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NIAGARA FALLS STORAGE SITE (NFSS)

ENVIRONMENTAL MONITORING REPORT

Calendar Year 1982

Prepared for the U.S. Department of Energy
Under Contract No. DE-AC05-810R20722

By
Bechtel National , Inc.
Nuclear Fuel Operations
P. O. Box 350
Oak Ridge, TN 37830

Date of Issue: May 1983

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ABSTRACT

At the Niagara Falls Storage Site all effluents (liquid and gaseous) are sampled regularly and analyzed to assess compliance with applicable environmental standards. Radioactivity is measured in air, water and sediments to allow calculation of radiation doses to the public. All site boundary radiation doses are well within Department of Energy standards, and non-radioactive effluents comply with federal standards. During remedial action activities the contaminant levels of effluents were controlled through chemical treatment and holding ponds. Site perimeter radon concentrations were reduced to near background levels by remedial action activities in areas where the bulk of radioactive residues are stored.

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INTRODUCTION

The purpose of this document is to report the findings of the environmental monitoring program for the Niagara Falls Storage Site (NFSS) for Calendar Year 1982. The following description of the site and its environs will permit better understanding of the reported results.

The NFSS occupies approximately 191 acres of land in western New York located within the town of Lewiston, Niagara County (Figure 1). The site is located 4 miles south of Lake Ontario, 10 miles north of the City of Niagara Falls, and 15 miles west of the City of Lockport.

The site is a remnant of an original 1,511-acre site which was used by the World War II Manhattan Engineer District (MED) project. This 1,511-acre site was a portion of the Department of the Army's Lake Ontario Ordnance Works (LOOW). The site's major use from 1944 to the present has been for storage of radioactive residues produced as by-products of uranium production during the MED project, and subsequent Atomic Energy Commission (AEC) projects.

Initially, materials stored at NFSS were pitchblende residues from the nearby Tonawanda, New York refinery. Following World War II, contaminated materials from other wartime plants and some contaminated materials from post-wartime operations were stored at the site.

In 1949, part of the high-grade pitchblende residues from a St. Louis processing facility were stored at the site in drums and subsequently transferred to a 165-foot high concrete silo. In the early 1950's, the site was used as an interim storage site for incoming and outgoing uranium billets. In addition, radioactive materials from the University of Rochester and Knolls Atomic Power

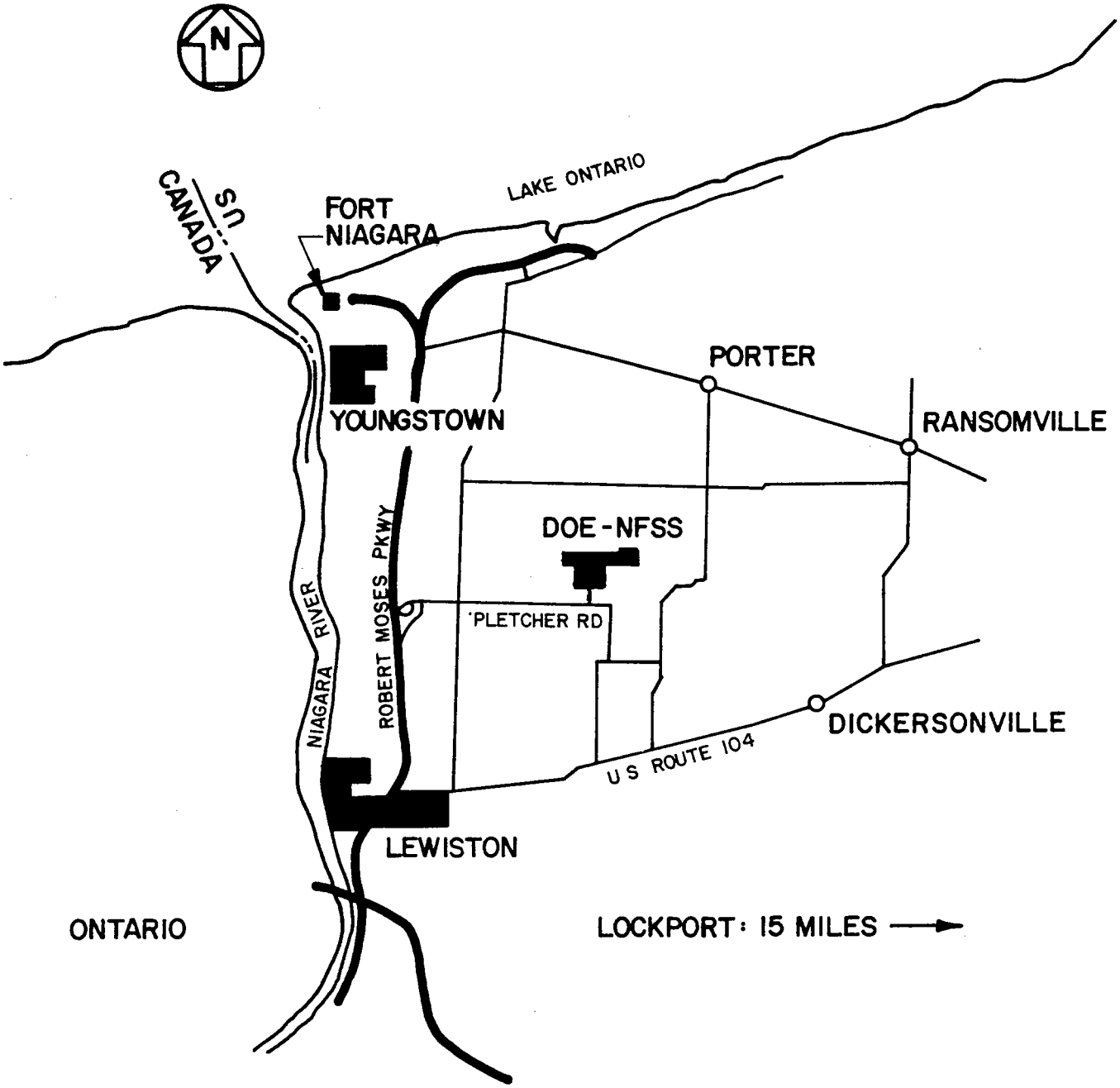

FIGURE 1
AREA MAP

Laboratory (KAPL) were transferred to the NFSS. (The KAPL wastes were later transferred to solid waste storage areas at Oak Ridge National Laboratory, Oak Ridge, Tennessee.)

In 1953, the AEC converted existing buildings, installed appropriate equipment, and began operating a boron isotopic separation plant at NFSS. The plant was placed in standby in 1958, restarted in 1964 and again put in standby in 1971. Subsequently, the equipment was sold and removed from the site. No radioactive materials were used in these plant operations.

In 1958, at the termination of uranium ore procurement contracts, a 25-year storage lease agreement was negotiated with AFRIMET-INDUSSA, Incorporated (AFRIMET), the U.S. subsidiary of Union Miniere du Haut Katanga of Brussels, Belgium (owner and supplier of Belgian Congo ore), for the storage of its residues in five concrete structures on the site. Approximately 60 percent (14,000 tons) of the radioactive residues stored at the site belongs to AFRIMET. The storage lease agreement expires on July 1, 1983.

By 1968, most of the property of the 1,511-acre site had been determined to be surplus and was sold, leaving the present 191-acre site. The site is now owned and managed by the U.S. Department of Energy (DOE) - the successor to the MED/AEC. Now used solely for storage of the low-level radioactive wastes, the NFSS has been designated a DOE Surplus Facility and is the responsibility of DOE's Division of Remedial Action Programs (DRAP). The site is managed under contract to DOE by Bechtel National, Inc., hereafter referred to as Bechtel.

A summary of the residues stored on the site is presented in Table 1. The table lists each residue's identification code, ownership, storage location and amounts by weight and volume. The R-10 residue pile includes soil and debris removed from other areas surrounding NFSS in 1972 and similar materials removed from an adjacent property in 1981.

TABLE 1: SUMMARY OF MAJOR PITCHBLENDE RESIDUES STORED AT THE DOE-NIAGARA FALLS STORAGE SITE

Residue I.D.	Ownership	Storage Location	Weight Tons	Volume Yds^3
K-65	AFRIMET(a)	Building 434	3,891	4,080
L-30	AFRIMET	Building 411	8,227	7,960(b)
L-50	AFRIMET	Buildings 413-414	1,878	2,150
F-32	AFRIMET	Recarbonation Pit	138	445
Middlesex Sands	U. S.	Building 410	2	230
R-10	U. S.	North of Building 411	8,235	9,400(c)

(a) AFRIMET-INDUSSA, Incorporated.

(b) This residue is also covered by water.

(c) Approximate volume at time of emplacement; excludes overburden.

The waste storage locations and other site features are illustrated in Figure 2. Features include the residue storage buildings (including Building 434, a 165-ft tower), service structures, a mound of contaminated soil, paved and gravelled roadways and drainage ditches.

The site is poorly drained because of the flatness of the terrain and soil characteristics. Soils at NFSS are predominantly silt loams underlain by a clayey glacial till. Sand-gravel inclusions are frequent. Bedrock lies 30 to 50 feet beneath the surface and consists of the thick (1,200 feet) Queenston shale.

All surface water from the site currently discharges via the Central Drainage Ditch and its tributary ditches into Fourmile Creek, located northwest of the site. Groundwater is present in an aquifer at the bedrock surface, in sand-gravel lenses and in saturated clay zones at depths of 5 to 20 feet. Groundwater level contours indicate a slope of the primary aquifer to the north-northwest of approximately 10 feet per mile. The groundwater discharges into the northern reaches of the Niagara River close to Lake Ontario.

Vegetation present at the site is mixed second-growth forest (maple, ash and oak), northern shrub, grass and aquatic emergents in the ditches. Secondary growth has been allowed since the early 1950's in most portions of the site, and the area is currently densely vegetated, furnishing an excellent wildlife habitat.

NFSS is located in a generally rural setting and is adjacent to a sanitary landfill and a chemical waste disposal facility. There are several nearby populated areas, including the village of Lewiston, the City of Porter, and the unincorporated areas of Youngstown and Ransomville (Figure 1). The nearest communities with substantial populations are Lewiston (population: 16,185), Youngstown (population: 2,196), Ransomville (population: 1,101) and Porter (population: 7,258).

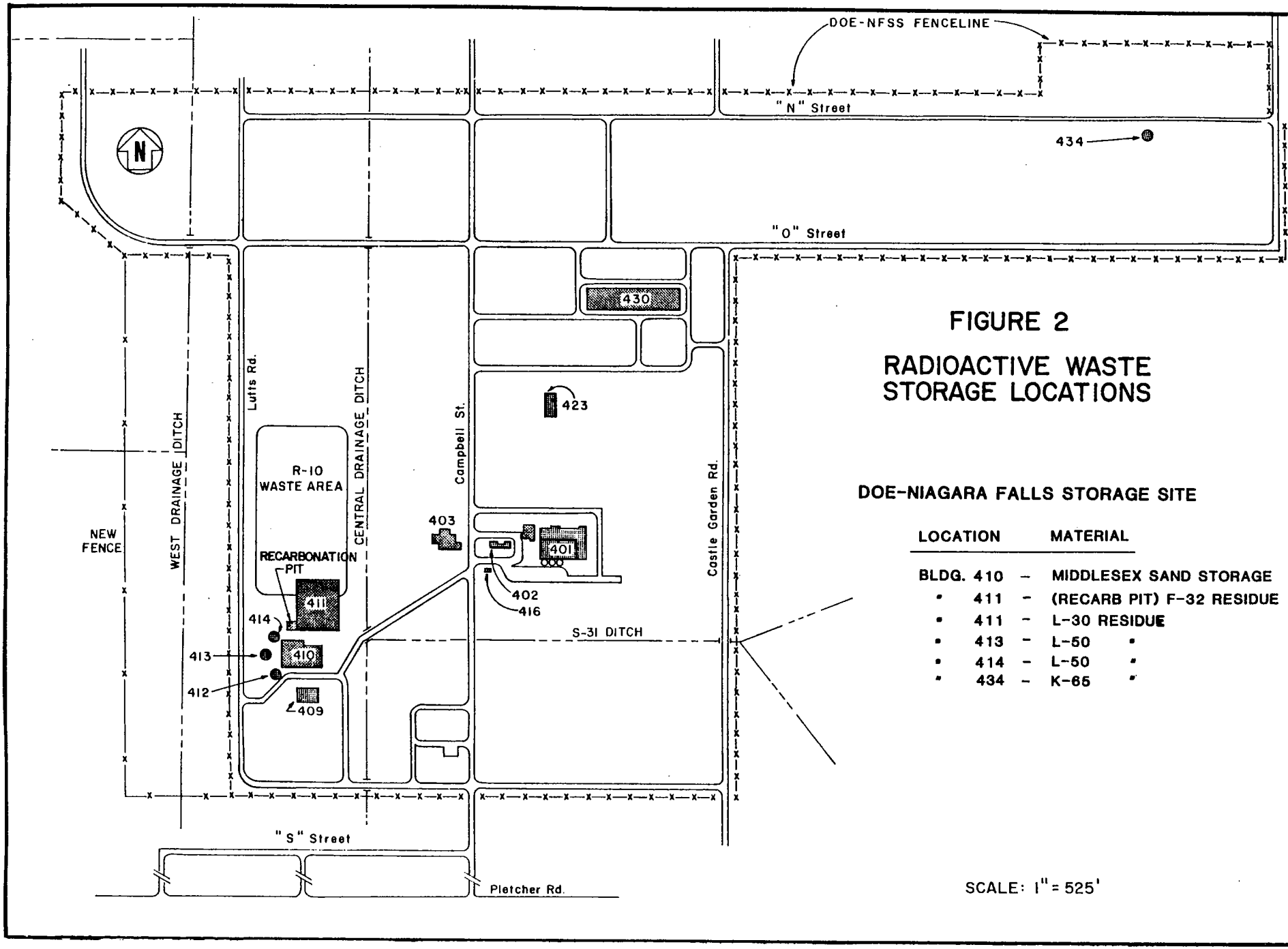

FIGURE 2

RADIOACTIVE WASTE STORAGE LOCATIONS

DOE-NIAGARA FALLS STORAGE SITE

LOCATION		MATERIAL
BLDG. 410	–	MIDDLESEX SAND STORAGE
" 411	–	(RECARB PIT) F-32 RESIDUE
" 411	–	L-30 RESIDUE
" 413	–	L-50 "
" 414	–	L-50 "
" 434	–	K-65 "

SCALE: 1" = 525'

SUMMARY

Air, water and drainage ditch sediment samples were collected both from the local environment and from the site's effluents. These samples were analyzed to determine compliance with applicable environmental quality standards.

Air and water radioactivity analyses indicated annual average concentrations well below the DOE-recommended Concentration Guides (CGs) at site boundaries.

The Central Drainage Ditch receives most of the surface water from the site. Uranium concentrations in sediment samples from onsite and offsite locations in the Central drainage ditch were within DOE limits. Radium concentrations at two onsite (Locations 10 and 11) and one offsite (Location 12) sample location exceeded limits by a factor of two. However, Locations 10, 11 and 12 are in the area scheduled for remedial action cleanup activities. All uranium and radium-226 results for surface water samples were less than nine percent of the DOE Concentration Guide limits. All uranium results for groundwater samples were less than one percent of the DOE Concentration Guide limits. All radium-226 results for groundwater samples were less than two percent of the DOE Concentration Guide limits.

Radon concentration at the site boundaries for 1982 were influenced by remedial activities in areas containing radioactive residues. Early in the year (May) radon levels at the NFSS west property line exceeded the DOE annual average limit because of soil disturbance type construction activities. Remedial actions in these areas were successful in reducing radon levels to near background for the remainder of the year for the west property line.

The maximum potential radiation dose to the public, based on measured levels of radon and external gamma radiation, was determined to be at the site boundary south of the K-65 tower

(Building 434). The radon and external gamma measurements include emanation from naturally-occurring radiation sources. The radiation doses are calculated on the basis that an individual would have to remain at the site boundary 24 hours per day for one year.

The radon dose is approximately one-third the DOE guideline of 1,500 mrem/year and is about equal to the annual average dose received nationally (NCRP-45) by the lungs from naturally-occurring gaseous radiation sources. The whole body dose from external gamma radiation would be 432 mrem/year or slightly less than four times the Western New York background (ORP/CSD 72-1). The dose to an individual who would eat 25 pounds of venison from a deer that had ranged on NFSS would be 0.05 mrem.

The calculated dose from uranium-238 and radium-226 in water to bone would be 0.8 percent of the Radiation Protection Standard of 1,500 mrem (DOE Order 5480.1A, Chapter XI). This dose is a small fraction of the natural background dose from internal emitters.

DATA COLLECTION, ANALYSIS, AND EVALUATION

GENERAL REMARKS

This section describes the various environmental standards applicable to the Niagara Falls Storage Site; the sampling, monitoring, and analytical procedures; and the extent of conformance with applicable standards. The average values listed in the individual tables are the arithmetic average of the sum of individual results. Individual sources of error (i.e., analytical error, sampling error, etc.) were not estimated. In computing the averages, where values are less than the limit of sensitivity of the analytical method, values are considered as being equal to the limit of sensitivity and the average value is reported without the notation, "less than."

CLIMATE

The climate of the site is classified as humid continental with considerable moderating influence from Lake Ontario. The normal temperature range is 25° to 76°F, with a mean annual temperature of 48°F. Mean annual precipitation is 32 inches. Snowfall averages 56 inches per year, accounting for five to six inches of the annual precipitation.

A meteorological data station was established at the site in August 1980 (Figure 2). Wind speeds and directions (Wind Rose) for 1982 are shown in Figure 3. Examination of the data shows that the wind originated predominantly from a 45° sector that includes west, west-southwest and southwest for a total of 31 percent of the time. Of this total time, velocities were 0-5 m/sec (meters per second) (0-11 mi/hr (miles per hour)) 69 percent of the time, 5.1-10 m/sec (11.4-22.4 mi/hr) 29 percent of the time, with velocities over 10 m/sec (22.4 mi/hr) being reached only about 2 percent of the time.

RADIOACTIVE MATERIALS

The Niagara Falls Storage Site is not a producer of radioactive material, but is a facility used for radioactive residue storage as discussed in the preceding section. The purpose of the remedial action operations presently underway at the site is to restrict the release of radioactive material from the site. The environmental monitoring program is performed to assure that this containment function is being fulfilled in conformance with DOE Orders.

Air Sampling: Thirty-three radon gas detectors (Terradex) were analyzed monthly (January through September) at 30 onsite and site boundary locations with three detectors designated as quality control samples (31, 32 and 33). On October 1, 1982, the radon gas monitoring program was revised to include one additional location (34) and to relocate detector 29 within the site's fenceline as shown in Figure 4.

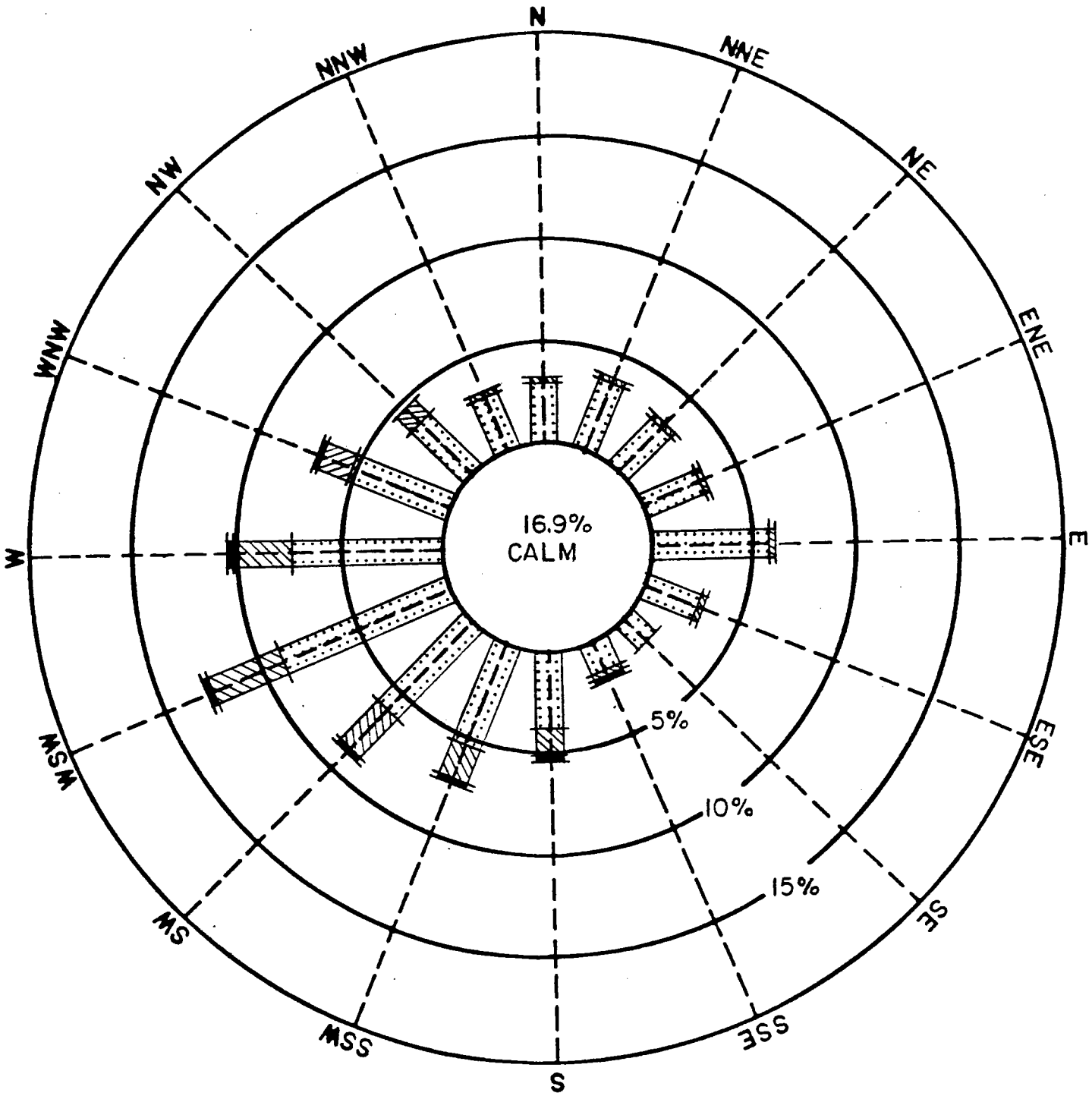

FIGURE 3

WIND ROSE FOR NIAGARA FALLS STORAGE SITE, 1982

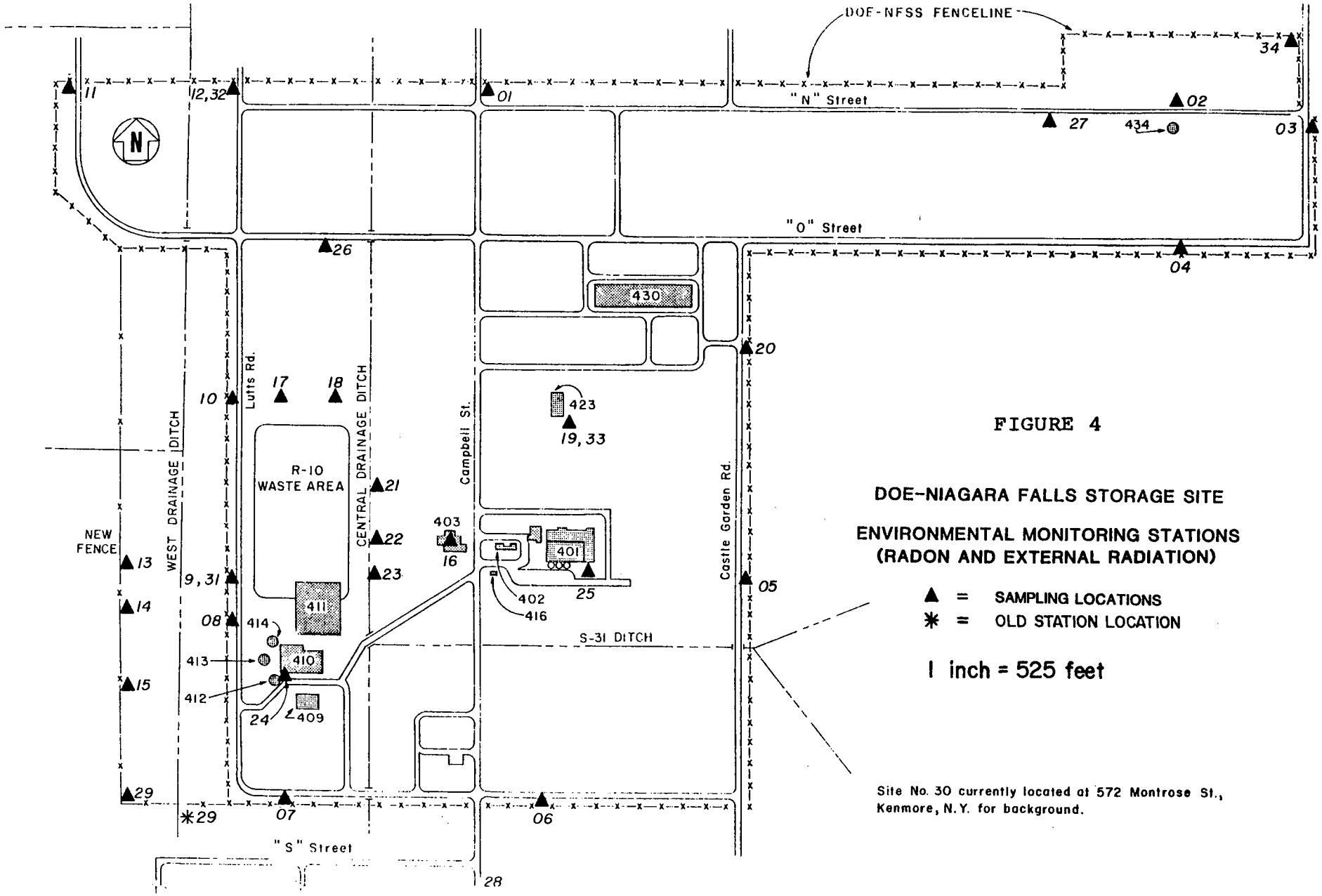

FIGURE 4

DOE-NIAGARA FALLS STORAGE SITE

ENVIRONMENTAL MONITORING STATIONS
(RADON AND EXTERNAL RADIATION)

▲ = SAMPLING LOCATIONS
✱ = OLD STATION LOCATION

1 inch = 525 feet

Site No. 30 currently located at 572 Montrose St., Kenmore, N.Y. for background.

The radon gas monitors were Terradex, Type-F Track-Etch detectors, with a reported minimum detection level of 1.0 pCi/l per month (picocuries per liter). Detectors were obtained from the Terradex Corporation, placed and collected at the sample locations by site personnel, then returned to Terradex for analytical services. The analyses results are summarized in Table 2.

DOE Order 5480.1A, Chapter XI, provides applicable Concentration Guides for controlled and uncontrolled areas (Appendix A). In 1982, the average concentrations of radon gas in the air at site boundary locations ranged from 0.60 to 1.15 pCi/l. This highest value is 38.3 percent of the Guide limit (3.0 pCi/l) for release to an uncontrolled area.

Radon-222 concentrations along the DOE western property line in the areas where the majority of residues are stored are monitored by Terradex stations 8, 9, and 10 (see Figure 4 for station locations). Pre-1982 concentrations observed at these stations reflected anticipated increases in radon levels during the summer months as ground and air temperatures increased. Monthly concentration values for Stations 8 and 9 for 1979, 1980 and 1981 are averaged with values for Station 10 (for 1981 only) and are plotted in Figure 5. Monthly averages for 8, 9, and 10 for 1982 are also shown, as are the times for various construction activities that were of such a nature to either enhance or reduce radon releases. During the three years of no significant site activities (1979-1981), it is seen that radon levels reached higher levels, as predicted, in the warmer months, peaking in August. For 1982, the average concentration for stations 8, 9, 10 reached a maximum in the month of May (8.1 pCi/l).

TABLE 2
Monthly Averages for Radon-222 Monitoring at Site Boundaries and New Exclusion Area[a]
Units = Picocuries per liter (pCi/l)

Month/ Sampling Location	1	3	4	5	6	7	8[b]	9[b]	10[b]
January[e]	—	—	—	—	—	—	—	—	—
February	0.36	0.07	0.17	0.36	0.27	0.17	0.27	0.86	0.76
March	0.27	0.27	0.27	0.37	0.77	1.07	4.08	5.18	2.67
April	1.33	0.94	0.36	0.07	0.55	2.01	4.63	4.92	4.24
May	1.57	0.83	0.40	0.50	0.40	1.25	6.82	12.97	4.46
June	0.80	0.52	1.36	1.36	0.99	0.99	2.28	2.00	1.08
July	1.55	0.56	0.56	0.46	0.46	0.66	1.45	1.25	0.80
August	1.44	0.79	1.44	1.44	0.71	0.71	1.20	0.71	0.38
September	2.58	1.57	1.65	1.48	1.65	2.26	2.42	2.09	2.09
October	1.68	0.48	0.66	0.14	0.31	1.30	0.95	0.95	1.48
November	0.72	0.30	0.55	0.22	0.30	0.55	0.30	0.55	2.61
December	0.29	0.29	0.37	0.37	0.69	0.21	1.09	0.37	0.61
Average[k]	1.15	0.60	0.71	0.62	0.65	1.02	2.32	2.97	1.93
No. of Measurements	11	11	11	11	11	11	11	11	11
Percent of[l] Standard	38.3	20	23.7	20.7	21.7	34.0	2.3[n]	3.0[n]	1.9[n]

a - These measurements are total radon concentrations and background has not been subtracted.
b - Sampling locations 8, 9, 10 and 31 are at the site's legal boundary and are in a controlled area.
c - Sampling locations 13, 14 and 15 are located at the perimeter of the new exclusion area established October 1, 1981.
d - Sample location established October 1, 1982.
e - Terradex detectors did not arrive at site in time for placement for exposure during January.
f - Terradex detectors were not exchanged due to flooding.
g - Terradex detector possibly exposed by contaminated soil during placement.
h - Terradex detector damaged.
i - Terradex detector missing from sample location.
j - Sampling location 29 relocated October 1, 1982; See Figure 4.
k - Average is calculated on the number of mesurements corresponding to an identical number of months.
l - The DOE Concentration Guide limit for radon-222 is 3 picocuries per liter of air for uncontrolled areas per DOE Order 5480.1A.
m - Offsite detector located at Pletcher Road Site entrance sign.
n - Percentage of standard calculated using controlled area Concentration Guide limit.

TABLE 2
Monthly Averages for Radon-222 Monitoring at Site Boundaries and New Exclusion Area
Units = Picocuries per liter (pCi/l)
(CONTINUED)

Month/ Sampling Location	11	12	13[c]	14[c]	15[c]	20	28[m]	29	31[b]	32	34[d]
January	___	___	___	___	___	___	___	___	___	___	___
February	0.17	0.27	0.17	0.07	0.17	0.46	0.07	0.46	3.66	0.38	___
March	0.67	1.17	0.77	___[f]	___[f]	0.47	0.37	0.37	2.88	0.47	___
April	0.85	1.14	0.55	___[f]	___[f]	1.04	0.65	7.73[g]	3.46	0.85	___
May	1.36	0.83	0.83	___[f]	___[f]	0.61	1.57	0.83	8.86	1.04	___
June	0.16	0.34	___[f]	___[f]	___[f]	0.89	1.08	0.99	___[h]	2.10	___
July	0.46	0.56	___[f]	___[f]	___[f]	1.25	0.27	0.46	___[h]	___[h]	___
August	0.95	___[h]	0.46	0.38	0.14	1.28	1.28	0.71	___[h]	0.63	___
September	3.33	2.66	2.42	1.28	3.07	0.98	1.77	1.77	2.75	2.49	___
October	1.08	___[i]	2.27	0.77	0.50	0.66	0.59	0.41[j]	0.95	___[h]	0.66
November	0.22	0.47	0.14	1.21	0.30	0.22	0.14	0.47	0.30	0.55	0.30
December	0.53	0.45	0.29	0.37	0.37	0.29	0.29	0.13	0.61	0.37	0.13
Average[k]	0.89	0.83	0.88	0.68	0.76	0.74	0.74	___[j]	2.61	0.99	0.36
No. of Measurements	11	9	9	6	6	11	11	___[j]	8	9	3
Percent of[l] Standard	29.7	27.7	29.3	22.7	25.3	24.7	24.7	___[j]	2.6[m]	33.0	12.0

ACTIVITY

1. CLEARING-R-10 AREA AND LUTTS ROAD AND O STREET
2. DIKE CUT OFF WALLS
3. DIKES: BACKFILL AND EMBANKMENT

4,5,6 7&8. PERIODS OF PLACEMENT OF SOIL EXCAVATED ON SITE ON R-10 PILE

9. R-10 LINER INSTALLATION
10. CLEAR AND GRUB: 413,414 AREA
11. ROOF REMOVAL: 413,414
12. BACKFILL: 413,414
13. HYPALON & EPDM INSTALLATION: 413,414

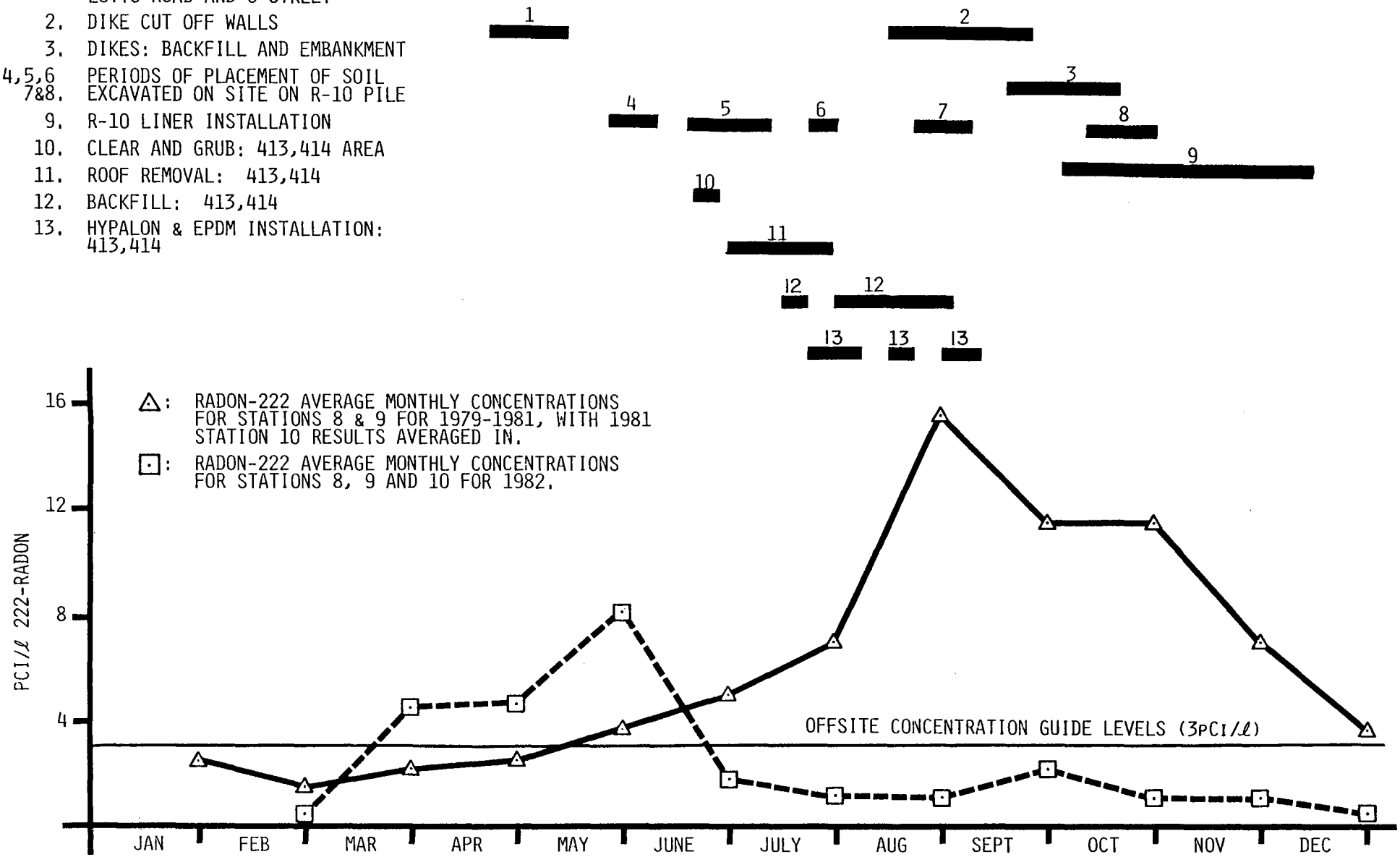

FIGURE 5

AVERAGE RADON-222 CONCENTRATIONS FOR NFSS WEST BOUNDARY AND 1982 RELATED SITE CONSTRUCTION ACTIVITIES

From Figure 5, a direct correlation is seen between enhanced radon emanations for late April and early May and clearing and grubbing in the immediate area of the R-10 pile. Loosening and relocating surface soils and materials allowed a substantial increase in radon release during this time. From the end of May through mid-September at five separate intervals (Activities 4, 5, 6, 7, and 8, Figure 5), soil excavated from several areas of the site was placed over the residues in the R-10 pile which resulted in a marked reduction in radon releases. Activities 10 and 11, Figure 5, undoubtedly enhanced radon releases; however, these were minor compared to the reduction in releases affected by the placement of soil on the R-10 residues (Activities 4 through 8), the sealing of Buildings 413 and 414 (Activities 12 and 13), as well as the R-10 liner installation (Activity 9). Following the highest level (of the year) seen for May, the average radon concentrations for Stations 8, 9, and 10, located on the west site boundary near the stored residues, never exceeded 2.5 pCi/1. As expected, the higher summer levels of previous years (1979-1981) were not reached following the remedial actions of 1982.

Water Sampling: Well water and surface water samples have been collected routinely at both onsite and offsite locations (Figures 6 and 7). Groundwater from wells drilled to a depth of about 25 feet was sampled at nine onsite wells around the major residue storage area (sample points 1-9, Figure 6). Groundwater draining from under Building 411 into a French drain was collected at points 13 and 14. Sampling point 15 was onsite tap water supplied from a municipal system; point 16 was offsite tap water from the same municipal main after it passed through the DOE site. Sampling points 17-19 are offsite wells approximately 25 feet deep.

Surface water was collected from the Central Drainage Ditch at points 10, 11, 12 and 20. Point 10 is at the head of the ditch near the R-10 storage area. Point 11 is at the northern boundary of the site. Points 12 and 20 are one mile and two miles, respectively, downstream from the site's northern boundary.

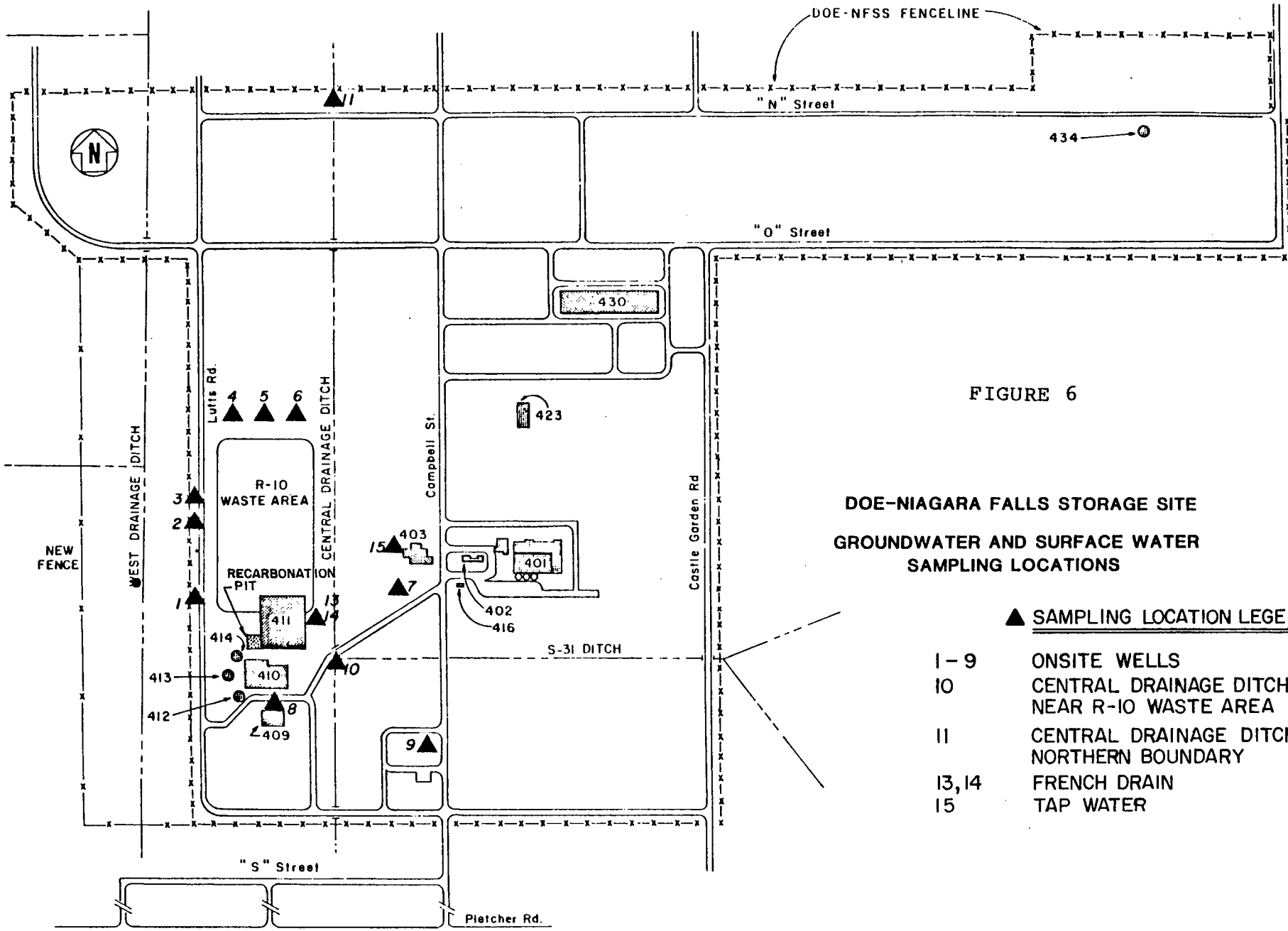

FIGURE 6

DOE-NIAGARA FALLS STORAGE SITE

GROUNDWATER AND SURFACE WATER SAMPLING LOCATIONS

▲ SAMPLING LOCATION LEGEND

1 - 9	ONSITE WELLS
10	CENTRAL DRAINAGE DITCH NEAR R-10 WASTE AREA
11	CENTRAL DRAINAGE DITCH NORTHERN BOUNDARY
13,14	FRENCH DRAIN
15	TAP WATER

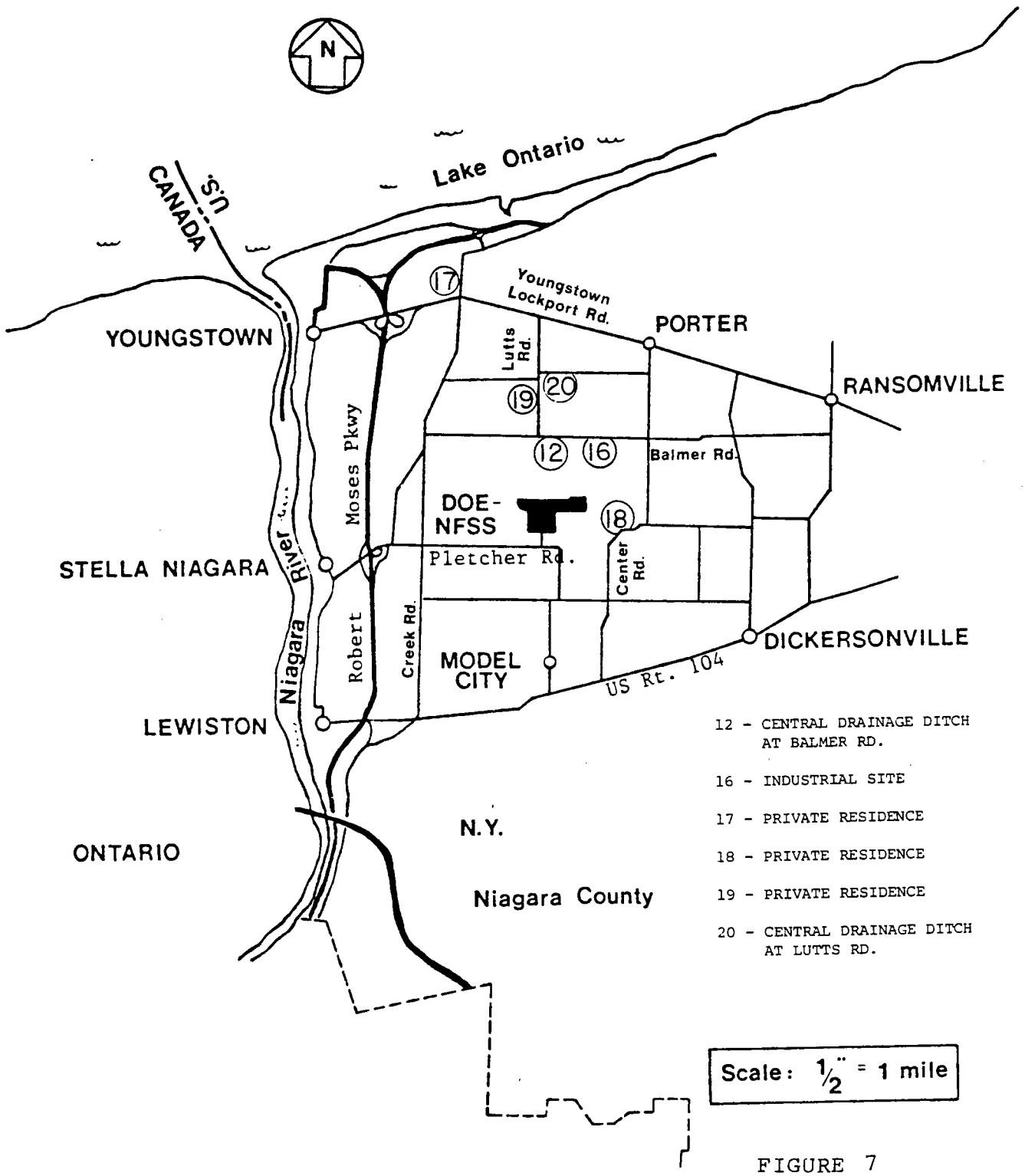

FIGURE 7

OFFSITE WATER SAMPLING LOCATIONS

Samples 1 through 15 and 20 were collected quarterly, whereas samples 16 through 19 were collected annually. Well samples were collected 24 hours after the well had been pumped "dry" or two casing volumes removed. Standing well water was removed by means of an airlift well sampler. Each well had its own collection equipment to prevent cross contamination of samples.

A series of two samples was collected from the 8-inch concrete pipe draining the French drain under Building 411. Standing water in the French drain was pumped out. When water can be seen flowing via the 8-inch pipe into the well, the first sample was collected (No. 13). Another sample (No. 14) was collected one hour after the first to provide a representative measurement of any water in the drain.

The uranium and radium-226 results for calendar year 1982 are presented in Tables 3 and 4, respectively. Uranium values ranged from <0.005 to 0.360 mg/l with radium-226 levels ranging from <0.1 to 3.6 pCi/l. The maximum uranium value was from a sample collected at sample point 14 (onsite French drain) during the third quarter. The maximum radium-226 value was from a sample collected at sample point 11 (site boundary surface water in Central Drainage Ditch) also during the third quarter.

Sample point 20 showed the highest yearly-average uranium concentration (0.059 mg/l) measured at any of the offsite locations. Sample point 11 had the highest yearly-average radium-226 concentration (1.5 pCi/l) and uranium concentration (0.164 mg/l) measured for a site boundary location. All uranium and radium-226 results for water samples were less than nine percent of the DOE Concentration Guide limits.

Site Boundary/Exclusion Area Exposure Levels From External Radiation: External gamma radiation exposure levels were determined at different locations along the boundaries of the site and the exclusion area (established October 1, 1981) using lithium-fluoride (LiF) thermoluminescent dosimeters (TLD). Each dosimeter contains

Table 3
Uranium Concentrations in Water, 1982
Units = mg/l[a]

Sampling Location	Quarters 1st	2nd	3rd	4th	No. of Samples	Minimum	Maximum	Average	Percent of Standard[b]
1	0.006	0.006	<0.005	0.008	4	<0.005	0.008	0.006	0.30
2	<0.005	<0.005	<0.020	0.007	4	<0.005	0.020	0.009	0.45
3	<0.005	<0.005	<0.010	<0.005	4	<0.005	<0.010	0.006	0.30
4	0.006	<0.005	0.010	0.008	4	<0.005	0.010	0.007	0.35
5	<0.005	<0.005	<0.005	0.009	4	<0.005	0.009	0.006	0.30
6	<0.005	<0.005	0.012	<0.005	4	<0.005	0.012	0.007	0.35
7	<0.005	<0.005	0.012	0.007	4	<0.005	0.012	0.007	0.35
8	<0.005	<0.005	0.010	<0.005	4	<0.005	0.010	0.006	0.30
9	<0.005	<0.005	0.019	0.010	4	<0.005	0.019	0.010	0.50
10[c]	0.055	0.092	0.270	0.042	4	0.042	0.270	0.115	0.002[d]
11	0.130	0.170	0.300	0.056	4	0.056	0.300	0.164	8.2
12	0.034	0.045	0.130	0.015	4	0.015	0.130	0.056	2.8
13[c]	0.240	0.110	0.320	0.130	4	0.110	0.320	0.200	0.003[d]
14[c]	0.210	<0.005	0.360	0.110	4	<0.005	0.360	0.171	0.003[d]
15	<0.005	<0.005	<0.005	0.042	4	<0.005	0.042	0.014	0.70
16[e]	<0.005	———	———	———	1	———	———	———	<0.25
17[e]	0.013	———	———	———	1	———	———	———	0.65
18[e]	<0.005	———	———	———	1	———	———	———	<0.25
19[e]	<0.005	———	———	———	1	———	———	———	<0.25
20	0.027	0.022	0.150	0.035	4	0.022	0.150	0.059	2.95

a - Concentrations in mg/l can be converted to pCi/l by multiplying by 333.

b - DOE Concentration Guide for uranium in water in uncontrolled areas is 2 mg/l.

c - The DOE Concentration Guide limit for uncontrolled areas does not apply to this onsite sampling point.

d - DOE Concentration Guide for uranium in water in controlled areas is 60 mg/l.

e - Annual sample only.

Table 4

Radium-226 in Water, 1982

Units = picocuries per liter (pCi/l)

Sampling Location	Quarters 1st	2nd	3rd	4th	No. of Samples	Minimum	Maximum	Average	Percent of Standard[a]
1	<0.1	0.3 ± 0.1	0.2 ± 0.1	0.5 ± 0.2	4	<0.1	0.5	0.3	1.0
2	0.2 ± 0.1	0.2 ± 0.1	<0.1	0.1 ± 0.1	4	<0.1	0.2	0.2	0.7
3	0.3 ± 0.1	0.3 ± 0.1	0.2 ± 0.1	0.1 ± 0.1	4	0.1	0.3	0.2	0.7
4	0.1 ± 0.1	0.3 ± 0.1	0.4 ± 0.1	0.7 ± 0.2	4	0.1	0.7	0.4	1.3
5	0.2 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	<0.1	4	<0.1	0.2	0.1	0.3
6	0.1 ± 0.1	0.2 ± 0.1	0.4 ± 0.1	0.2 ± 0.1	4	0.1	0.4	0.2	0.7
7	0.3 ± 0.1	<0.1	0.3 ± 0.1	0.2 ± 0.1	4	<0.1	0.3	0.2	0.7
8	0.3 ± 0.1	0.2 ± 0.1	0.4 ± 0.1	0.2 ± 0.1	4	0.4	0.2	0.3	1.0
9	0.2 ± 0.1	<0.1	0.3 ± 0.1	0.4 ± 0.1	4	<0.1	0.4	0.3	1.0
10[b]	0.1 ± 0.1	0.6 ± 0.2	1.0 ± 0.3	0.6 ± 0.2	4	0.1	1.0	0.6	0.2[c]
11	1.0 ± 0.3	0.5 ± 0.2	3.6 ± 1.1	1.0 ± 0.3	4	0.5	3.6	1.5	5.0
12	0.5 ± 0.2	0.8 ± 0.2	1.4 ± 0.4	0.4 ± 0.1	4	0.4	1.4	0.8	2.7
13[b]	0.4 ± 0.1	0.5 ± 0.2	1.4 ± 0.4	0.6 ± 0.2	4	0.4	1.4	0.7	0.2[c]
14[b]	0.3 ± 0.1	0.7 ± 0.2	0.7 ± 0.2	0.7 ± 0.2	4	0.3	0.7	0.6	0.2[c]
15	0.2 ± 0.1	0.4 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	4	0.2	0.4	0.3	1.0
16[d]	0.1 ± 0.1	———	———	———	1	—	—	—	0.3
17[d]	0.3 ± 0.1	———	———	———	1	—	—	—	1.0
18[d]	0.1 ± 0.1	———	———	———	1	—	—	—	0.3
19[d]	0.4 ± 0.1	———	———	———	1	—	—	—	1.3
20	0.6 ± 0.2	0.6 ± 0.1	0.9 ± 0.3	0.3 ± 0.1	4	0.3	0.9	0.6	2.0

a – DOE Concentration Guide for radium-226 in water in uncontrolled areas is 30 pCi/l.

b – The DOE Concentration Guide for uncontrolled areas does not apply to this onsite sampling point.

c – DOE Concentration Guide for radium-226 in water in controlled areas is 400 pCi/l.

d – Annual sample only.

five individual TLD chips whose responses were averaged. At the 95 percent confidence level the error for dosimeter results was approximately ±25 percent. The dosimeters were changed quarterly. Fifteen site boundary and exclusion area perimeter locations were monitored during January 1 through September 30, as shown in Figure 8. At the beginning of the fourth quarter, the TLD monitoring program was expanded to provide a unified monitoring effort in conjunction with the radon (Terradex) monitoring program. The total external radiation monitoring program (offsite and onsite) was increased from 18 to 34 monitoring locations with 19 of these being located on the site boundary and the perimeter of the exclusion area. All of these new locations correspond to radon (Terradex) detector locations as shown in Figure 4.

The results for the first three quarters (January - September) are summarized in Table 5. Radiation levels measured at all but five of the monitored points were within the normal background range of 10 to 15 μR/hr. Of the five locations with elevated levels, three (stations 3, 4 and 5) were adjacent to the R-10 storage pile area and two (Stations 13 and 14) were near Building 434 (the K-65 tower). Three of the five elevated levels (Stations 3, 4, and 5) were at the site boundary, but in the fenced exclusion area (established October 1, 1981) where members of the public would not be exposed. The other two elevated levels (Stations 13 and 14) were at the site boundary where members of the public could possibly be exposed.

The results for the fourth quarter (October - December) are summarized in Table 6. Radiation levels measured at all but nine of the monitored points were within the normal background range. Of the nine locations where levels were elevated, three (Stations 3, 4 and 34) are near Building 434 (the K-65 tower); two (Stations 5 and 20) are on the east perimeter; and four (Stations 8, 9, 10 and 31) are at the site boundary but in a controlled area (due to the fenced exclusion area) where members of the public would not be exposed. In the highly unlikely event that a person remained at the point of

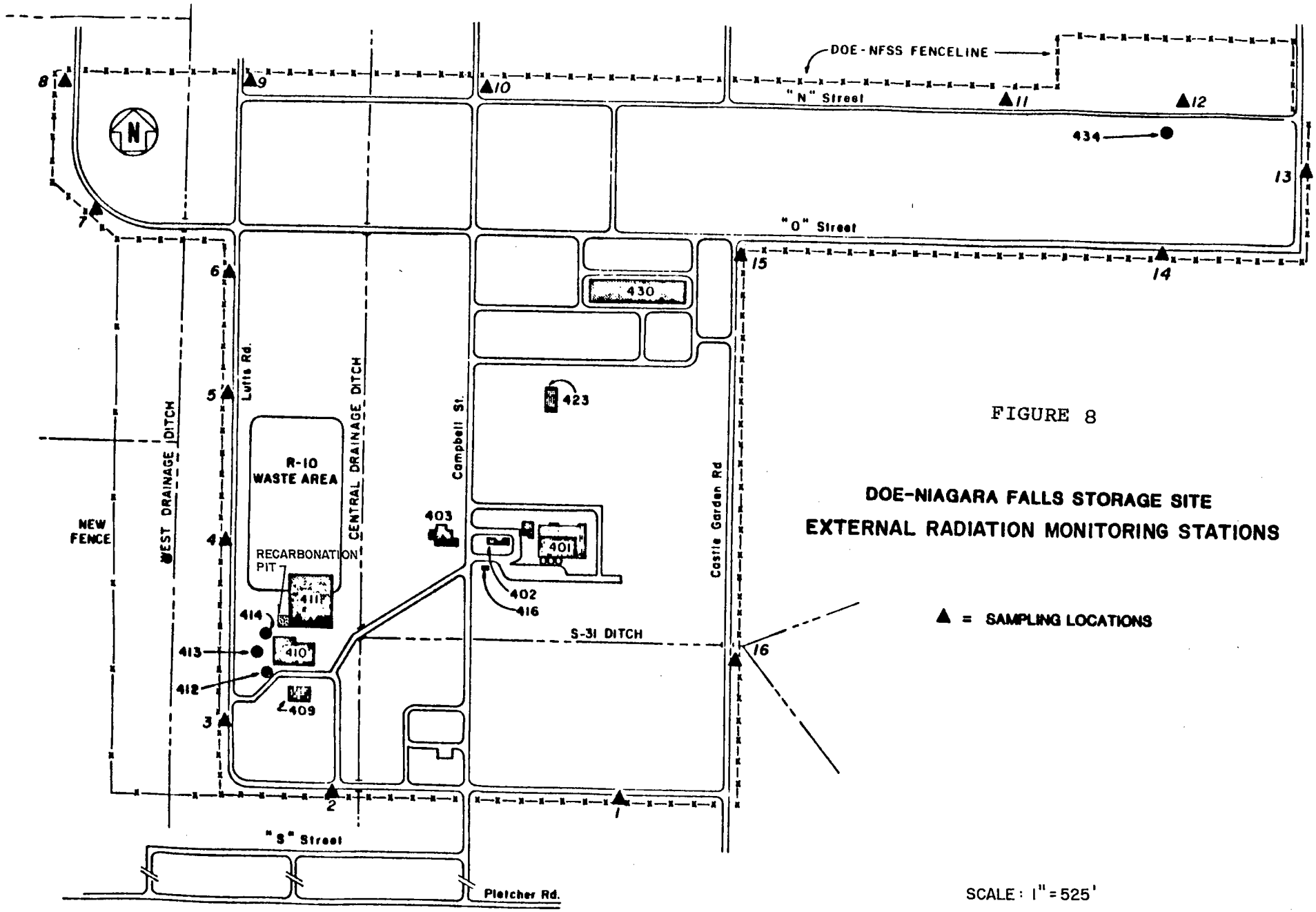

FIGURE 8

DOE-NIAGARA FALLS STORAGE SITE
EXTERNAL RADIATION MONITORING STATIONS

▲ = SAMPLING LOCATIONS

TABLE 5

Boundary and Exclusion Area External Radiation Levels Due to Gamma Radiation, 1982 [a, b]

Units = Average Response in μR/hr[c]

Sampling[d] Location	No. of Measurements	Minimum	Maximum	Average[e]
Control	3	5.4	11.4	9.1
1	3	8.3	9.3	8.8
2	2[f]	12.8	13.8	13.3
3	3	16.4	17.5	17.0
4	3	48.7	56.8	54.6
5	3	23.9	98.4	75.2
6	3	8.7	15.9	15.3
7	3	9.4	11.8	10.5
8	3	8.8	11.8	10.0
9	3	8.0	11.2	9.5
10	3	9.8	12.5	10.8
11	3	10.8	12.5	11.4
13	3	27.8	29.7	29.0
14	3	40.9	59.5	52.6
15	3	12.0	12.8	12.8
16	2[f]	10.5	12.0	11.3

a - Background equals 10 to 15 μR/hr.

b - TLD detectors exposed quarterly during January 1 - September 30, 1982 at old numbered sample locations.

c - Reported at the 95 percent confidence level.

d - Sample location 12 is an onsite detector.

e - Average is based on three quarter's results (except as noted in f).

f - TLD detector missing, average based on two quarter's results.

TABLE 6

Boundary and Exclusion Area External Radiation Levels Due to Gamma Radiation, Fourth Quarter, 1982[a,b,c]

Units = Average Response in μR/hr[d]

Sampling Locations[e]	No. of Measurements	Fourth Quarter Average
Control	1	10.0
1	1	12.5
3	1	27.9
4	1	40.0
5	1	20.4
6	1	13.0
7	1	15.0
8	1	29.7
9	1	40.7
10	1	16.6
11	1	[f]
12	1	[f]
13	1	[f]
14	1	7.8
15	1	12.5
20	1	29.9
29	1	10.6
31	1	38.6
32	1	11.5
34	1	19.8

a - Background equals 10 to 15 μR/hr.

b - TLD detectors exposed October 1 - December 31, 1982 at new numbered sample locations.

c - TLD's used for external radiation monitoring were relocated to correspond with Terradex radon detector locations October 1, 1982; see Figure 4.

d - Reported at the 95 percent confidence level.

e - Sample locations 2, 16-19, 21-28, 30 and 33 are onsite detectors.

f - Detector missing from sample location.

maximum exposure on the site boundary (monitoring location new number 4 and old number 14) for 24 hours per day for an entire year, his yearly exposure would be 432mR ± 85mR, or slightly less than four times natural background [110 mrem-Western New York] (ORP/CSD 72-1) and 86 percent of the DOE radiation protection guide (DOE Order 5480.1A, Chapter XI) for an individual member of the general public.

Sediment Monitoring: During the fourth quarter of 1982, drainage ditch sediment samples were collected at four surface water sample locations: 10, 11, 12 and 20 (Figures 6 and 7). The analytical results, based on dry weight, are presented in Table 7.

Uranium concentrations in sediment samples from the ditch were within DOE limits. Radium concentrations in two onsite (Locations 10 and 11) and one offsite (Location 12) samples exceeded limits by a factor of two. However, Locations 10, 11 and 12 are in the area scheduled for remedial action cleanup activities.

Radiological Data From Other Entities: Mound Laboratories (Mound), Monsanto Research Corporation monitored 14 locations on the NFSS boundary and at 30 offsite locations. Mound's program uses detectors called passive environmental radon monitors (PERMS) which have a thermoluminescent dosimeter (TLD) as the detection element. The TLD's are changed on a weekly basis.

Results for the 14 onsite perimeter locations are given in Table 8. Figure 4 shows their locations which are the same as Bechtel radon monitoring locations for monitors numbered 1-12. Monitors 13 and 14 are located on the southwest boundary of the site. The Mound results expressed as quarterly averages ranged from 0.13 to 4.6 pCi/l.

A comparison of the results of these two independent radon monitoring programs shows that the Terradex results were, on the average, 18 percent higher than the average result for all comparable locations. However, the largest differences were for measurements at levels near natural background. For all values

TABLE 7

Uranium and Radium Concentrations
in Central Drainage Ditch Sediments, 1982

Sampling Location	No. of Measurements	Uranium (pCi/g)[a,b]	Radium (pCi/g)[a,c]
10	1	17.6	7 ± 2
11	1	13.5	9 ± 3
12	1	4.9	9 ± 3
20	1	0.9	1.7 ± 0.5

a - Based on dry weight.

b - DOE FUSRAP Proposed Guideline for cleanup for uranium in soil is 75 pCi/g (40 CFR 192).

c - DOE FUSRAP Proposed Guideline for cleanup for radium in soil is <5 pCi/g above background in the top 15 cm and <15 pCi/g averaged over 15-cm thick layers more than 15 cm below surface (40 CFR 192).

TABLE 8

Summary of Data for Onsite Passive
Environmental Radon Monitors, 1982[a,b]
Units - Picocuries per liter (pCi/l)

Sampling	Quarterly Averages							Percent of
Location	1st	2nd	3rd	4th	Minimum	Maximum	Average[c]	Standard[d]
1	0.34	0.64	0.70	0.76	0.34	0.76	0.61	20.3
2	0.17	0.33	0.44	0.37	0.17	0.44	0.33	11.0
3	0.15	0.32	0.40	0.38	0.15	0.40	0.31	10.3
4	0.18	0.42	0.56	0.46	0.18	0.56	0.41	13.7
5	0.13	0.48	0.47	0.40	0.13	0.48	0.37	12.3
6	0.20	0.49	0.47	0.43	0.20	0.49	0.40	13.3
7	0.50	1.1	0.82	0.94	0.50	0.94	0.84	28.0
8	1.9	3.1	1.3	1.0	1.0	3.1	1.83	61.0[f]
9	3.0	4.6	1.5	0.95	0.95	4.6	2.5	83.3[f]
10	1.7	3.2	0.80	0.94	0.94	3.2	1.7	56.7[f]
11	0.38	0.90	0.77	0.43	0.38	0.90	0.62	20.7
12	0.36	0.62	0.57	0.73	0.36	0.73	0.57	19.0
13[e]	0.25	0.62	0.52	0.44	0.25	0.62	0.46	15.3
14[e]	0.41	0.64	0.59	0.49	0.41	0.64	0.53	17.7

a - Measurements by Mound Laboratory, Monsanto Research Corporation.

b - These measurements are total radon concentrations and background has not been subtracted.

c - Average is calculated on the number of measurements corresponding to an identical number of quarters.

d - The DOE Concentration Guide limit for radon-222 is 3 picocuries per liter of air for uncontrolled areas per DOE Order 5480.1A.

e - Monitoring was initiated at this location on March 23, 1982. The first quarter value is the average for one week only.

f - Monitoring locations are within a controlled area where members of the public cannot enter.

above 1.0 pCi/l, the average difference was only 11 percent. These differences were within the typical measurement error ranges associated with either monitoring system.

The 1982 results for the 30 offsite locations are presented in Table 9 and locations are shown in Figures 9 and 10. Quarterly values ranged from 0.07 to 0.54 pCi/l and averaged 0.25 pCi/l for the 1982 average natural background.

Quality Assurance: Established procedures were followed in the collection and analysis of environmental samples. Eberline Instrument Corporation's internal quality control program consists of duplicates, spikes and blanks. Eberline's internal quality control results were compared monthly with EPA crosscheck program results.

RADIOLOGICAL EXPOSURE

The radiation doses to members of the general public living in the vicinity of NFSS were calculated using dose assessment models recommended in Appendix B of Report ERDA 77-24 "A Guide for Environmental Radiological Surveillance at ERDA Installations" and using the available environmental data. Doses were calculated assuming continuous residency for a person hypothetically at the site boundary, for a person living 1600 feet southwest of the site and for a person who had eaten 25 pounds of venison from a deer that had ranged on the site.

The dose to a person who had resided continuously at the site boundary south of Building 434 (K-65 Tower) was calculated based on radon levels and external gamma exposure rate measurements at that point on the site boundary. This point would produce the maximum possible dose at an NFSS boundary site. The individual would have to remain at the point 24 hours per day for one year to incur the doses listed below.

TABLE 9

Summary of Data for Offsite Passive Environmental Radon Monitors, 1982[a,b]

Units - Picocuries per liter (pCi/l)

Sampling	Quarterly Averages							Percent of
Location	1st	2nd	3rd	4th	Minimum	Maximum	Average[c]	Standard[d]
LE01	0.07	0.19	0.20	0.29	0.07	0.29	0.19	6.3
LE02	0.11	0.18	0.31	0.29	0.11	0.31	0.22	7.4
LE03	0.07	0.20	0.40	0.41	0.07	0.41	0.27	9.0
LE04	0.08	0.15	0.25	0.32	0.08	0.32	0.20	6.7
LE05	0.08	0.19	0.34	0.41	0.08	0.41	0.26	8.5
LE06	0.12	0.21	0.33	0.29	0.12	0.33	0.24	7.9
LE07	0.09	0.13	0.23	0.30	0.09	0.30	0.19	6.3
LE08	0.17	0.23	0.48	0.47	0.17	0.48	0.34	11.3
LE09	0.09	0.22	0.41	0.39	0.09	0.41	0.28	9.3
LE10	0.09	0.21	0.50	0.47	0.09	0.50	0.32	10.6
LE11	0.14	0.16	0.26	0.34	0.14	0.34	0.23	7.5
LE12	0.11	0.16	0.27	0.34	0.11	0.34	0.22	7.3
LE13	0.07	0.16	0.16	0.19	0.07	0.19	0.15	4.8
LE14	0.10	0.13	0.20	0.28	0.10	0.28	0.18	5.9
LE15	0.11	0.21	0.35	0.44	0.11	0.44	0.28	9.3
LE16	0.11	0.20	0.33	0.41	0.11	0.41	0.26	8.8
LE17	0.08	0.14	0.20	0.28	0.08	0.28	0.18	5.8
LE18	0.08	0.15	0.27	0.32	0.08	0.32	0.21	6.8
LE19	0.08	0.10	0.14	0.22	0.08	0.22	0.14	4.5
LE20	0.11	0.27	0.45	0.29	0.11	0.45	0.28	9.3
LE21	0.16	0.31	0.50	0.48	0.16	0.50	0.36	12.1
LE22	0.19	0.31	0.54	0.52	0.19	0.54	0.39	13.0
LE23	0.09	0.22	0.39	0.51	0.09	0.51	0.30	10.1
LE24	0.12	0.18	0.26	0.42	0.12	0.42	0.25	8.2

Table 9 (continued)

Sampling Location	Quarterly Averages 1st	2nd	3rd	4th	Minimum	Maximum	Average[c]	Percent of Standard[d]
LE25	0.07	0.30	0.35	0.35	0.07	0.35	0.27	8.9
LE26	0.10	0.23	0.36	0.45	0.10	0.45	0.29	9.5
LE27	0.10	0.21	0.44	0.49	0.10	0.49	0.31	10.3
LE28	0.09	0.15	0.31	0.38	0.09	0.38	0.23	7.8
LE29	0.08	0.14	0.27	0.39	0.08	0.39	0.22	7.3
LE30	0.09	0.14	0.23	0.31	0.09	0.31	0.19	6.4

a - Measurements by Mound Laboratory, Monsanto Research Corporation.

b - These measurements are average radon concentrations for the locations in the outdoor control group. Values ranged from 0.07 to 0.54 pCi/l and averaged 0.25 pCi/l for 1982 average natural background.

c - Average is calculated on the number of measurements corresponding to an identical number of quarters.

d - The DOE Concentration Guide limit for radon-222 is 3 picocuries per liter of air for uncontrolled areas per DOE Order 5480.1A, Chapter XI.

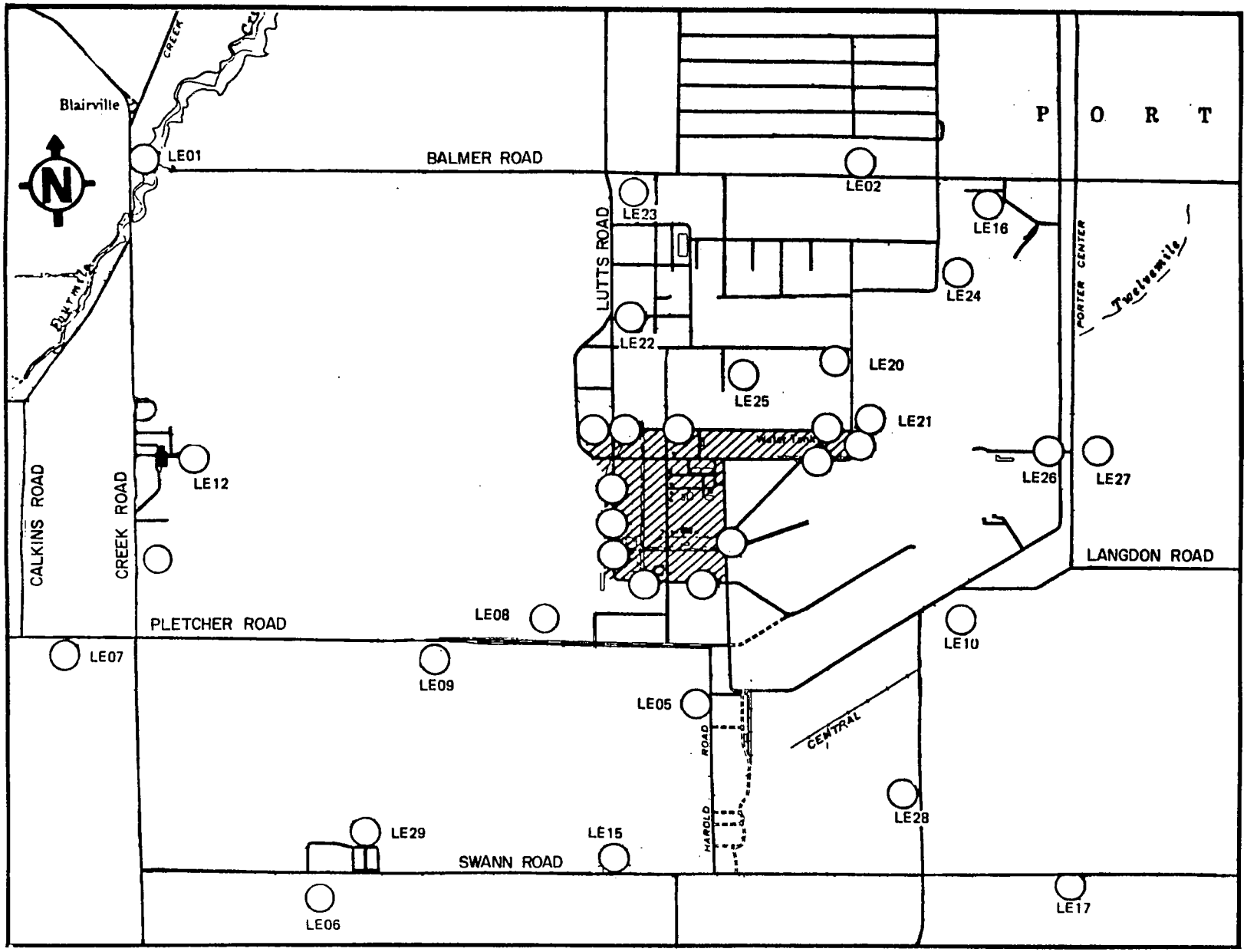

FIGURE 9

OFFSITE AND SITE BOUNDARY RADON MONITORING (MOUND LABORATORY) LOCATIONS

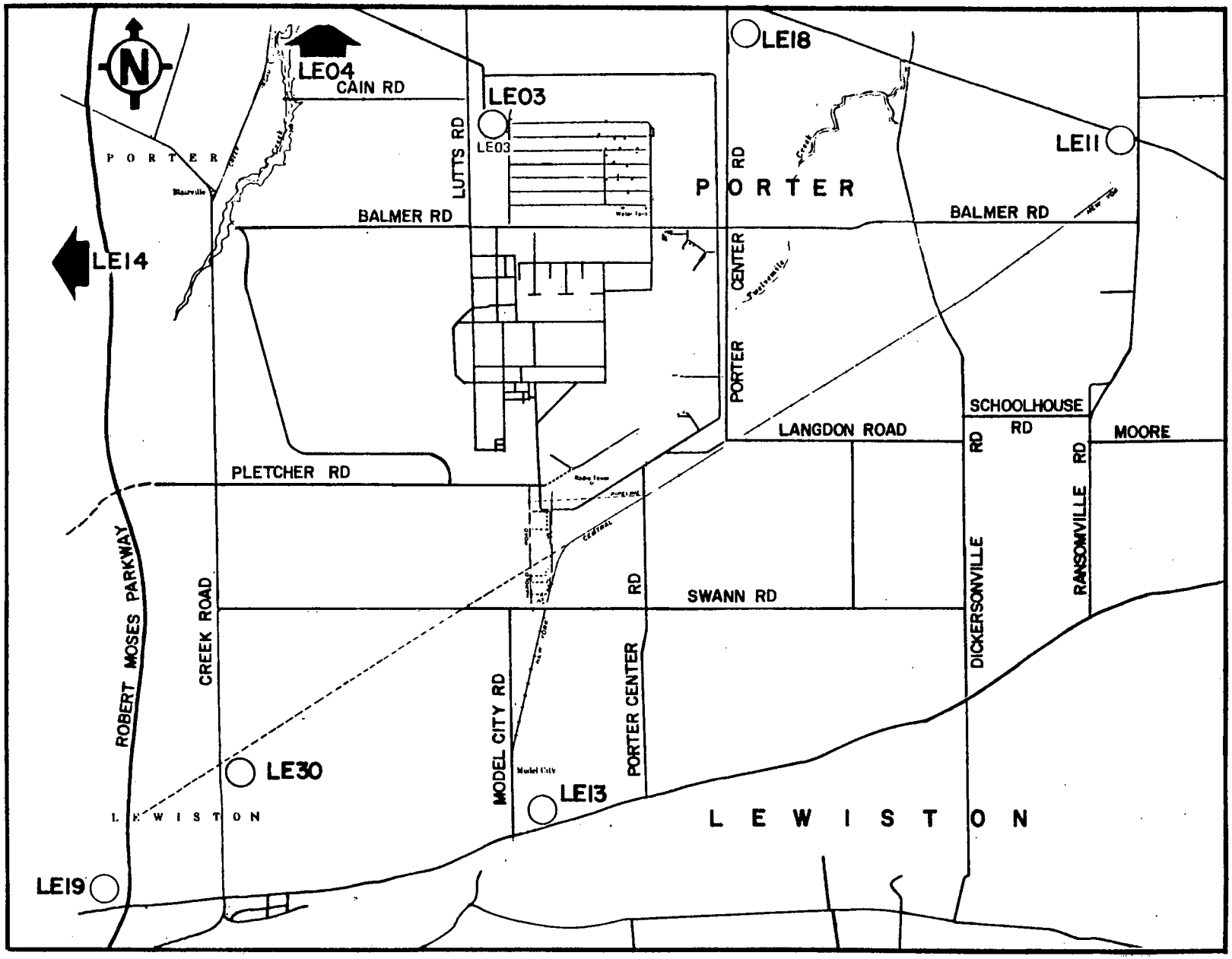

FIGURE 10

EIGHT OFFSITE RADON MONITORS AT GREATER THAN 2,000 METERS FROM SITE

Based on the environmental data, the dose to the bronchial epithelium of this individual would be 450 mrem per year due to inhalation of radon and radon daughter products. This dose is about one third of the annual dose limit, 1500 mrem, and approximately equal to the annual average dose received by the lungs from naturally occurring gaseous radiation sources.

The whole body dose from external gamma radiation would be 432 mR $\pm$ 85 mR per year, or slightly less than four times natural background [110 mrem - Western New York] ORP/CSD 72-1) and 86 percent of the DOE radiation protection guide (DOE 5480.1A) for an individual member of the general public.

The dose to an individual residing 1600 feet southwest of the site is due primarily to inhalation of radon and radon daughter products emanating from the site. The dose to the bronchial epithelium of such an individual would be approximately 5 mrem per year, which is equivalent to a one percent increase in the exposure rate due to naturally occurring sources of radon (NCRP-45). A one percent change in dose is within the range of normal fluctuations in dose caused by natural environmental factors.

The internal dose to a person who hypothetically obtains all of his water (for drinking, food processing, plant irrigation, etc.) from the only NFSS boundary discharge point (Location 11) has been calculated. The maximum dose from radium-226 would be approximately four mrem per year and from uranium-238 would be approximately eight mrem per year to the bone. This calculated dose is a small fraction of the natural background dose from internal emitters. The total dose of 12 mrem to bone would be 0.8 percent of the Radiation Protection Standard of 1,500 mrem (DOE Order 5480.1A, Chapter XI).

The dose to an individual who eats 25 pounds of venison from deer that have ranged on NFSS would be 0.05 mrem. The doses calculated for the assumed resident at the location southwest of the site and person eating venison obtained onsite are small fractions of the

doses incurred due to naturally occurring sources of radium-226 and radon. The average exposure to members of the public residing in the surrounding areas would be significantly less than those postulated above.

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APPENDIX A
ENVIRONMENTAL STANDARDS

Radioactivity Concentration Guides (CGs): The applicable guides provide the limits for maximum permissible radioactivity both onsite (controlled area) and beyond the external perimeter of the site (uncontrolled area) DOE Order 5480.1A, Chapter XI. The guides for the common radionuclides at the NFSS are presented in Table A-1.

Table A-1
Radioactivity Concentration Guides
for the Niagara Falls Storage Site

Radionuclide	Transport Media	Controlled Area		Uncontrolled Area	
Uranium	Water Soluble	60	mg/l	2	mg/l
	Water Insoluble	1500	mg/l	60	mg/l
	Soil			75[a]	pCi/g
Radium	Water Soluble	400	pCi/l	30	pCi/l
	Soil			5[a]	pCi/g
Radon	Air	100	pCi/l	3	pCi/l

a - DOE FUSRAP Proposed Guideline for soil cleanup (40 CFR 192).