.08	0.10
	Direct Alpha Activity	dpm/100 cm^2	10	49-69	110
Floor/Wall Intersection	Beta-Gamma Dose Rate	mrad/h	142	0-0.68	0.98
	Direct Alpha Activity	dpm/100 cm^2	142	0-1930	2599
Fourth Level					
Ceiling	Beta-Gamma Dose Rate	mrad/h	39	0.05-4.34	4.34
	Direct Alpha Activity	dpm/100 cm^2	39	76-2703	2703
Floor	Beta-Gamma Dose Rate	mrad/h	1095	0-1.00	1.76
	Direct Alpha Activity	dpm/100 cm^2	1095	0-885	2561
East Wall	Beta-Gamma Dose Rate	mrad/h	33	0.03-1.26	1.26
	Direct Alpha Activity	dpm/100 cm^2	33	36-2331	2331
West Wall	Beta-Gamma Dose Rate	mrad/h	33	0.08-1.46	1.46
	Direct Alpha Activity	dpm/100 cm^2	33	0-3318	3318
North Wall	Beta-Gamma Dose Rate	mrad/h	20	0.07-0.27	0.27
	Direct Alpha Activity	dpm/100 cm^2	20	47-572	572
South Wall	Beta-Gamma Dose Rate	mrad/h	9	0.34-3.39	3.39
	Direct Alpha Activity	dpm/100 cm^2	9	40-3487	3487
Ceiling Heaters	Beta-Gamma Dose Rate	mrad/h	6	0.02-0.06	0.06
	Direct Alpha Activity	dpm/100 cm^2	6	93-195	195

[a]For beta-gamma dose rate, the average criteria limit is 0.2 mrad/h and maximum criteria limit is 1.0 mrad/h. For direct alpha activity on surfaces, the average criteria limit is 5000 dpm/100 cm^2 and maximum criteria limit is 15,000 dpm/100 cm^2 (Ref. 5).

6.0 SIGNIFICANCE OF FINDINGS

The 1983 survey results show that five of the six areas surveyed are contaminated above current guidelines. The interior of Building 845 also is contaminated. These results are explained in greater detail in the following subsections.

6.1 FIELD SURVEY

The volumes of material contaminated above applicable remedial action criteria were based on the areal extent of the contamination plus the depth of contamination based on estimates and/or measurements. For soils, the extent of contamination was based on near-surface gamma measurements, surface soil samples, gamma logging of boreholes, and subsurface soil sampling. The depth of contaminated layers was based on actual measurements.

The extent of surface contamination in Building 845 was based on surface alpha and beta-gamma measurements, with beta-gamma measurements used as the primary survey method. The depth of contamination was estimated to be 1 inch, averaged over the contaminated area.

6.1.1 Building 845 Area

Results from near-surface gamma radiation measurements were used to determine the extent of surface contamination. An area east of Building 845 was found to have readings greater than twice background, a finding in agreement with the ORNL survey (Ref. 1). The area that exhibited readings above criteria is shown in Figure 6-1.

Results from borehole gamma logs and subsurface soil samples were used to determine the depth of contamination. The major contaminant was found to be uranium-238, and subsurface contamination appears to be in layers to depths greater than 3 m (9 ft). However, the most

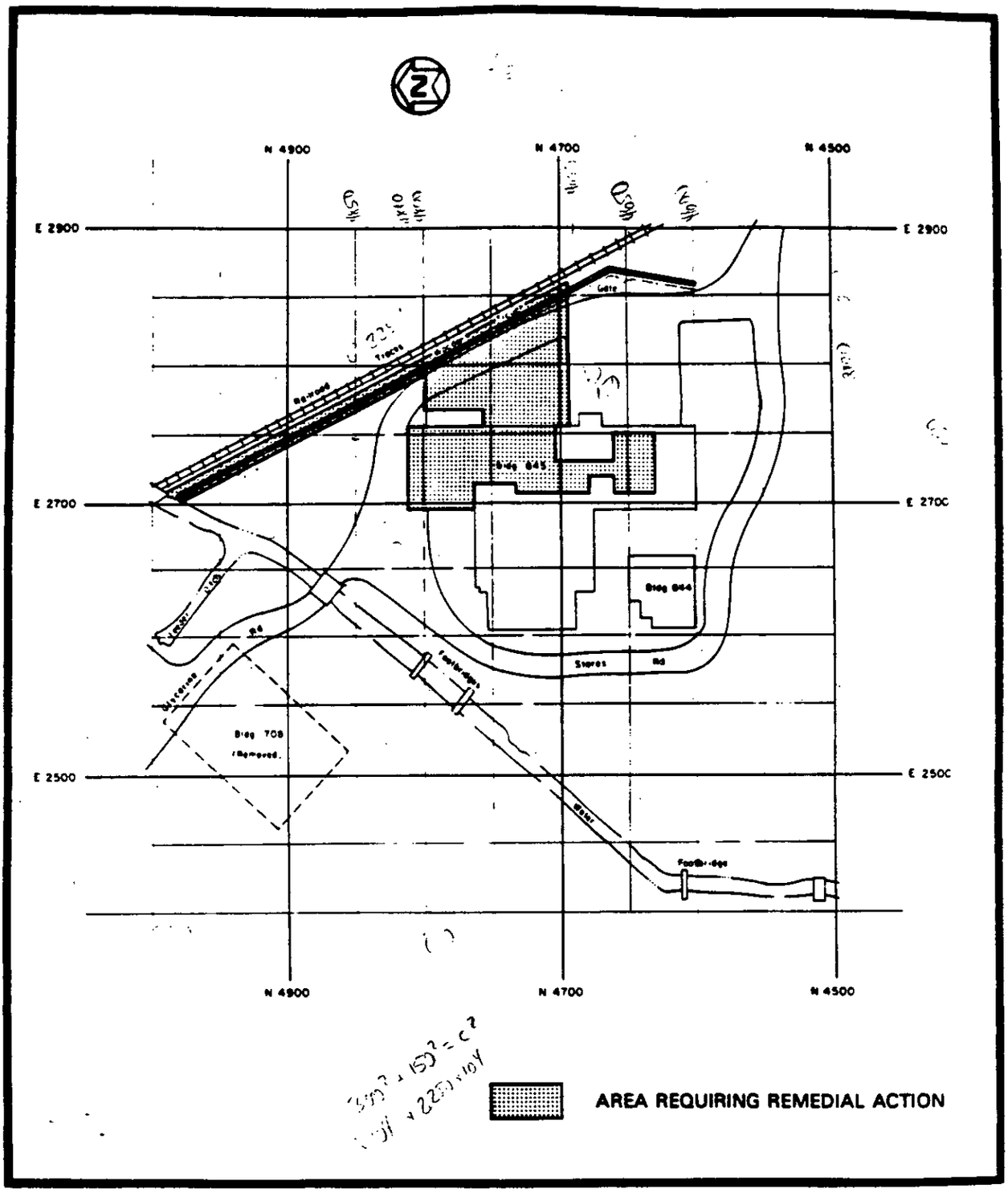

FIGURE 6-1 BUILDING 845 AREA AND WOODEN DRAINAGE TROUGH REQUIRING REMEDIAL ACTION

significant layer of contamination was located in the upper 1 m (3 ft) of soil. Gamma loggings in the soil below the depth of 1 m (3 ft) are approaching remedial action criteria.

Based on results from sediment samples, the wooden drainage trough located east of Building 845 would also require remedial action.

To comply with DOE guidelines, an estimated 765 m^3 (1000 yd^3) of material would require removal from the area around Building 845, including the wooden drainage trough, during remedial action.

6.1.2 Central Drainage Ditch

Results from near-surface gamma measurements made in the Central Drainage Ditch area indicated that an area located southwest of the drainage ditch had readings which were greater than twice background. Borehole gamma loggings in this area indicated areas of elevated readings which approach remedial action criteria limits. The elevated areas appear to be in layers which are at depths from 15 cm (6 in.) to greater than 2.5 m (8 ft).

Sediment samples taken from the Central Drainage Ditch and the Feeder ditch indicated below-criteria concentrations of uranium-238, -235, and -234.

During remedial action, the banks of the Central Drainage Ditch would require "hot spotting" to comply with guidelines. During hot spotting operations, approximately 11 m^3 (15 yd^3) of material would require removal from the area.

6.1.3 F Corral Parking Area

One near-surface gamma measurement exceeded twice background. All other measurements were within background levels. Borehole gamma loggings indicated contamination at depths greater than 3 m (9 ft), with the most significant layer of contamination located in the

upper 1 m (3 ft) of soil. Major readings below this depth approach remedial action guidelines. Soil samples show the contaminant is uranium-238, and the maximum uranium-238 concentration observed in subsurface soil samples was 4378 pCi/g.

Groundwater sample results from the F Corral parking area showed total uranium concentrations above the criteria limit. The maximum concentration observed for uranium-238 was 105,105 pCi/l. This sample was collected at a depth of 1 m (3 ft).

The area exhibiting measurements above guidelines is shown in Figure 6-2. During remedial action, an estimated 2700 m^3 (3500 yd^3) would require removal to meet DOE guidelines.

6.1.4 Building J-26 Area

All surface and subsurface measurements made in the Building J-26 area indicate the area is not contaminated. Water samples collected from the J-26 area were below criteria limits.

6.1.5 East Burial Area

Near-surface gamma readings indicate three locations which exceeded twice background levels. All beta-gamma dose rates were below criteria limits.

Borehole gamma logging indicated contaminated layers of soil to depths greater than 2.7 m (8.5 ft). The most significant layer of contamination was located in the upper 1 m (3 ft). Elevated readings below this depth approach remedial action criteria. Higher count rates were observed in the boreholes drilled adjacent to the road. Areas which exhibited measurements above criteria are shown on Figure 6-3.

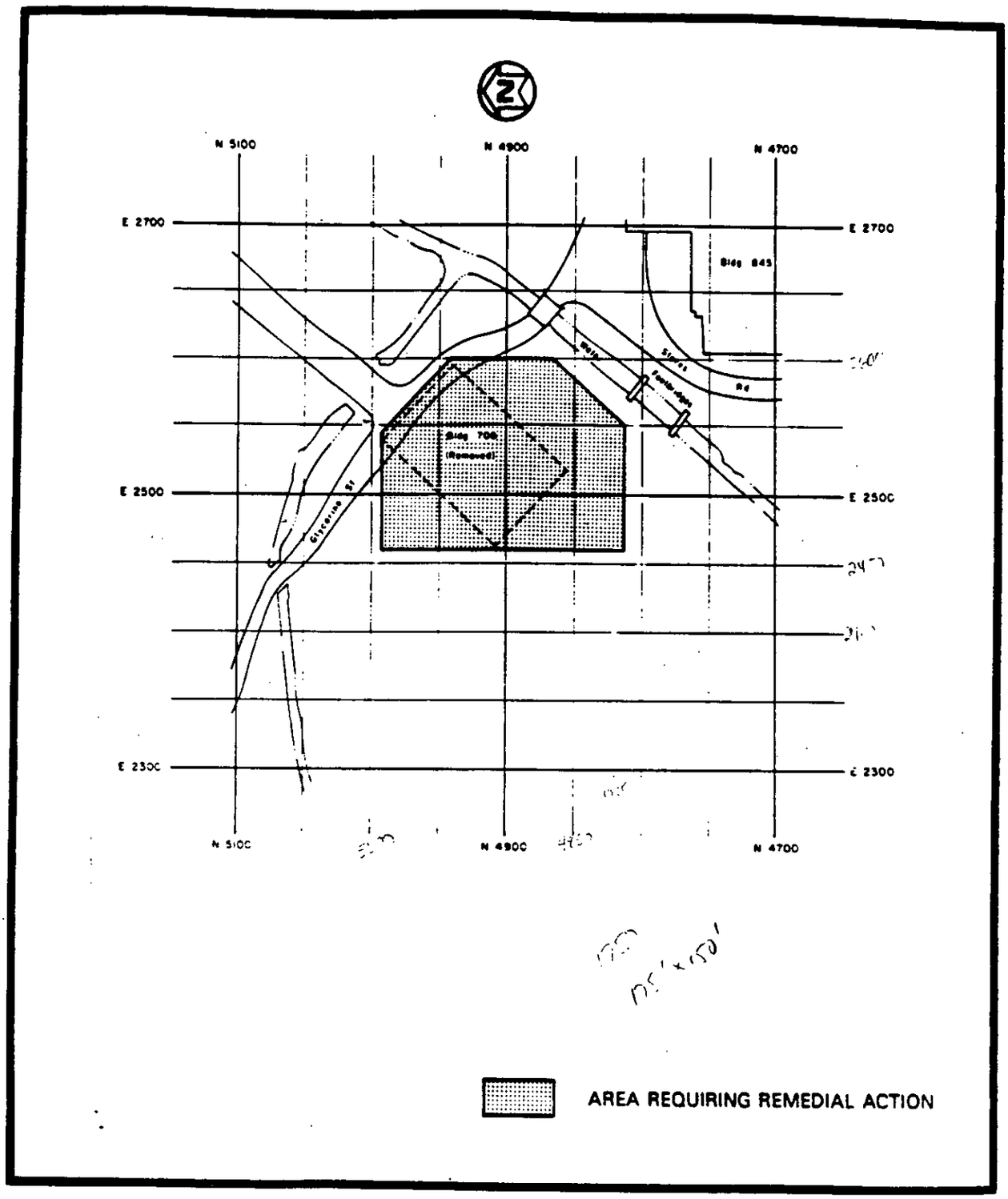

FIGURE 6-2 F CORRAL AREA REQUIRING REMEDIAL ACTION

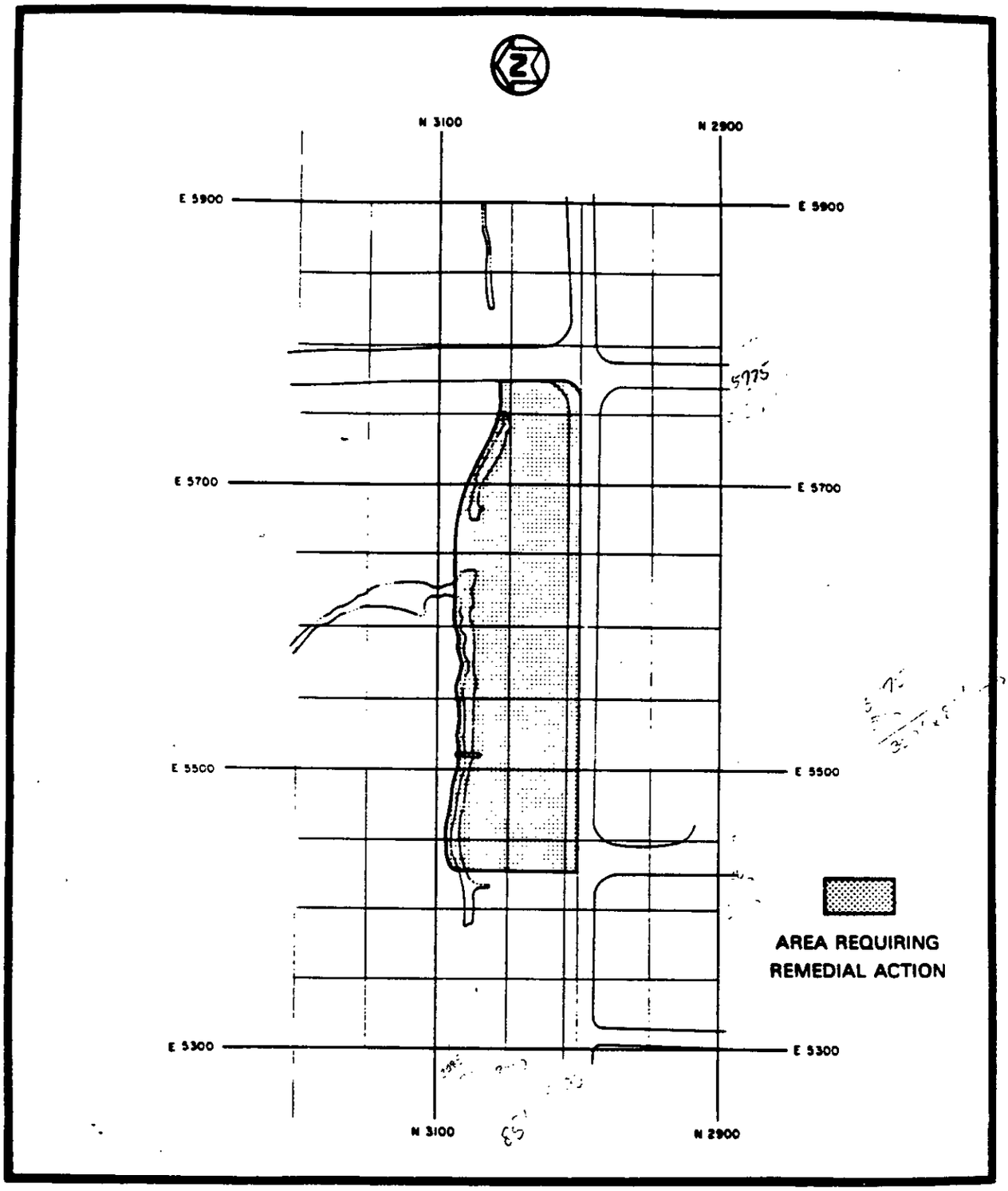

FIGURE 6-3 EAST BURIAL AREA REQUIRING REMEDIAL ACTION

Based on soil sample results, uranium-238 is the major contaminant, and the maximum concentration observed was 20,810 pCi/g. Elevated concentrations of radium-226 were observed in some soil samples (see Table 5-5).

During remedial action, an estimated 2800 m^3 (3700 yd^3) of material would require removal from the East Burial Area to comply with criteria.

6.1.6 Lagoon A

All surface measurements made in the Lagoon A area were within normal background. Borehole gamma count rates below 1.6 m (5.3 ft) indicated readings above background, but below the guideline.

6.2 BUILDING 845 SURVEY

As shown in Table 5-8, alpha and beta-gamma contamination levels on some interior surfaces of all four levels of Building 845 were in excess of the surface contamination guidelines for release of property for unrestricted use (Ref. 4). Figures 6-4 through 6-11 show floor, wall, and ceiling areas which indicated surface readings above guidelines. The area shown inside the lunch room (Grid Block Numbers 210, 211, 212, 214, 220, 230, 242, 254, and 258) indicated beta-gamma measurements above criteria. This contamination is fixed and poses no health hazard for activities presently carried on in the lunch room.

Building 845 first floor borehole loggings, coupled with Shelby tube soil samples indicated areas of contamination beneath the building up to depths of 1.2 m (4 ft). These areas of contamination are illustrated in Figure 6-12.

Based on these results, an estimated 560 m^3 (760 yd^3) of soil would require removal from beneath Building 845 to comply with criteria. In addition, remedial action would include the

decontamination of all areas inside Building 845 which exhibited surface measurements above remedial action criteria limits. Surface decontamination of the building would involve removal of 2.5 cm (1 in.) of material from approximately 2050 m^2 (22,000 ft^2) of contaminated surface areas. This would result in approximately 50 m^3 (70 yd^3) of material which would require removal. Total demolition of Building 845 would result in approximately 2300 m^3 (3000 yd^3) of material.

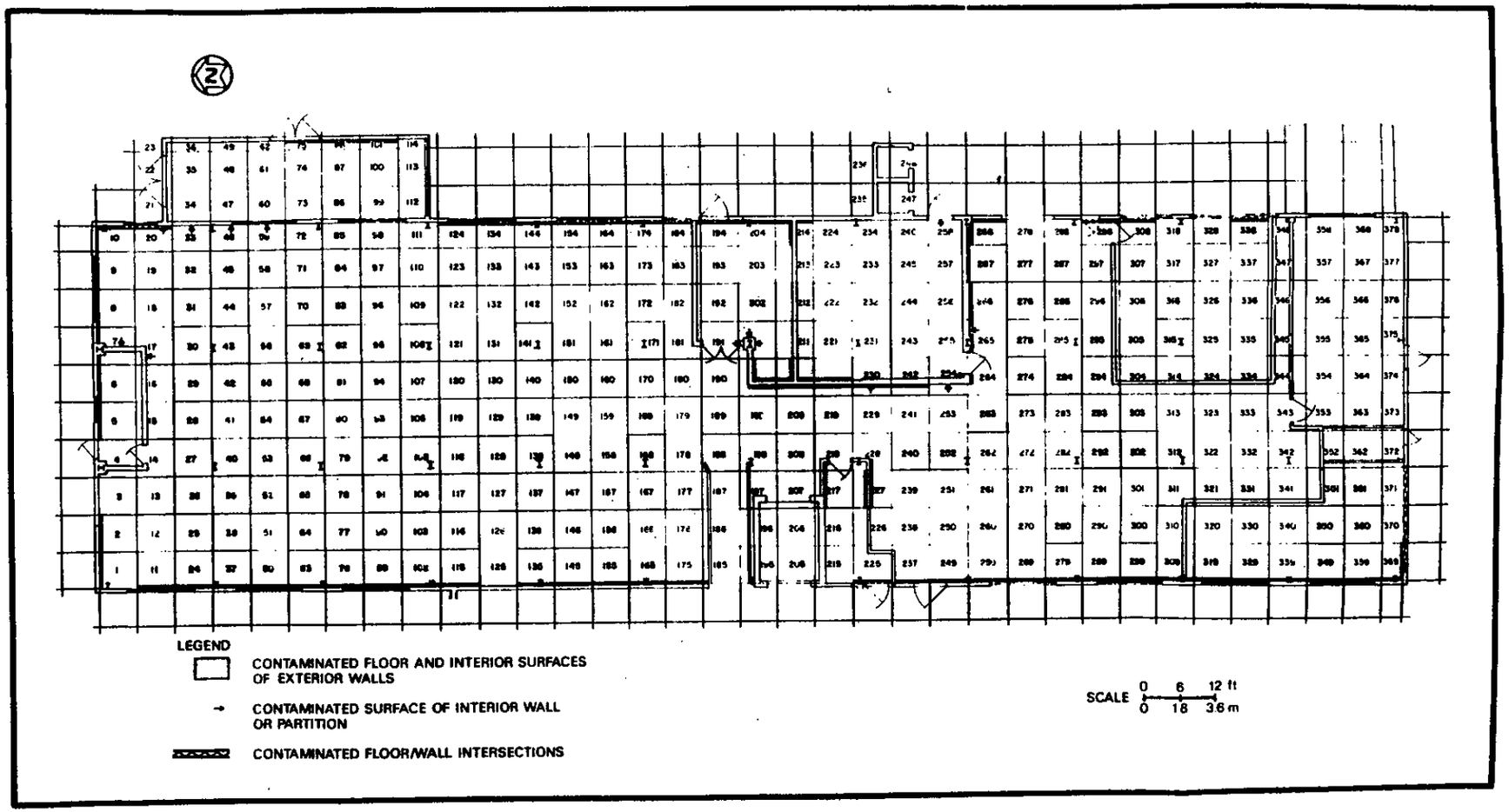

FIGURE 6-4 BUILDING 845, FIRST FLOOR: AREAS OF SURFACE CONTAMINATION ON FLOOR, WALLS, AND FLOOR/WALL INTERSECTIONS

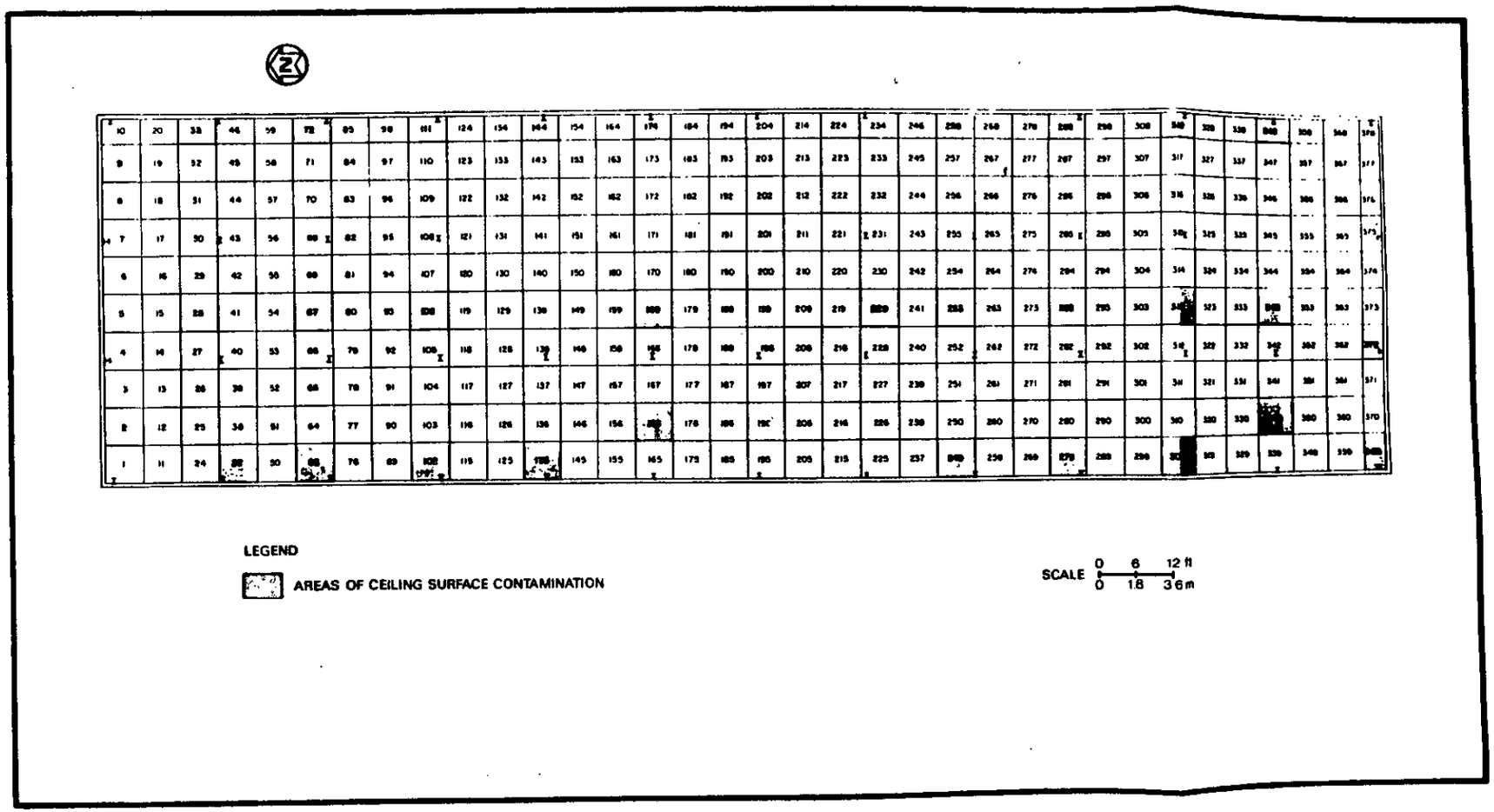

FIGURE 6-5 BUILDING 845, FIRST FLOOR CEILING: AREAS OF SURFACE CONTAMINATION

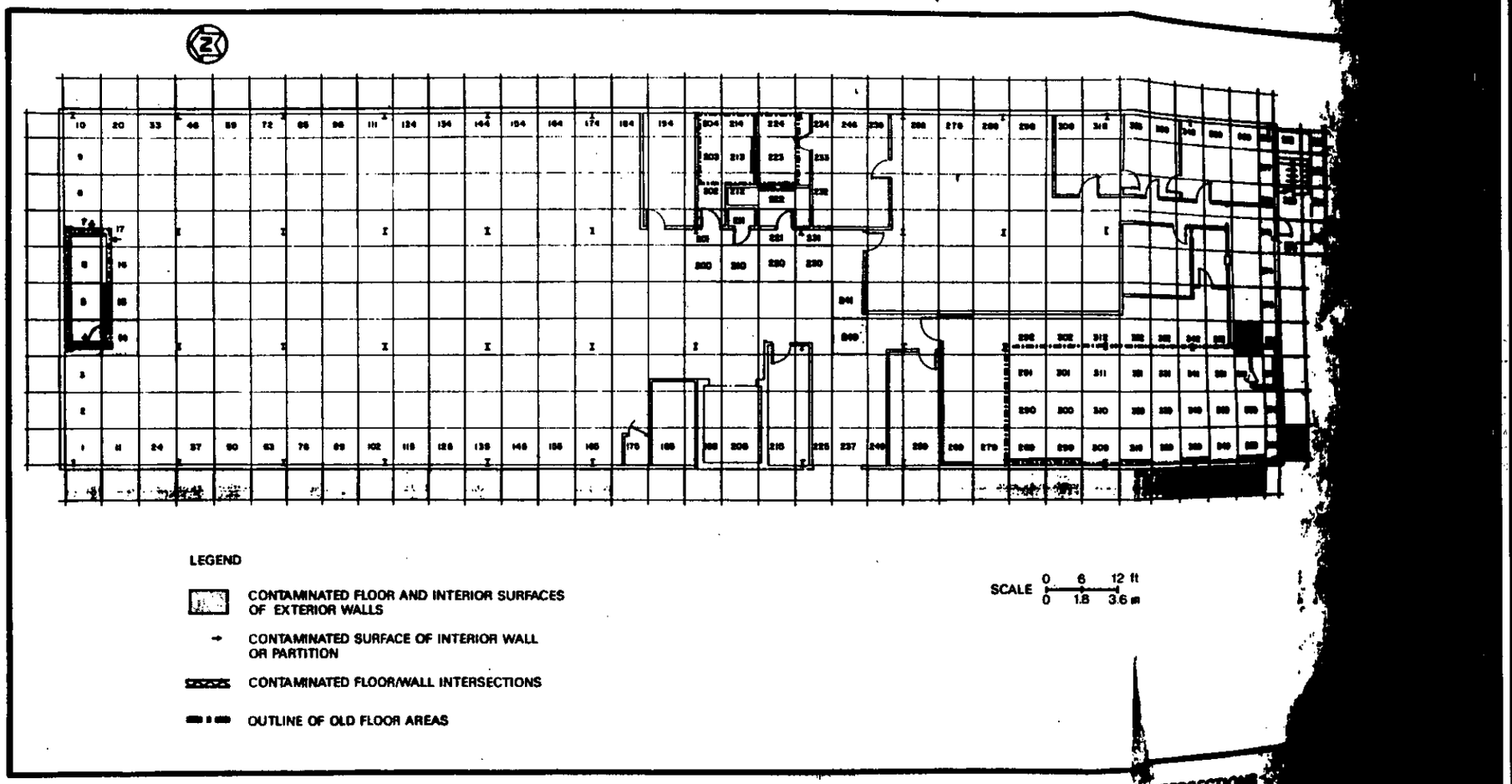

FIGURE 6-6 BUILDING 845, SECOND FLOOR: AREAS OF CONTAMINATION ON FLOOR, WALLS, AND FLOOR/WALL INTERSECTIONS

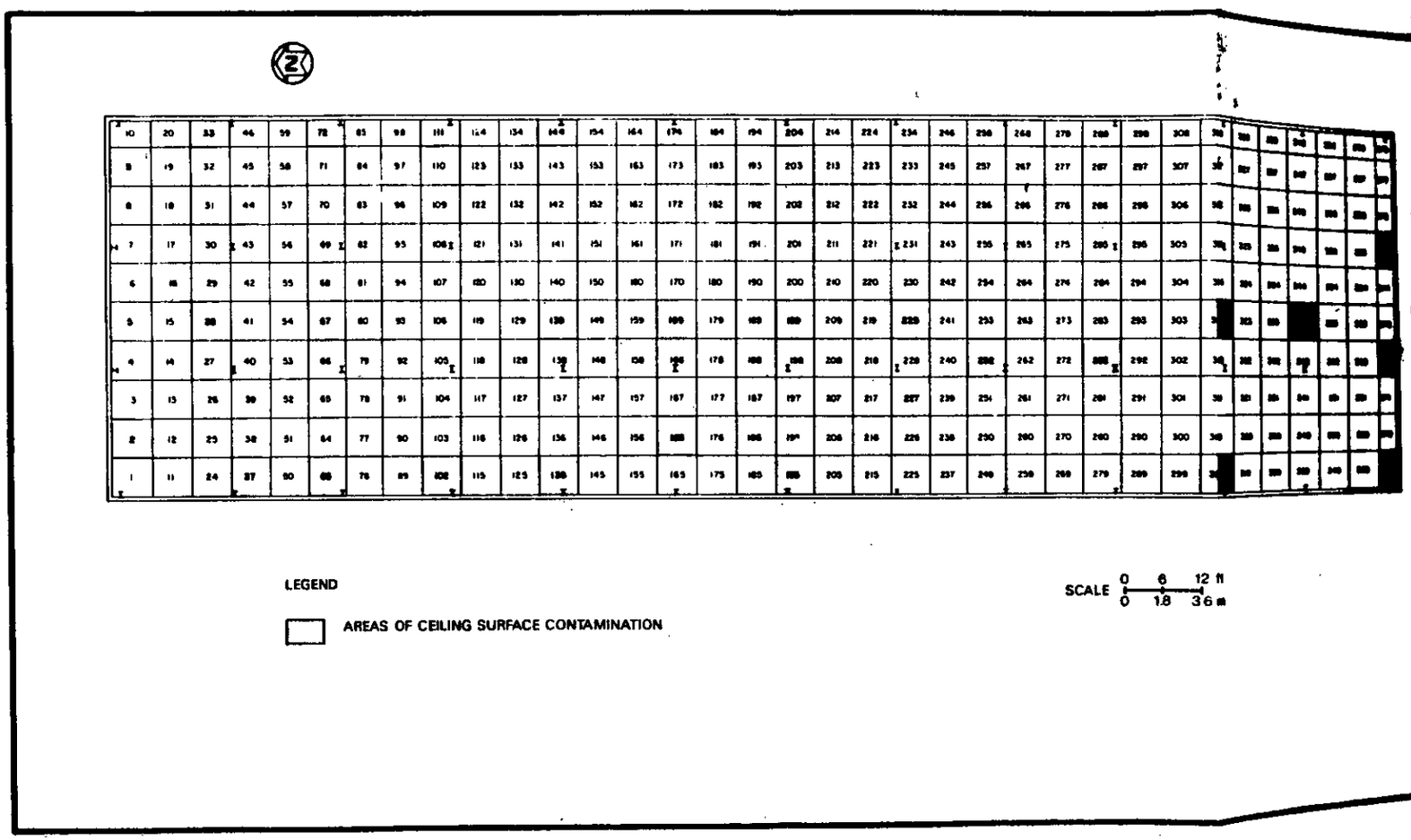

FIGURE 6-7 BUILDING 845, SECOND FLOOR CEILING: AREAS OF S ONTAMINATION

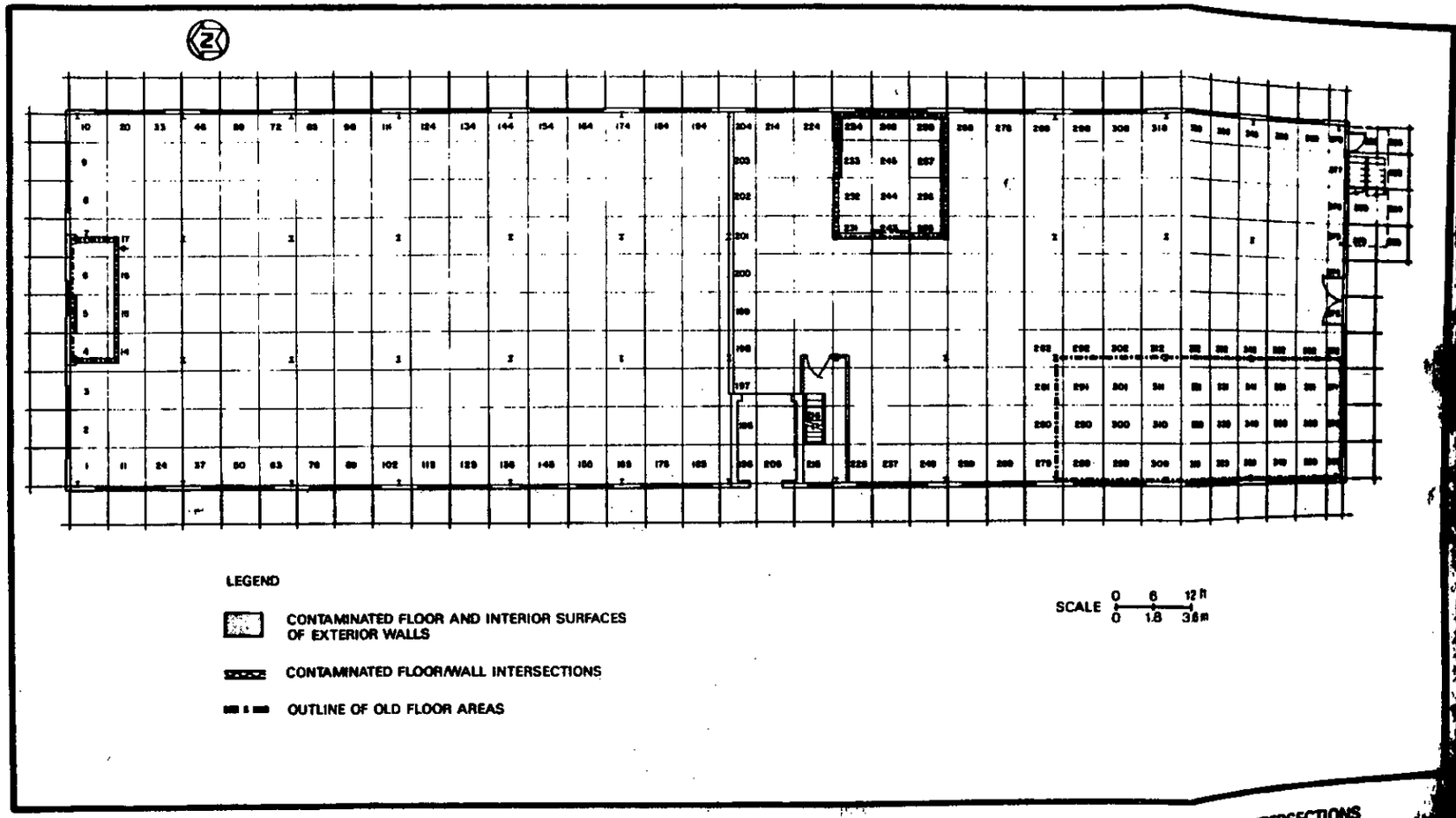

FIGURE 6-8 BUILDING 845, THIRD FLOOR: AREAS OF SURFACE CONTAMINATION ON FLOOR, WALLS, AND FLOOR/WALL INTERSECTIONS

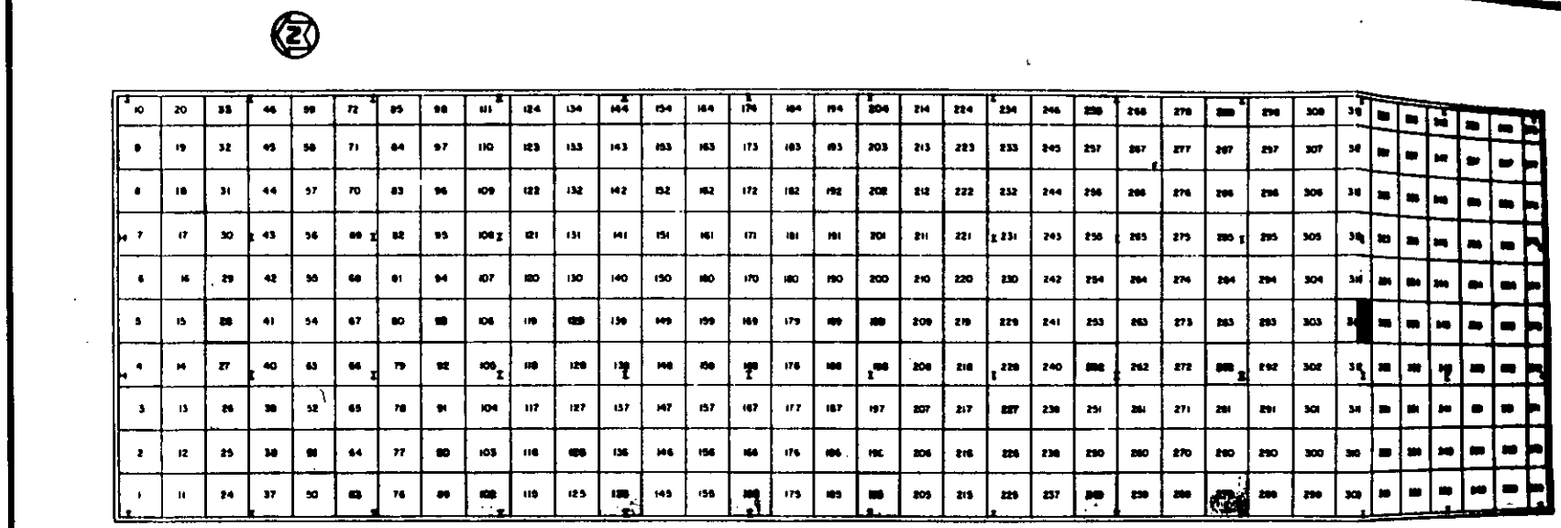

FIGURE 6-9 BUILDING 845, THIRD FLOOR CEILING: AREAS OF SURFACE CONTAMINATION

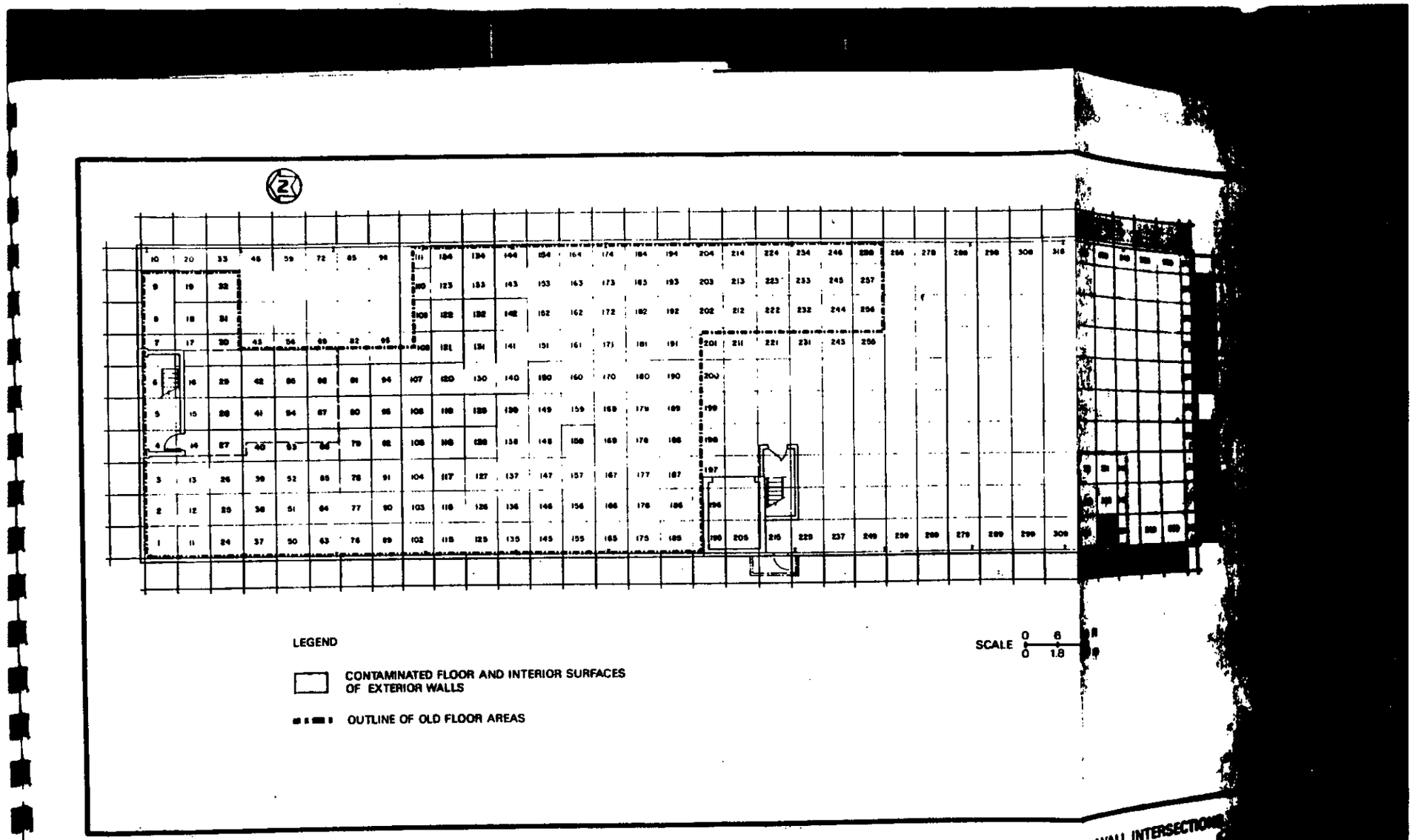

FIGURE 6-10 BUILDING 845, FOURTH FLOOR: AREAS OF SURFACE CONTAMINATION ON FLOOR, WALLS, AND FLOOR/WALL INTERSECTIONS

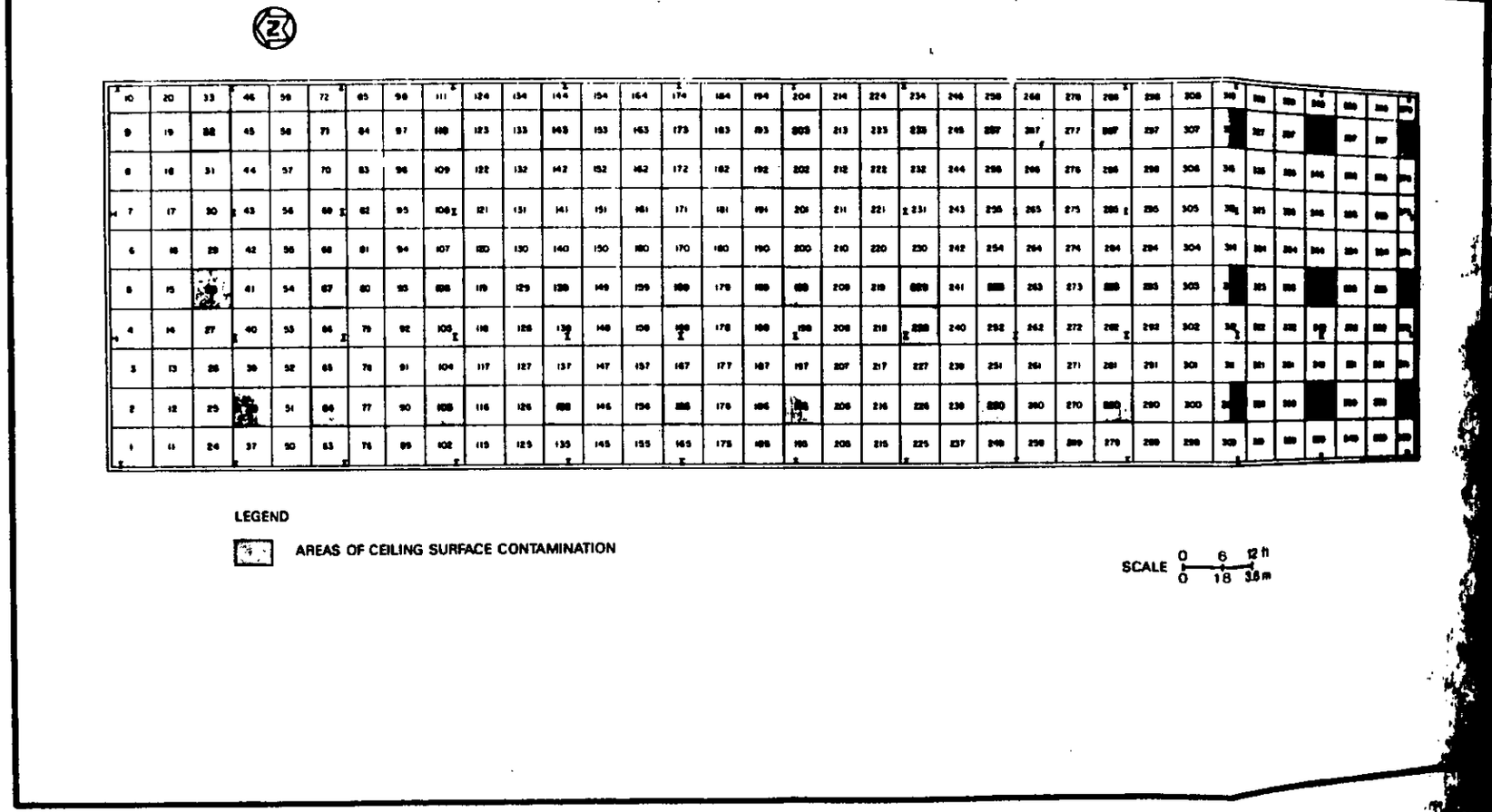

FIGURE 6-11 BUILDING 845, FOURTH FLOOR CEILING: AREAS OF SURFACE CONTAMINATION

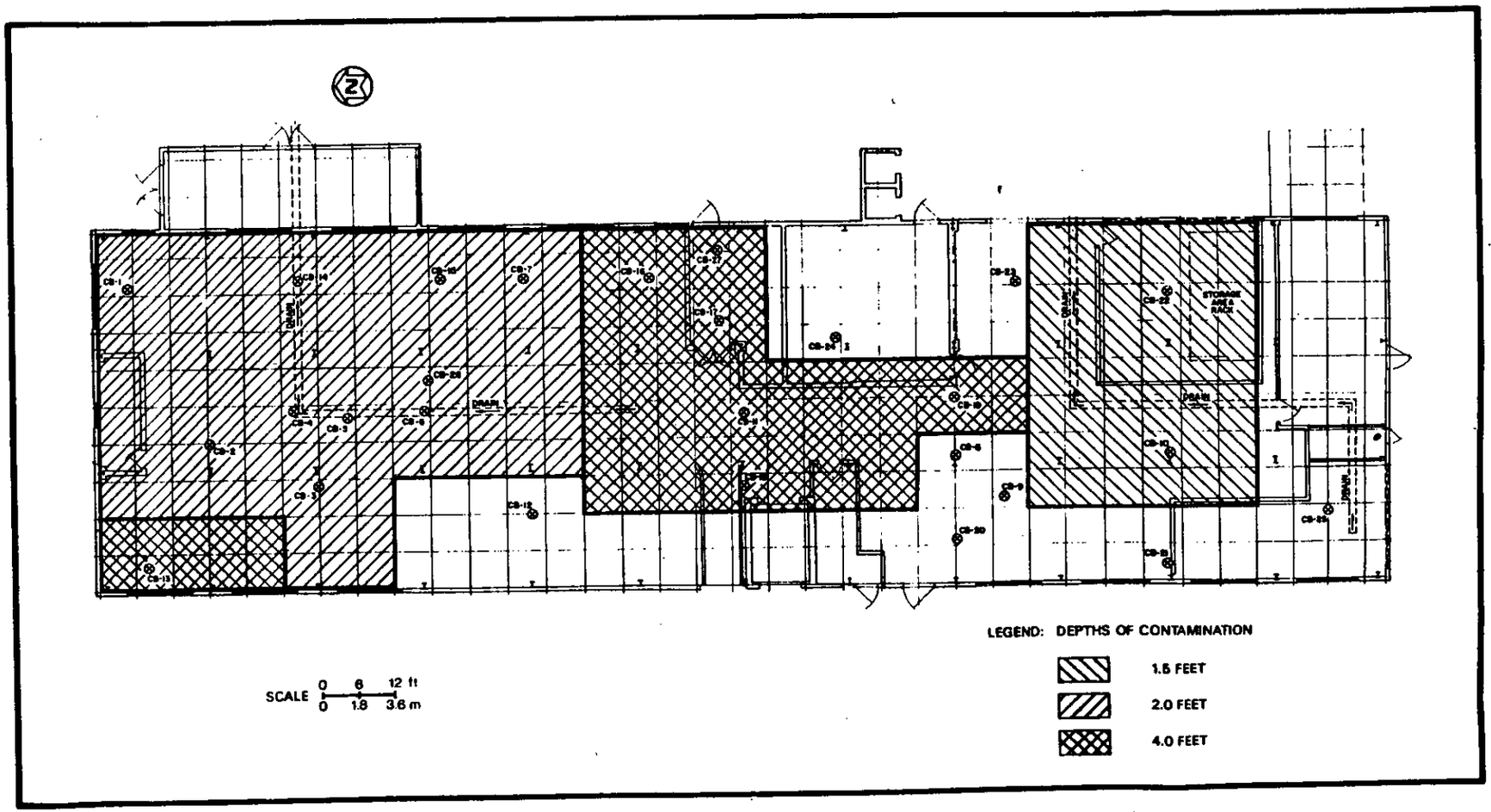

FIGURE 6-12 AREAS OF CONTAMINATION BENEATH BUILDING 845

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1 of 2

DOE/OR/20722-22

Formerly Utilized Sites Remedial Action Program (FUSRAP)
Contract No. DE-AC05-81OR20722

RADIOLOGICAL SURVEY REPORT FOR THE DUPONT CHAMBERS WORKS PLANT

Deepwater, New Jersey

March 1985

Bechtel National, Inc.
Advanced Technology Division

DOE/OR/20722-22

RADIOLOGICAL SURVEY
OF THE
E. I. DUPONT DE NEMOURS AND COMPANY
CHAMBERS WORKS PLANT
DEEPWATER, NEW JERSEY

MARCH 1985

Prepared for

UNITED STATES DEPARTMENT OF ENERGY

OAK RIDGE OPERATIONS OFFICE

Under Contract No. DE-AC05-81OR20722

By

Bechtel National, Inc.

Advanced Technology Division

Oak Ridge, Tennessee

Bechtel Job No. 14501

ABSTRACT

During October and November 1983, a radiological survey was conducted in six separate areas of the DuPont Chambers Works Plant in Deepwater, New Jersey. The survey was performed as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), a U.S. Department of Energy effort to identify, clean up, or otherwise control sites where low-level radioactive contamination (exceeding current guidelines) remains from the early years of the nation's atomic energy program.

A 1977 radiological survey conducted by Oak Ridge National Laboratory had established that contamination existed at the site. The 1983 survey was necessary to define locations and boundaries of the contamination. The survey was conducted by the FUSRAP Program Management Contractor, Bechtel National, Inc., and its radiological subcontractor, Eberline Analytical Corporation (EAC).

Measurements taken during the 1983 radiological survey indicate that four of the six site areas surveyed are contaminated above current guidelines. In both soil and water samples, the major contaminant was found to be uranium-238. In some areas, contamination was found at depths greater than 3 m (9 ft), and in some cases contamination extended into the water table.

If remedial action were performed at the site, approximately 6300 m^3 (8200 yd^3) of contaminated materials would require removal to decontaminate exterior areas. One building would require surface decontamination [approximately 50 m^3 (70 yd^3) of material] or total demolition [approximately 2300 m^3 (3000 yd^3) of material]. However, in the areas of subsurface contamination, measures currently enforced by DuPont to protect against the site's chemical contaminants are adequate to protect personnel from the low-level radioactive contamination. DuPont does not permit excavation in areas of known chemical contamination and this prohibition extends to low-level radioactive contamination. Additionally, DuPont has positive access controls to the site.

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ABBREVIATIONS

cm	centimeter
cm^2	square centimeter
cpm	counts per minute
dpm/cm^2	disintegrations per minute per square centimeter
ft	foot
ha	hectare
l	liter
m	meter
µR/h	microroentgens per hour
mg	milligram
mrad/h	millirads per hour
pCi/g	picocuries per gram
pCi/l	picocuries per liter
yd^3	cubic yards

1.0 INTRODUCTION AND SUMMARY

This report describes the procedures, results, and significance of findings for a radiological survey conducted during October and November 1983 at the DuPont Chambers Works Plant in Deepwater, New Jersey. The survey was conducted as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP). FUSRAP is a U. S. Department of Energy (DOE) program to identify, clean up, or otherwise control sites where low-level radioactive contamination, at levels above current guidelines, remains from the early years of the nation's atomic energy program. Under contract to DOE, Bechtel National, Inc., (BNI) acts as the Program Management Contractor (PMC) for FUSRAP.

An earlier radiological survey, performed in 1977 by Oak Ridge National Laboratory (ORNL), established that contamination existed at the site and resulted in its designation as a FUSRAP site (Ref. 1). The 1983 radiological survey was necessary to define the locations and boundaries of the contamination identified in the ORNL survey, as a prelude to possible remedial action at the site. BNI and its radiological subcontractor, Eberline Analytical Corporation (EAC), conducted the 1983 survey.

Six separate areas were surveyed throughout the site: Building 845 (interior and exterior); Central Drainage Ditch; F Corral Parking Area; Building J-26 Area; East Burial Area and Lagoon A.

Surface and subsurface measurements in the J-26 and Lagoon A areas indicate the areas are not contaminated above guidelines and do not require remedial action. The remaining areas surveyed were contaminated above guidelines. In some areas, subsurface contamination exists at depths greater than 3 m (9 ft). Due to the high water table under the DuPont site, contamination at depths below the water line could not be quantified. The major on-site contaminant was found to be uranium-238, both in water and soil samples.

Groundwater uranium-238 concentrations collected from the F Corral Parking area ranged from background levels to over 105,105 pCi/l. Contamination in soil was found to exist in stratified layers down to the water table.

External-gamma radiation levels ranged from 11.2 to 27.8 μR/h. These levels are above the normal background level for the DuPont area; however, they are below the DOE guideline of 60 μR/h above background.

The survey also determined the extent of contamination present in Building 845. The building was surveyed for beta-gamma and alpha contamination; elevated dose rates and above-guideline alpha surface contamination were measured on all four levels of the building. First floor corehole loggings indicated areas of contamination beneath the building up to depths of 1.2 m (4 ft).

If remedial action were to be performed at the site, a total of approximately 6300 m^3 (8200 yd^3) of contaminated materials would have to be excavated from the site's exterior areas. In addition, surface decontamination of Building 845 would result in approximately 50 m^3 (70 yd^3) of contaminated material. Total demolition of Building 845 would result in approximately 2300 m^3 (3000 yd^3) of contaminated material. In areas of subsurface radioactive contamination, measures presently required by DuPont to protect against chemical contaminants are adequate to protect personnel from the low-level radioactive contamination. DuPont does not permit excavation in areas of known chemical contamination and this prohibition extends to low-level radioactive contamination. Additionally, DuPont has positive access controls to the site.

2.0 SITE DESCRIPTION AND HISTORY

2.1 LOCATION AND DESCRIPTION

The DuPont Chambers Works Plant is an active chemical plant which primarily manufactures organic chemicals. Products include fluorinated hydrocarbons (Freon), petroleum chemicals (tetraalkyl lead), elastomers (Viton and Hytrel), specialty chemicals (Zepel and organic titanates), and aromatics (phenylene diamines). The Chambers Works covers approximately 283 ha (700 acres) in Pennsville and Carneys Point townships on the southeast shore of the Delaware River, adjacent to the residential community of Deepwater, New Jersey. The site location is illustrated in Figure 2-1.

The following areas were investigated as part of the site radiological survey: Building 845 interior and exterior areas, F Corral (demolished Building 708, now a parking area), Building J-26 Area, East Burial Area, sections of the Central Drainage Ditch, and Lagoon A. These areas are shown in an aerial photograph of the site presented in Figure 2-2.

2.2 SITE HISTORY AND PREVIOUS RADIOLOGICAL SURVEYS

Operations involving uranium at the Chambers Works began in 1942. DuPont was conducting experiments with uranium hexafluoride under contract to the U. S. Office of Scientific Research and Development when the Manhattan Engineer District (MED) was established. As a part of its work on the MED program, DuPont worked on developing a process for converting uranium oxide to produce uranium tetrafluoride and small quantities of uranium metal. Other research activities were also performed.

All MED activities were transferred to the Atomic Energy Commission (AEC) when that agency was created by Congress in 1946. DuPont continued its research activities for AEC until late 1947.

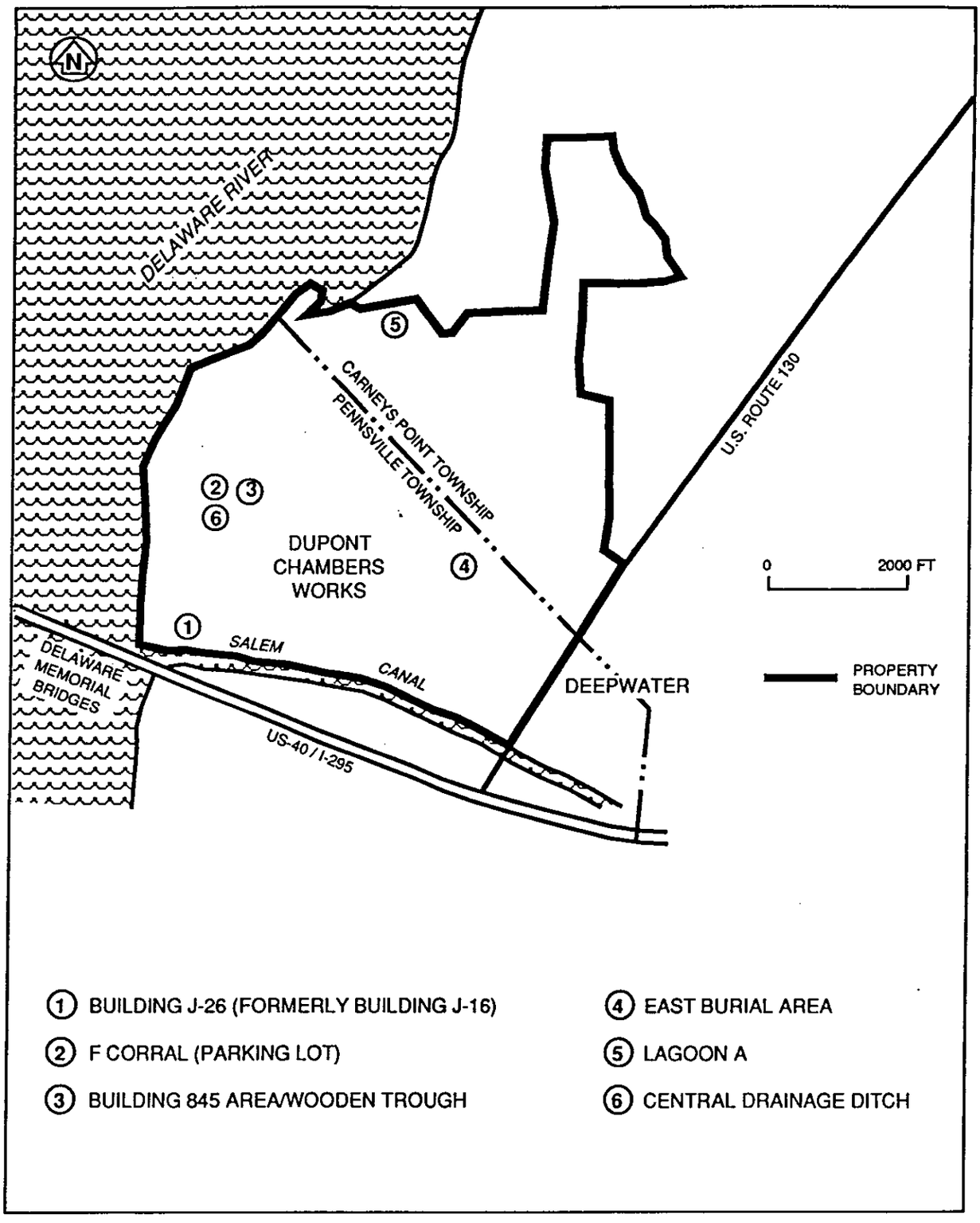

Figure 2-1
Location of the DuPont Chambers Works Plant

FIGURE 2-2 AERIAL PHOTOGRAPH OF THE DUPONT CHAMBERS WORKS PLANT, LOOKING EAST

In 1948 and 1949, the AEC conducted radiological surveys and decontamination activities at the site. These activities included sandblasting, vacuuming, and washing building surfaces. Following a radiological survey based on then-existing criteria, AEC released the buildings back to DuPont in 1949.

In March 1977, another radiological survey of the site was conducted by ORNL as part of FUSRAP. The 1977 survey results indicated that elevated concentrations of uranium were present in rubble from the operations building and in some surface and subsurface soil samples. Alpha and beta-gamma contamination levels in some areas of Building 845 were above present federal guidelines (Ref. 1). The 1977 survey concluded that, under current conditions of site use, this contamination does not cause employees working at the site to receive radiation exposures appreciably different from those due to background radiation. However, under different conditions of use (e.g., actions which involved agitation or abrasion of dry contaminated surfaces), the potential for low-level radiation exposures to employees and the public could result.

Based on the 1977 survey results, the DOE Assistant Secretary for Environment determined that the DuPont site warranted remedial action under FUSRAP. In its role as PMC for FUSRAP, BNI conducted the 1983 survey to more accurately define the boundaries and depth of contamination at the site.

2.3 PRESENT SITE CONDITIONS

Of the three buildings used for MED activities, only Building 845 remains. Building 845 is presently used as a miscellaneous stores warehouse. The other two buildings were demolished from 1945 to 1953.

In 1945, part of Building 708 was demolished and removed from the site. In 1953, the remainder of Building 708 was removed along with several feet of underlying earth. Materials removed in 1953 were

disposed of in the Lagoon A area (Ref. 2). A parking facility, F Corral, is now located on the location of Building 708.

Following release of the site by the AEC in 1949, Building J-16 was demolished and disposed of in the Lagoon A area (Ref. 2). A new building, J-26, now stands at this location.

The East Burial Area contains some equipment from the demolition of Building 845. In addition, various chemical wastes and small amounts of New Jersey-approved low-level radioactive material have been stored in this area.

The Central Drainage Ditch is in approximately the same location as in the 1940s. The primary purpose of the ditch is to carry residual wastes from chemical operations. In the past, residual wastes from Building 845 were discharged into a wooden trough located east of the building. The trough dumped into the Central Drainage Ditch approximately 150 feet north of Building 845. The Central Drainage Ditch flows toward the northeast, adjacent to the northwest corner of Building 845, and drains out into the eastern corner of Lagoon A. The composite from Lagoon A is then pumped into the on-site water treatment facility for chemical processing of the waste.

3.0 HEALTH AND SAFETY PLAN

The presence of various chemicals used and manufactured at the site posed potential health hazards to employees involved in the sampling and handling of subsurface soil and water samples. These conditions necessitated the use of special measures to protect employees involved with the subsurface investigations and a Health and Safety Plan was designed by BNI.

The primary components of the Health and Safety Plan were: pre-work medical examinations; safety education in handling and sampling precautions; personal protective equipment consisting of gloves, shoe covers, disposable coveralls, eye protection, hard hats, and butyl-rubber air-supplied suits; urine sampling; and follow-up medical examinations performed upon completion of the survey. Controls required for chemical protection were reviewed and approved by DuPont. All drilling and soil sampling in the Central Drainage Ditch, Lagoon A, and East Burial Area, under direction from DuPont, were carried out with drillers and support personnel attired in one-piece, air-supplied butyl-rubber suits. In addition, two 30-minute self-contained breathing apparatus air cylinders were used during the sediment sampling conducted west and northwest of Building 845 along secondary drainage ditches.

During the radiological survey, the FUSRAP BNI Safety Supervisor was present and supervised operations. There were no recorded illnesses or injuries involving any person working on this survey. Medical examinations given at the conclusion of the survey showed no evidence of personnel having been exposed to hazardous chemicals.

4.0 SURVEY PROCEDURES

4.1 FIELD SURVEY PROCEDURES

The survey grid system for the site, exclusive of the grid for the interior of Building 845, was established by a civil surveyor during October 1983 and was based on the New Jersey state geological survey. The areas surveyed on a 15-m (50-ft) grid included Lagoon A, East Burial Area, Central Drainage Ditch, F Corral parking lot, areas around Building J-26, and areas around Building 845. The radiological measurements taken and the methods used for taking the measurements are described in the following subsections.

4.1.1 Measurements Taken and Methods Used

Within the grid blocks of all field areas, beta-gamma measurements were made on the ground surfaces at 6-m (20-ft) intervals. The measurements were made using a pancake geometry (Geiger-Mueller) probe coupled to a digital ratemeter/scaler [Eberline Instrument Corporation (EIC) models HP-210 and PRS-1, respectively.].

Near-surface gamma measurements were made 30 cm (12 in.) above the ground surface at 6-m (20-ft) intervals within the grid using a 5- x 5-cm (2- x 2-in.) sodium-iodide (NaI) detector. This detector (EIC model SPA-3) was mounted in a probe assembly surrounded with a conical lead shield to reduce the gamma intensity through the sides, thus producing a downward directional response.

Gamma exposure rates at 1 m (3 ft) above the ground were measured using a pressurized ionization chamber (PIC) with a response to gamma radiation that is proportional to exposure in roentgens. Readings were made at 15-m (50-ft) intervals above all open area surfaces in all gridded areas (gamma exposure rate measurements were not taken in the J-26 area).

Boreholes 15 cm (6 in.) in diameter were drilled in all areas. Material from the boreholes was returned to the holes. Drilling was conducted in accordance with safety precautions described in Section 3.0. The locations and number of holes in each area were based on near-surface gamma measurements made in the area and the historical data on the site. A section of 10-cm (4-in.) diameter PVC plastic pipe with a closed bottom was inserted into each hole as a temporary sleeve to allow gamma logging. A 5- x 5-cm (2- x 2-in.) NaI (Tl) gamma scintillation detector (SPA-3 NaI crystal in a modified probe used specifically for borehole logging), coupled with a PRS-1 ratemeter/scaler, was lowered into the pipe to obtain a profile of the depth of contamination. Timed gamma measurements were made at 15-cm (6-in.) vertical intervals. By calibrating these measurements with the results from laboratory analyses of soil samples, borehole loggings provide a reliable estimate of radionuclide concentrations in subsurface soils.

4.1.2 Sample Collection and Analyses

Building 845 (Exterior) Area

In the area surrounding Building 845, in addition to the boreholes drilled for gamma logging, undisturbed (Shelby tube) soil samples, water samples, and sediment samples were taken. The locations of the boreholes and of each type of sample taken are illustrated in Figure 4-1. In some cases, more than one type of sample was taken at the same location.

Based on the gamma logs, four Shelby tube soil samples were taken in areas which had revealed the most significant subsurface deposits of radioactivity. The soil samples extended to 30 cm (1 ft) below the depth of the radionuclide deposits as indicated by the gamma logging. Shelby tubes, 61 cm long and 7.6 cm in diameter (24 x 3 in.) were used to collect these soil samples. The soil in the tubes was extruded in 10-cm (4-in.) sections, placed in 500-ml plastic containers, identified, and packaged. The samples were

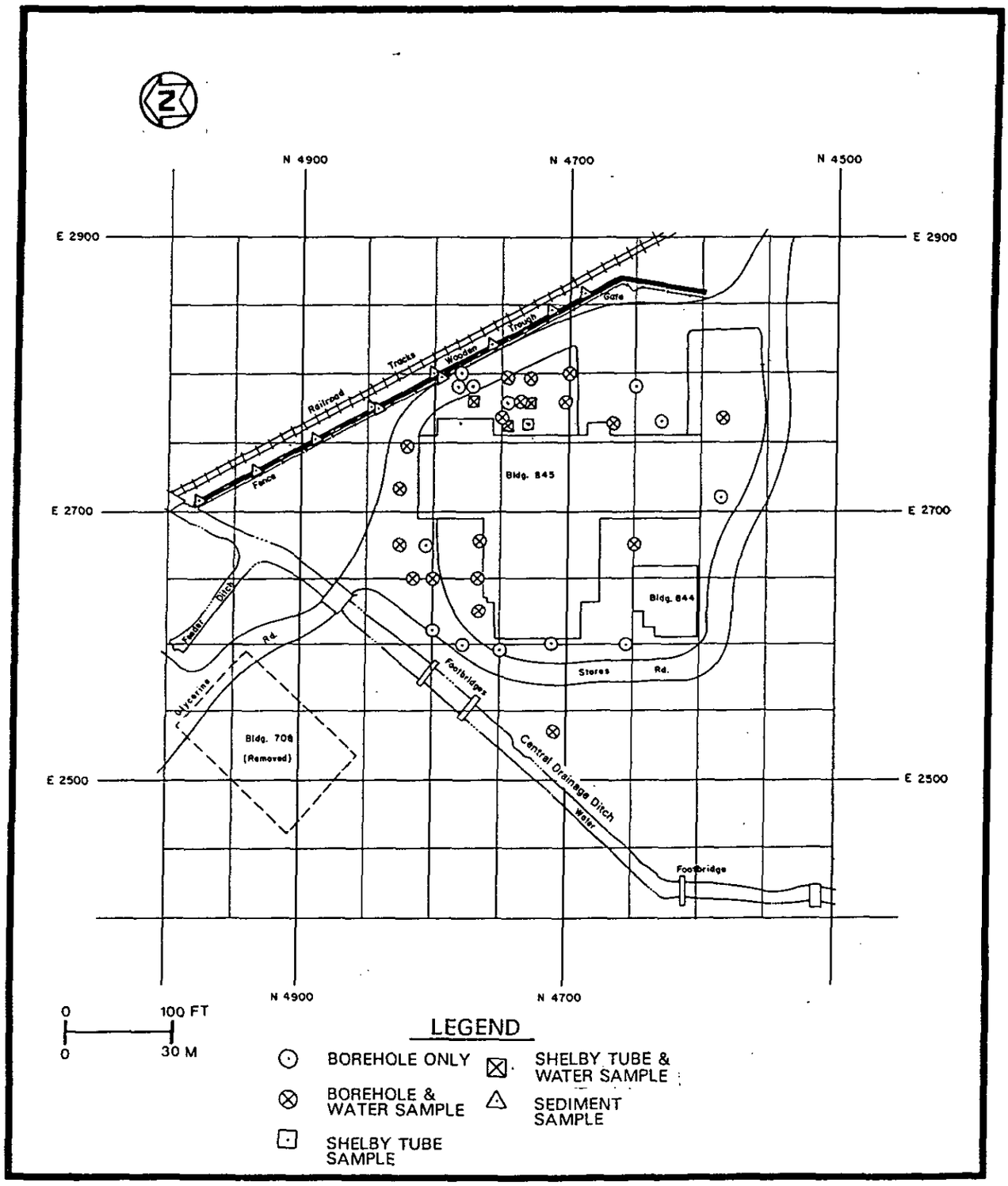

FIGURE 4-1 BOREHOLES AND SAMPLING LOCATIONS IN THE VICINITY OF BUILDING 845

shipped to DOE's Niagara Falls Storage Site where they were dried, pulverized, and homogenized before they were analyzed for uranium-238. The samples were analyzed by EAC personnel using the high resolution gamma spectrometry system in the FUSRAP in situ van (Ref. 3). Each sample was analyzed for 10 minutes using an intrinsic germanium detector housed in a lead counting cave lined with cadmium and copper. The detector is coupled to a computer base pulse height analyzer. Following the initial gamma spectrometry analysis of the soil samples, aliquots of selected samples were taken and sent to the EAC laboratory in Albuquerque, New Mexico, for radiochemical analysis. This analysis was performed to measure the concentrations of uranium-234 and uranium-235 in the samples and also to verify the uranium-238 analysis.

Water samples also were collected from all boreholes in the Building 845 area whenever the water table was reached. Water table depth proved to vary from 1 to 1.3 m (3 to 4 ft). Water samples were collected in 1-liter plastic sample bottles, clearly marked, and identified. (Chemical contamination of the water samples was evident through both odor and consistency of the liquid. For handling precautions, analytical laboratory personnel were advised of the possibility of chemical contamination.) All water samples collected were shipped to the EAC Albuquerque laboratory for analysis for uranium-234, uranium-235, and uranium-238 by radiochemical techniques.

Ten sediment samples were collected at 15-m (50-ft) intervals in the wooden drainage trough east of Building 845. Prior to analysis, all samples were heated on-site in an oven (at the in situ van) to 600°C (1112°F) to remove organics and eliminate possible chemical exposures during handling. Sediment samples then were analyzed using the same methods used for soil samples.

Central Drainage Ditch

Ten sediment samples were collected from the Central Drainage Ditch between grid location N4700-2485 and N5150-E3220. Sediment sampling

locations are shown in Figure 4-2. Sediment samples were collected primarily utilizing foot and traffic bridges and in areas of the ditch that were accessible during drilling operations.

Four sediment samples were collected at 15-m (50-ft) intervals from the Feeder Ditch. All sediment samples taken were heated to 600°C (1112°F) to remove organics and to eliminate possible chemical exposures during handling. Samples were then analyzed for radioactivity by the same methods used for soil samples.

F Corral Parking Area

Two Shelby tube soil samples were collected in the F Corral parking area. Samples were collected and analyzed in the same manner as described earlier. Water samples also were collected from boreholes in the F Corral when applicable. Water was collected and analyzed as described earlier. Sampling locations are shown in Figure 4-3.

Building J-26 Area (Formerly J-16)

Water samples were collected from boreholes, when possible, in the Building J-26 area. Boreholes and water sample locations are shown in Figure 4-4.

East Burial Area

In the East Burial Area, two locations were selected for Shelby tube soil samples. These samples were taken in the immediate vicinity of the two boreholes which revealed the most significant subsurface deposits of radioactivity. Water samples also were collected from boreholes when possible. Sampling locations are shown in Figure 4-5.

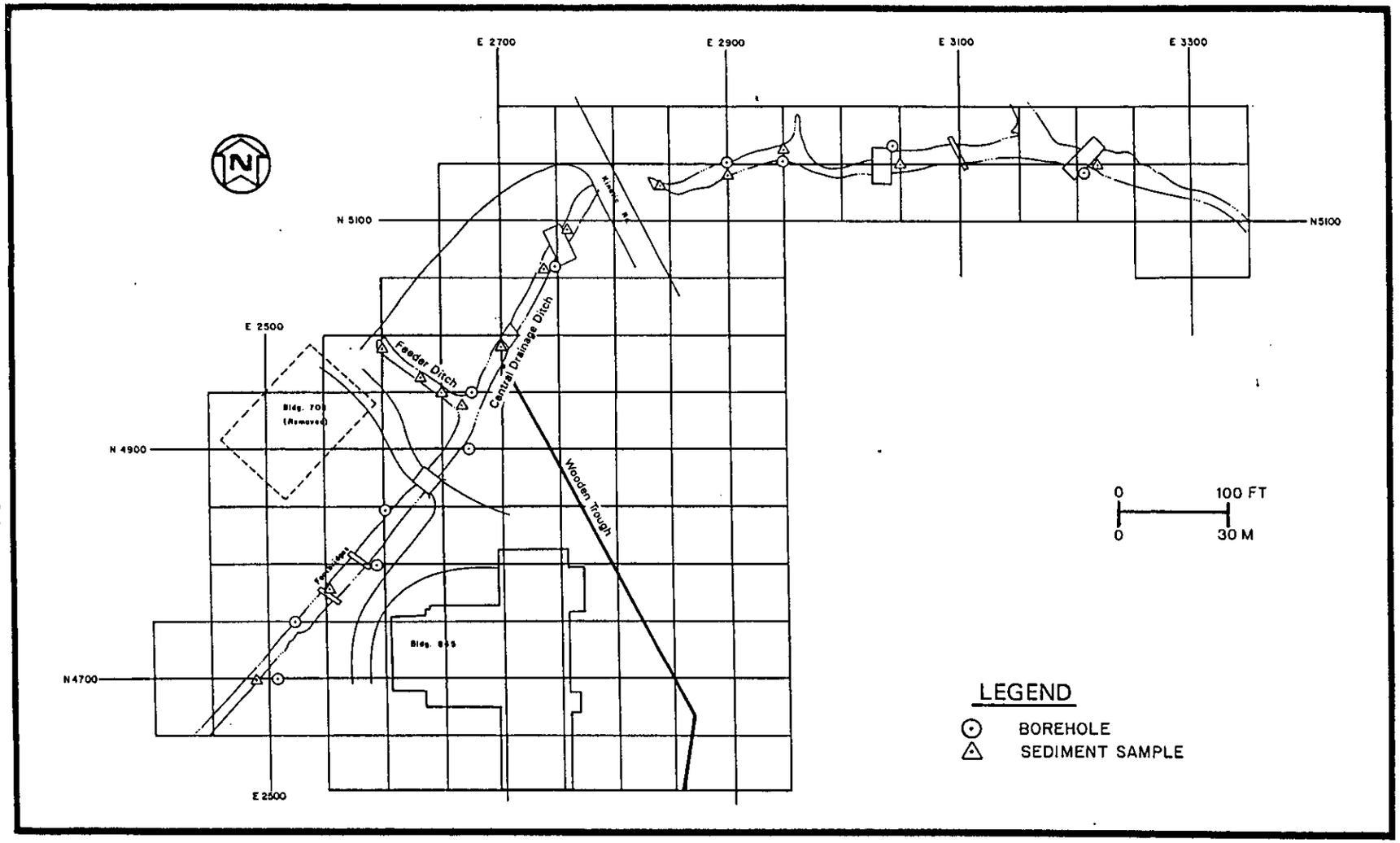

FIGURE 4-2 BOREHOLE AND SEDIMENT SAMPLE LOCATIONS, CENTRAL DRAINAGE DITCH AND FEEDER DITCH

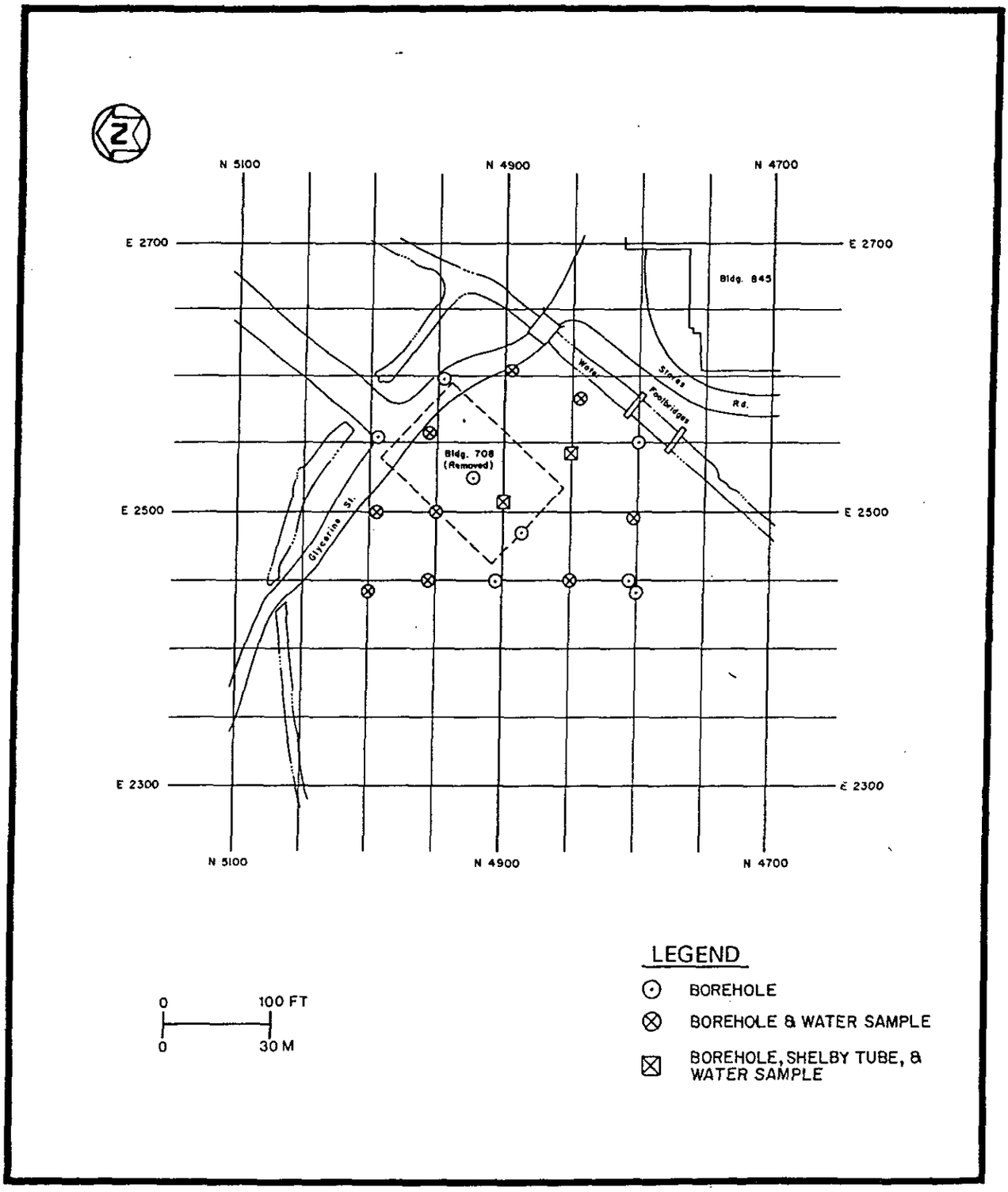

FIGURE 4-3 BOREHOLES AND SAMPLING LOCATIONS, F CORRAL AREA

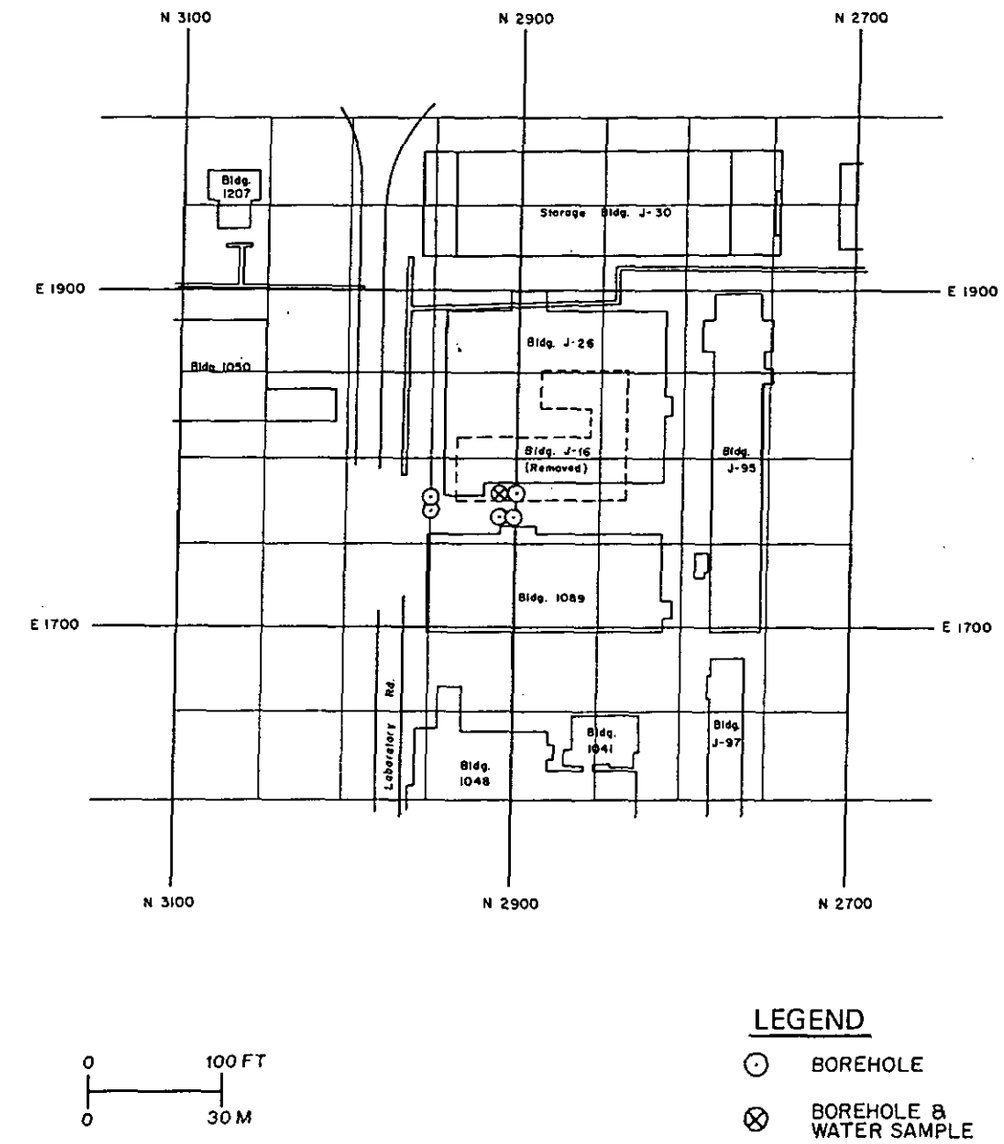

FIGURE 4-4 BOREHOLES AND WATER SAMPLING LOCATIONS, BUILDING J-26 AREA

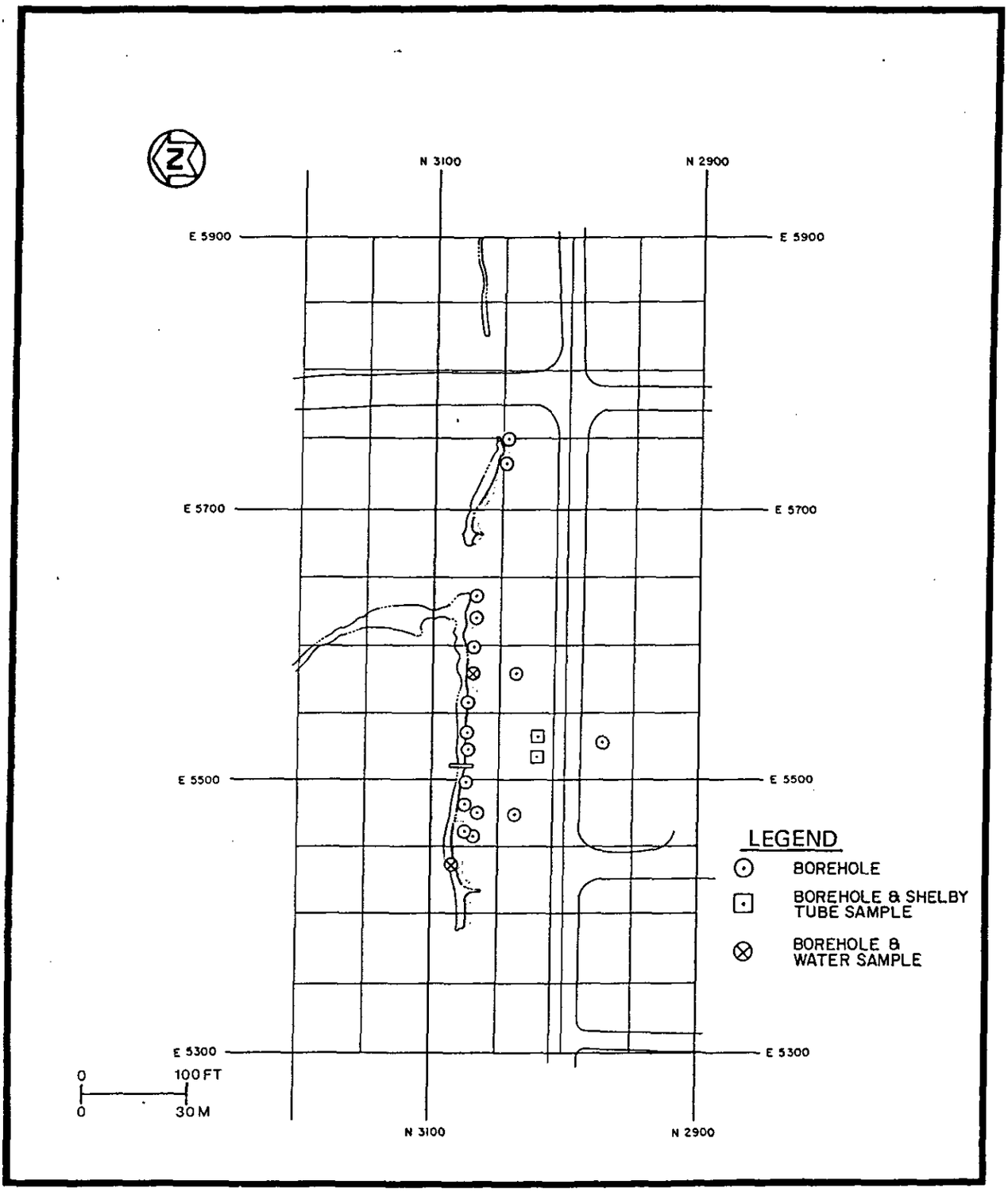

FIGURE 4-5 BOREHOLE AND SAMPLING LOCATIONS, EAST BURIAL AREA

Lagoon A

Two sediment samples were taken from Lagoon A and were processed using the same method used on the sediment samples taken from central drainage ditch. Sampling locations are shown in Figure 4-6.

4.2 BUILDING 845 SURVEY PROCEDURES

The grid system used for Building 845 consisted of a 1.8- x 1.8-m (6- x 6-ft) grid established on the walls, floors, and ceilings. Building 845 presently has four floors. During early plant operation this was not the case. The building contained equipment that reached from the ground floor to the upper parts of the building, and upper floors were only partial -- to varying extents. The present upper floors contain original flooring and recently added "new" flooring. For the purposes of this radiological survey, each floor of Building 845 was gridded independently and random measurements were made on the new floor areas to verify that these areas were not contaminated.

4.2.1 Measurements Taken and Methods Used

The surface of each floor of Building 845 was monitored for beta-gamma radiation, with a total of five measurements made in each grid segment on the original floor areas and random measurements made on the new floor areas. Measurements were made with a thin window (7 mg/cm^2) Geiger-Mueller detector with digital readout (EIC model HP-210/PRS-1). The HP-210 detector was in contact with floor surfaces. Five 30-second counts were obtained and recorded in each grid block. Measurements were made along the floor/wall intersection and along new and old floor joints at 3-ft intervals.

Wall surface measurements were obtained in the same manner as floor surface measurements. A 1.8-m (6-ft) grid was used from the floor to a height of 1.8 m (6 ft) above the floor. For upper walls the

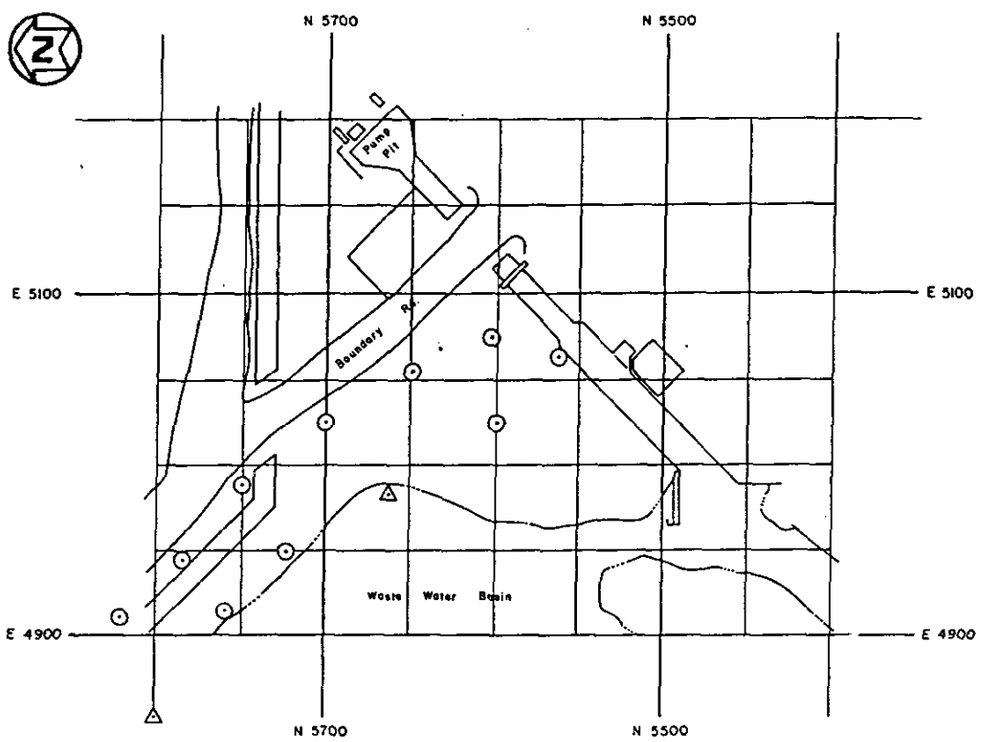

FIGURE 4-6 BOREHOLE AND SEDIMENT SAMPLING LOCATIONS, LAGOON A

grid was increased to 5 m (16 ft). All horizontal surfaces, such as window sills, also were scanned and radiation levels were recorded. All wall measurements are referenced to the floor grid numbering system.

Ceilings were monitored in the same manner as floors and walls. Measurement points were selected on horizontal and vertical surfaces such as beams, pipes, and ledges in each building unit (rooms, halls). All ceiling measurements were referenced to the floor grid numbering system.

Alpha radiation measurements were made at the same locations as beta-gamma measurements, using a 59-cm^2 zinc sulfide (ZnS) scintillation detector with digital readout (EIC models AC-3/PRS-1).

Based on results of the 1977 ORNL survey and surface beta-gamma measurements conducted during the 1983 building survey, 27 locations were identified for coring through the ground floor concrete slab. Locations are illustrated in Figure 4-7. Typical cores indicated the concrete slab was 10 to 15 cm (4 to 6 in.) thick, with a spread foundation footing 15 to 45 cm (6 to 18 in.) deep under columns.

A sealed drain trench was located in core boring number 4 (CB-4) and CB-6. The trench extended approximately 11 m (35 ft) south of CB-6 and was an average 45 cm (1.5 ft) deep. In CB-6, a 7.5-cm (3-in.) diameter steel drain pipe was located in the sealed trench at a depth of 22 to 30 cm (9 to 12 in.). This pipe contained elevated levels of radiological contamination in a dry, yellow powder form.

Augering techniques inside the building varied from methods used in the exterior areas of the plant due to limited overhead clearances. A 15-cm (6-in.) diameter hand auger was used to remove soil in 10-cm (4-in.) increments, allowing sufficient clearance for insertion of the PVC pipe for downhole gamma logging.

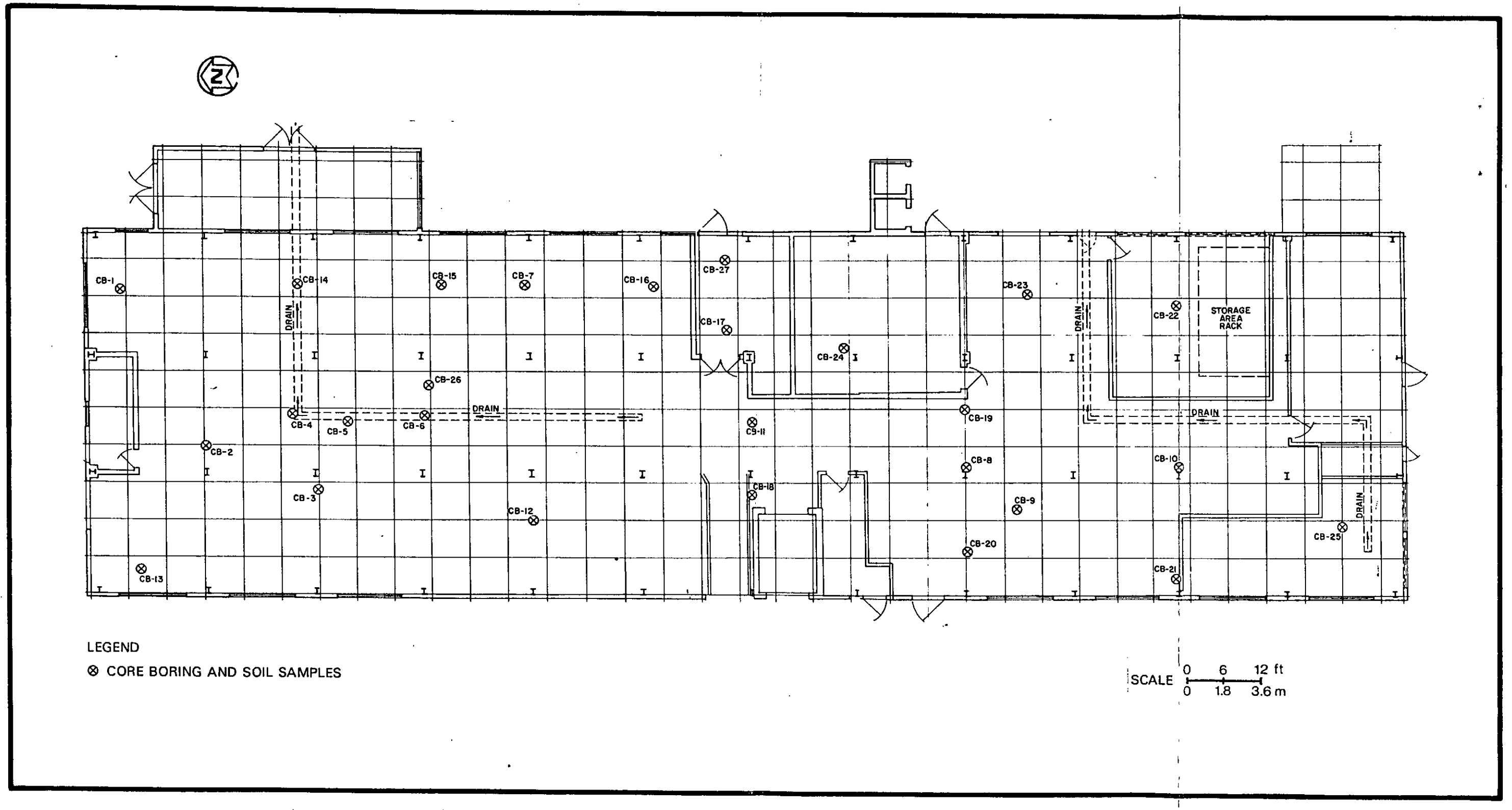

FIGURE 4-7 CORE BORINGS AND SOIL SAMPLE LOCATIONS, BUILDING 845 (GROUND FLOOR)

4.2.2 Sample Collection and Analysis

Shelby tube soil samples were collected inside Building 845 near all core boring locations. These samples were collected and analyzed using the same methods described in Subsection 4.1.2 of this report. Water samples also were taken from the borings wnen possible and processed as noted in Subsection 4.1.2.

During this radiological survey, four particulate air samplers (EIC Model RAS-1) were employed. These samplers, one on each floor, ran continuously and sampling filters were exchanged daily. Composite samples for each location were sent to the NFSS, where they were analyzed for gross alpha and beta-gamma.

Two composite dust samples also were collected from the first and fourth floors of Building 845. These samples were analyzed for uranium-238 and radium-226 at the EAC Albuquerque Laboratory.

5.0 SURVEY RESULTS

5.1 FIELD SURVEY RESULTS

All direct field measurements and laboratory results in this report represent gross readings; background measurements and concentrations have not been subtracted.

Background measurements were made in 1977 as part of the ORNL survey. At six locations on the DuPont property, at distances ranging from 300 to 1800 m (1000 to 6000 ft) from the nearest area in which radioactive materials were handled or stored, surface soil samples were taken to determine radionuclide concentrations. Concentrations of uranium-238 in the background soil samples ranged from 0.3 to 4.0 pCi/g and averaged 1.8 pCi/g.

External gamma measurements 1 m (3 ft) above the ground were made at the same six points. Background external gamma readings ranged from 3 to 6 μR/h and averaged 4.5 μR/h (Ref. 1). Background radiation rates and radionuclide concentrations in soil are summarized in Table 5-1, at the end of Section 5.0.

In addition to these background data, a series of additional external gamma exposure rate measurements were made throughout the state of New Jersey. The average statewide measurement was 6.1 μR/h (Ref. 4).

During the 1977 ORNL survey, three river water samples, which were assumed to represent background concentrations, were collected from the Delaware River. The results of these samples are presented in Table 5-2.

Background near-surface gamma measurements for the DuPont site were made during the 1983 BNI survey using an EIC SPA-3 detector. These measurements showed the site's near-surface gamma reading to be 2500 cpm.

Current DOE guidelines for radionuclide concentrations in soil, sediment and water are presented in Table 5-3.

In all field areas, measurements were taken for near-surface gamma, surface beta-gamma, and gamma exposure rates 1 m (3 ft) above the ground (gamma exposure rates were not measured in the J-26 area). Boreholes were drilled and gamma logging was performed, and undisturbed (Shelby tube) soil samples, water samples, and sediment samples were taken in each area as appropriate.

The results of near-surface gamma, surface beta-gamma, and gamma exposure rates are summarized in the following subsections. A summary table, Table 5-4, is presented at the end of Section 5.0. Analysis results for soil, sediment, and water samples also are summarized in the following sections, with specific results reported in Tables 5-5 (soil), 5-6 (sediment), and 5-7 (water) at the end of Section 5.0.

5.1.1 Building 845 Area

Near-surface gamma readings taken in the Building 845 area ranged from 1770 to 12,246 cpm. Only four surface areas east of Building 845 exhibited readings greater than twice background. All beta-gamma measurements were below the DOE guideline of 0.20 mrad/h dose rate averaged over one square meter.

Gamma exposure rates in the area ranged from 11.6 to 27.8 μR/h. As noted earlier, the overall site background rate measured by ORNL is 4.5 μR/h. The DOE criteria for continuous exposure to an individual in the general population is 60 μR/h above background.

Twenty-five boreholes, ranging in depth from 1.4 to 2.8 m (4.5 to 9 ft) were drilled in the area around Building 845. Borehole gamma logging then was performed to indicate general depth and concentrations of contamination. When possible, the borehole gamma loggings were correlated with undisturbed (Shelby tube) soil samples

analyses, relating the gamma detector's cpm response to the specific radionuclide concentration in picocuries per gram (pCi/g).

Due to the high water table encountered under the DuPont site, in many instances soil samples could not be collected. However, four Shelby tube soil samples were taken in the area east of Building 845 (refer to Figure 4-1). Specific analysis results are presented in Table 5-5, which lists the samples by coordinates and depth. The results indicate uranium is the major contaminant in the Building 845 exterior area, with levels ranging from 0.63 to 7398.0 pCi/g. The DOE remedial action guideline for uranium is 150 pCi/g.

Ten sediment samples were collected from the drainage trough located east of Building 845. Sampling locations are shown in Figure 4-1. All samples were analyzed for uranium-238, and concentrations ranged from 1.9 to 255.6 pCi/g. Selected samples also were analyzed for uranium-234, uranium-235, thorium-232, and radium-226. Results are given in Table 5-6. All results were below the DOE guidelines for these radionuclides (Ref. 5).

Twenty-one water samples were collected from boreholes in the area around Building 845. These samples were analyzed for total uranium. Results, given in Table 5-7, range from 1.5 to 11,712.0 pCi/l.

5.1.2 Central Drainage Ditch

Near-surface gamma measurements and beta-gamma measurements were made along both sides of the Central Drainage Ditch and the Feeder Ditch. Near-surface gamma readings ranged from 1806 to 14,532 cpm. Three measurements taken in the southwest portion of the Feeder Ditch had readings greater than twice background. All beta-gamma dose rates were below the DOE guideline.

Gamma exposure rates in the area of the Central Drainage Ditch ranged from 12.8 to 15.4 μR/h. These measurements are elevated above natural background but are below the DOE guideline of 60 μR/h.

Eleven boreholes were drilled 1.8 to 2.6 m (6 to 8.5 ft) deep along the sides of the Central Drainage Ditch (refer to Figure 4-2). Boreholes were gamma logged, and elevated measurements were detected along both sides of the ditch. All measurements were below but near the guideline limit.

Sediment samples were collected from 10 locations in the Central Drainage Ditch and 4 locations in the Feeder Ditch. These samples were analyzed for uranium-234, -235, and -238. Results ranged from 0.90 to 4.10 pCi/g for uranium-238, 1.20 to 1.90 pCi/g for uranium-234, and 0.04 to 0.15 pCi/g for uranium-235. Complete results are given in Table 5-6. All results were below the DOE guidelines.

5.1.3 F Corral Parking Area

Near-surface gamma measurements and beta-gamma measurements were made in the F Corral parking area at 6-m (20-ft) intervals. Near-surface gamma readings ranged from 1608 to 5020 cpm. All beta-gamma dose rates were below the DOE guideline. Gamma exposure rates in the F Corral parking area ranged from 11.6 to 13.8 μR/h.

Nineteen boreholes ranging from 0.6 to 2.7 m (2 to 9 ft) in depth were drilled in the F Corral area (refer to Figure 4-3). Based on gamma logs, subsurface contamination is indicated in layers to a depth greater than 2.7 m (9 ft).

Two Shelby tube soil samples were collected from the F Corral, and sample results are given in Table 5-5 by depth and coordinate. Uranium-238 was the major contaminant found in the parking area, with concentrations ranging from 0.90 to 4347 pCi/g.

Eleven water samples were collected from boreholes located in the F Corral. These samples were analyzed for total uranium. Results, given in Table 5-7, ranged from 1.50 to 105,105 pCi/l.

5.1.4 Building J-26 Area

In the Building J-26 area, near-surface gamma measurements ranged from 1568 to 4334 cpm. Beta-gamma dose rates were below the DOE guideline.

Six boreholes were drilled in the area around Building J-26 (refer to Figure 4-4), and one water sample was collected. The total uranium concentration of the sample was 13.51 pCi/l. Analysis results are given in Table 5-7.

5.1.5 East Burial Area

Near-surface gamma readings in the East Burial area ranged from 1212 to 17,878 cpm. Three measurements exceeded normal background levels. All beta-gamma dose rates were below the DOE guideline. Gamma exposure rates in the East Burial area ranged from 12.2 to 15.0 μR/h.

Twenty boreholes were drilled in the East Burial area (refer to Figure 4-5). Gamma loggings indicate contamination exists in layers to depths greater than 2.6 m (8.5 ft). Higher count rates were observed in the boreholes drilled adjacent to the road.

Two Shelby tube soil samples were collected in the East Burial area, and samples were analyzed for uranium-238, thorium-232, and radium-226. Uranium-238 was the major contaminant found, with concentrations ranging from 297 to 20,810 pCi/g. Both sampling locations also showed concentrations of radium-226 above the DOE guideline, with concentrations ranging from 0.19 to 27.8 pCi/g. All thorium-232 concentrations were below the DOE guideline. Complete results are given in Table 5-5. Due to the high water table, subsurface soil samples could not be collected below 1 m (3 ft).

Groundwater samples were collected from two locations at a depth of 90 cm (36 in.). Water samples were analyzed for total uranium. Both samples had uranium-238 concentrations below the DOE guideline.

5.1.6 Lagoon A

In the Lagoon A area, near-surface gamma measurements ranged from 1566 to 3436 cpm. All beta-gamma dose rates were below the DOE guideline. Gamma exposure rates ranged from 11.2 to 15.8 uR/h.

Ten boreholes were drilled in the Lagoon A area (refer to Figure 4-6). Gamma loggings exhibited readings above background but below the guideline.

A surface water sample was collected from Lagoon A. The total uranium concentration in the sample was 4.20 pCi/l. Results are given in Table 5-7.

5.2 BUILDING 845 SURVEY RESULTS

All building survey measurements in this report represent gross readings; background measurements have not been subtracted. Beta-gamma dose-rate measurements taken on the DuPont site in buildings that have not been contaminated with radioactive materials were less than 0.03 mrad/h (Ref. 1). DOE guidelines for the release of property for unrestricted use state that beta-gamma dose rates at 1 cm from the surface shall not exceed 0.2 mrad/h (averaged over one square meter) and 1.0 mrad/h maximum in an area not greater than 100 cm^2 (Ref. 5). The guidelines also state that alpha surface contamination levels shall not exceed 1000 dpm/100 cm^2 average and 3000 dpm/100 cm^2 maximum when natural uranium is known to be the contaminant.

Results of measurements for beta-gamma dose rates and alpha contamination taken in Building 845 are summarized in the following subsections. More detailed results are presented in summary form in Table 5-8. Results for soil and water samples are summarized in the following sections, with specific results reported in Tables 5-5 (soil) and 5-7 (water).

While work was being performed inside Building 845, air particulate samples were taken. All results were within the DOE guideline for gross alpha of 0.1 pCi/m^3 (for uncontrolled areas) (Ref. 6).

5.2.1 First Level

A total of five measurements were made for beta-gamma and alpha contamination in each floor grid block. Average and maximum values per grid block are recorded in this report. The floor beta-gamma dose rates per grid block ranged from 0 to 4.54 mrad/h. Alpha measurement averages ranged from 0 to 6819 dpm/100 cm^2, with a maximum reading of 26,544 dpm/100 cm^2.

Floor/wall intersections were surveyed in 1-m (3-ft) increments for beta-gamma and alpha contamination. Beta-gamma dose rate averages ranged from 0 to 6.05 mrad/h, with a maximum reading of 8.88 mrad/h. Alpha measurement averages ranged from 0 to 10,621 dpm/100 cm^2, with a maximum reading of 18,041 dpm/100 cm^2.

Beta-gamma dose rates measured on the ceiling ranged from 0 to 4.78 mrad/h. Alpha measurements ranged from 0 to 5568 dpm/ 100 cm^2. Beta-gamma and alpha measurement results are summarized in Table 5-8.

Twenty-seven coreholes were drilled through the first floor of Building 845. Locations are shown in Figure 4-7. In several locations, the auger hit the spread footings of the building's foundation. Thus, the corehole depths ranged from 0.5 to 2 m (1.5 to 6.0 ft). Eighteen boreholes indicated elevated gamma readings.

Soil samples were collected at all corehole locations and were analyzed for uranium-238, thorium-232, and radium-226. The major contaminant was uranium-238, with concentrations ranging from 0.70 to 8334 pCi/g. Thorium-232 and radium-226 concentrations were below the DOE criteria limit. Several samples were selected for uranium-234 and uranium-235 analysis, and concentrations were below guidelines. Results are given in Table 5-5.

Beta-gamma and alpha measurements also were made on accessible lower wall areas during the survey. Beta-gamma dose rates ranged from 0.05 to 10.92 mrad/h. Alpha measurements ranged from 0 to 9068 dpm/ 100 cm^2.

Floor/wall intersections and the new floor/old floor intersections also were also surveyed. Beta-gamma dose rate averages ranged from 0.01 to 2.16 mrad/h, with a maximum reading of 2.77 mrad/h. All alpha measurements were below the guideline.

On the ceiling, beta-gamma dose rates ranged from 0.02 to 4.87 mrad/h. Alpha measurements ranged from 8 to 3992 dpm/100 cm^2.

Results of second level readings are summarized in Table 5-8.

5.2.3 Third Level

Beta-gamma and alpha measurements were taken on the old floor areas of the third level, and new floor areas were spot checked for contamination. Beta-gamma dose-rate averages ranged from 0 to 1.40 mrad/h, with a maximum reading of 2.38 mrad/h. Alpha measurement averages ranged from 0 to 1017 dpm/100 cm^2.

On the lower walls, beta-gamma dose rate averages ranged from 0.08 to 2.84 mrad/h, with a maximum reading of 2.84 mrad/h. Alpha measurements ranged from 37 to 3076 dpm/100 cm^2.

At floor/wall intersections and new floor/old floor intersections, beta-gamma dose rates ranged from 0 to 0.68 mrad/h, with a maximum reading of 0.98 mrad/h. Alpha measurements ranged from 0 to 1930 dpm/100 cm^2, with a maximum reading of 2599 dpm/100 cm^2.

On the third level ceiling, beta-gamma dose rate measurements ranged from 0.02 to 1.49 mrad/h, with a maximum reading of 7.05 mrad/h. Alpha measurement averages ranged from 8 to 1347 dpm/100 cm^2.

TABLE 5-1

BACKGROUND RADIATION RATES AND RADIONUCLIDE CONCENTRATIONS IN SOIL

Location	Gamma Exposure Rate at 1 m (μR/h)	Radionuclide Concentrations (pCi/g)			
		U-238	Ra-226	Ac-227	Th-232
1	4	1.5	0.8	not found	0.7
2	4	1.9	0.5	0.3	0.6
3	6	4.0	0.6	2.2	0.7
4	6	1.6	0.9	not found	1.0
5	3	0.3	0.2	not found	0.3
6	4	1.8	0.8	not found	0.8
Averages	4.5	1.8	0.6	0.4	0.7

Source: ORNL (Ref. 1)

TABLE 5-2

RADIONUCLIDE CONCENTRATIONS IN THE DELAWARE RIVER

Location	Radionuclide Concentrations (pCi/ml)			
	U-238	Ra-226	Th-230	Pb-210
W-1	1.5×10^{-3}	9×10^{-6}	1.7×10^{-5}	9×10^{-4}
W-2	1.1×10^{-3}	9×10^{-6}	1.5×10^{-5}	9×10^{-4}
W-3	4.3×10^{-4}	2.3×10^{-5}	3.2×10^{-5}	4.5×10^{-4}

Source: ORNL (Ref. 1)

TABLE 5-4

DUPONT CHAMBERS WORKS SITE: PRE-REMEDIAL ACTION

SUMMARY OF OUTDOOR MEASUREMENT RESULTS

Measurement Location and Type[a]	Units	Number of Measurements Made	Range	Normal Background (BKG)
Building 845 Area				
Near-surface gamma	cpm	142	1770-12246	2,500
Beta-gamma dose rates	mrad/h	142	BKG - 0.08	0.02
External gamma exposure rates	µR/h	31	11.6 - 27.8	4.5
Feeder Ditch and Central Drainage Ditch				
Near-surface gamma	cpm	73	1806-14532	2,500
Beta-gamma dose rates	mrad/h	73	BKG-0.13	0.02
External gamma exposure rates	µR/h	12	12.8 - 15.4	4.5
F Corral Parking Area				
Near-surface gamma	cpm	203	1608-5020	2,500
Beta-gamma dose rates	mrad/h	203	BKG-0.14	0.02
External gamma exposure rates	µR/h	27	11.6 - 13.8	4.5
Building J-26 Area				
Near-surface gamma	cpm	41	1568-4334	2,500
Beta-gamma dose rates	mrad/h	41	BKG-0.05	0.02
East Burial Area				
Near-surface gamma	cpm	89	1212-17878	2,500
Beta-gamma dose rates	mrad/h	89	BKG-0.04	0.02
External gamma exposure rates	µR/h	15	12.2-15.0	4.5
Lagoon A				
Near-surface gamma	cpm	64	1566-3436	2,500
Beta-gamma dose rates	mrad/h	64	BKG-0.05	0.02
External gamma exposure rates	µR/h	4	11.2-15.8	4.5

[a]Near-surface gamma measurements were made with a SPA-3 coupled with a PRS-1. Beta-gamma dose rates were measured with an HP-210 and PRS-1. Gamma exposure rates were measured with a PIC.

TABLE 5-5

DUPONT CHAMBERS WORKS SITE: GAMMA SPECTROMETRY OF SOIL SAMPLES

Sampling Location		Depth (inches)	Radionuclide Concentrations (pCi/g +/- 2 Sigma) Uranium-238	Radium-226	Thorium-232	Uranium-234	Uranium-235
Building 845 Area:							
Grid E	Grid N						
2761	4730	6-10	581.20 ± 11.80	1.83 ± .28	.96 ± .55	---	---
2761	4730	10-14	427.60 ± 9.68	1.07 ± .20	1.51 ± .56	---	---
2761	4730	14-18	164.80 ± 5.34	.38 ± .13	---	---	---
2761	4730	18-22	61.92 ± 21.60	.33 ± .22	.86 ± .29	---	---
2761	4730	22-26	4.92 ± 1.47	.28 ± .23	.62 ± .26	---	---
2761	4745	0-4	7398.00 ± 32.70	4.06 ± .77	---	---	---
2761	4745	6-10	720.10 ± 9.50	.67 ± .20	.66 ± .23	---	---
2761	4745	42-45	321.80 ± 7.14	.78 ± .19	.46 ± .26	---	---
2761	4745	46-50	358.40 ± 11.14	.69 ± .21	---	---	---
2761	4745	50-54	269.50 ± 6.88	.36 ± .17	.40 ± .42	---	---
2761	4745	54-58	94.98 ± 5.88	.37 ± .29	---	---	---
2761	4745	58-62	152.40 ± 9.25	.86 ± .20	---	---	---
2761	4745	62-66	.63 ± 1.54	.63 ± .14	.94 ± .28	---	---
2780	4771	6-10	10.61 ± 6.69	---	---	---	---
2780	4771	10-14	25.61 ± 5.12	---	---	---	---
2780	4771	14-18	159.30 ± 10.19	.90 ± .29	---	---	---
2780	4771	36-40	40.87 ± 3.39	.92 ± .15	.97 ± .49	---	---
2782	4730	2-3	4355.00 ± 68.70	5.12 ± 2.17	---	---	---
2782	4730	3-7	561.40 ± 11.12	1.99 ± .27	---	---	---
2782	4730	7-11	58.06 ± 2.93	.82 ± .16	---	---	---
2782	4730	11-15	.80 ± .20	.63 ± .11	.58 ± .22	.70 ± .20	.09 ± .08
2782	4730	15-19	---	.53 ± .13	.48 ± .17	---	---
2782	4730	19-23	---	.42 ± .14	.23 ± .23	---	---
2782	4730	23-27	---	.46 ± .25	---	---	---
F Corral Parking Area:							
Grid E	Grid N						
2507	4900	13-17	323.70 ± 16.36	1.04 ± .42	---	---	---
2507	4900	17-21	1333.00 ± 41.20	8.58 ± .93	---	---	---
2507	4900	21-25	1768.00 ± 42.40	8.91 ± .86	---	---	---
2507	4900	25-29	863.30 ± 26.24	2.66 ± .50	---	---	---
2507	4900	29-33	3531.00 ± 25.90	2.11 ± .62	---	---	---
2507	4900	54-56	1629.00 ± 51.30	1.69 ± .86	---	---	---
2507	4900	56-60	4378.00 ± 25.29	1.16 ± .48	---	---	---
2507	4900	60-64	4247.00 ± 61.35	1.03 ± .71	---	---	---
2507	4900	64-68	1734.00 ± 44.40	.76 ± .56	---	---	---
2507	4900	68-72	662.30 ± 37.91	1.10 ± .58	---	---	---
2507	4900	72-76	536.20 ± 18.65	---	.79 ± .26	---	---
2540	4850	6-10	12.59 ± 2.21	.28 ± .16	---	---	---
2540	4850	10-14	1.40 ± .20	---	---	---	---
2540	4850	14-18	.90 ± .20	---	---	1.70 ± .20	.12 ± .05

TABLE 5-5

(continued)

Sampling Location		Depth (Inches)	Radionuclide Concentrations (pCi/g +/- 2 Sigma)				
			Uranium-238	Radium-226	Thorium-232	Uranium-234	Uranium-235
F Corral Parking Area:							
Grid E	Grid N						
2540	4850	18-22	3.90 ± 1.01	.15 ± .05	---	.80 ± .20	.05 ± .04
2540	4850	22-26	6.93 ± 1.46	.19 ± .12	.11 ± .12	---	---
2540	4850	26-30	281.20 ± 11.70	2.72 ± .33	.62 ± .18	---	---
2540	4850	36-42	1066.00 ± 12.11	6.51 ± .51	.84 ± .38	---	---
East Burial Area:							
Grid E	Grid N						
5518	3018	9-13	11210. ± 39.40	27.84 ± 2.28	---	---	---
5518	3018	13-17	20810. ± 54.38	25.98 ± 2.37	---	---	---
5518	3018	17-21	673.30 ± 9.59	1.27 ± .10	.69 ± .34	---	---
5518	3018	21-25	185.40 ± 4.94	1.04 ± .08	1.05 ± .24	---	---
5518	3018	25-29	296.90 ± 6.59	3.93 ± .32	---	---	---
5518	3018	29-33	375.40 ± 8.33	.19 ± .02	---	---	---
5518	3018	34-38	602.10 ± 13.30	5.02 ± .41	.64 ± .53	---	---
5533	3018	6-10	18670. ± 16.83	5.13 ± .42	---	---	---
5533	3018	10-14	6029.00 ± 30.04	16.02 ± 1.31	---	---	---
5533	3018	14-18	710.20 ± 9.75	5.45 ± .45	---	---	---
5533	3018	18-23	577.40 ± 11.39	3.73 ± .31	---	---	---
5533	3018	22-26	745.80 ± 9.92	1.87 ± .15	.48 ± .60	---	---
5533	3018	26-30	517.20 ± 8.04	.63 ± .22	---	---	---
5533	3018	30-32	530.10 ± 11.10	1.24 ± .39	.57 ± .58	---	---
Building 845 (Interior)							
Grid No.	Core No.						
9	CB-1	6-9	2092.00 ± 3.31	1.44 ± .19	1.05 ± .40	---	---
9	CB-1	9-13	21.82 ± 2.54	.80 ± .17	1.14 ± .30	---	---
11	CB-13	15-19	3281.00 ± 28.45	---	---	---	---
11	CB-13	19-24	1342.00 ± 13.80	.43 ± .28	---	---	---
11	CB-13	24-29	130.10 ± 3.70	.90 ± .29	---	---	---
11	CB-13	33-36	1351.00 ± 18.00	1.40 ± .46	---	---	---
11	CB-13	39-43	18.35 ± 2.33	.70 ± .14	.73 ± .28	---	---
11	CB-13	43-47	1.35 ± 1.49	1.30 ± .20	1.28 ± .25	---	---
11	CB-13	47-51	---	.90 ± .45	---	---	---
11	CB-13	51-55	---	1.07 ± .18	.97 ± .29	---	---
11	CB-13	55-59	1.14 ± .93	.65 ± .14	---	---	---
11	CB-13	59-63	4.09 ± 1.44	.43 ± .12	.28 ± .31	---	---
40	CB-2	0-6	149.80 ± 8.21	1.13 ± .20	---	---	---
40	CB-2	0-6	86.89 ± 5.00	.33 ± .16	.61 ± .17	---	---
40	CB-2	12-16	166.40 ± 8.10	1.09 ± .38	.86 ± .45	---	---
40	CB-2	12-16	36.24 ± 1.32	.48 ± .08	.62 ± .14	---	---
40	CB-2	16-20	145.60 ± 10.47	---	---	---	---

TABLE 5-5

(continued)

Sampling Location		Depth (inches)	Radionuclide Concentrations (pCi/g +/- 2 Sigma)				
			Uranium-238	Radium-226	Thorium-232	Uranium-234	Uranium-235
Building 845 (Interior):							
Grid No.	Core No.						
40	CB-2	16-20	177.20 ± 8.04	.48 ± .31	.18 ± .50	---	---
40	CB-2	20-24	106.20 ± 8.36	.57 ± .22	---	---	---
40	CB-2	20-24	49.37 ± 4.26	.56 ± .24	.13 ± .45	---	---
40	CB-2	24-28	29.09 ± 3.70	.85 ± .37	---	---	---
40	CB-2	24-28	56.79 ± 4.63	.94 ± .28	.23 ± .39	---	---
40	CB-2	28-32	43.66 ± 6.30	---	---	---	---
40	CB-2	28-32	18.58 ± 5.29	---	---	---	---
65	CB-3	0-3	1256.00 ± 42.13	---	---	---	---
65	CB-3	3-7	484.70 ± 19.50	---	---	---	---
65	CB-3	7-11	569.90 ± 10.30	.35 ± .19	---	---	---
65	CB-3	11-15	427.80 ± 9.74	.22 ± .32	.99 ± .31	---	---
67	CB-4	23-27	45.87 ± 3.64	.77 ± .16	.62 ± .25	---	---
67	CB-4	27-31	790.10 ± 10.00	.66 ± .44	---	---	---
71	CB-14	20-23	39.12 ± 3.00	.74 ± .13	.42 ± .21	---	---
80	CB-5	21-30	72.63 ± 7.24	.84 ± .21	---	---	---
80	CB-5	30-39	10.09 ± 2.87	---	---	---	---
106	CB-6	22-27	9.82 ± 7.59	---	---	---	---
107	CB-26	6-10	43.14 ± 7.67	1.01 ± .25	---	---	---
107	CB-26	10-14	37.89 ± 2.64	.51 ± .20	.91 ± .32	---	---
107	CB-26	14-18	42.07 ± 3.13	.90 ± .13	.37 ± .22	---	---
107	CB-26	18-22	17.89 ± 2.19	.92 ± .14	.71 ± .16	---	---
123	CB-15	8-12	2014.00 ± 15.80	.78 ± .32	1.20 ± .41	---	---
123	CB-15	12-16	166.80 ± 5.78	.98 ± .18	1.22 ± .31	---	---
123	CB-15	16-20	71.34 ± 4.29	.36 ± .16	.75 ± .29	---	---
123	CB-15	20-24	12.52 ± 2.29	1.10 ± .20	1.15 ± .39	---	---
123	CB-15	24-28	1.00 ± .20	.99 ± .18	10.44 ± .25	1.00 ± .20	.04 ± 0.3
136	CB-12	7-12	38.16 ± 3.63	.85 ± .17	---	---	---
136	CB-12	12-18	56.41 ± 3.92	1.64 ± .28	.61 ± .28	---	---
136	CB-12	18-21	3.30 ± .30	---	---	3.40 ± .30	.11 ± .07
143	CB-7	6-10	991.20 ± 11.71	1.42 ± .21	---	---	---
143	CB-7	10-14	94.34 ± 4.39	.63 ± .15	1.16 ± .25	---	---
143	CB-7	14-18	1.24 ± 6.96	---	---	---	---
143	CB-7	18-22	1.53 ± 1.06	.44 ± .23	.56 ± .29	---	---
143	CB-7	22-26	1.69 ± 1.46	1.10 ± .15	.54 ± .31	---	---
173	CB-16	6-10	2785.00 ± 48.20	4.94 ± .82	---	---	---
173	CB-16	10-14	5839.00 ± 76.74	4.27 ± .90	---	---	---
173	CB-16	14-18	8057.00 ± 3.62	.83 ± .70	---	---	---
173	CB-16	18-22	6721.00 ± 31.70	---	---	---	---
173	CB-16	33-37	2083.00 ± 16.50	.80 ± .35	---	---	---
173	CB-16	37-41	843.20 ± 11.10	1.23 ± .34	.95 ± .33	---	---
173	CB-16	41-45	719.00 ± 10.30	1.10 ± .24	---	---	---

TABLE 5-5

(continued)

Sampling Location		Depth (inches)	Radionuclide Concentrations (pCi/g +/- 2 Sigma)				
			Uranium-238	Radium-226	Thorium-232	Uranium-234	Uranium-235
Building 845 (Interior):							
Grid No.	Core No.						
173	CB-16	45-49	7.76 ± 3.90	.78 ± .17	---	---	---
173	CB-16	49-53	35.37 ± 3.43	.62 ± .22	.93 ± .32	---	---
192	CB-17	0-1	4699.00 ± 68.90	---	---	---	---
192	CB-17	6-10	2517.00 ± 18.63	.54 ± .38	---	---	---
192	CB-17	10-14	1471.00 ± 13.25	---	---	---	---
192	CB-17	14-18	151.90 ± 5.36	.49 ± .12	---	---	---
192	CB-17	18-22	197.10 ± 5.91	.35 ± .14	.34 ± .27	---	---
194	CB-27	6-10	32.62 ± 2.38	.32 ± .13	---	---	---
197	CB-18	6-10	187.90 ± 4.78	1.73 ± .20	---	---	---
199	CB-11	6-10	8334.00 ± 122.40	---	---	---	---
199	CB-11	10-14	3938.00 ± 31.60	.31 ± .77	---	---	---
199	CB-11	14-18	2168.00 ± 58.40	---	---	---	---
199	CB-11	18-22	409.90 ± 10.49	.48 ± .30	---	---	---
199	CB-11	22-26	302.10 ± 11.06	.72 ± .36	---	---	---
199	CB-11	26-30	59.62 ± 4.04	.58 ± .18	.56 ± .30	---	---
221	CB-24	0-4	2.30 ± .30	---	---	2.40 ± .30	.08 ± .05
221	CB-24	4-12	3.40 ± .30	---	---	3.40 ± .30	.11 ± .05
221	CB-24	4-12	6.89 ± 1.75	.67 ± .20	.71 ± .20	---	---
221	CB-24	12-16	7.00 ± 1.69	.58 ± .13	---	---	---
221	CB-24	12-16	3.23 ± 2.22	.55 ± .16	.72 ± .26	---	---
221	CB-24	16-20	6.23 ± 3.47	---	---	---	---
221	CB-24	16-20	5.66 ± 1.43	.76 ± .16	.41 ± .19	---	---
221	CB-24	20-24	3.61 ± 3.03	.31 ± .14	---	---	---
221	CB-24	20-24	3.00 ± 1.88	.70 ± .13	---	---	---
252	CB-8	6-8	268.90 ± 15.50	---	---	---	---
252	CB-8	8-12	29.24 ± 3.92	.26 ± .18	---	---	---
252	CB-8	12-16	23.54 ± 2.13	.38 ± .15	.33 ± .12	---	---
253	CB-19	35-36	1143.00 ± 53.20	---	---	---	---
253	CB-19	36-40	446.60 ± 9.70	.74 ± .25	.63 ± .20	---	---
253	CB-19	40-44	817.50 ± 27.91	---	---	---	---
253	CB-19	44-48	1113.00 ± 11.70	---	---	---	---
253	CB-19	48-52	12.83 ± 1.72	.55 ± .11	---	---	---
253	CB-19	52-56	---	.52 ± .13	.32 ± .22	---	---
253	CB-19	56-60	2.67 ± 1.32	.42 ± .12	.80 ± .18	---	---
260	CB-20	7-10	25.03 ± 4.17	.23 ± .10	---	---	---
260	CB-20	10-14	3.32 ± 1.23	.08 ± .12	---	---	---
260	CB-20	14-18	---	.41 ± .18	---	---	---
260	CB-20	18-22	---	.15 ± .12	.43 ± .13	---	---
260	CB-20	22-26	1.19 ± 1.54	.47 ± .16	.55 ± .30	---	---
260	CB-20	26-30	---	.47 ± .17	.86 ± .27	---	---
271	CB-9						
277	CB-23	6-10	.70 ± .10	.42 ± .15	.59 ± .19	.80 ± .10	.03 ± .03
277	CB-23	10-14	---	.52 ± .29	---	---	---
277	CB-23	14-18	---	.26 ± .10	.59 ± .19	---	---
277	CB-23	18-22	---	.49 ± .13	.55 ± .15	---	---

TABLE 5-5

(continued)

Sampling Location		Depth (Inches)	Radionuclide Concentrations (pCi/g +/- 2 Sigma)				
			Uranium-238	Radium-226	Thorium-232	Uranium-234	Uranium-235
Building 845 (Interior):							
Grid No.	Core No.						
277	CB-23	22-26	---	.67 ± .13	.82 ± .18	---	---
309	CB-21	6-10	17.29 ± 2.14	.47 ± .14	---	---	---
309	CB-21	10-14	3.16 ± .97	.26 ± .08	---	---	---
309	CB-21	14-18	10.61 ± 4.58	.25 ± .20	---	---	---
312	CB-10	6-7	305.50 ± 1.96	3.30 ± 1.96	---	---	---
312	CB-10	7-11	17.95 ± 1.94	.61 ± .10	.34 ± .26	---	---
316	CB-22	6-10	44.95 ± 6.20	1.01 ± .25	---	---	---
316	CB-22	10-14	11.50 ± 2.05	.60 ± .12	.46 ± .18	---	---
316	CB-22	14-18	---	.69 ± .28	---	---	---
316	CB-22	18-22	5.82 ± 1.17	.86 ± .15	---	---	---
316	CB-22	22-26	4.64 ± 2.07	1.53 ± .23	.98 ± .36	---	---
316	CB-22	26-30	---	.55 ± .29	---	---	---
360	CB-25	5-9	3.56 ± 1.19	.33 ± .14	---	---	---

TABLE 5-6

DUPONT CHAMBERS WORKS SITE: GAMMA SPECTROMETRY OF SEDIMENT SAMPLES

Sampling Location		Depth (inches)	Radionuclide Concentrations (pCi/g +/- 2 Sigma)				
			Uranium-238	Radium-226	Thorium-232	Uranium-234	Uranium-235
Wooden Trough East of Building 845:							
Grid E	Grid N						
2710	4980	0-6	42.03 ± 9.62	1.03 ± .70	---	---	---
2730	4935	0-6	255.60 ± 18.50	2.45 ± .65	1.86 ± 1.07	---	---
2755	4890	0-6	40.98 ± 6.11	1.27 ± .34	.47 ± .64	---	---
2775	4840	0-6	49.13 ± 6.74	.87 ± .28	---	---	---
2775	4848	0-6	10.99 ± 4.53	---	---	---	---
2795	4795	0-6	127.60 ± 11.90	1.67 ± .73	2.03 ± .12	---	---
2800	4845	0-6	1.90 ± .30	---	---	2.10 ± .30	.09 ± .06
2820	4755	0-6	31.99 ± 4.45	---	---	---	---
2845	4715	0-6	16.52 ± 6.29	---	---	---	---
2760	4690	0-6	21.81 ± 6.09	2.58 ± .46	---	---	---
Central Drainage Ditch and Feeder Ditch:							
Grid E	Grid N						
2485	4700	0-6	1.20 ± .20	---	---	1.40 ± .20	.05 ± .04
2485	4700	0-6	1.00 ± .20	---	---	1.20 ± .20	.08
2550	4770	0-6	1.70 ± .20	---	---	1.60 ± .20	.07 ± .04
2600	4990	0-6	4.10 ± 2.85	.50 ± .26	---	---	---
2630	4970	0-6	1.00 ± .20	---	---	1.20 ± .20	.04
2650	4950	0-6	.90 ± .20	.41 ± .21	---	1.80 ± .20	.13 ± .07
2670	4940	0-6	1.50 ± .20	---	---	1.80 ± .20	.15 ± .07
2700	4990	0-6	1.60 ± .20	---	---	1.70 ± .20	.10 ± .06
2740	5060	0-6	1.50 ± .20	---	---	1.60 ± .20	.08 ± .04
2805	4820	0-6	1.20 ± .20	---	---	1.20 ± .20	.08 ± .05
2840	5130	0-6	1.60 ± .20	---	---	1.50 ± .20	.07 ± .04
2900	5145	0-6	1.70 ± .20	---	---	1.60 ± .20	.06 ± .04
2950	5160	0-6	1.00 ± .20	---	---	1.30 ± .20	.04
3050	5150	0-6	2.10 ± .30	---	---	1.90 ± .30	.10 ± .06
3220	5150	0-6	1.90 ± .30	---	---	1.80 ± .30	.08 ± .05
Lagoon A:							
Grid E	Grid N						
4850	5800	0-6	.20 ± .10	---	---	.40 ± .10	.03 ± .02
4980	5665	0-6	1.60 ± .20	---	---	1.70 ± .20	.05 ± .05

TABLE 5-7

DUPONT CHAMBERS WORKS SITE:

RESULTS OF RADIOCHEMISTRY ANALYSIS OF WATER SAMPLES

Page 1 of 2

Sampling Location		Depth (inches)	Total Uranium (pCi/l ± 2 sigma)
Inside Building 845:		42	7507.51
Building 845 Area:			
Grid E	Grid N		
2534	4710	60	12.01
2600	4655	48	10.51
2624	4766	40	18.02
2650	4766	50	15.32
2650	4798	50	1.80
2650	4816	51	2.70
2667	4600	40	1.50
2678	4829	48	1.50
2681	4765	46	1.50
2717	4824	32	5.11
2747	4822	48	2.10
2761	4745	54	1,381.38
2768	4586	52	60.06
2768	4750	39	660.66
2779	4738	34	246.25
2780	4702	30	150.15
2790	4771	34	11,712.00
2799	4701	60	10.21
2799	4730	26	132.13
2799	4748	54	150.15
2816	4670	30	1,001.80
F Corral:			
Grid E	Grid N		
2444	5000	48	6.01
2450	4850	43	105.11
2450	4954	42	1,621.62
2492	4802	52	156.16
2500	4950	56	2,852.85
2500	4995	46	4.50
2507	4900	44	105,105.00
2540	4850	36	16,817.00
2565	4958	54	264.26
2580	4844	56	7.51
2603	4897	54	1.50

TABLE 5-7

(continued)

Sampling Location		Depth (inches)	Total Uranium (pCi/l ± 2 sigma)
Building J-26 Area:			
Grid E	Grid N		
1765	2910	30	14
East Burial Area:			
Grid E	Grid N		
5440	3080	36	24
5580	3070	36	6
Lagoon A:		Surface	4

TABLE 5-8

DUPONT CHAMBERS WORKS SITE: PRE-REMEDIAL ACTION

SUMMARY OF BUILDING 845 MEASUREMENT RESULTS

Measurement Locations	Measurement Type[a]	Units[a]	No. of Readings Taken	Grid Block Average Range	Maximum Reading Observed
First Level					
Ceiling	Beta-Gamma Dose Rate	mrad/h	41	0-4.78	4.78
	Direct Alpha Activity	dpm/100 cm^2	41	0-5568	5568
Floor	Beta-Gamma Dose Rate	mrad/h	1850	0-4.54	5.78
	Direct Alpha Activity	dpm/100 cm^2	1850	0-6819	26544
East Wall	Beta-Gamma Dose Rate	mrad/h	120	0-10.34	10.34
	Direct Alpha Activity	dpm/100 cm^2	120	2-4169	6229
West Wall	Beta-Gamma Dose Rate	mrad/h	175	0-8.69	16.30
	Direct Alpha Activity	dpm/100 cm^2	175	8-2461	6110
North Wall	Beta-Gamma Dose Rate	mrad/h	105	0.04-3.29	3.65
	Direct Alpha Activity	dpm/100 cm^2	105	17-483	890
South Wall	Beta-Gamma Dose Rate	mrad/h	65	0.08-1.51	1.57
	Direct Alpha Activity	dpm/100 cm^2	65	29-102	161
Floor/Wall Intersection	Beta-Gamma Dose Rate	mrad/h	244	0-6.05	8.88
	Direct Alpha Activity	dpm/100 cm^2	244	0-10621	18041
Second Level					
Ceiling	Beta-Gamma Dose Rate	mrad/h	38	0.02-4.87	4.87
	Direct Alpha Activity	dpm/100 cm^2	38	8-3992	3992
Floor	Beta-Gamma Dose Rate	mrad/h	580	0-2.85	3.45
	Direct Alpha Activity	dpm/100 cm^2	580	0-264	584
East Wall	Beta-Gamma Dose Rate	mrad/h	20	0.09-10.92	10.92
	Direct Alpha Activity	dpm/100 cm^2	20	51-9068	9068
West Wall	Beta-Gamma Dose Rate	mrad/h	30	0.05-5.53	5.53
	Direct Alpha Activity	dpm/100 cm^2	30	0-3712	3712
North Wall	Beta-Gamma Dose Rate	mrad/h	60	0.07-0.96	1.19
	Direct Alpha Activity	dpm/100 cm^2	60	14-763	763
South Wall	Beta-Gamma Dose Rate	mrad/h	15	0.07-0.54	0.54
	Direct Alpha Activity	dpm/100 cm^2	15	34-44	85
Floor/Wall Intersection	Beta-Gamma Dose Rate	mrad/h	118	0.01-2.16	2.77
	Direct Alpha Activity	dpm/100 cm^2	118	0-1221	1516

TABLE 5-8

(Continued)

Measurement Locations	Measurement Type[a]	Units[a]	No. of Readings Taken	Grid Block Average Range	Maximum Reading Observed
Ceiling	Beta-Gamma Dose Rate	mrad/h	240	0.02-1.49	7.05
	Direct Alpha Activity	dpm/100 cm^2	240	8-1347	1347
Floor	Beta-Gamma Dose Rate	mrad/h	120	0-1.40	2.38
	Direct Alpha Activity	dpm/100 cm^2	120	0-1017	1281
East Wall	Beta-Gamma Dose Rate	mrad/h	24	0.09-2.84	2.84
	Direct Alpha Activity	dpm/100 cm^2	24	53-3976	3076
West Wall	Beta-Gamma Dose Rate	mrad/h	180	0.25-2.37	2.37
	Direct Alpha Activity	dpm/100 cm^2	180	42-1754	1754
North Wall	Beta-Gamma Dose Rate	mrad/h	36	0.08-0.61	0.65
	Direct Alpha Activity	dpm/100 cm^2	36	37-653	653
South Wall	Beta-Gamma Dose Rate	mrad/h	10	0.08-0.08	0.10
	Direct Alpha Activity	dpm/100 cm^2	10	49-69	110
Floor/Wall Intersection	Beta-Gamma Dose Rate	mrad/h	142	0-0.68	0.98
	Direct Alpha Activity	dpm/100 cm^2	142	0-1930	2599
Fourth Level					
Ceiling	Beta-Gamma Dose Rate	mrad/h	39	0.05-4.34	4.34
	Direct Alpha Activity	dpm/100 cm^2	39	76-2703	2703
Floor	Beta-Gamma Dose Rate	mrad/h	1095	0-1.00	1.76
	Direct Alpha Activity	dpm/100 cm^2	1095	0-885	2561
East Wall	Beta-Gamma Dose Rate	mrad/h	33	0.03-1.26	1.26
	Direct Alpha Activity	dpm/100 cm^2	33	36-2331	2331
West Wall	Beta-Gamma Dose Rate	mrad/h	33	0.08-1.46	1.46
	Direct Alpha Activity	dpm/100 cm^2	33	0-3318	3318
North Wall	Beta-Gamma Dose Rate	mrad/h	20	0.07-0.27	0.27
	Direct Alpha Activity	dpm/100 cm^2	20	47-572	572
South Wall	Beta-Gamma Dose Rate	mrad/h	9	0.34-3.39	3.39
	Direct Alpha Activity	dpm/100 cm^2	9	40-3487	3487
Ceiling Heaters	Beta-Gamma Dose Rate	mrad/h	6	0.02-0.06	0.06
	Direct Alpha Activity	dpm/100 cm^2	6	93-195	195

[a]For beta-gamma dose rate, the average criteria limit is 0.2 mrad/h and maximum criteria limit is 1.0 mrad/h. For direct alpha activity on surfaces, the average criteria limit is 5000 dpm/100 cm^2 and maximum criteria limit is 15,000 dpm/100 cm^2 (Ref. 5).

6.0 SIGNIFICANCE OF FINDINGS

The 1983 survey results show that five of the six areas surveyed are contaminated above current guidelines. The interior of Building 845 also is contaminated. These results are explained in greater detail in the following subsections.

6.1 FIELD SURVEY

The volumes of material contaminated above applicable remedial action criteria were based on the areal extent of the contamination plus the depth of contamination based on estimates and/or measurements. For soils, the extent of contamination was based on near-surface gamma measurements, surface soil samples, gamma logging of boreholes, and subsurface soil sampling. The depth of contaminated layers was based on actual measurements.

The extent of surface contamination in Building 845 was based on surface alpha and beta-gamma measurements, with beta-gamma measurements used as the primary survey method. The depth of contamination was estimated to be 1 inch, averaged over the contaminated area.

6.1.1 Building 845 Area

Results from near-surface gamma radiation measurements were used to determine the extent of surface contamination. An area east of Building 845 was found to have readings greater than twice background, a finding in agreement with the ORNL survey (Ref. 1). The area that exhibited readings above criteria is shown in Figure 6-1.

Results from borehole gamma logs and subsurface soil samples were used to determine the depth of contamination. The major contaminant was found to be uranium-238, and subsurface contamination appears to be in layers to depths greater than 3 m (9 ft). However, the most

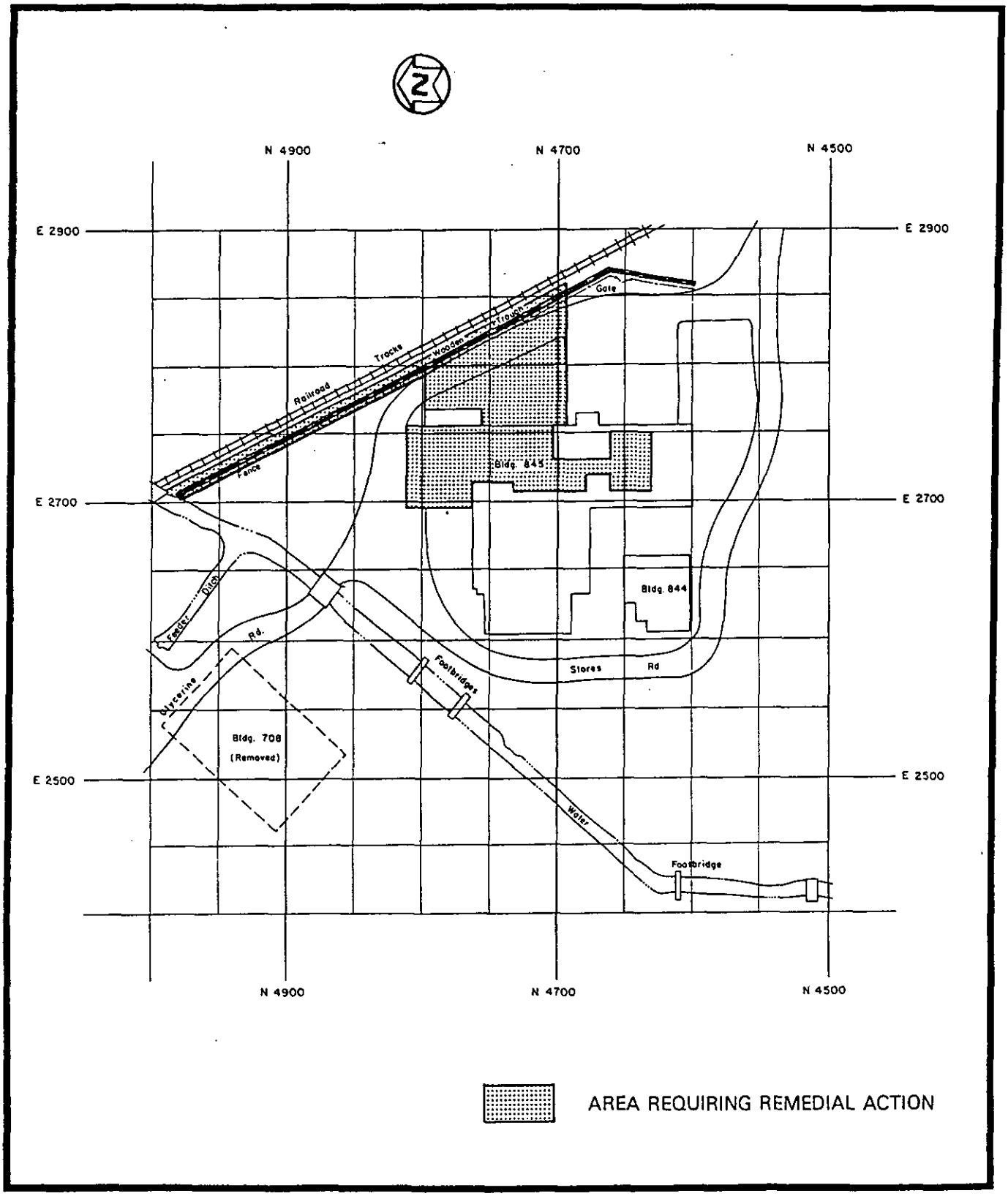

FIGURE 6-1 BUILDING 845 AREA AND WOODEN DRAINAGE TROUGH REQUIRING REMEDIAL ACTION

significant layer of contamination was located in the upper 1 m (3 ft) of soil. Gamma loggings in the soil below the depth of 1 m (3 ft) are approaching remedial action criteria.

Based on results from sediment samples, the wooden drainage trough located east of Building 845 would also require remedial action.

To comply with DOE guidelines, an estimated 765 m^3 (1000 yd^3) of material would require removal from the area around Building 845, including the wooden drainage trough, during remedial action.

6.1.2 Central Drainage Ditch

Results from near-surface gamma measurements made in the Central Drainage Ditch area indicated that an area located southwest of the drainage ditch had readings which were greater than twice background. Borehole gamma loggings in this area indicated areas of elevated readings which approach remedial action criteria limits. The elevated areas appear to be in layers which are at depths from 15 cm (6 in.) to greater than 2.5 m (8 ft).

Sediment samples taken from the Central Drainage Ditch and the Feeder ditch indicated below-criteria concentrations of uranium-238, -235, and -234.

During remedial action, the banks of the Central Drainage Ditch would require "hot spotting" to comply with guidelines. During hot spotting operations, approximately 11 m^3 (15 yd^3) of material would require removal from the area.

6.1.3 F Corral Parking Area

One near-surface gamma measurement exceeded twice background. All other measurements were within background levels. Borehole gamma loggings indicated contamination at depths greater than 3 m (9 ft), with the most significant layer of contamination located in the

upper 1 m (3 ft) of soil. Major readings below this depth approach remedial action guidelines. Soil samples show the contaminant is uranium-238, and the maximum uranium-238 concentration observed in subsurface soil samples was 4378 pCi/g.

Groundwater sample results from the F Corral parking area showed total uranium concentrations above the criteria limit. The maximum concentration observed for uranium-238 was 105,105 pCi/l. This sample was collected at a depth of 1 m (3 ft).

The area exhibiting measurements above guidelines is shown in Figure 6-2. During remedial action, an estimated 2700 m^3 (3500 yd^3) would require removal to meet DOE guidelines.

6.1.4 Building J-26 Area

All surface and subsurface measurements made in the Building J-26 area indicate the area is not contaminated. Water samples collected from the J-26 area were below criteria limits.

6.1.5 East Burial Area

Near-surface gamma readings indicate three locations which exceeded twice background levels. All beta-gamma dose rates were below criteria limits.

Borehole gamma logging indicated contaminated layers of soil to depths greater than 2.7 m (8.5 ft). The most significant layer of contamination was located in the upper 1 m (3 ft). Elevated readings below this depth approach remedial action criteria. Higher count rates were observed in the boreholes drilled adjacent to the road. Areas which exhibited measurements above criteria are shown on Figure 6-3.

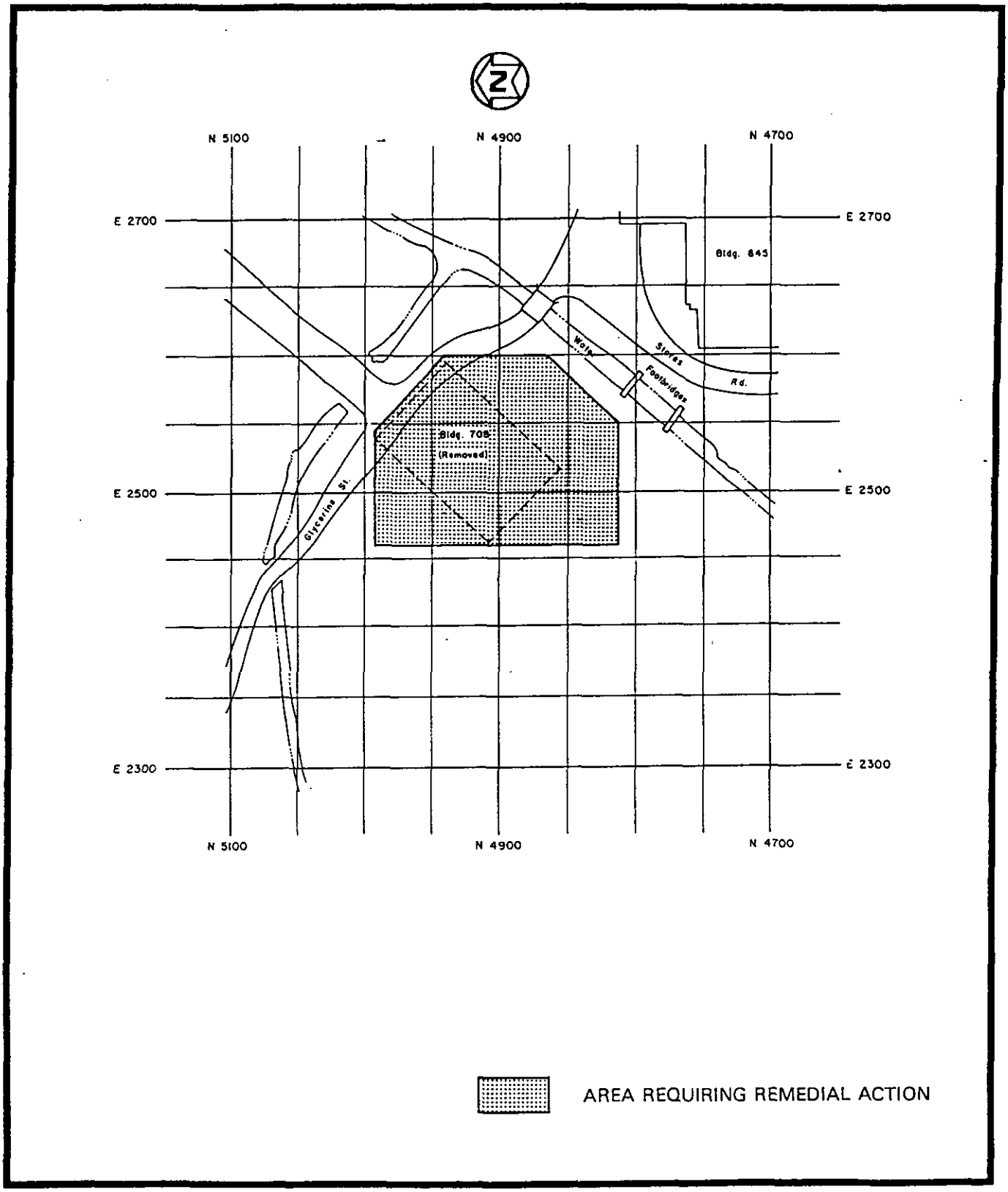

FIGURE 6-2 F CORRAL AREA REQUIRING REMEDIAL ACTION

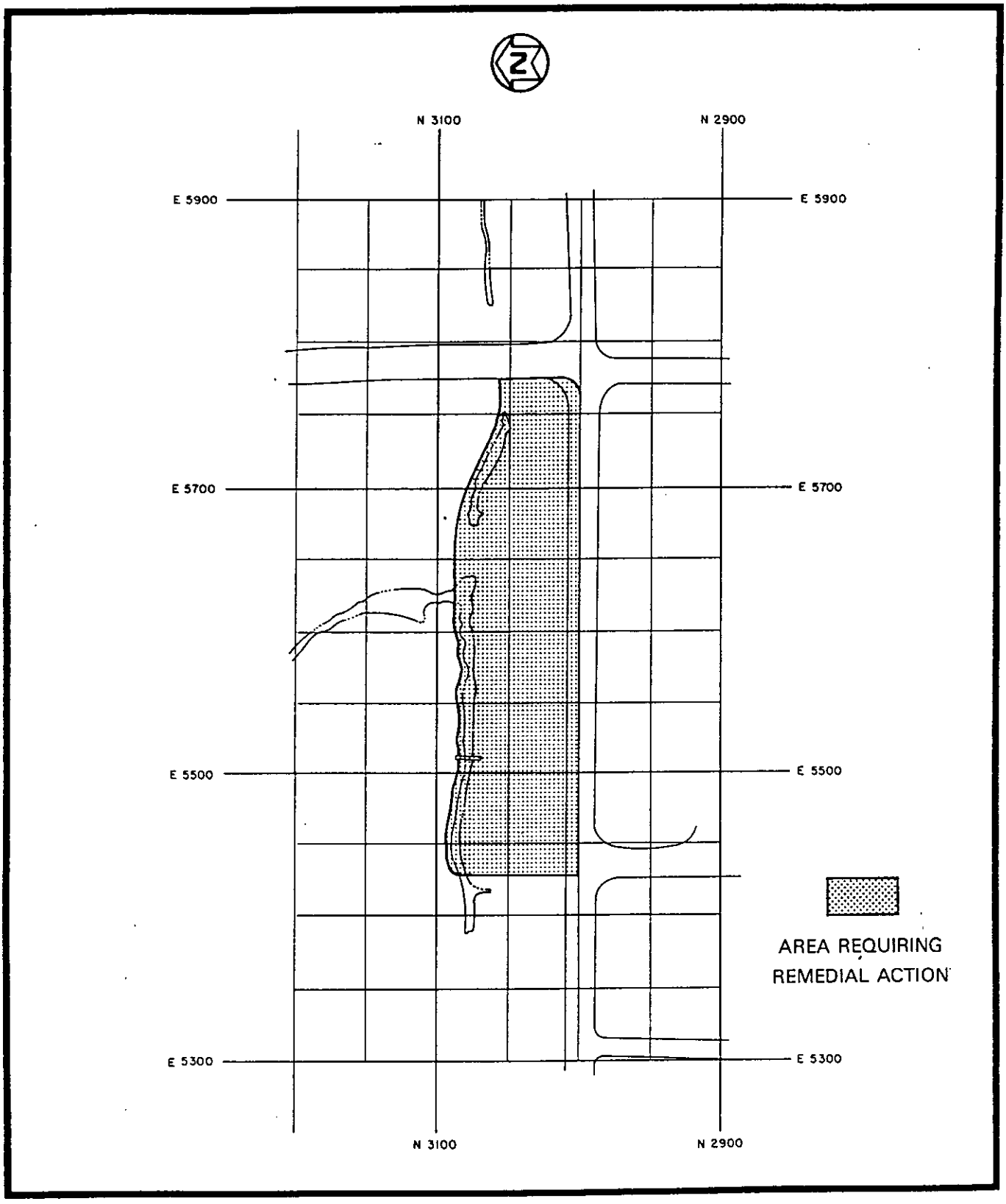

FIGURE 6-3 EAST BURIAL AREA REQUIRING REMEDIAL ACTION

Based on soil sample results, uranium-238 is the major contaminant, and the maximum concentration observed was 20,810 pCi/g. Elevated concentrations of radium-226 were observed in some soil samples (see Table 5-5).

During remedial action, an estimated 2800 m^3 (3700 yd^3) of material would require removal from the East Burial Area to comply with criteria.

6.1.6 Lagoon A

All surface measurements made in the Lagoon A area were within normal background. Borehole gamma count rates below 1.6 m (5.0 ft) indicated readings above background, but below the guideline.

6.2 BUILDING 845 SURVEY

As shown in Table 5-8, alpha and beta-gamma contamination levels on some interior surfaces of all four levels of Building 845 were in excess of the surface contamination guidelines for release of property for unrestricted use (Ref. 4). Figures 6-4 through 6-11 show floor, wall, and ceiling areas which indicated surface readings above guidelines. The area shown inside the lunch room (Grid Block Numbers 210, 211, 212, 214, 220, 230, 242, 254, and 258) indicated beta-gamma measurements above criteria. This contamination is fixed and poses no health hazard for activities presently carried on in the lunch room.

Building 845 first floor corehole loggings, coupled with Shelby tube soil samples indicated areas of contamination beneath the building up to depths of 1.2 m (4 ft). These areas of contamination are illustrated in Figure 6-12.

Based on these results, an estimated 560 m^3 (760 yd^3) of soil would require removal from beneath Building 845 to comply with criteria. In addition, remedial action would include the

decontamination of all areas inside Building 845 which exhibited surface measurements above remedial action criteria limits. Surface decontamination of the building would involve removal of 2.5 cm (1 in.) of material from approximately 2050 m^2 (22,000 ft^2) of contaminated surface areas. This would result in approximately 50 m^3 (70 yd^3) of material which would require removal. Total demolition of Building 845 would result in approximately 2300 m^3 (3000 yd^3) of material.

REFERENCES

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3. Glenn, R.D., et al. "Radiation Measurement Capability for Decontamination to Unrestricted Use," paper presented at the 1982 International Decommissioning Symposium, Seattle, WA, October, 1982.

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5. Letter, E. L. Keller to R. L. Rudolph. "Comments on the Radiological Survey Report for the Former Middlesex Sampling Plant, Middlesex, New Jersey and the Draft Radiological Survey Report for the DuPont Chambers Works Plant, Deepwater, New Jersey," September 11, 1984.

6. U.S. Department of Energy, Order 5480.1A. "Environmental Protection, Safety, and Health Protection Program for DOE Operations," Washington, DC.

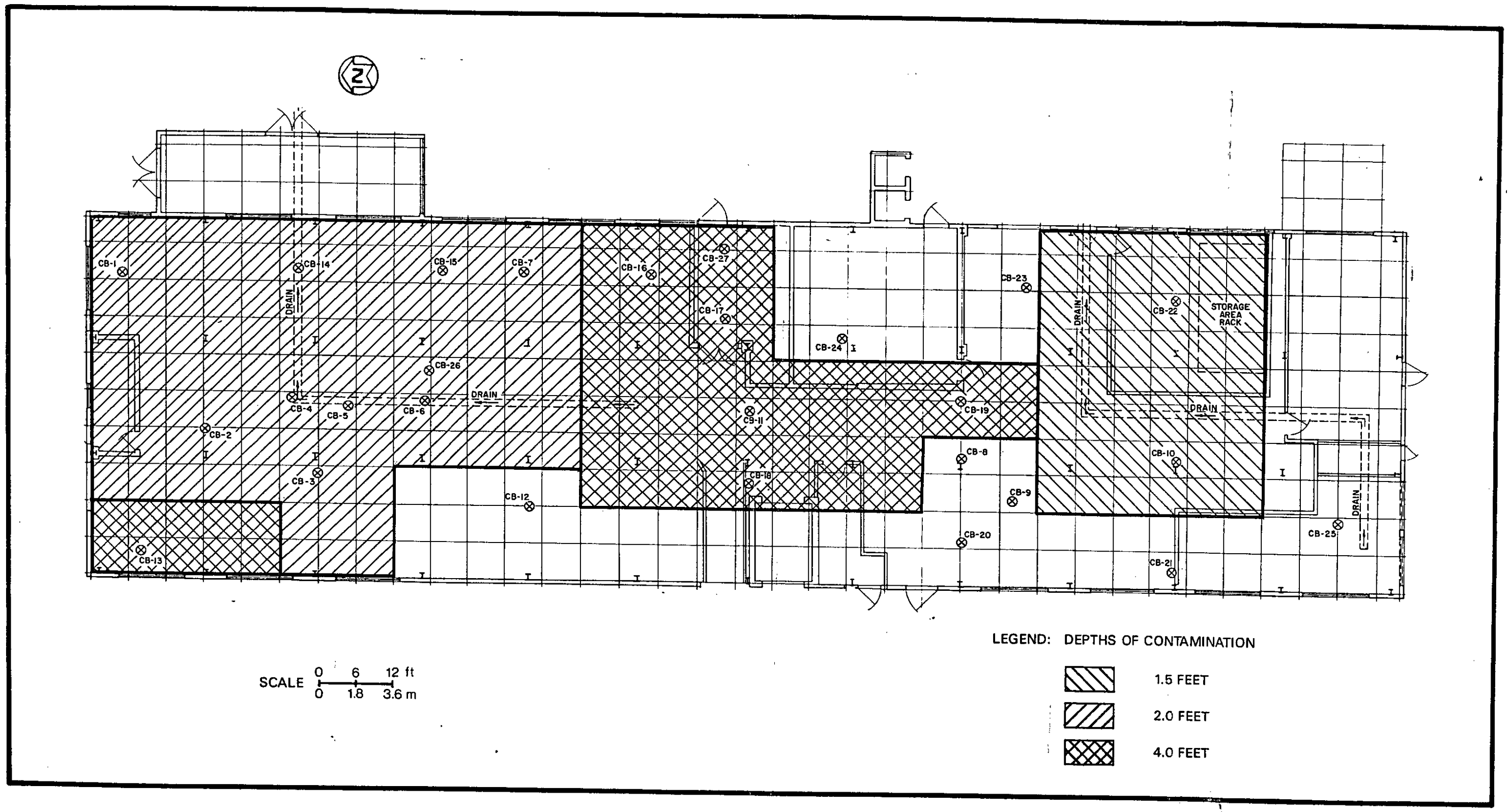

FIGURE 6-12 AREAS OF CONTAMINATION BENEATH BUILDING 845

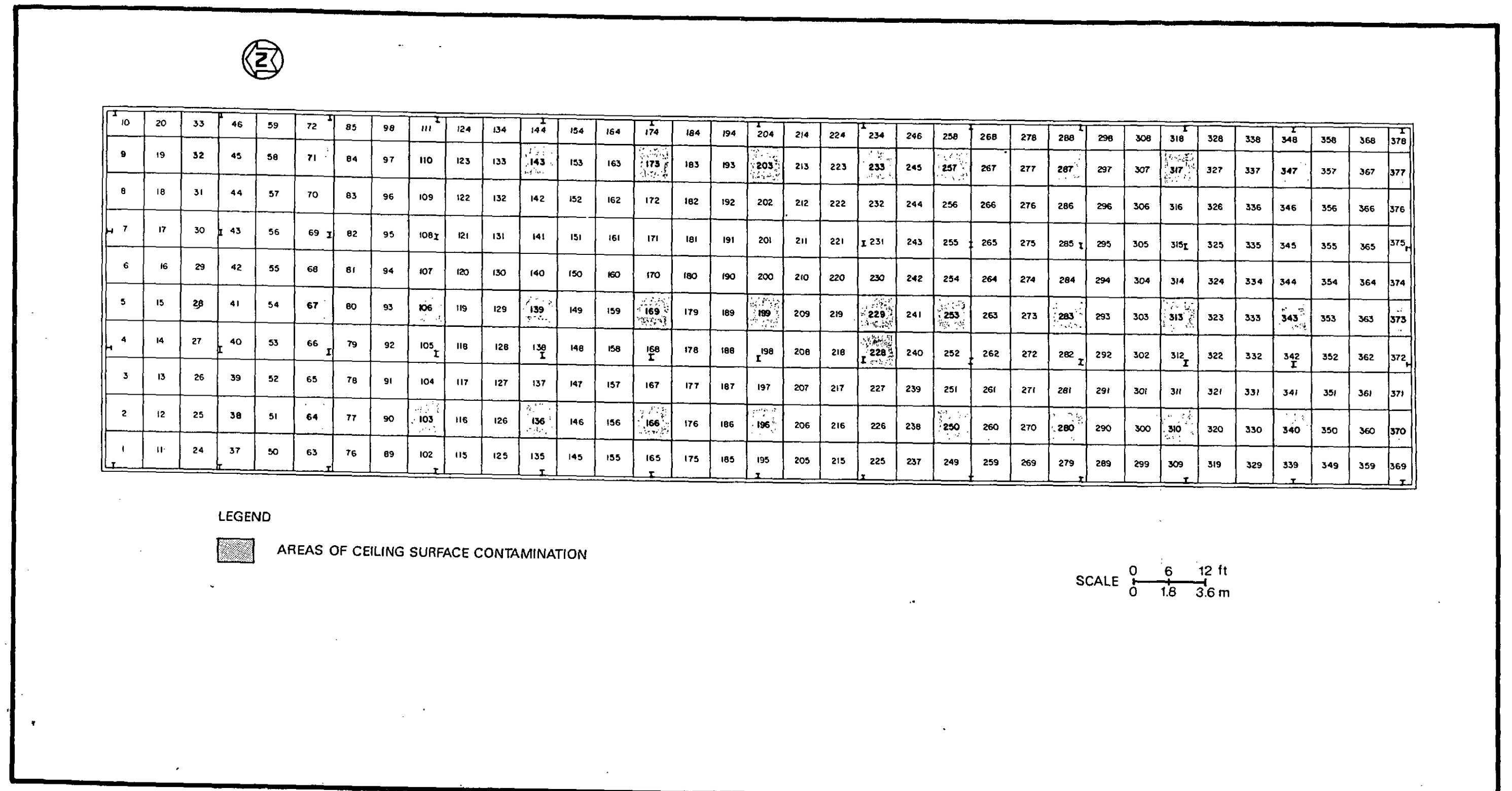

FIGURE 6-11 BUILDING 845, FOURTH FLOOR CEILING: AREAS OF SURFACE CONTAMINATION

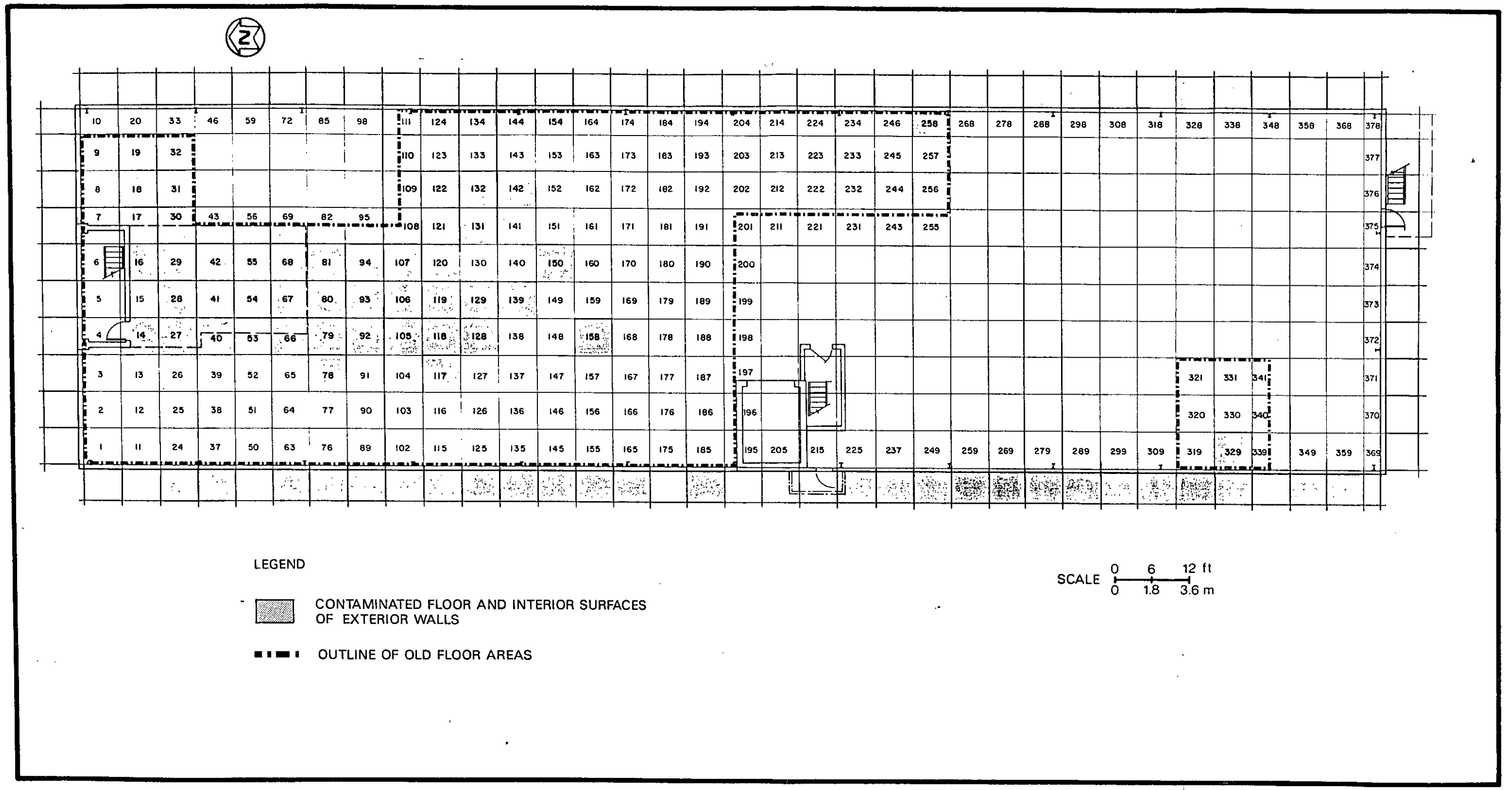

FIGURE 6-10 BUILDING 845, FOURTH FLOOR: AREAS OF SURFACE CONTAMINATION ON FLOOR, WALLS, AND FLOOR/WALL INTERSECTIONS

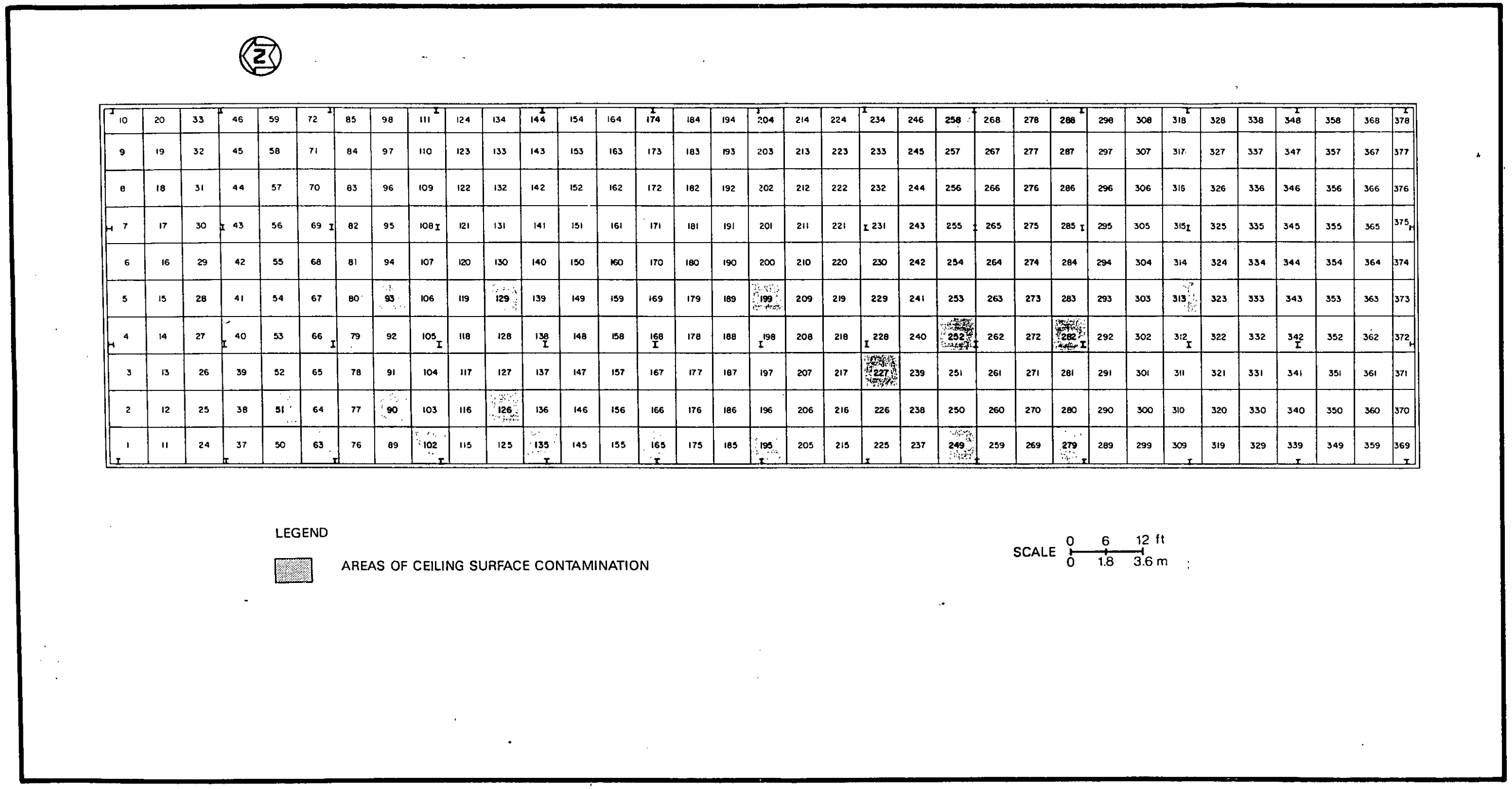

FIGURE 6-9 BUILDING 845, THIRD FLOOR CEILING: AREAS OF SURFACE CONTAMINATION

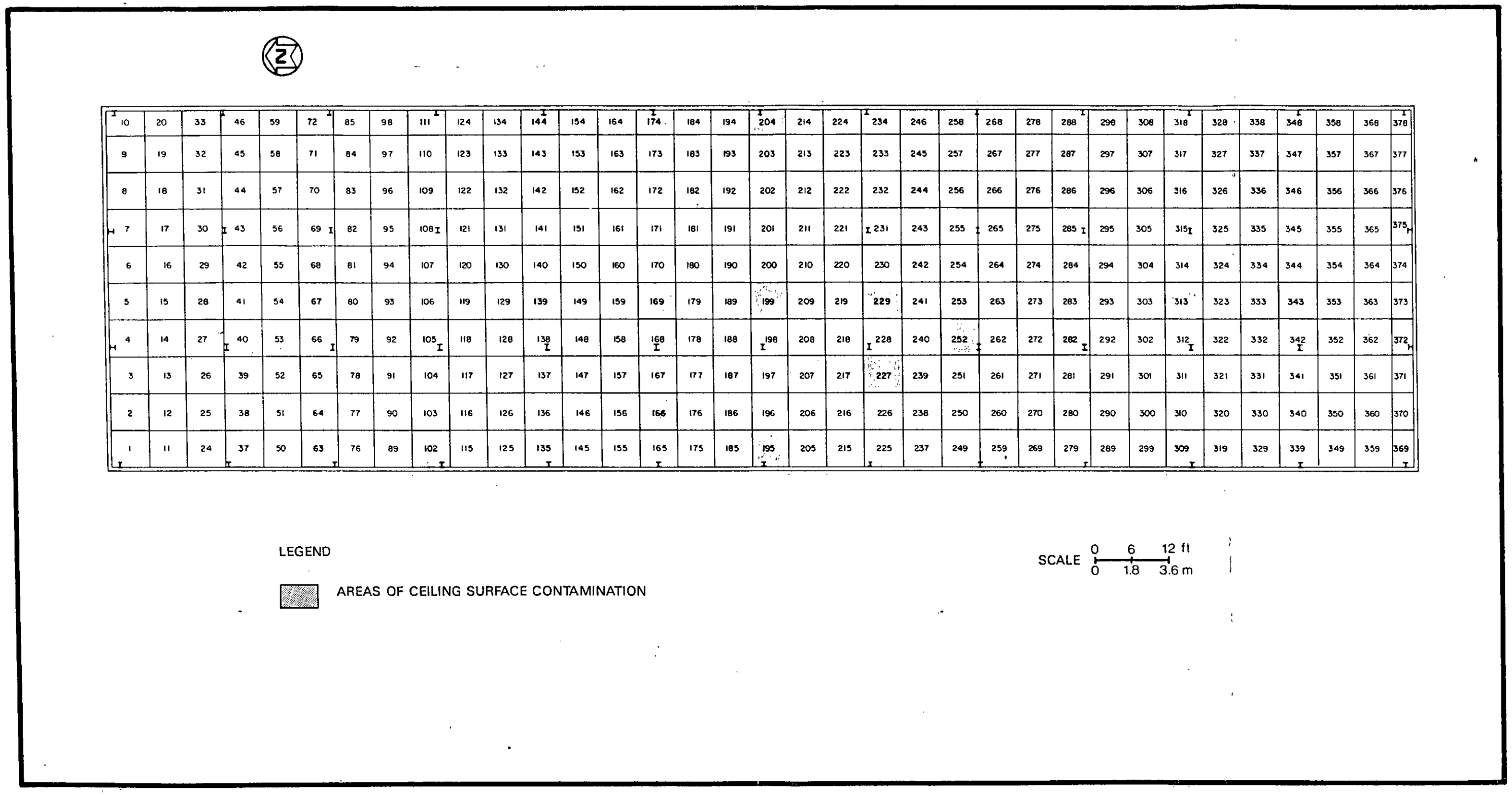

FIGURE 6-7 BUILDING 845, SECOND FLOOR CEILING: AREAS OF SURFACE CONTAMINATION

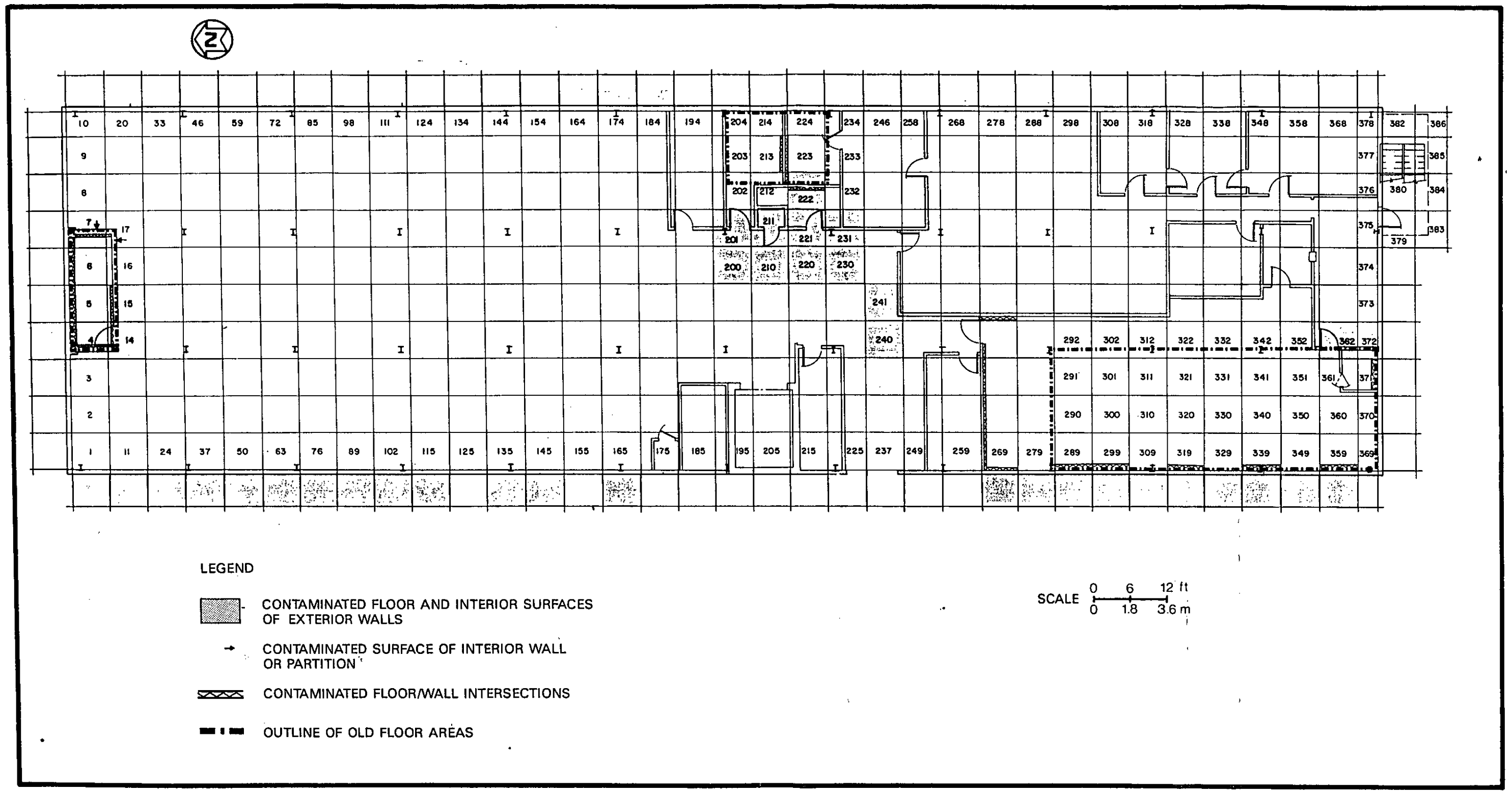

FIGURE 6-6 BUILDING 845, SECOND FLOOR: AREAS OF CONTAMINATION ON FLOOR, WALLS, AND FLOOR/WALL INTERSECTIONS

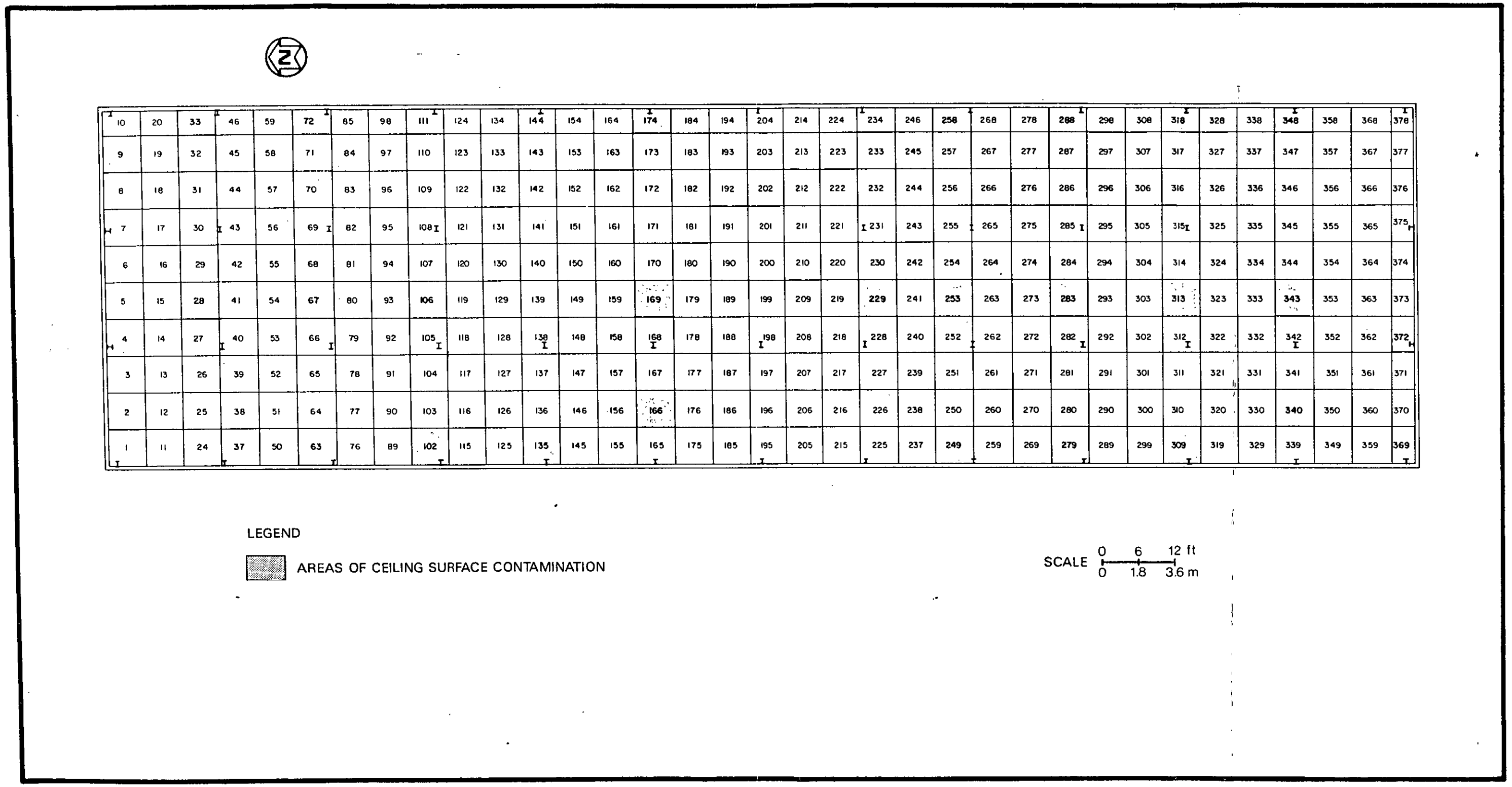

FIGURE 6-5 BUILDING 845, FIRST FLOOR CEILING: AREAS OF SURFACE CONTAMINATION