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Formerly Utilized Sites Remedial Action Program (FUSRAP)
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Post-Remedial Action Report for the Removal Action at the Seymour Specialty Wire Site

Seymour, Connecticut

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POST-REMEDIAL ACTION REPORT FOR THE REMOVAL ACTION AT THE SEYMOUR SPECIALTY WIRE SITE SEYMOUR, CONNECTICUT

JANUARY 1994

Prepared for

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By

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ACRONYMS

AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
BNI	Bechtel National, Inc.
CFR	Code of Federal Regulations
DAC	derived air concentration
DCG	derived concentration guide
DOE	Department of Energy
ECC	Electric Cable Company
FUSRAP	Formerly Utilized Sites Remedial Action Program
HEPA	high-efficiency particulate air
IVC	independent verification contractor
LLRW	low-level radioactive waste
LSA	low-specific-activity
ORNL	Oak Ridge National Laboratory
PCB	polychlorinated biphenyl

UNITS OF MEASURE

cm	centimeter
cpm	counts per minute
dpm	disintegrations per minute
ft	foot
g	gram
gal	gallon
h	hour
ha	hectare
in.	inch
lb	pound
m	meter
μCi	microcurie
MeV	million electron volts
ml	milliliter
μR	microroentgen
mrad	millirad
mrem	millirem
pCi	picocurie
yd	yard
yr	year

1.0 INTRODUCTION

1.1 BACKGROUND

This report documents the expedited removal action conducted at the Seymour Specialty Wire Company site located at 15 Franklin Street in Seymour, Connecticut (see Figure 1-1) from August 1992 to March 1993. An expedited removal action is an efficient, cost-effective approach that streamlines the remedial action process for cleanup of small sites. It complies with the National Environmental Policy Act and the Comprehensive Environmental Response, Compensation, and Liability Act. Approximately 30.5 m^3 (40 yd^3) of low-level radioactive waste (LLRW) was generated during the cleanup of the site and shipped to an approved, licensed commercial LLRW disposal facility.

Activities at the Seymour site were performed as part of the U.S. Department of Energy's (DOE) Formerly Utilized Sites Remedial Action Program (FUSRAP) following the protocols and procedures established by DOE for implementing expedited remedial actions. FUSRAP was established to identify and clean up or otherwise control sites where residual radioactive contamination (exceeding current federal guidelines) remains from the early years of the nation's atomic energy program or from commercial operations causing conditions that Congress has authorized DOE to remedy.

The objectives of FUSRAP that are applicable to the Seymour site are to:

- identify and evaluate all sites used to support former Manhattan Engineer District and Atomic Energy Commission (AEC) nuclear development activities,
- remove or otherwise control contamination on sites identified as contaminated above current DOE guidelines, and
- achieve and maintain compliance with applicable criteria for the protection of human health and the environment.

The primary legislation authorizing FUSRAP is the Atomic Energy Act of 1954. FUSRAP was established in 1974, and major remedial actions began at FUSRAP sites in

1981, with Bechtel National, Inc. (BNI) as the project management contractor for FUSRAP. Administered by DOE's Office of Environmental Restoration and Waste Management, FUSRAP currently includes 44 sites in 14 states. The Seymour site was designated for cleanup under FUSRAP in 1985.

1.2 HISTORY

The Bridgeport Brass Company, later known as the Seymour Specialty Wire Company, performed operations under contract to AEC from 1962 to 1964. The contractual agreement was for the development of a process for the cold-forming, or extrusion, of natural uranium metal. During this time other activities associated with the extrusion process, such as analytical support of the development work and storage of radioactive material, also took place at the site. The portion of the Seymour facility where the AEC work was conducted, the Rufert Building (see Figures 1-2 and 1-3), is currently leased and operated by Electric Cable Company (ECC) as an industrial manufacturing plant.

In 1964, AEC conducted a radiological survey of the 1.9-ha (4.8-acre) parcel of the Seymour site that includes the Rufert Building. The survey was conducted after the Bridgeport Brass Company terminated all of the AEC-related work at the Seymour site to consolidate the AEC contract work at the Bridgeport facility in Ashtabula, Ohio. Although there were no AEC standards for surface contamination with which to compare the survey data at that time, the survey report states that the radionuclide concentrations observed were "... quite low and certainly are insignificant with respect to any mode of exposure that can be hypothesized" (AEC 1964).

After FUSRAP was established, review of former AEC records indicated that the Seymour site should be resurveyed because of the lack of satisfactory, protective release criteria at the time of the first survey. At the request of DOE, the Oak Ridge National Laboratory (ORNL) Health and Safety Research Division conducted a preliminary radiological survey of the facility on January 26, 1977 (ORNL 1980). This survey consisted of gamma exposure rate measurements at 1 m (3.3 ft) from the floor surface, beta-gamma exposure rate measurements at 1 cm (0.4 in.) above the floor surface, and direct alpha

radiation measurements taken on contact with the floor. Because of gamma radiation measurements observed during this preliminary survey, ORNL conducted a follow-up survey at the site on August 26, 1980 (ORNL 1985). The purpose of the designation survey was to determine whether the site exceeded current DOE guidelines for residual contamination on structural surfaces. Therefore, this survey was limited to those areas of the building where former AEC contract work had been carried out. In addition to the same types of measurements that were taken during the 1977 survey, smear samples were taken to determine the extent of transferable contamination. Smear samples taken from the bowls and traps of several floor drains yielded transferable contamination concentrations of 70 to 150 dpm/100 cm^2. Because of these readings and visual inspection of the drains, samples of the residue from three drains were also collected for analysis. These samples contained uranium concentrations ranging from 2,860 to 15,600 pCi/g (the 1980 report does not indicate whether this was total uranium or uranium-238). Both the 1977 and 1980 surveys indicated that radioactive contamination was present in the Rufert Building, primarily in the Dynapack (extrusion) area, in excess of current DOE guidelines for residual contamination on structural surfaces (see Section 2.0). As a result of these surveys, the site was designated for remediation under FUSRAP in December 1985.

ORNL conducted more extensive characterization surveys in May and June 1992 to more precisely define the locations and delineate the boundaries of the radioactive contamination identified during the initial designation surveys (ORNL 1993). The characterization surveys confirmed that the primary contaminants in the areas of the Rufert Building used to perform AEC work were uranium-238 and its decay products. The contamination was also determined to extend throughout a much greater portion of the first floor of the building than originally thought (see Figure 1-3). In addition, near-surface walkover gamma radiation surveys were conducted on exterior areas. Two isolated areas were determined to be contaminated with radioactive material (see Figure 3-1).

Based on data collected and evaluated during the characterization activities, an expedited removal action was conducted at the Seymour site in 1992 and 1993.

FIGURES FOR SECTION 1.0

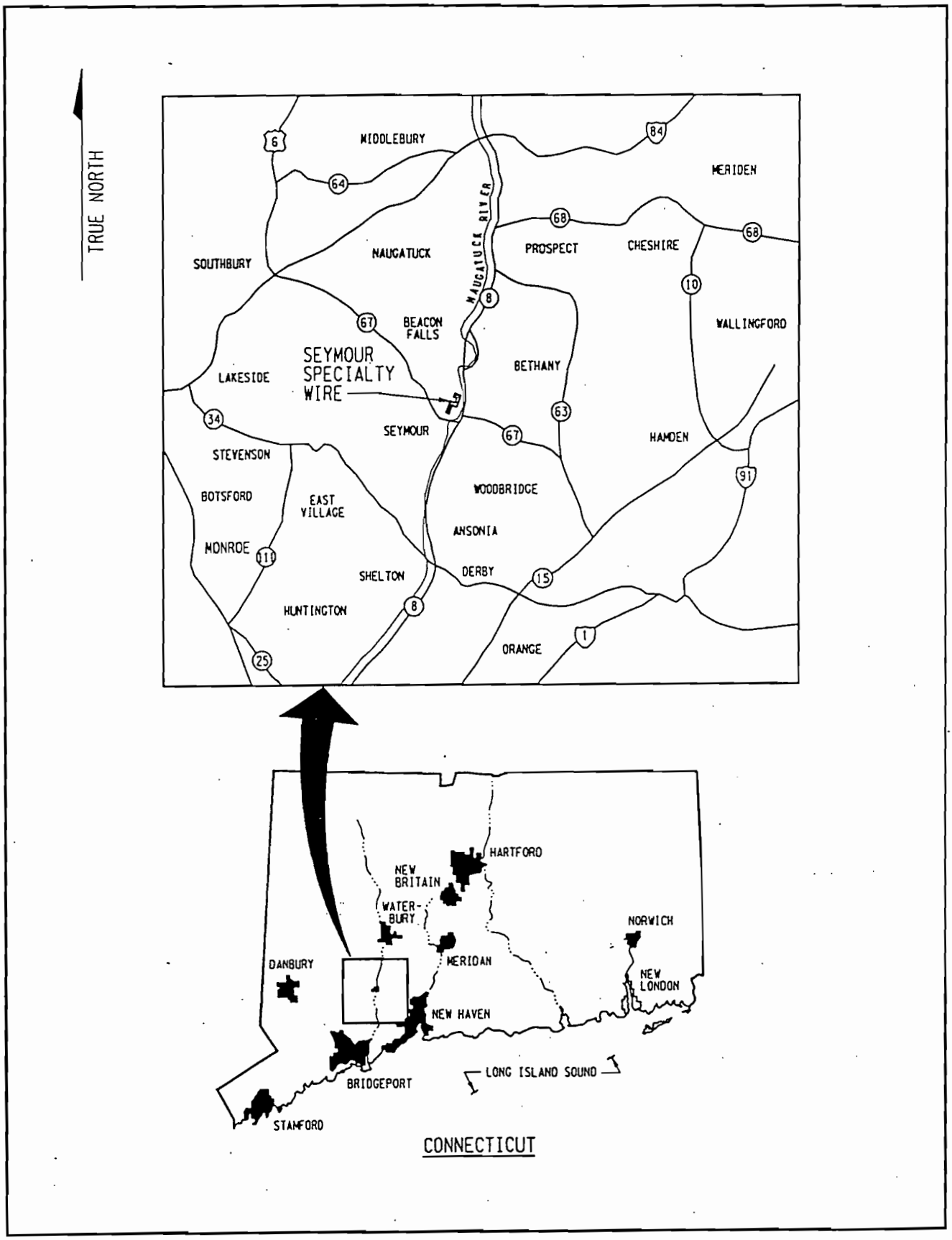

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Figure 1-1
Location of the Seymour Site and Its Vicinity

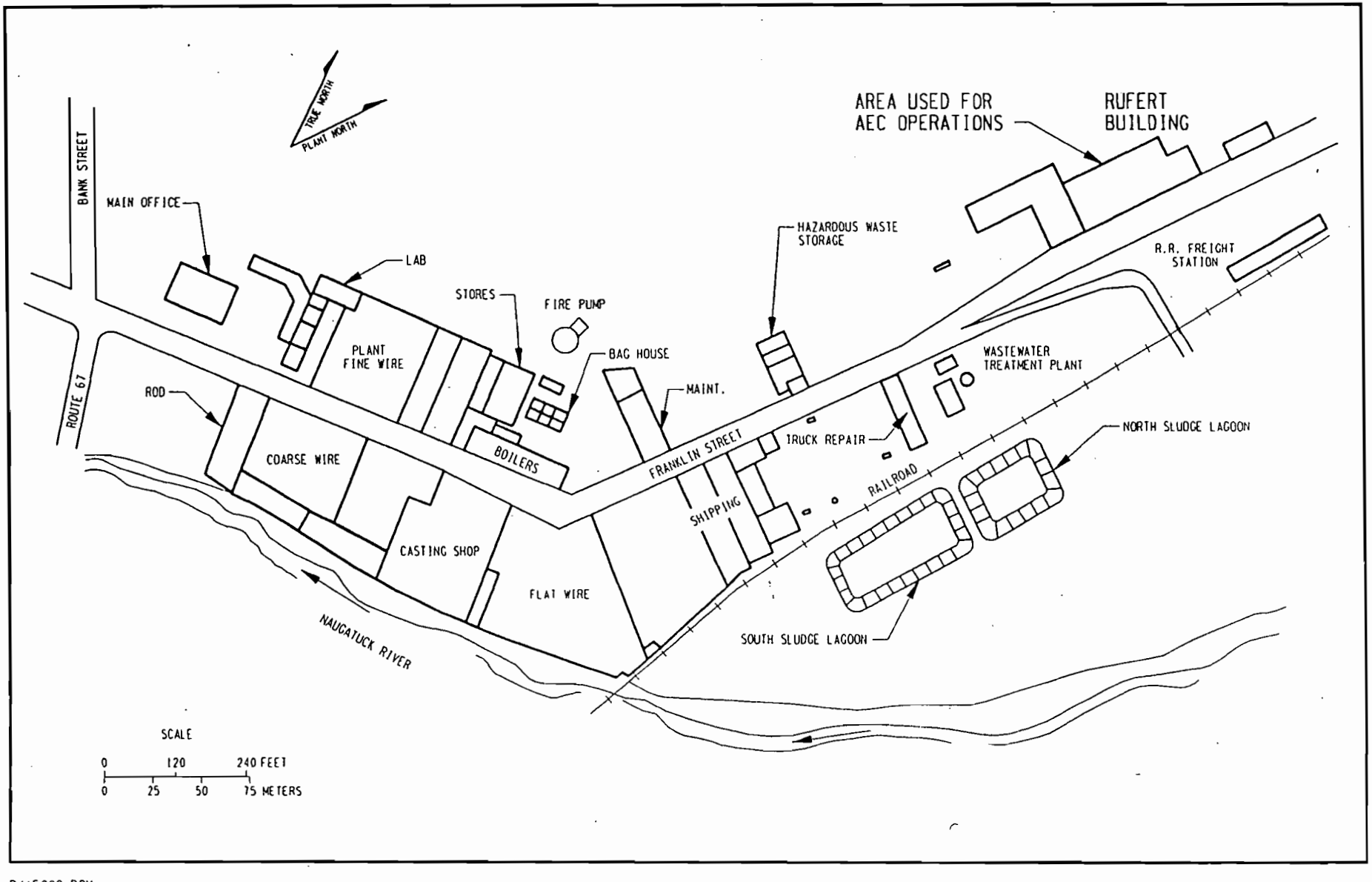

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Figure 1-2
Site Plan of the Seymour Specialty Wire Complex

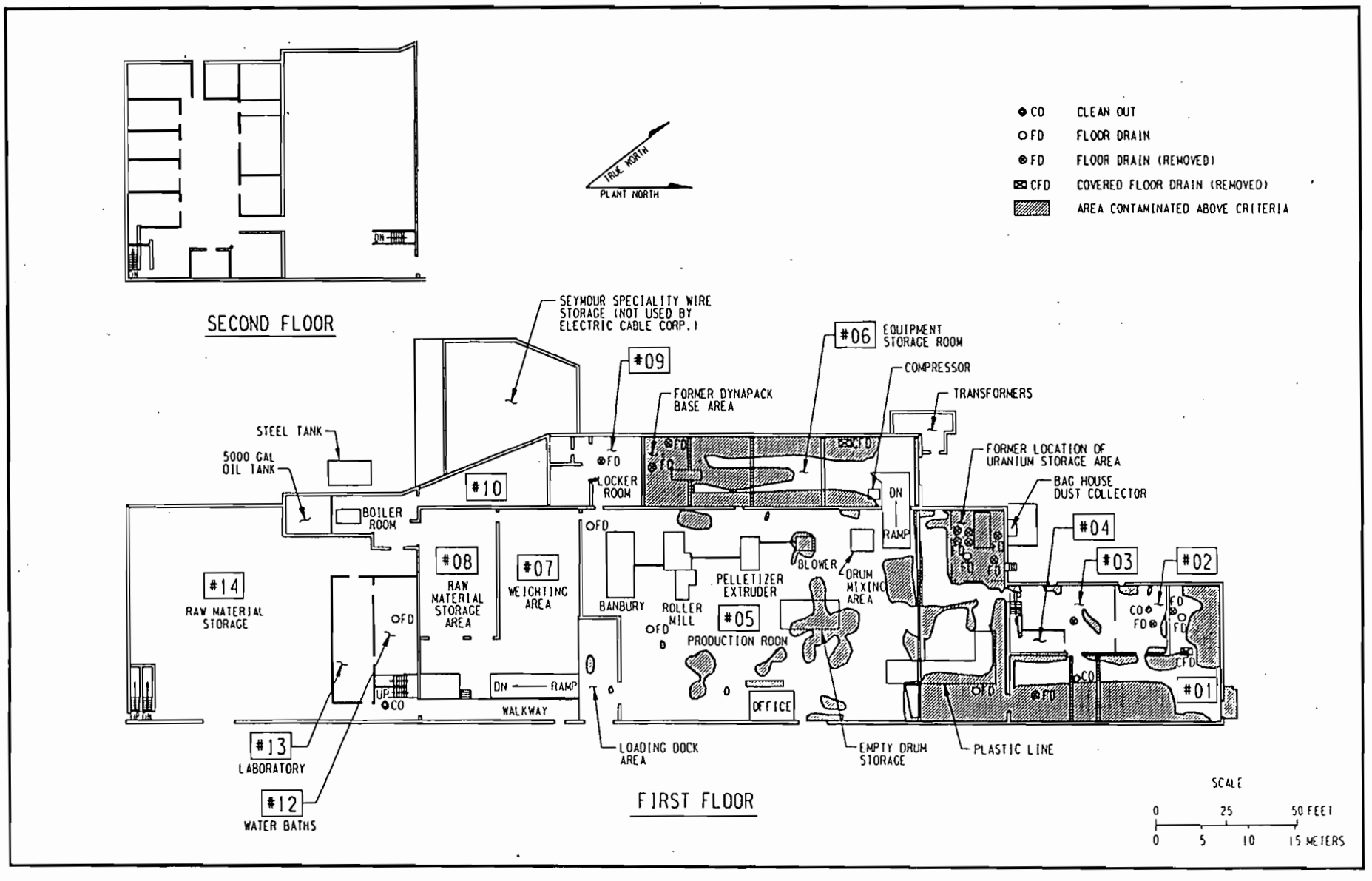

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Figure 1-3
Rufert Building

2.0 REMEDIAL ACTION GUIDELINES

Consistent with previous surveys, the 1992 characterization results indicated that several areas of the Rufert Building exceeded the DOE guidelines for total residual radioactivity on structural surfaces, and uranium-238 was identified as the primary contaminant. The DOE residual contamination guidelines are summarized in Table 2-1. In accordance with DOE Order 5400.5 (DOE 1990), the relevant remedial action guidelines for alpha activity resulting from residual uranium on structural surfaces at the Seymour site are 5,000 dpm/100 cm^2 average and 15,000 dpm/100 cm^2 maximum for fixed (nontransferable) alpha activity, and 1,000 dpm/100 cm^2 for transferable alpha activity. DOE policy further requires that all radiation exposures be maintained as low as reasonably achievable (ALARA); the ALARA goal for remediation of the building was set at 3,000 dpm/cm^2 average, below the 5,000 dpm/cm^2 limit. Therefore, all structural surfaces at the Seymour site that were contaminated above the ALARA goal were remediated and verified to be below the ALARA goal where practical; remaining areas were remediated and verified to be below the limits specified in DOE Order 5400.5. The interior surfaces of several pipes and manholes associated with floor drains embedded in the foundation of the building could not be remediated to below these concentration guidelines. As a result, fixed contamination above the DOE guidelines was left in place. A hazard assessment of these pipes and manholes was performed, and the results and conclusions are discussed in Section 5.1.

The DOE guidelines for residual concentrations of radium-226, thorium-232, and thorium-230 in soil at FUSRAP sites are 5 pCi/g above background when averaged over the first 15 cm (6 in.) of soil below the surface, and 15 pCi/g above background when averaged over any 15-cm- (6-in.-) thick soil layer below the surface layer (Table 2-1). These guidelines do not include naturally occurring background radioactivity in soils near the site. No generic guidelines are available for the remediation of uranium-238, however, and site-specific guidelines are typically developed based on the reasonable exposure pathways that can be hypothesized for the site. These guidelines for most FUSRAP sites are typically between 50 and 200 pCi/g. The ORNL radiological survey team determined that two isolated areas outside the building (see Figure 3-1) were contaminated with radioactive material.

The average background concentration of uranium-238 in soil representative of the Seymour area was determined by obtaining several soil samples from areas chosen based on their proximity to the site, relative independence from potential influence of the site, and representativeness of area land uses. External gamma radiation exposure rates were also measured at each background soil sampling location. Analytical results for uranium-238 and external gamma radiation exposure rates in background locations are included in Table 2-2. The average concentration of uranium-238 in background samples was 2.0 pCi/g, and the average gamma exposure rate was 9.3 μR/h.

TABLES FOR SECTION 2.0

Table 2-1
Summary of DOE Guidelines for Residual Radioactive Contamination

BASIC DOSE LIMITS

The basic limit for the annual radiation dose (excluding radon) received by an individual member of the general public is 100 mrem/yr. In implementing this limit, DOE applies ALARA principles to set site-specific guidelines.

SOIL GUIDELINES

Radionuclide	Soil Concentration (pCi/g) Above Background[a,b,c]
Radium-226 Radium-228 Thorium-230 Thorium-232	5 pCi/g when averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over any 15-cm-thick soil layer below the surface layer.
Other Radionuclides	Soil guidelines will be calculated on a site-specific basis using the DOE manual developed for this use.

STRUCTURE GUIDELINES

Airborne Radon Decay Products

Generic guidelines for concentrations of airborne radon decay products shall apply to existing occupied or habitable structures on private property that has no radiological restrictions on its use; structures that will be demolished or buried are excluded. The applicable generic guideline (40 CFR 192) is: In any occupied or habitable building, the objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL[d]. In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Remedial actions are not required in order to comply with this guideline when there is reasonable assurance that residual radioactive materials are not the cause.

External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site that has no radiological restrictions on its use shall not exceed the background level by more than 20 μR/h and will comply with the basic dose limits when an appropriate-use scenario is considered.

Indoor/Outdoor Structure Surface Contamination

Radionuclide[f]	Allowable Surface Residual Contamination[e] (dpm/100 cm²)		
	Average[g,h]	Maximum[h,i]	Removable[h,j]
Transuranics, Ra-226, Ra-228, Th-230, Th-228 Pa-231, Ac-227, I-125, I-129[k]	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224 U-232, I-126, I-131, I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5,000 α	15,000 α	1,000 α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above[l]	5,000 β - γ	15,000 β - γ	1,000 β - γ

Table 2-1
(Continued)

[a]These guidelines take into account ingrowth of radium-226 from thorium-230 and of radium-228 from thorium-232, and assume secular equilibrium. If either thorium-230 and radium-226 or thorium-232 and radium-228 are both present, not in secular equilibrium, the guidelines apply to the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that (1) the dose for the mixtures will not exceed the basic dose limit, or (2) the sum of ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity").

[b]These guidelines represent allowable residual concentrations above background averaged across any 15-cm-thick layer to any depth and over any contiguous 100-m^2 surface area.

[c]If the average concentration in any surface or below-surface area less than or equal to 25 m^2 exceeds the authorized limit or guideline by a factor of $(100/A)^{1/2}$, where A is the area of the elevated region in square meters, limits for "hot spots" shall also be applicable. Procedures for calculating these hot spot limits, which depend on the extent of the elevated local concentrations, are given in the DOE Manual for Implementing Residual Radioactive Materials Guidelines, DOE/CH/8901. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil.

[d]A working level (WL) is any combination of short-lived radon decay products in 1 liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha energy.

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

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

[g]Measurements of average contamination should not be averaged over an area of more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

[h]The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.

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

[j]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping tehniques to measure removable contamination levels if direct scan surveys indicate that total residual surface cotamination levels are within the limits for removable contamination.

[k]Guidelines for these radionuclides are not given in DOE Order 5400.5; however, these guidelines are considered applicable until guidance is provided.

[l] This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.

Table 2-2

Uranium-238 Concentrations and External Gamma Radiation

Exposure Rates in Background Locations

	Location	Distance from Site	Gamma Radiation Exposure Rate (μR/h)	Uranium-238 (pCi/g)	
1.	Connecticut Light and Power, Oxford, Connecticut	1.5 mi	10.3	Soil Brick Concrete	1.5 1.10 0.68
2.	Union Cemetery, Seymour, Connecticut	1.2 mi	8.1	Soil	1.8
3.	Brooks Apartment Complex, Seymour, Connecticut	1.5 mi	9.4	Soil	2.6
			Average = 9.3	Soil Average = 2.0	

3.0 REMEDIAL ACTION

3.1 CLEANUP/DECONTAMINATION ACTIVITIES

Immediately before the expedited removal action, the ORNL radiological survey team surveyed in and around the Rufert Building to determine the extent and boundaries of radioactive contamination that would require remediation (ORNL 1993). These surveys included portions of the facility that had been inaccessible during previous surveys, either because ECC was using the areas for the storage of raw materials (on pallets), or because heavy equipment could not be moved for measurements to be taken on the floor areas beneath it. Several of these areas were found to be contaminated above the DOE guidelines for residual contamination and were subsequently designated for inclusion in the removal action. This detailed, prestart survey significantly increased the total square footage of the Rufert Building that would require remediation.

Techniques used in performing the remedial action are summarized in Table 3-1. The techniques were primarily standard remediation methods with the exception of the carbon dioxide (CO_2) blasting that was demonstrated by a vendor on a small portion of the contaminated floor in Room 1 and on a small piece of rusty, painted steel. The CO_2 blasting method was not effective in reducing surface contamination on painted concrete, but it was effective on painted and/or rusty metal surfaces. The exhaust pressure generated by the CO_2 blasting proved to be too great for the plastic-lined (10-mil-thick) tents that were constructed to contain the airborne contamination that could have been generated during use of the system. For this reason, use of the CO_2 blast method was discontinued.

Volume reduction and waste minimization techniques employed during the expedited remedial action included segregation, sampling, and surveying of the wastes produced. Specific examples of waste volume reduction at the Seymour site included the following:

- Lead pipe joints were removed from non-lead-containing portions of radioactively contaminated pipe to minimize the quantity of potential mixed waste that would require disposal.

- Dust removed with high-efficiency particulate air (HEPA) vacuums, BlasTrak™, and VacuBlast™ was sampled to determine the specific activity of the waste and the necessary means of disposal.

- Rinse water used during decontamination and cooling water used during concrete cutting operations was evaporated in open drums by using drum heaters.

- Residual sludge, produced as a result of wastewater evaporation, was sampled, determined to be below ALARA goals, and released.

- Radioactively contaminated expansion joint material was removed from uncontaminated concrete debris.

- Materials used in controlled areas, including consumables such as coveralls, were surveyed for release.

The total volume of waste reduced during remediation was estimated to be approximately 15 m^3 (20 yd^3), or 53 percent of the total waste volume.

As decontamination of various portions of the interior of the building was completed, exposure rates and concentrations of direct alpha and beta/gamma and transferable beta/gamma contamination were measured to ensure that decontamination efforts were successful in achieving the DOE cleanup criteria. DOE protocol (DOE 1990) provides for the release of property without radiological restrictions in cases where residual radioactive material may exceed criteria but not pose a potential exposure risk (present or future) and where the cost of remedial action is unreasonably high relative to the long-term benefits. Three manholes and the interconnecting piping that were contaminated above criteria remain in place at the site.

During remediation of the exterior portions of the site (see Figure 3-1), approximately 3 m^3 (4 yd^3) of radioactively contaminated soil was removed from two areas with a total area of approximately 10 m^2 (108 ft^2). The excavated soil was packaged in low-specific-activity

(LSA) boxes. After the soil was excavated, direct gamma measurements were taken, and soil samples were collected from the bottom of the excavations. The samples were shipped to the Thermo Analytical/Eberline laboratory in Oak Ridge, Tennessee, for analysis to ensure that all contaminated soils had been removed. The analysis indicated that the residual uranium-238 concentration was 7 pCi/g.

Approximately 25 m^3 (32 yd^3) of contaminated building material waste was generated during the building remediation. Of the material generated, 9 m^3 (12 yd^3) was classified as LLRW, and 16 m^3 (21 yd^3) was classified as asbestos-containing material/LLRW.

All contaminated material generated during the expedited removal action was packaged in accordance with applicable Department of Transportation regulations in ten 55-gal drums and ten LSA transportable boxes. A label identifying the contents was placed on each LSA box and drum. Table 3-2 provides the individual drum and LSA box inventory. All waste containers were maintained in temporary storage at the site until the waste was disposed of at an approved, licensed commercial disposal facility; disposal was completed in October 1993.

The following sections describe the remedial action activities in the interior and exterior areas at the Seymour site.

3.1.1 Interior Areas

Six rooms (Figure 1-3) in the building were decontaminated and then restored to their original conditions. An industrial-grade air compressor was relocated to a new permanent location at the tenant's request during remediation and restoration of the Dynapack room.

Room 1

The designation surveys indicated radioactive contamination above DOE guidelines in Room 1 on most of the floor, two expansion joints in the center of the room, the expansion joint at the wall/floor interface around the entire room, several areas on the walls, overhead

beams and trusses, overhead pipes, overhead ducts and fans, overhead light fixtures, and three floor drains. Room 1 was unoccupied before and during the removal action.

A contaminated overhead area of approximately 195 m^2 (2,100 ft^2) consisted of 41 trusses, 7 light fixtures, 2 fans, and several pipes and ducts; it was decontaminated using a HEPA-filtered vacuum to remove unattached dust. Light abrasive techniques (using wire brushes) were used to remove rust and other material that was resistant to vacuuming. Several contaminated light fixtures were removed, taken to a negative-pressure decontamination booth for decontamination, and reinstalled after they were surveyed and released as clean.

Approximately 56 m^2 (600 ft^2) of radioactively contaminated, asbestos-containing floor tile was removed using long-handled, hand-held scrapers inside dust containment tents. Approximately 140 m^2 (1,500 ft^2) of the concrete floor was also decontaminated using a metallic abrasive material on the work surface and removing incremental layers of contaminated material (BlasTrak™ system).

Radioactive contamination was identified in two expansion joints [approximately 14 m (45 ft)] in the concrete floor (see Figure 3-2). The expansion joints were exposed first by cutting the slab with a gasoline-powered circular saw that contained a water-cooled concrete blade and then using pry bars to break and remove sections of the surrounding concrete floor. Radioactive contamination was limited to the upper portions of the expansion joint and had not migrated to the soil beneath the expansion joints or adhered directly to the concrete. The upper portion of the expansion joint at the floor/wall interface was contaminated around the entire perimeter of the room [73 m (240 ft)]. The interface was decontaminated using pneumatic and hand-held chisels to break the floor away from the wall and remove the expansion joint material. The volume of expansion joint material that would ultimately require disposal as radioactive waste was minimized by separating the contaminated expansion joint material from the uncontaminated concrete, surveying the concrete, and releasing it for disposal at a municipal landfill.

Three floor drains that were contaminated above criteria were removed and replaced with new drains and traps. The pipes were then surveyed and decontaminated in place with a variable-speed motor outfitted with a cylinder hone, which is an abrasive scale remover on a flexible shaft. Portions of these drains suspected of containing lead were decontaminated using an abrasive material so that as much radioactivity as possible could be removed from the lead-containing material to minimize the volume of potential mixed waste that would require disposal.

Room 2

The designation surveys indicated radioactive contamination above DOE guidelines in Room 2 on several small areas of the floor [approximately 21 m^2 (230 ft^2)], several areas on the northern and eastern walls [approximately 3.7 m^2 (40 ft^2)], overhead pipes, and 21 overhead light fixtures.

Radioactive contamination in the overhead areas was removed using a HEPA-filtered vacuum to remove unattached dust; light abrasive techniques (using wire brushes) were used to remove rust and other material that was resistant to vacuuming. The contamination on the floor was removed with the BlasTrak™ system. Three venetian blinds and window sills on the western wall were decontaminated using the VacuBlast™ system. Several clay bricks also had to be removed from the wall.

Rooms 3 and 4

Room 3 and Room 4 (a small area at the base of the stairs leading to the attic storage area) were radioactively contaminated above DOE guidelines in several small areas on the floor [approximately 16 m^2 (170 ft^2)]. Radioactive contamination slightly above criteria was present on several overhead beams, pipes, and lights and on duct work. The floor areas were decontaminated using the BlasTrak™ system, and overhead contamination was removed by HEPA vacuuming.

Room 5

Room 5, the main production room used by ECC, was radioactively contaminated over approximately 344 m^2 (3,700 ft^2) of the floor and approximately 910 m^2 (9,800 ft^2) of the overhead areas. The contaminated overhead areas included trusses, lights, heaters, pipes, and duct work.

Approximately 74 m^2 (800 ft^2) of radioactively contaminated, asbestos-containing floor tile was removed from the pedestal area in the northwestern corner of the room. The tile was removed with long-handled, hand-held scrapers inside negative-pressure containment tents. Five additional contaminated floor drains were discovered in the pedestal area during the removal of the asbestos floor tile; they were removed and replaced with new drains and traps. The pipes were surveyed and decontaminated in place with a variable-speed motor outfitted with a cylinder hone. The remaining 270 m^2 (2,900 ft^2) of contamination on the floors was removed with the BlasTrak™ system.

Three manholes in Room 5 contained sludge contaminated with uranium-238 at an average concentration of 2,716 pCi/g (when averaged with sludge removed from all contaminated manholes and pipes onsite). Contamination in the manholes and their associated piping was reduced, but fixed surface contamination remained at concentrations above the DOE guidelines. The radioactivity in the manholes and associated piping is the subject of a hazard assessment (BNI 1993); the results and conclusions of the assessment are discussed in Section 5.1.

Room 6

Room 6, the Dynapack room, was radioactively contaminated on most of the floor [approximately 210 m^2 (2,260 ft^2)], three floor drains, floor expansion joints [21 m (69 ft)], floor/wall interface expansion joints [approximately 73 m (240 ft)], and approximately 223 m^2 (2,400 ft^2) of the overhead area. The floor tiles were also determined to contain asbestos. This room was the location of an industrial-grade Ingersol Rand (SSR 2000) air compressor, which was permanently relocated to an exterior location to facilitate survey and

subsequent decontamination of the floor beneath the compressor. This room was decontaminated using the same techniques previously described for other rooms.

Radioactively contaminated concrete stained with lubrication oil was suspected to contain polychlorinated biphenyls (PCBs). The oil stains appeared to be relatively recent and were probably associated with activities of the current tenant. The stains were sampled, and results indicated that they did contain PCBs; however, no oil remained on the concrete floor after sampling.

Upstairs Laboratory

During the preremediation surveys, ORNL discovered that five floor drains in the upstairs laboratory (see Figure 1-3), currently used as a development laboratory by ECC, had been used to dispose of radioactively contaminated liquids. Several of these drains also contained small droplets of mercury in their traps. The drains were vacuumed with a mercury vacuum and subsequently decontaminated. The mercury was segregated from the other waste and packaged separately. It was maintained in temporary storage at the Seymour site until final disposal at an approved, licensed commercial disposal was completed in October 1993. Drain piping, located in the boiler room directly underneath the laboratory, was cut to facilitate survey of the downstream piping and the possible removal of mercury-containing residue. However, no significant mercury contamination was discovered in any of the piping associated with the floor drains. The drains were decontaminated with a rotating abrasive scale remover.

3.1.2 Exterior Areas

Removal actions involving the excavation of radioactively contaminated soil were performed in two distinct areas outside the Rufert Building. Figure 3-1 shows the location of the smaller area (Area 2) [approximately 2.2 m^2 (24 ft^2)] outside the loading dock area (porch or "scale room") at the northern end of the building, and the larger area (Area 1) [approximately 13.4 m^2 (144 ft^2)] near the former waste disposal/burn area approximately

30.5 m (100 ft) north of the Rufert Building. Both areas were fully remediated by removing all radioactively contaminated soil.

3.2 CONTAMINATION CONTROL DURING REMEDIAL ACTION

During the expedited removal action, engineering controls, administrative controls, and personal protective equipment were used to protect remediation workers, ECC employees, and members of the general public from exposure to radiation in excess of applicable standards. These measures also controlled the migration of radioactive material to adjacent uncontaminated areas of the Seymour site and vicinity properties.

The primary pathway by which persons onsite could be exposed to radioactive material during removal activities at the site was inhalation and ingestion of radioactively contaminated airborne dust generated during the mechanical decontamination of interior structural surfaces. To prevent such exposure, negative-pressure booths (with HEPA filtration units) were constructed around contaminated floor areas to control the spread of dust within the building. The VacuBlast™ decontamination system was also used on several smaller areas to minimize the potential for airborne contaminants.

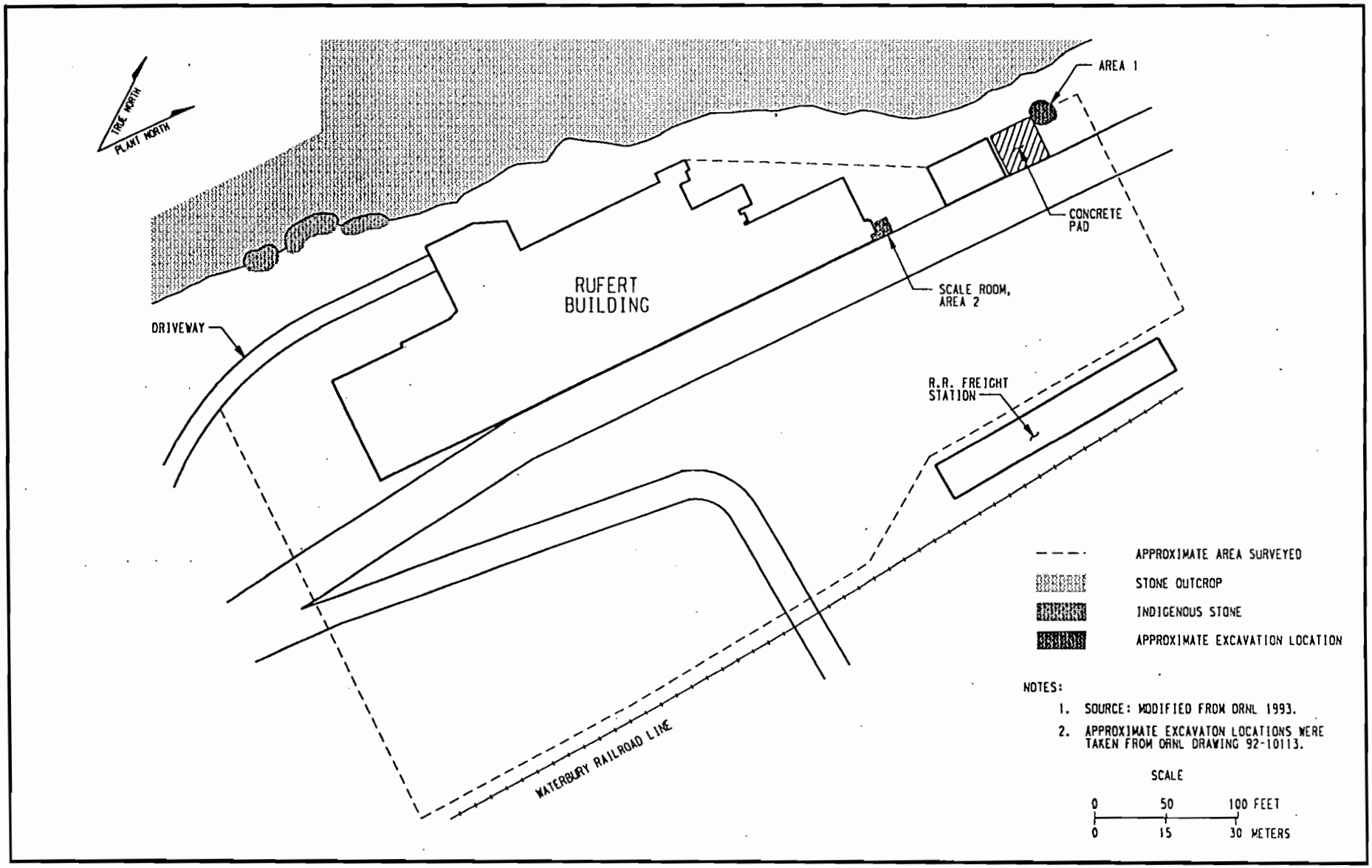
The primary pathway by which members of the general public offsite could have received an exposure to radioactive material during the expedited removal action was inhalation and ingestion of airborne dust generated during the excavation of contaminated soils outside the Rufert Building. During remediation of the two exterior areas, soil was excavated by hand, and wet suppression was employed to prevent airborne contaminant migration.

During the exterior and interior remediation, particulate air monitoring devices were placed in the areas being remediated. The concentrations of uranium-238 ranged from 3.6 E-14 to 1.3 E-12 μCi/ml. These concentrations were conservatively derived by collecting air particulate samples daily from lapel air samplers worn by workers. The filters were counted after four days to allow for radon decay. After the gross activity per volume of air that passed through the filter was determined, the source of all activity on the filter was

assumed to be uranium-238. These derived air concentrations (DACs) were then compared with the applicable DOE guideline, which is a DAC of 2 E-11 μCi/ml for occupational exposures (DOE Order 5480.11) of airborne uranium-238. No particulate air sample measurement exceeded the action level for occupational workers established for the remedial action (i.e., 10 percent of the DAC for uranium-238).

Ambient air monitoring for particulates was also performed adjacent to areas being remediated to ensure that no member of the general public or ECC employee was exposed above DOE guidelines (DOE Order 5400.5) established to protect members of the general public and the environment against undue risk from radiation. An Eberline RAS-1, high-volume monitor was used, and the filters were collected daily and counted after four days to allow for radon decay. The limits expressed in DOE Order 5400.5 are derived concentration guides (DCGs); a DCG is the concentration of a particular radionuclide that would provide an effective dose equivalent of 100 mrem/yr, the DOE basic dose limit, to an individual continuously exposed to that radionuclide for an entire year. Concentrations of uranium-238 measured by area air particulate monitors ranged from 2.0 E-15 to 2.0 E-13 μCi/ml. The DCG is 2.0 E-12 μCi/ml for uranium-238, a factor of ten greater than any concentration observed in any area monitor at the Seymour site.

FIGURES FOR SECTION 3.0



R41F003.DGN

Figure 3-1
Locations of Exterior Radioactively Contaminated Areas

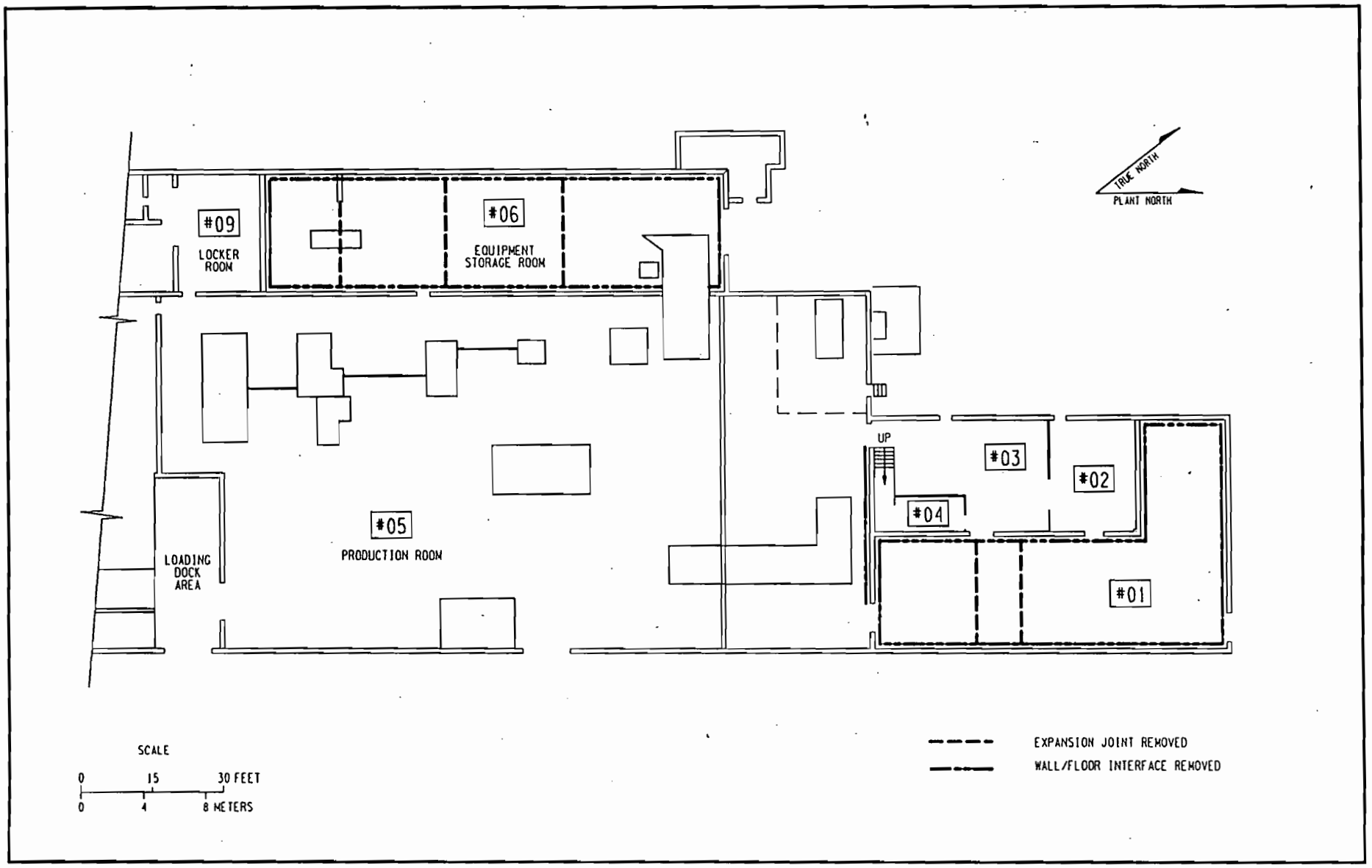


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Figure 3-2
Wall/Floor Interfaces and Expansion Joints Removed
From the Northern End of the Rufert Building

TABLES FOR SECTION 3.0

Table 3-1

Decontamination Techniques Used at the Seymour Site

Technique	Description
HEPA vacuuming	High-efficiency particulate air- (HEPA-) filtered vacuum cleaners were used to remove loose contamination primarily in overhead areas.
Hand wiping/light abrasion	Small areas and structural surfaces (primarily overhead) that were either inaccessible or resistant to HEPA vacuuming were wiped with a dry cloth or a cloth wetted with a detergent solution to remove loose surface contamination. Contamination that was resistant to simple wiping was brushed with a wire brush.
Mechanical shot blasting	Two commercially available shot-blast systems, the BlasTrak™ and VacuBlast™ decontamination systems with self-contained dust collection systems, were used to clean floor and wall surfaces by using metallic abrasive material on the work surface and removing incremental layers of contaminated material.
Using variable-speed cylinder hones	Piping was decontaminated using an abrasive hone on a flexible shaft attached to a variable-speed motor.
Cutting with a gasoline-powered circular saw	A gasoline-powered circular saw with a concrete blade, vented to the exterior of the building, was used to remove sections of the foundation that had contaminated expansion joint material attached.
Scraping and chiseling	Contaminated asbestos tiles were removed using hand-held scrapers. The expansion joint material at the wall/floor interface was removed using pneumatic and hand-held chisels.
CO_2 blasting	CO_2 pellets were shot against contaminated surfaces. The technique was used only in a limited test area at the Seymour site because of its inability to decontaminate concrete and the high exhaust pressures generated.

Table 3-2

Drum and LSA Box Inventory

Identification Number	Contents	Type Waste	Container Weight (lbs)
Drums			
CD01901	10 plastic bags containing expansion joint material	LLRW[a]	300
CD01902	Plastic bags containing expansion joint material	LLRW	300
CD01903	Drain sludge from Manholes 1 and 2	LLRW	650
CD01904	Drain sludge from Manholes 1 and 2	LLRW	500
CD01905	Drain sludge and HEPA filters	LLRW	500
CD01906	Drain sludge from Manhole 3	LLRW	550
CD01907	Drain sludge from Manhole 3	LLRW	620
CD01908	Concrete and expansion joint material	LLRW	250
CD01909	Sludge	LLRW	300
CD01910	Drain sludge	LLRW	550
LSA Boxes			
CL01209	ACM	LLRW/ACM[b]	4,000
CL01210	ACM and soil	LLRW/ACM	6,600
CL01211	ACM and misc. building materials	LLRW/ACM	4,000
CL01212	ACM, soil, dust, and scrap metal	LLRW/ACM	7,720

Table 3-2

(continued)

Identification Number	Contents	Type Waste	Container Weight (lbs)
LSA Boxes (cont.)			
CL01213	Filters, rags, rocks, and soil	LLRW/ACM	6,600
CL01214	HEPA filters, dust, and soil	LLRW	2,800
CL01215	Respirator filters, dust, PPE[c], rock, and soil	LLRW/ACM	4,350
CL01216	Concrete, filters, and iron pipe fiberglass insulation	LLRW/ACM	2,650
CL01217	Filters, bags, and rags	LLRW	3,850
CL01218	ACM, concrete, dust, filters conduit, and hand vacuum	LLRW/ACM	3,250

[a]LLRW - low-level radioactive waste.

[b]ACM - asbestos-containing material.

[c]PPE - personal protective equipment.

4.0 POST-REMEDIAL ACTION MEASUREMENTS

After each portion of the site was decontaminated, a survey of that area was conducted to confirm that no residual radioactive contamination above DOE guidelines for residual radioactivity (see Table 2-1) remained in the area. Initial post-remediation surveys were conducted by the radiological support contractor on behalf of BNI. Survey techniques employed during the post-remediation and verification surveys included direct (nontransferable) surface contamination measurements, transferable contamination measurements, walkover gamma scans, and external gamma radiation exposure rate measurements. ORNL, functioning in the role of an independent verification contractor (IVC), performed independent verification surveys of the remediated areas using similar or identical survey techniques. The IVC survey data will be issued as a separate report by ORNL.

In the data tables included in this section, use of the "less than" (<) notation in reporting analytical results indicates that the radioactive contamination, either on a structural surface or in a soil sample, was below the detection limit of the analytical technique and/or the detection instrument used to quantify the amount of radioactivity present. This lower limit, or the quantitative capacity, depends on various factors, including the efficiency and total surface area of the detection instrument used, the background radiation present when and where samples are being counted, the size and volume of the sample, and the length of time that the sample is counted. The actual concentration of radioactivity in a sample is less than the reported value preceded by the less than (<) symbol. Radionuclide concentrations in soils are expressed in units of pCi/g, and for direct and transferable contamination measurements taken on structural surfaces, concentrations are expressed in units of dpm/100 cm^2 of surface area surveyed (1 pCi is equivalent to 2.22 dpm).

4.1 INTERIOR AREAS

Direct alpha measurements were taken with an alpha scintillation detector connected to a rate meter. Direct beta/gamma measurements were obtained with a Geiger-Mueller beta/gamma survey instrument probe, also attached to a rate meter. Direct measurements

were obtained by placing the probe directly on the surface to be surveyed and allowing pulses to accumulate for 30 seconds on the rate meter. These measurements were then converted, with appropriate calibration and conversion factors, to dpm/100 cm^2.

On floors and wall surfaces, before discrete post-remedial action survey locations were identified and measurements taken, the entire area was scanned to ensure that no small, isolated areas of contamination were missed during the removal action. The number of direct readings taken in each remediated area averaged five per square meter. For the first surveys performed (in the upstairs laboratory, hallway, and Room 5), five individual measurements were taken in each square meter surveyed. Upon approval by DOE (DOE 1992), in later post-remediation surveys, a corner measurement for each square meter surveyed was allowed to be used as the corner measurement for the adjacent square meter. This technique allowed a single measurement to be used to calculate the activity in four different square meters. Figures 4-1 through 4-7 show typical survey locations on various surfaces in the Rufert Building. These figures are for Room 1, but similar grid spacing and survey measurement locations were used in all areas of the building. Measurements were biased within specific square-meter areas to demonstrate that previously contaminated areas were no longer contaminated above criteria.

Direct readings were also taken in adjacent areas within 0.5 m (1.6 ft) of the formerly contaminated areas to verify that contaminants had not spread to previously clean areas during the removal activities.

Transferable (removable) beta/gamma contamination was also measured, at a minimum, at any location that exhibited direct alpha or beta/gamma contamination that was above the guideline for removable contamination (1,000 dpm/100 cm^2).

Post-remedial action measurements of direct and transferable contamination inside the Rufert Building are summarized in Table 4-1. No residual radioactive contamination above DOE guidelines was detected in any accessible area of the building.

Approximately 165 m (540 ft) of pipe in the foundation of the first floor and three manholes were determined to be resistant to all but the most aggressive decontamination techniques. The manholes were not decontaminated because their structural integrity would have been compromised. All removable sludge material was removed from the manholes and associated piping and properly packaged for disposal. A hazard assessment (BNI 1993) was performed for these three manholes and the interconnecting pipes to determine the reasonable maximum exposure for current and future use scenarios. Table 4-2 summarizes the post-remedial action data for the manholes and pipes, and Figure 4-8 shows the locations of these manholes in the Rufert Building.

Exposure rates were measured with a pressurized ionization chamber throughout the Rufert Building (see Table 4-3) to ensure that the DOE basic dose limit of 100 mrem/yr above background was not being exceeded by a member of the general public (in this case, an employee of ECC). All exposure rates were low; the highest was 15.1 μR/h, including 9.3 μR/h background (i.e., the highest rate is 5.8 μR/h above the background rate for the area). This exposure rate is well below the DOE guideline for average exposure rates inside a building or habitable structure (20 μR/h above background). For a reasonable maximum exposure scenario (defined as a worker working in the Rufert Building for 8 hours a day, 5 days a week, 52 weeks a year), the maximum dose would be 12 mrem/yr (approximately 12 percent of the DOE limit).

4.2 EXTERIOR AREAS

The two small areas of soil determined to be contaminated above DOE guidelines for uranium-238 in soil were excavated, and then the excavations were surveyed. The surveys consisted of obtaining direct gamma measurements using a gamma scintillation detector connected to a rate meter (SPA-3) and converting the measurements to μR/h. Post-remediation soil samples were obtained from each of the excavations and analyzed to verify that the soil contaminated at concentrations above the DOE guidelines had been removed.

4.2.1 Surface Gamma Radiation Scans and Dose Rate Measurements

Direct gamma radiation exposure rates in the excavated areas were determined before the areas were backfilled by performing a walkover gamma scan in each area and converting the measurements obtained from cpm to μR/h. Exposure rates derived from count rates measured in the two excavated pits ranged from 10.6 to 15 μR/h (see Figures 4-9 and 4-10). These rates included a background rate of 10.9 μR/h, which was different from the background measurements obtained with the pressurized ionization chamber offsite because of the difference in instrument efficiencies. For a reasonable maximum exposure scenario as described previously for interior areas, the maximum anticipated dose to a worker would be 8.5 mrem/yr if the soil remained accessible.

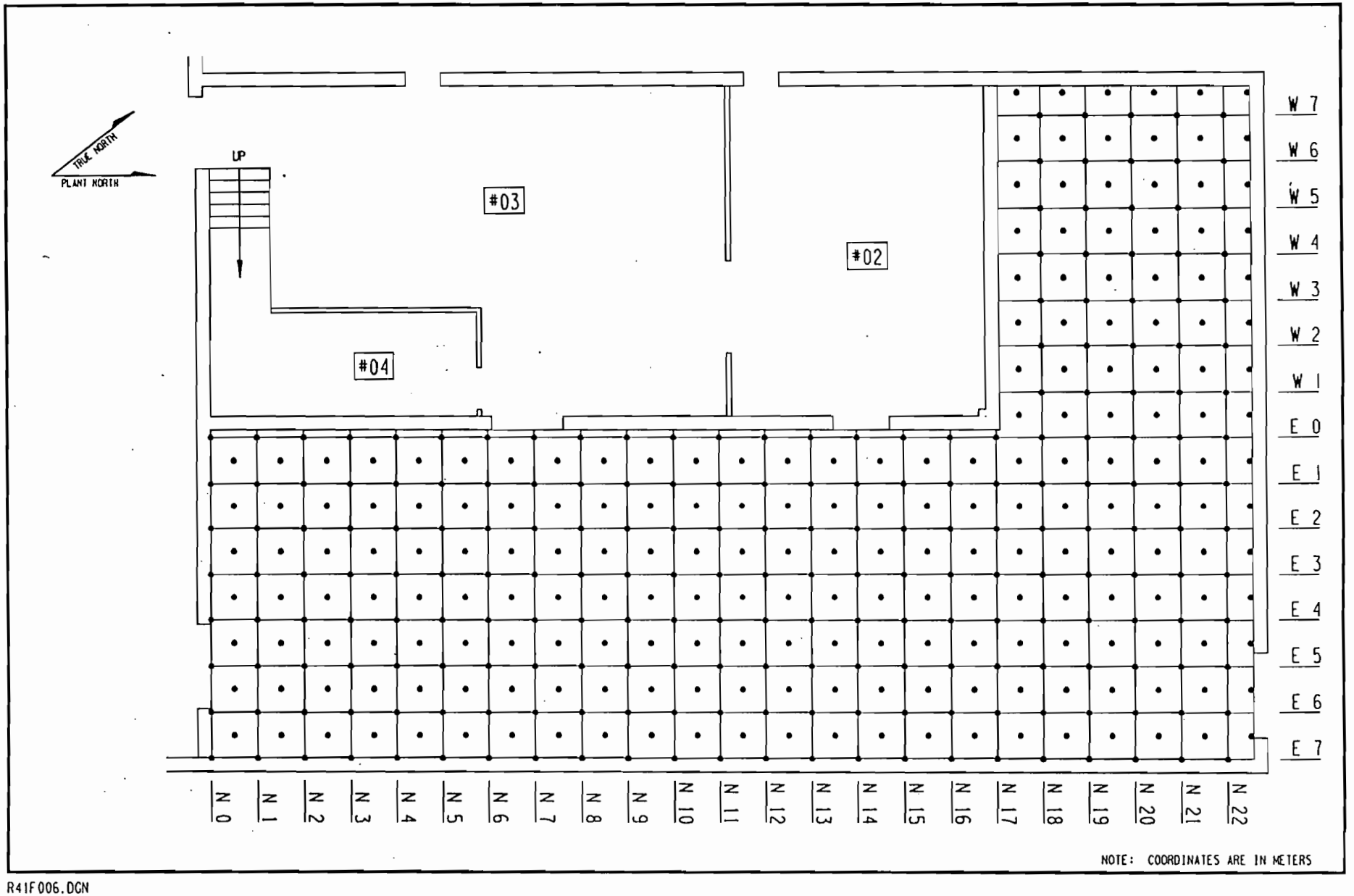
4.2.2 Soil Sampling

Composite post-remediation soil samples were also taken from each of the excavated areas and analyzed to determine the radionuclide concentrations in the remaining soil before the excavations were backfilled. A sample was obtained from each 0.9- by 0.9-m (3- by 3-ft) area (see Figures 4-9 and 4-10) from a depth of 0 to 15 cm (0 to 6 in.) in the bottom of the excavated pit and composited for each pit separately. The concentrations of uranium-238, radium-226, and thorium-232 in these samples ranged from 6.8 to 9.0 pCi/g, 0.82 to 0.86 pCi/g, and 1.2 to 1.5 pCi/g, respectively. DOE performed calculations using the residual radioactive (RESRAD) material computer code (Version 4.3) and the following conservative assumptions:

- The area of remaining contamination is 100 m^2 (1,076 ft^2).
- The thickness of the remaining contamination is 1 m (3 ft).
- The thickness of clean backfill material used is 15 cm (6 in.).

Even using these assumptions, the dose to a member of the general public from the residual radioactivity in the unexcavated soil would be less than 1 mrem/yr (DOE 1992). Therefore, the cleanup met the dose limit by reducing exposures to less than the 100-mrem/yr limit by a factor of 100.

FIGURES FOR SECTION 4.0



R41F006.DGN

Figure 4-1
Post-Remedial Action Survey Locations
on the Floor of Room 1

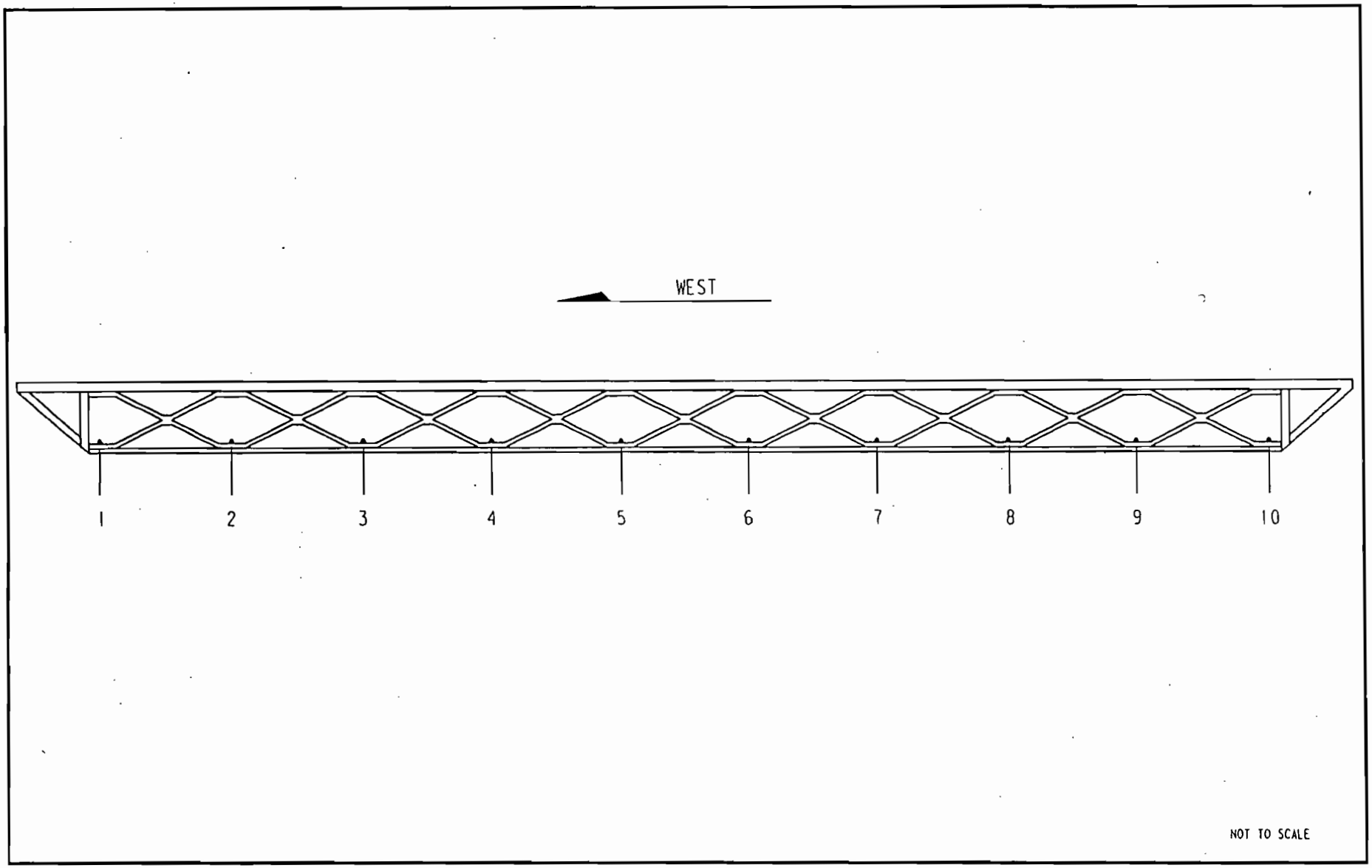


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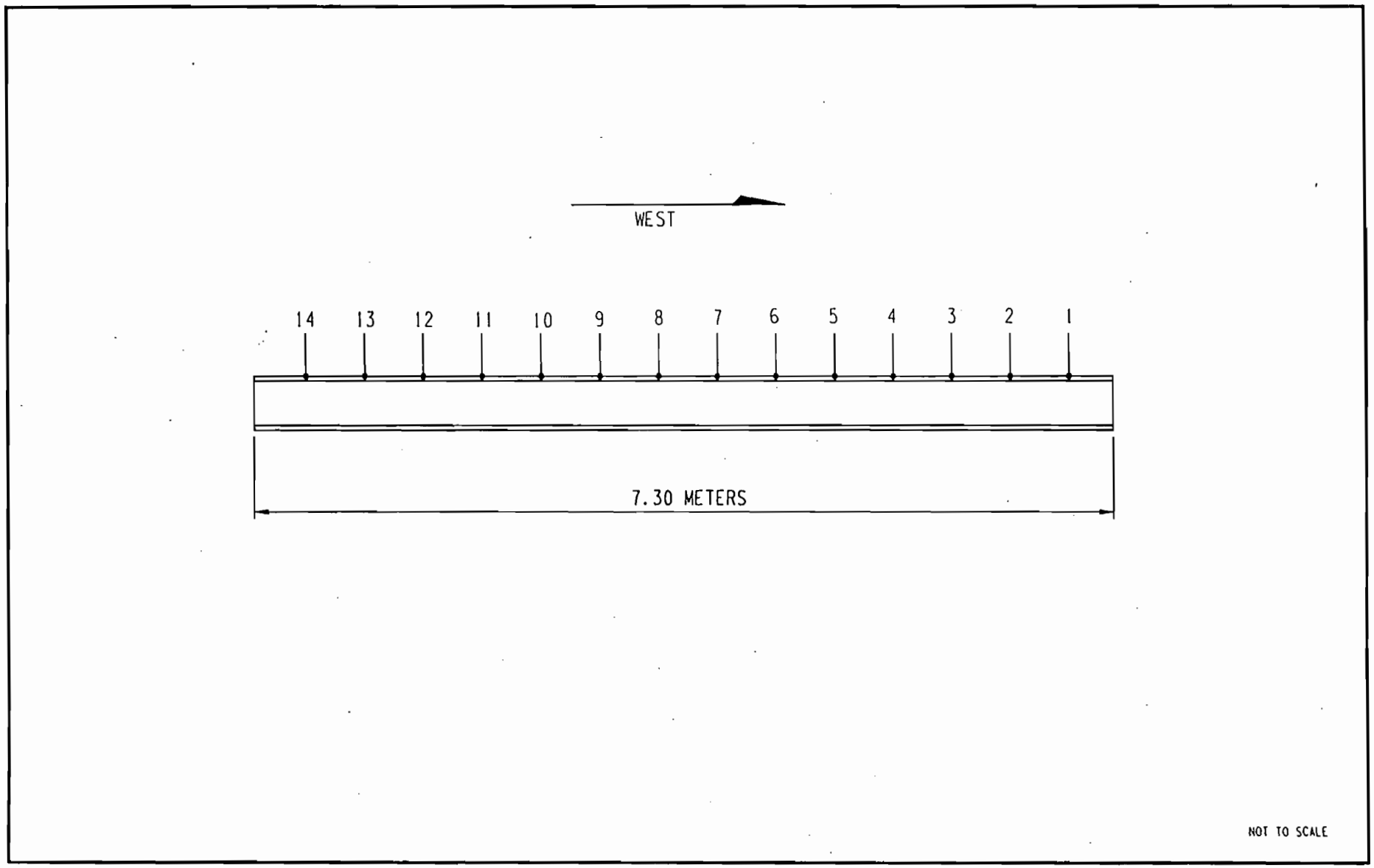
Figure 4-2
Post-Remedial Action Survey Locations
on Truss 1 in Room 1



R41F008.DGN

Figure 4-3
Post-Remedial Action Survey Locations
on Beam 1 in Room 1

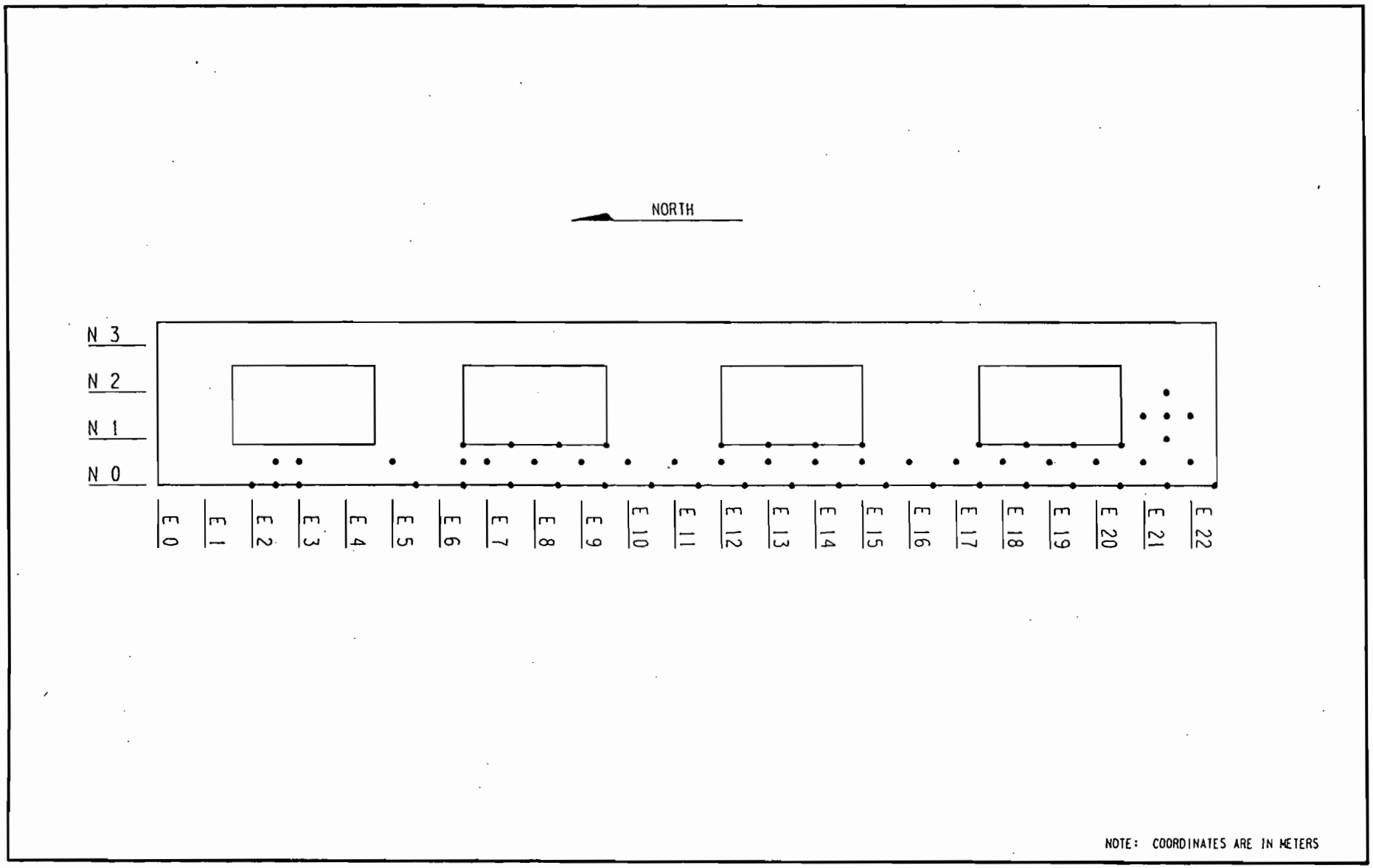


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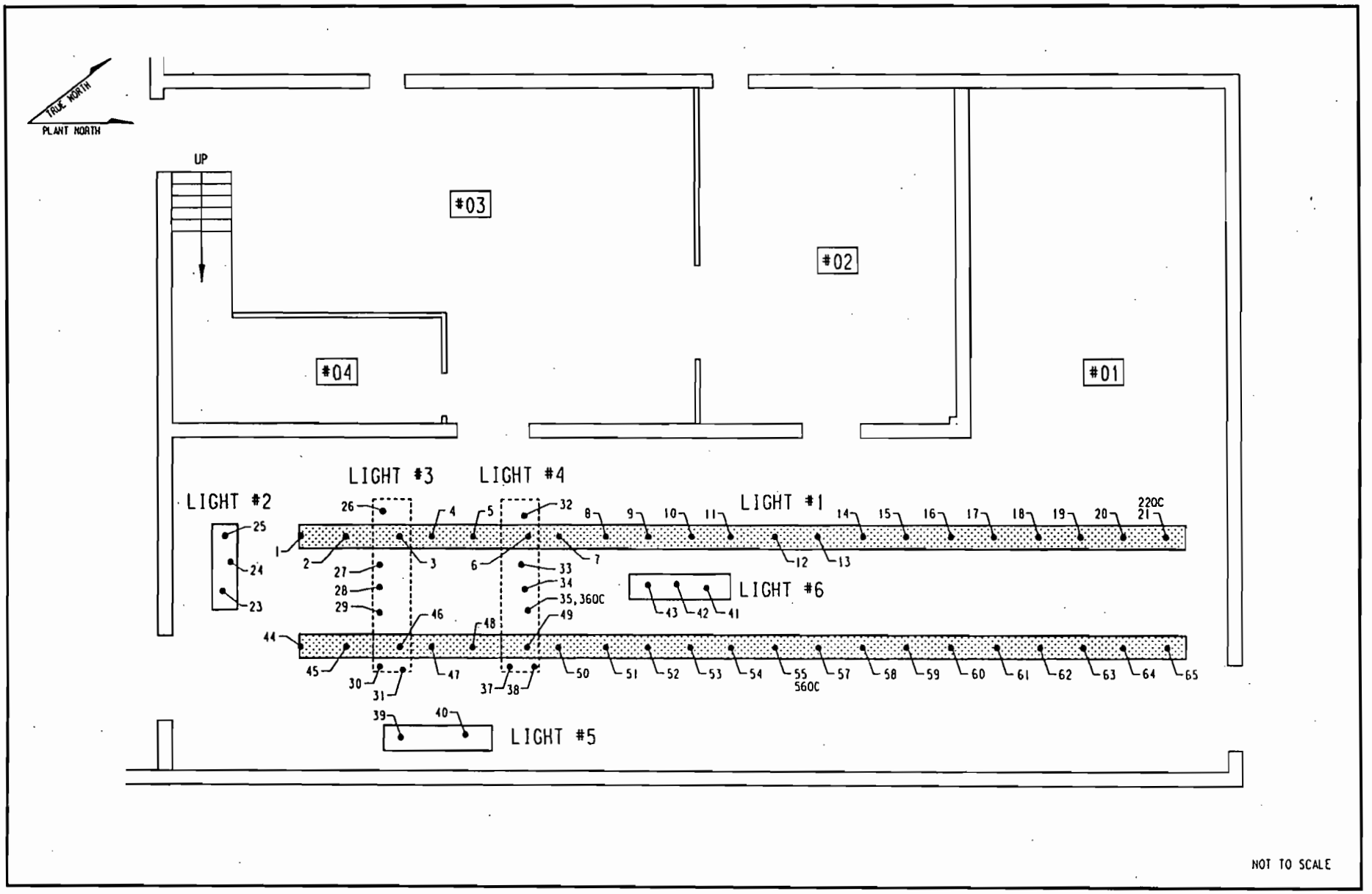
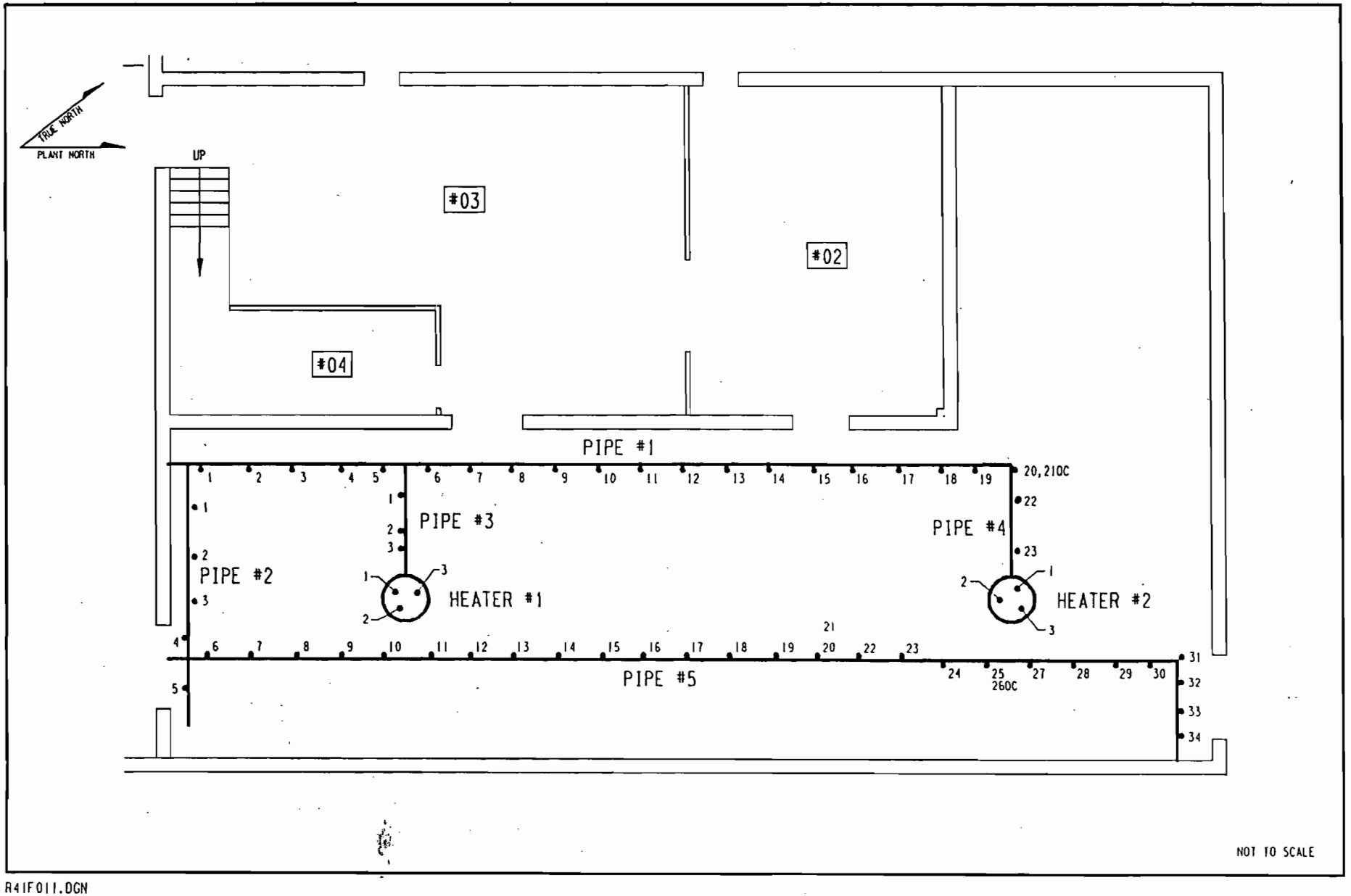
Figure 4-4
Post-Remedial Action Survey Locations
on the Eastern Wall of Room 1



R41F010.DGN

Figure 4-5
Post-Remedial Action Survey Locations
on the Light Fixtures in Room 1



R41F011.DGN

Figure 4-6
Post-Remedial Action Survey Locations
on Overhead Pipes and Heaters in Room 1

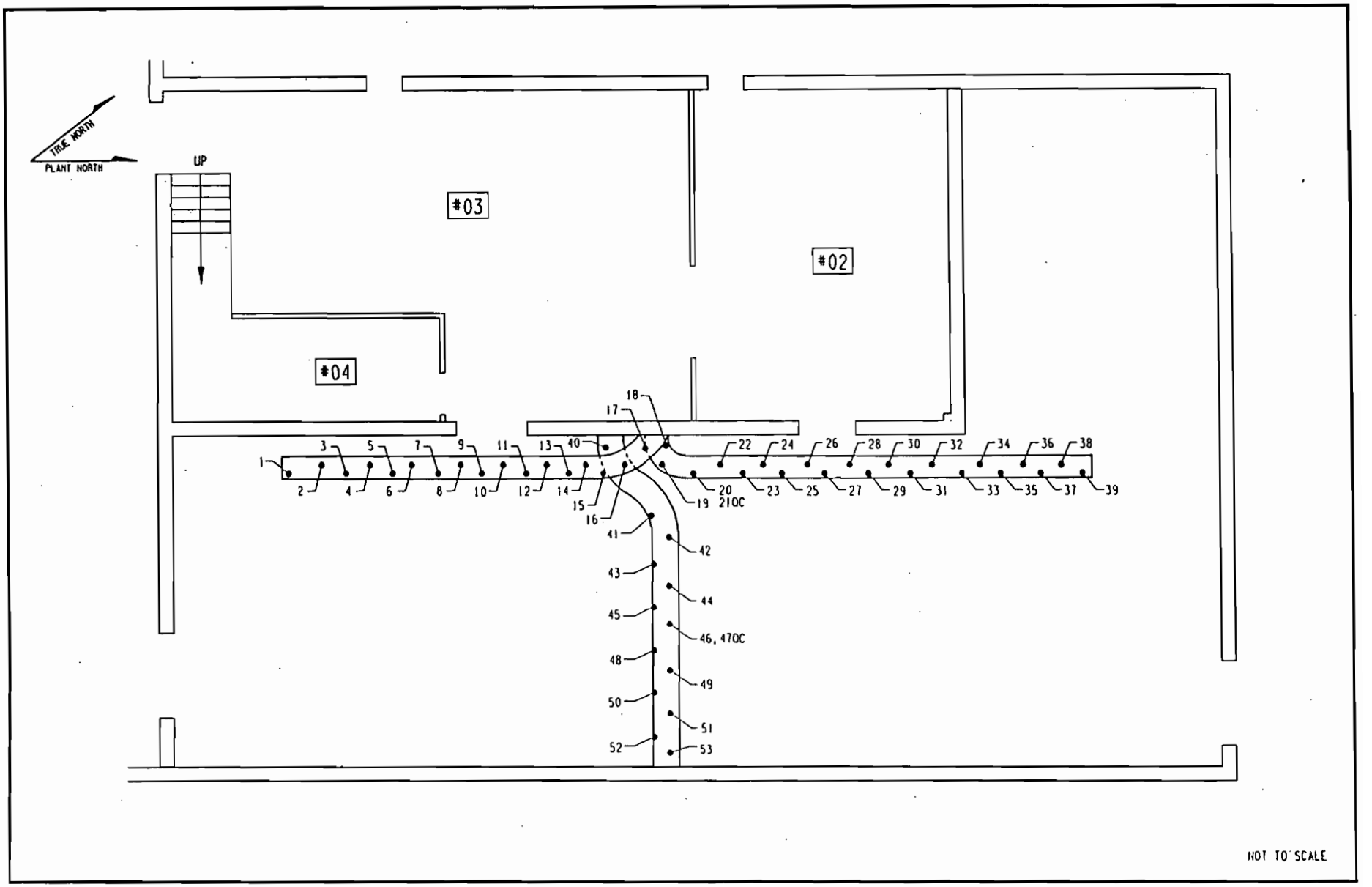


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Figure 4-7
Post-Remedial Action Survey Locations
on Duct Work in Room 1

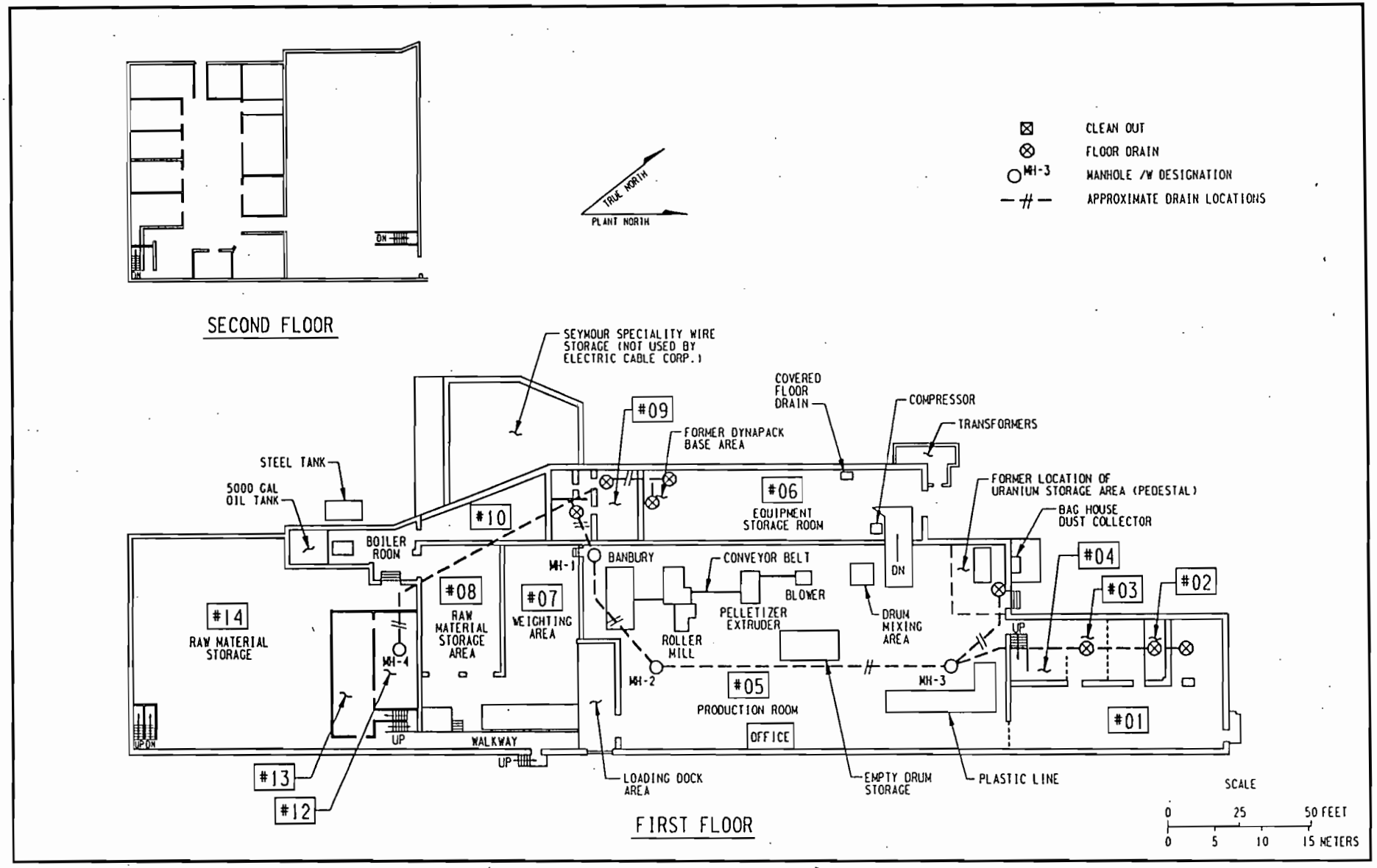

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Figure 4-8
Locations of Remaining Contaminated Manholes and Piping

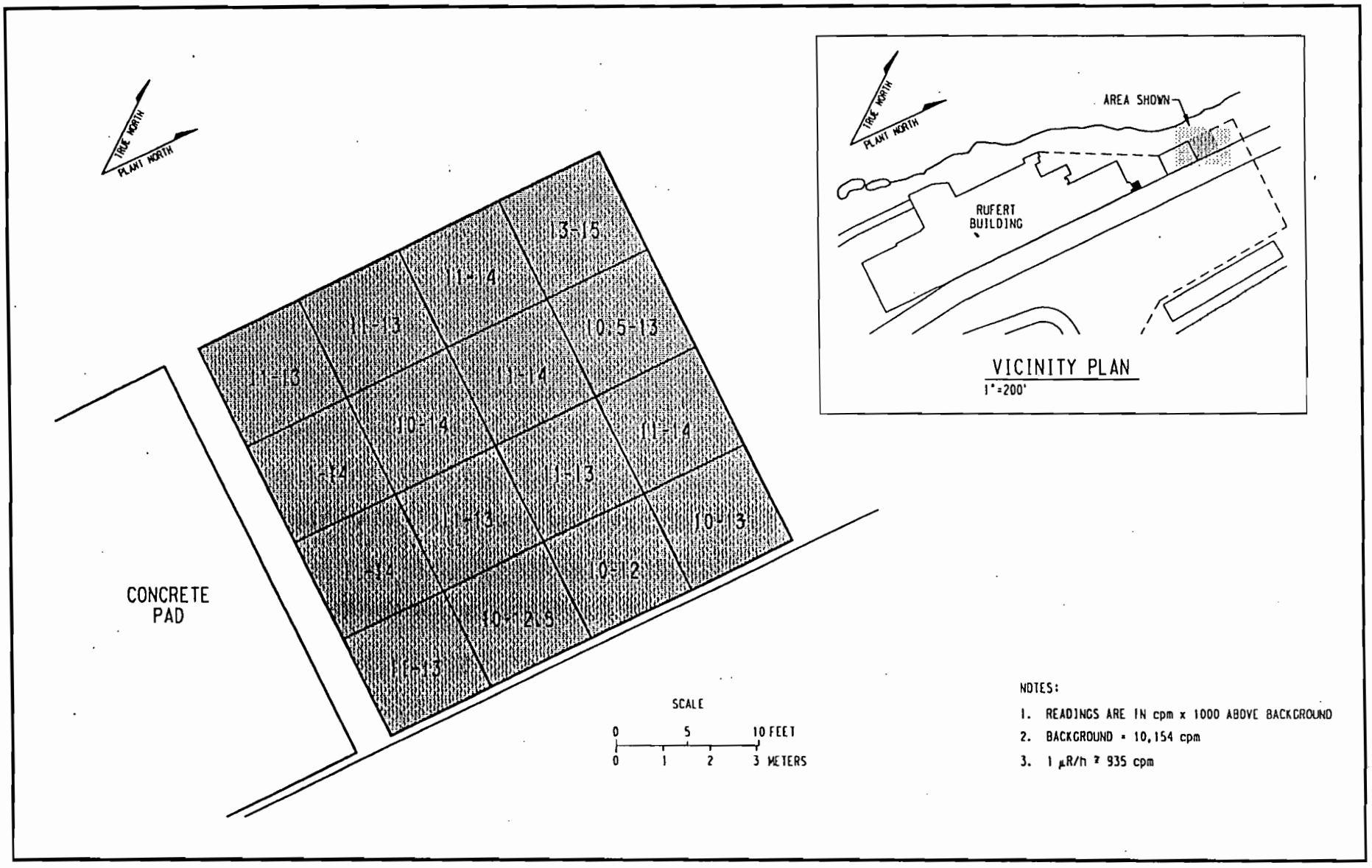

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Figure 4-9
Detail of Post-Remedial Action Survey of Excavated Area 1
North of Building 52

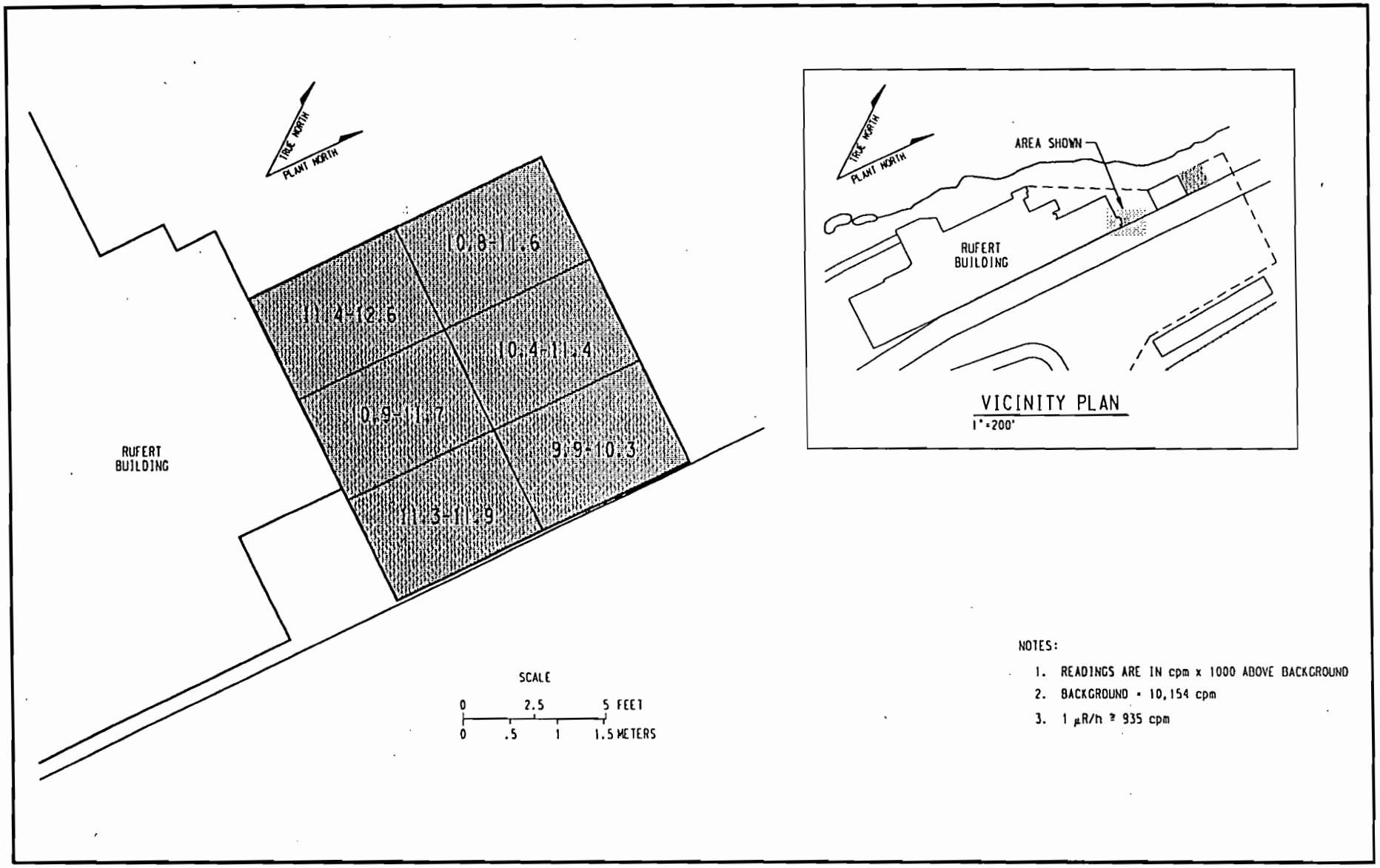

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Figure 4-10
Detail of Post-Remedial Action Survey of Excavated Area 2
North End of the Rufert Building

TABLES FOR SECTION 4.0

Table 4-1

Summary of Post-Remedial Action Radiological Survey Results for the Rufert Building

		Direct Surface Contamination				Transferable Contamination	
		Alpha		Beta/Gamma		Beta/Gamma	
Room	Location	Sample Activity Range (dpm/100 cm^2)	Number of Measurements[a]	Sample Activity Range (dpm/100 cm^2)	Number of Measurements[a]	Sample Activity Range (dpm/100 cm^2)	Number of Measurements[a]
Room 1	Overhead trusses	<19 - 190	407	<447 - 686	410	<48 - <91	2
	Overhead beams	<21 - 90	57	<412 - 1,022	57	<76	1
	Ducts	<24 - 88	51	<412 - 773	51	-	-
	Overhead pipes	<24 - 245	57	<412 - 2,394	57	<44 - 69	9
	Fans	<21 - 49	6	<412 - 517	6	-	-
	Lights	<16 - 116	61	<469 - 1,427	61	<72 - 88	3
	Walls	<16 - 163	190	<694 - 2,924	190	<44 - 51	39
	Floor	<24 - 265	426	<599 - 1,752	426	<44 - <92	50
	North porch	<21 - 107	5	<556 - 1,092	5	<59	1
Room 2	Lights	<22 - 147	168	<402 - 1,972	168	46 - 119	103
	Venetian blinds	<22 - 53	18	<402 - 689	18	<86 - <102	3
	Walls	<16 - 152	53	<480 - 1,599	53	<52 - <77	12
	Floor	<11 - 342	92	<353 - 3,701	92	<52 - <56	6
Room 3	Beams	<13 - 75	221	<379 - 665	221	<52 - <95	4
	Ducts	<13 - 75	36	<379 - 785	36	<52 - <90	2
	Overhead pipes	<13 - 106	98	<379 - 1,226	98	<52 - 82	16
	Lights	<11 - 64	39	<354 - 1,360	39	<53 - <95	9
	Floor	<20 - 136	72	<498 - 2,558	72	<101	1
Room 4	Floor	<11 - 106	28	<418 - 837	28	<50	1

Table 4-1

(continued)

Room	Location	Direct Surface Contamination: Alpha: Sample Activity Range (dpm/100 cm²)	Direct Surface Contamination: Alpha: Number of Measurements[a]	Direct Surface Contamination: Beta/Gamma: Sample Activity Range (dpm/100 cm²)	Direct Surface Contamination: Beta/Gamma: Number of Measurements[a]	Transferable Contamination: Beta/Gamma: Sample Activity Range (dpm/100 cm²)	Transferable Contamination: Beta/Gamma: Number of Measurements[a]
Room 5	Trusses	<16 - 705	1,107	<493 - 1,335	1,107	<46 - <73	4
	Overhead pipes	<29 - 99	620	<515 - 1,747	620	<44 - 140	121
	Ducts	<29 - 59	116	<523 - 1,228	116	<46 - 76	5
	Lights	<33 - 87	196	<465 - 3,495	196	<44 - 76	21
	Heater	<29 - <72	11	<649 - <702	11	-	-
	Floor	<13 - 166	2,047	<420 - 2,484	2,047	<47 - 89	104
Room 6	Trusses	<19 - 157	384	<560 - 785	384	<46	1
	Beams	<21 - 423	98	<426 - 2,394	98	<46 - <93	13
	Overhead pipes	<24 - 245	97	<575 - 1,026	97	<64	1
	Fans	<21 - 382	6	<426 - 866	6	-	-
	Ventilation duct	37 - 343	40	<452 - 3,631	40	<53 - 55	31
	Floor	<21 - 266	486	<517 - 1,443	486	<46 - <78	15
Upstairs Lab	Hall floor	<39 - <69	24	<453 - 1,378	24	<77 - <93	2
	Floor drains	-	-	<382 - 449	30	-	-
	Floor around drains	<51	24	<513	24	-	-
	Floor drain pipe	-	-	-	-	alpha <3-13 / beta-gamma <53-<108	alpha 10 / beta-gamma 10
Boiler Room	Pipes	<28 - 35	22	<336 - 1,711	22	alpha <3-6 / beta-gamma <52-<111	alpha 22 / beta-gamma 22
	Lights	<11 - 16	12	<420 - 1,591	12	alpha <3-6 / beta-gamma <53-67	alpha 9 / beta-gamma 9

[a]No measurements exceeded the criteria in Table 2-1.

Table 4-2

Summary of Post-Remedial Action Survey Results in Manholes and Pipes

		Direct Beta/Gamma Surface Contamination			
		Sample Activity Range (dpm/100 cm^2)			
Room	Location[a]	Minimum	Maximum	Number of Measurements	Number of Measurements Exceeding Criteria[b]
Room 5	Manhole 2, 1:00 pipe	11,412	201,448	50	50
	Manhole 3, 6:00 pipe	2,330	60,896	44	30
	Manhole 3, 12:00 pipe	3,844	28,353	26	25
	Manhole 3	18,784	1,180,623	9	9
	Manhole 2, 8:00 pipe	529	150,538	47	21
	Manhole 1, 9:00 pipe	<881	25,953	6	4
	Pipe F on pedestal	1,979	49,413	10	6
	Discharge pipe from floor drain on pedestal	<1,010	14,626	32	12
Room 6	Drain 6	<820	880	29	0
	Drain 10	8,174	68,805	10	10
Room 12	Manhole 4	<872	2,786	20	0
	Manhole 4, after drain decontamination[c]	2,436	4,230	5	0

[a]The pipe designators refer to the pipe location with the north direction corresponding to 12:00.

[b]Refer to Table 2-1 and Figure 4-8.

[c]Five samples were also collected to determine whether transferable alpha contamination was present; sample activity ranged from <48 to 107 dpm/100 cm^2.

Table 4-3

Summary of Post-Remedial Action Gamma Radiation Exposure Rates

Room or Area	Exposure Rate[a] Range (μR/h)	Number of Measurements	Number Exceeding Criteria
Room 1	10.7 - 13.0	16	0
Room 2	12.8	1	0
Room 3	11.3 - 11.8	2	0
Room 4	12.0	1	0
Room 5	8.0 - 12.2	30	0
Room 6	10.4 - 12.2	12	0
Room 9	15.1	1	0
Upstairs south lab, Room 13	10.9 - 11.6	3	0
Boiler room	14.2	1	0
Outside Area 1	10.7 - 15[b]	16	0
Outside Area 2	10.6 - 13.5[b]	6	0

[a]Gamma radiation exposure rates include background, which is approximately 9.3 μR/h for the Seymour area.

[b]Exposure rates were derived by converting walkover gamma scan data. Background was 10.9 μR/h for these measurements.

5.0 POST-REMEDIAL ACTION STATUS

The post-remedial action survey data indicate that all accessible areas of the Rufert Building that had been determined to be contaminated during characterization surveys (except for the three manholes) are now in compliance with applicable DOE guidelines for cleanup of residual radioactive contamination. Based on a review of post-remedial action measurements, survey procedures, and quality assurance data, the IVC will confirm that the site was decontaminated to the radiological guidelines established for the site.

Some radioactive contamination above DOE guidelines remains in three manholes and approximately 165 m (540 ft) of connecting piping within the foundation of the Rufert Building (see Figure 4-8). The contamination is nontransferable and extremely resistant to all decontamination efforts (including normal and aggressive techniques). Because of this resistance, the projected cost to remediate this material (by removal and restoration of all manholes and piping) would be unreasonably high relative to the long-term reduction in risk to workers and members of the general public being exposed to this residual radioactive material any time in the future. For this reason, a hazard assessment (BNI 1993) was performed to further define the risk.

Approximately 30.5 m^3 (40 yd^3) of contaminated material was generated during the remediation of the Rufert Building and the two small outside areas and packaged in 55-gal drums and LSA boxes. These waste containers were placed in locked seavans (cargo storage units similar to trailers) for onsite storage pending offsite disposal. Offsite disposal at an approved, licensed commercial disposal facility was completed in October 1993.

5.1 HAZARD ASSESSMENT OF MANHOLES AND FOUNDATION PIPING

Using data from the post-remedial action surveys, potential exposures to the residual contamination in the drain system in the Rufert Building were calculated. The hazard assessment for this residual contamination considered both current and future workers. For the current worker, it was assumed that the worker spent all of his time in the area of the highest gamma exposure rate. Because the contamination in the manholes and piping is

fixed, internal exposure via inhalation was not considered a credible pathway for the current worker. The calculated dose to a current worker was approximately 11 mrem/yr. For the future worker, it was assumed that a worker would be involved in the demolition of the contaminated manholes and piping. Both the external and inhalation pathways were considered in the assessment. The calculated dose to a future worker was 0.7 mrem.

The calculated dose for both potential exposure scenarios is significantly below the DOE guideline for protection of the general public (100 mrem/yr above background). Because of the minimal risk and low potential exposure to these materials, it was determined that a very costly removal of these pipes and manholes would not be reasonable.

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