DOE/OR/20722--146

DE87 010559

COLONIE INTERIM STORAGE SITE

ANNUAL SITE ENVIRONMENTAL REPORT

CALENDAR YEAR 1986

JUNE 1987

Prepared for

UNITED STATES DEPARTMENT OF ENERGY

OAK RIDGE OPERATIONS OFFICE

Under Contract No. DE-AC05-81OR20722

By

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DISCLAIMER

ABSTRACT

During 1986, the environmental monitoring program continued at the Colonie Interim Storage Site (CISS), a U.S. Department of Energy (DOE) facility located in Colonie, New York. The CISS is part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), a DOE program to decontaminate or otherwise control sites where residual radioactive materials remain from the early years of the nation's atomic energy program or from commercial operations causing conditions that Congress has mandated DOE to remedy. As part of the decontamination research and development project authorized by Congress under the 1984 Energy and Water Appropriations Act, remedial action is being conducted at the site and at vicinity properties by Bechtel National, Inc. (BNI), Project Management Contractor for FUSRAP. The environmental monitoring program is also carried out by BNI.

The monitoring program at the CISS measures external gamma radiation levels as well as uranium and radium-226 concentrations in surface water, groundwater, and sediment. To verify that the site is in compliance with the DOE radiation protection standard and to assess the potential effect of the site on public health, the radiation dose was calculated for the maximally exposed individual. Based on the conservative scenario described in the report, the maximally exposed individual would receive an annual external exposure approximately equivalent to 5 percent of the DOE radiation protection standard of 100 mrem/yr. This is approximately equivalent to the exposure a person would receive during a round-trip by air from New York to Los Angeles due to increased cosmic radiation at higher altitudes. The cumulative dose to the population within an 80-km (50-mi) radius of the CISS that would result from radioactive materials present at the site would be indistinguishable from the dose that the same population would receive from naturally occurring radioactive sources.

Results of 1986 monitoring show that the CISS is in compliance with the DOE radiation protection standard.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

This report presents the findings of the environmental monitoring program conducted at the Colonie Interim Storage Site (CISS) during calendar year 1986. The first environmental monitoring report for this site presented data for 1984. As part of the decontamination research and development project authorized by Congress under the 1984 Energy and Water Appropriations Act, Bechtel National, Inc. is conducting remedial action at the site and at vicinity properties. The work is being performed as part of the U.S. Department of Energy (DOE) Formerly Utilized Sites Remedial Action Program (FUSRAP).

1.1 LOCATION AND DESCRIPTION

The Colonie Interim Storage Site (CISS) is located at 1130 Central Avenue in the Town of Colonie, New York. It is approximately 6.4 km (4 mi) northwest of downtown Albany and about 4.8 km (3 mi) southeast of the Village of Colonie as shown in Figure 1-1. The CISS covers 4.5 ha (11.2 acres); it consists of the former National Lead (NL) Industries, Inc. property and buildings where that company manufactured a variety of products using uranium, and approximately 0.8 ha (2 acres) of land northwest of the original property that was acquired by DOE from the Niagara Mohawk Power Corporation. Several vicinity properties are also radioactively contaminated as a result of airborne releases of uranium compounds produced during operations at the plant. While depleted uranium was used for most plant operations, small quantities of natural and enriched uranium were also used in selected manufacturing processes. The CISS property and the interim storage area inside the building are shown in Figure 1-2. Figure 1-3 is an aerial photograph of the site.

Remedial action is conducted in a manner designed to preclude the migration of contaminants from the CISS via groundwater or surface water. Pollution control measures implemented during the performance of remedial action include the use of prudent engineering controls, such as installation of sedimentation barriers

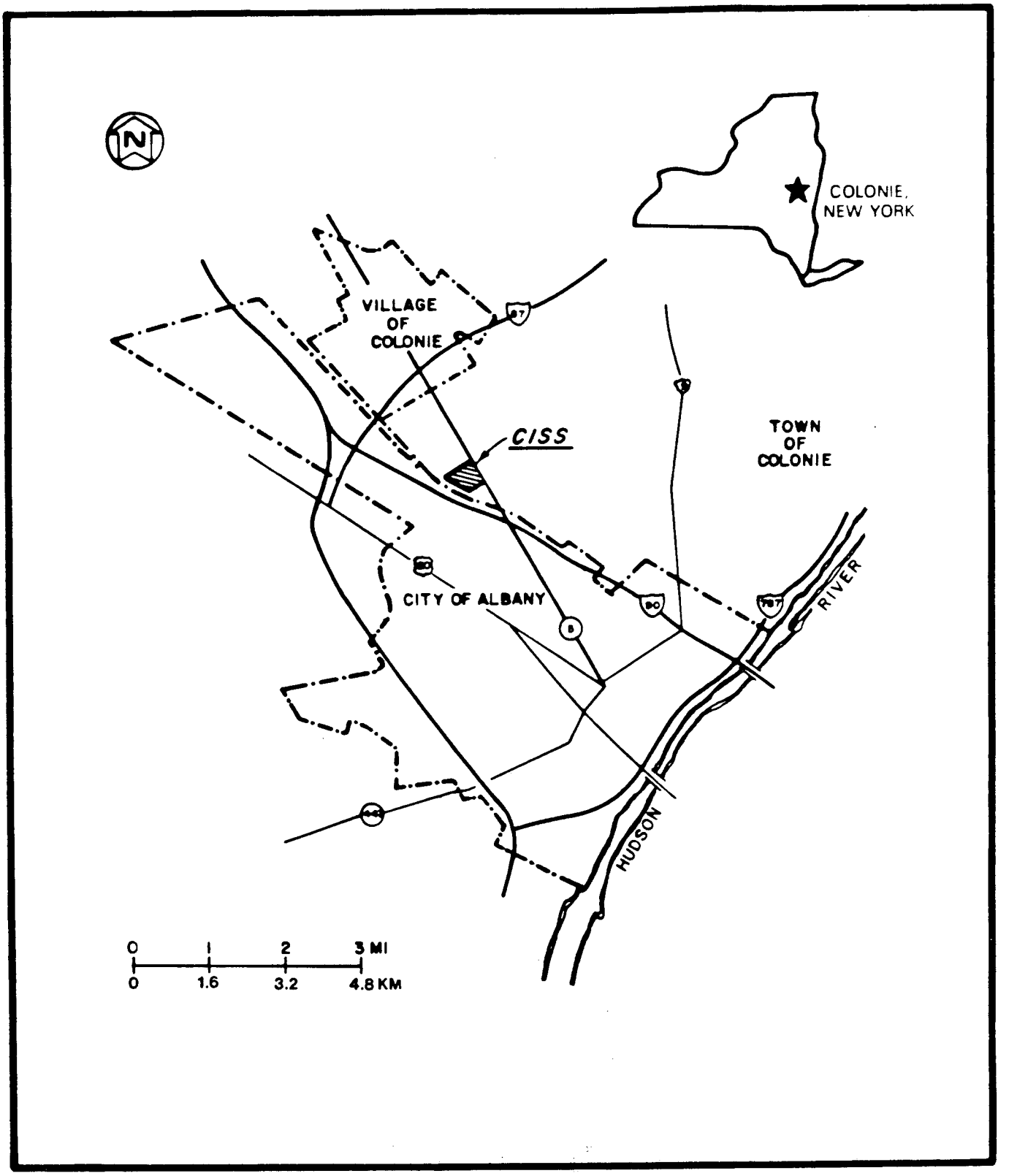


FIGURE 1-1 LOCATION OF THE CISS

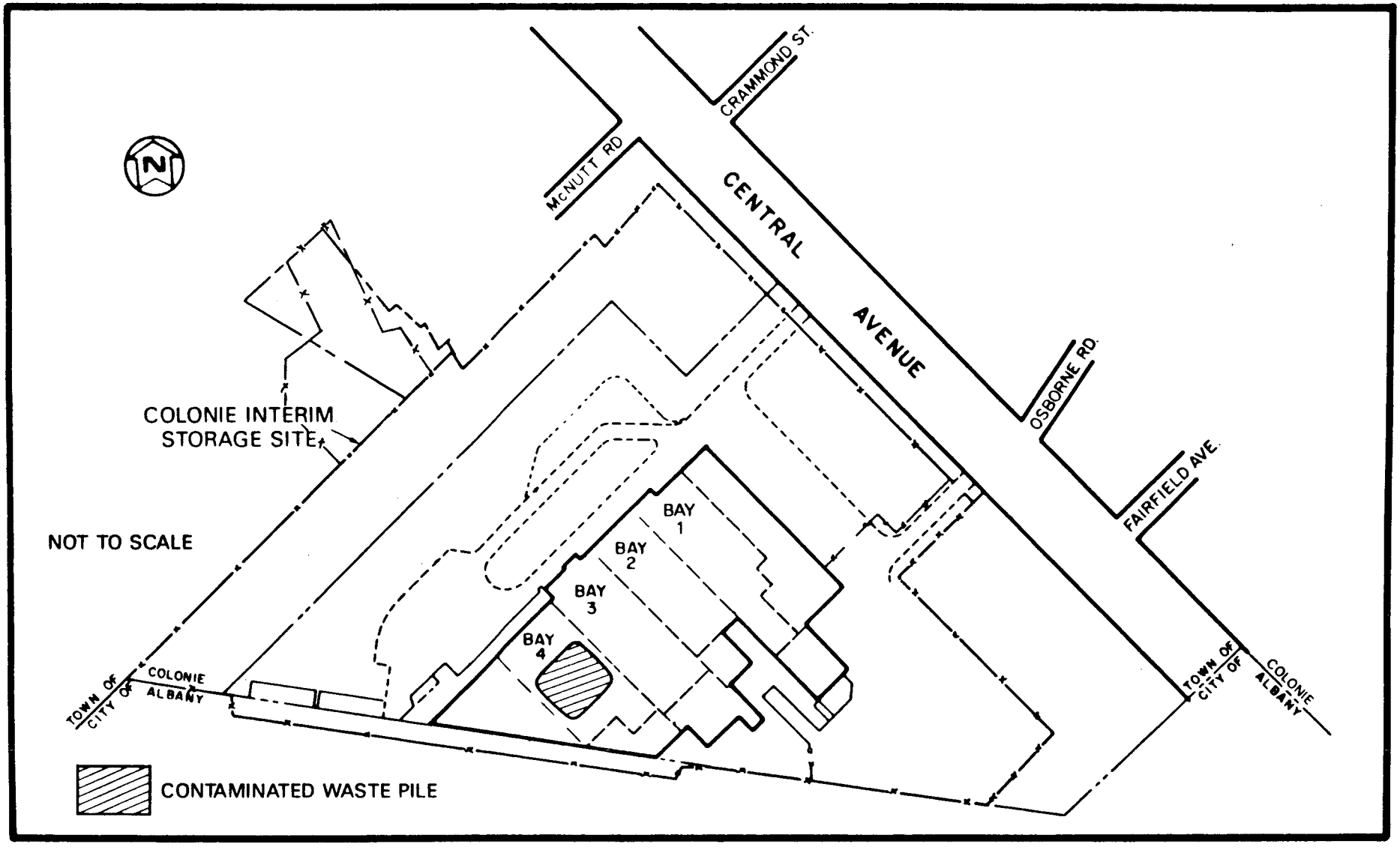


FIGURE 1-2 MAP OF THE CISS SHOWING INTERIM STORAGE AREA

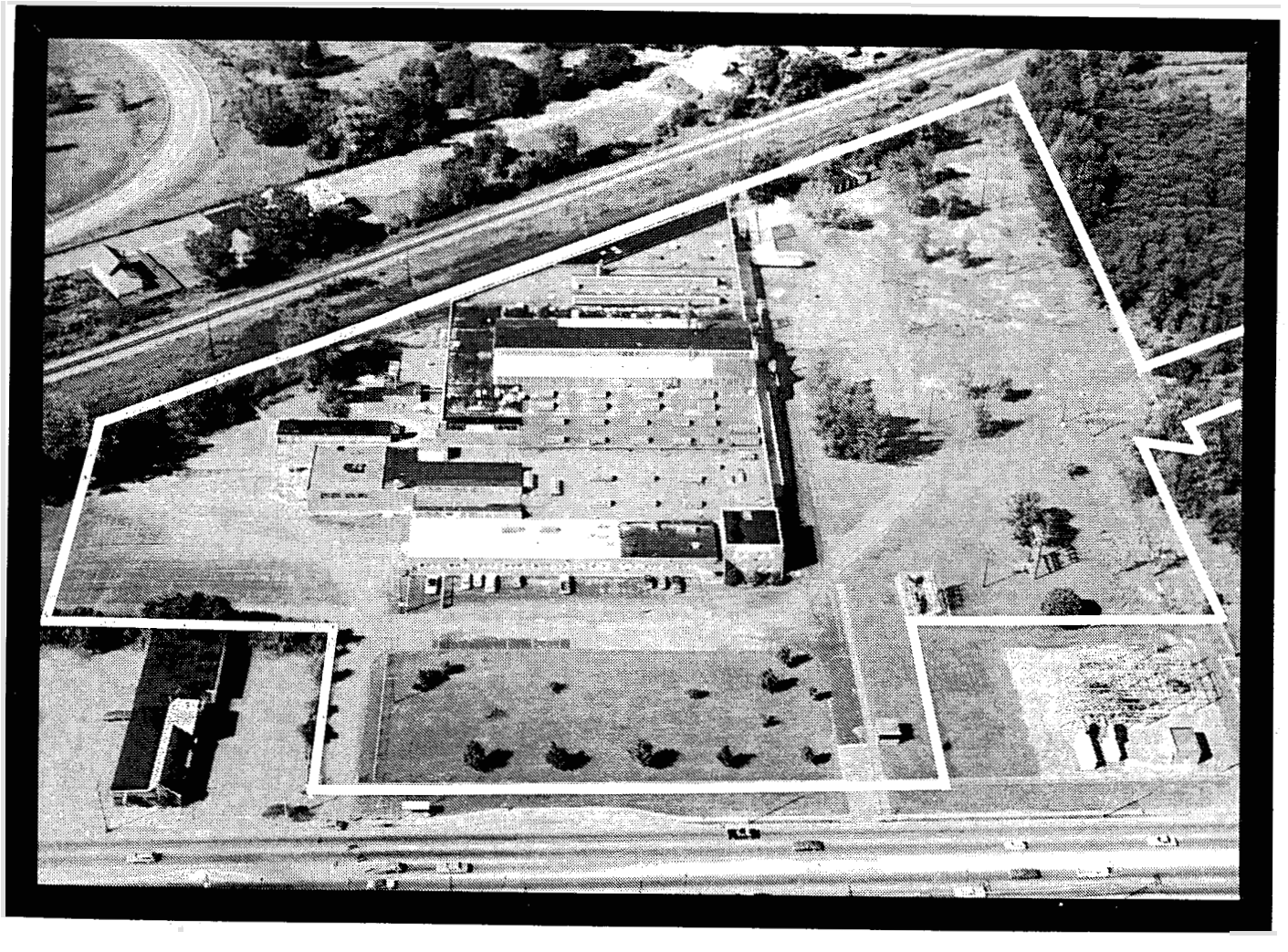


FIGURE 1-3 AERIAL VIEW OF THE CISS

in excavation areas and discharges of treated, impounded surface water in batches in accordance with the requirements of the Albany County Sewer District.

The CISS is located within the Patroons Creek drainage basin, about 2.6 km (1.6 mi) east of Rensselaer Lake (Figure 1-4). Patroons Creek lies approximately 0.4 km (0.25 mi) south of the site. A small, unnamed stream enters the site from the northwest through a culvert, flows through an old lake bed, and exits through another culvert on the south side of the site. The stream reappears after passing under the Penn Central railroad tracks and empties into Patroons Creek.

The site is underlain by Ordovician shale of the Normanskill Formation at a depth of about 45.7 to 60.9 m (150 to 200 ft). The bedrock is overlain by a 30.5- to 45.7-m (100- to 150-ft)-thick layer of unconsolidated deposits of clay and silt (Ref. 1).

Groundwater in the vicinity of the site is available in small quantities from the bedrock aquifer, and in moderate-to-large quantities from the unconsolidated deposits (Ref. 2). The groundwater table around the site ranged from about 0.6 to 4.9 m (2 to 16 ft) below ground during borehole drilling in March 1981 (Ref. 3). Depths to water measured in wells installed during November 1984 ranged from 1.1 to 5.5 m (3.5 to 18 ft) below the ground surface (Ref. 4). The groundwater flows to the south or east in the vicinity of the CISS (Refs. 4 and 5).

The average annual daily maximum temperature for the Albany Area is 14.2°C (57.6°F), and the average daily minimum is 2.7°C (36.8°F). The highest average monthly temperature is 28.4°C (83.2°F) (July), and the lowest is -11.2°C (11.9°F) (January). Average annual precipitation is 89.35 cm (35.7 in.), with average annual snowfall of 143.8 cm (57.5 in.). As shown in Figure 1-5, winds in the area blow predominantly from the south at a mean speed of 16 km/h (10 mph) (Ref. 6).

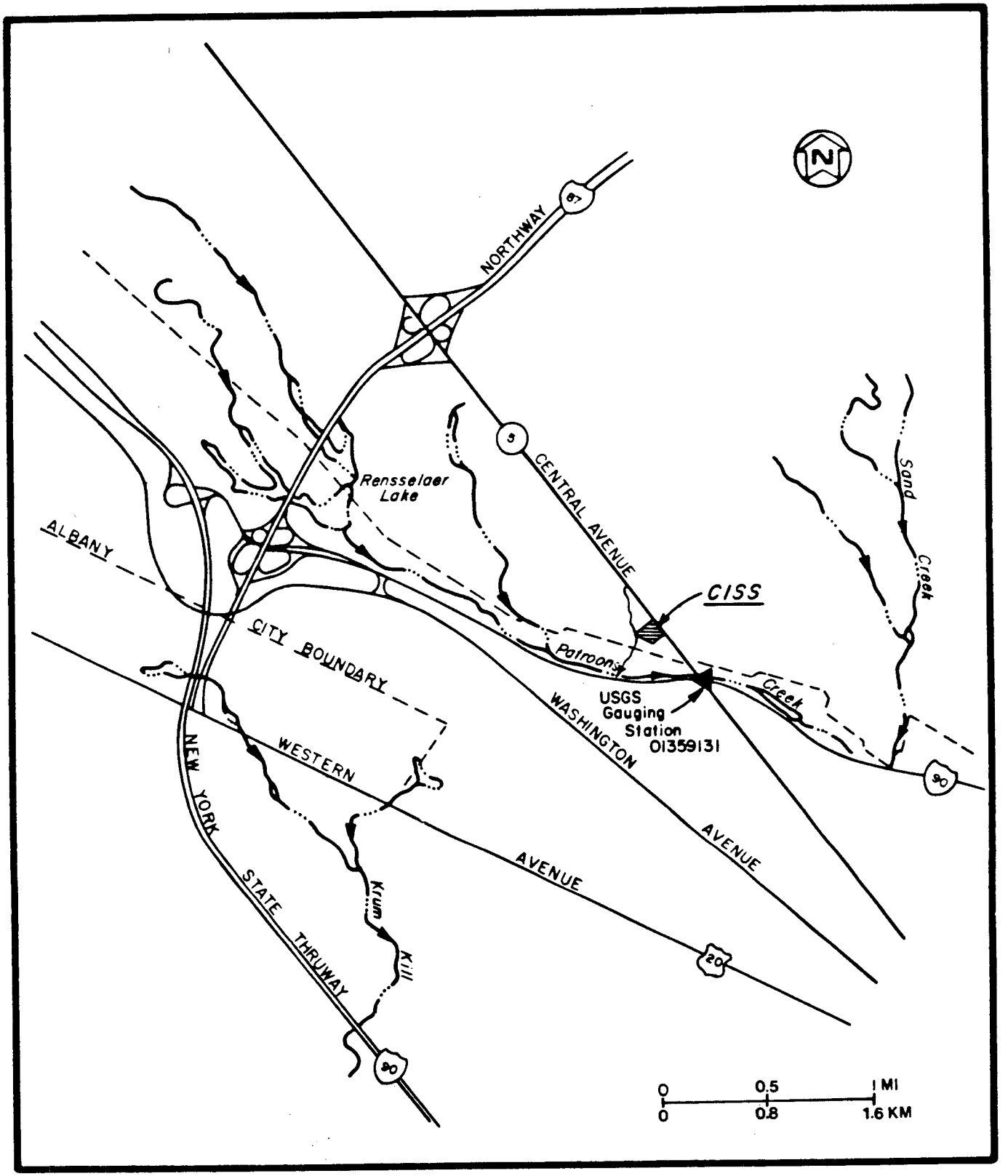


FIGURE 1-4 MAP OF SURFACE WATER DRAINAGE IN THE CISS AREA

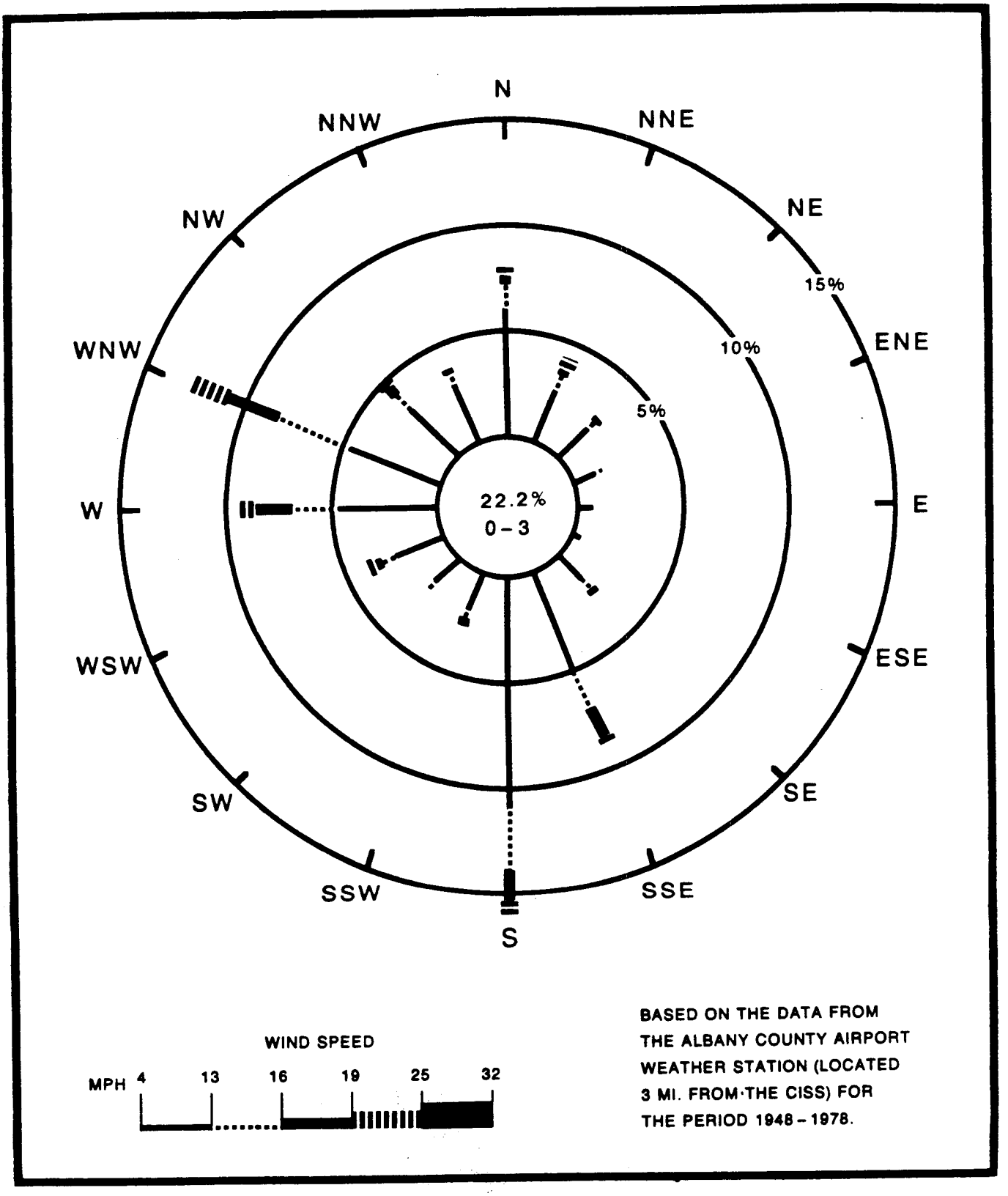


FIGURE 1-5 ANNUAL WIND ROSE FOR ALBANY, NEW YORK

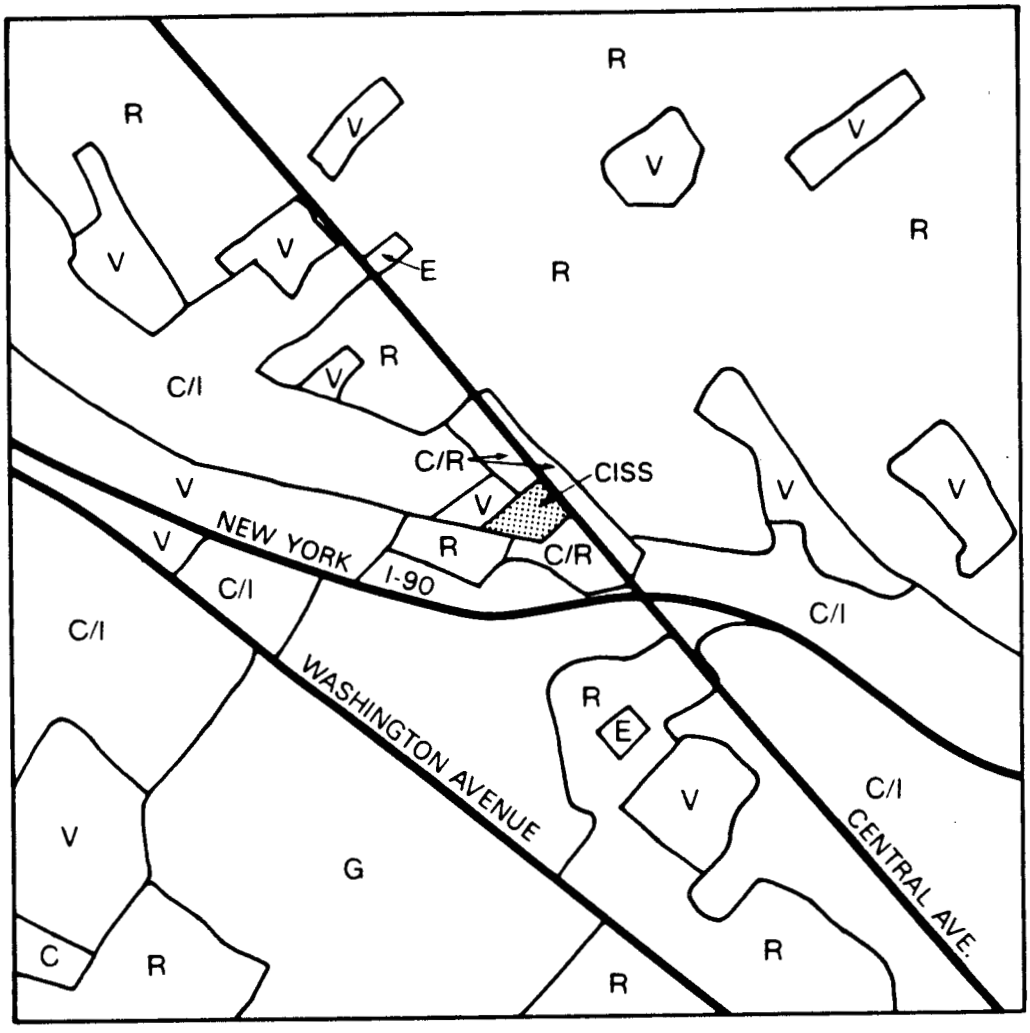
The residential population of the Town of Colonie is approximately 74,600. The 1980 population of the City of Albany was 101,727; that of Albany County was 285,909 (Ref. 7).

As shown in Figure 1-6, land use in the vicinity of the CISS is primarily industrial and residential. The site and adjacent area are currently zoned as industrial by the Town of Colonie; the site and the Yardboro Avenue area are zoned for light industry by Albany County. Central Avenue is lined by numerous small businesses, but the area across Central Avenue from the CISS is primarily residential and is zoned residential by the Town of Colonie (Ref. 7). To the northwest and west, the site is bordered by open land and an electrical substation owned by the Niagara Mohawk Power Corporation. The southeast and eastern boundaries adjoin various commercial properties. To the southwest and south, the facility is abutted by the Penn Central Railroad right-of-way.

1.2 SITE HISTORY

The NL Industries plant started producing uranium products in 1958 under a license issued by the U.S. Atomic Energy Commission (AEC), a predecessor of DOE. After the contract was terminated in 1968, plant production was limited to fabrication of shielding components, counterweights, and projectiles from depleted uranium.

On February 15, 1980, the New York State Supreme Court issued a temporary order restraining NL Industries from operating, on the basis that the facility emitted uranium compounds in airborne releases. The temporary restraining order was amended on May 12, 1980 to allow NL Industries to continue limited operation. The amended order also required the company to initiate an independent investigation to assess all adverse environmental effects to surrounding properties that could have resulted from the airborne discharge of radioactive materials from the plant. In 1980, Teledyne Isotopes was contracted by NL Industries to survey the radioactivity in the environs of the facility (Refs. 3 and 8).



BASED ON AERIAL PHOTOGRAPHS, SITE VISITS AND USGS TOPOGRAPHIC MAP 1:24000 SCALE, ALBANY NY QUADRANGLE (PHOTO REVISED 1982)

C	COMMERCIAL	G	GOVERNMENT
C/I	MIXED COMMERCIAL AND INDUSTRIAL	R	RESIDENTIAL
C/R	MIXED COMMERCIAL AND RESIDENTIAL	T	TRANSPORTATION
E	EDUCATIONAL	V	VACANT

0 0.5 MI
0 0.8 KM

N

FIGURE 1-6 GENERALIZED LAND USE IN THE VICINITY OF THE CISS

In February 1984, the Secretary of Energy accepted an NL Industries offer to donate to DOE the land, buildings, and equipment at the Colonie site, including the radioactively contaminated waste and residues on the property. The U.S. Army Corps of Engineers accepted the property on behalf of DOE on February 29, 1984, at which time the title was transferred to DOE. In addition, in 1985 DOE acquired a portion of the Niagara Mohawk Power Corporation property that borders the CISS to the north and northwest and designated it as part of the CISS.

Since 1984 the CISS has been used for interim storage of radioactively contaminated waste materials removed from vicinity properties under FUSRAP. The contaminated materials will be stored at the CISS until such time as a decision is made by DOE regarding their permanent disposition. Waste volume projections for Colonie are presented in Table 1-1 (Ref. 9).

In 1985 and 1986, work at the CISS consisted primarily of the following efforts: neutralizing or stabilizing hazardous chemicals left in the building, and improving the standby condition of the building. These activities will continue in 1987; further remedial action will be conducted at vicinity properties in the future.

TABLE 1-1

WASTE VOLUME PROJECTIONS FOR THE COLONIE SITE

Fiscal Year	Property	Projected Volume[a] (m^3/yd^3)	Actual Volume (m^3/yd^3)
1984	Yardboro, Central, and Palmer Avenue residences	266 / 350	532 / 700
1985	Yardboro, Central, and Palmer Avenue residences and Reynolds Street residence	517 / 680	182 / 240
1987 and Out Years	Vicinity residential properties and Town of Colonie properties west of the CISS	2718 / 3660	
	Buried and surface waste at the CISS; plant building rubble, metal, and equipment	19,304 / 25,400[b]	
	Total:	22,800 / 30,000[c]	

[a]Projected volume estimates are based on current information (Ref. 9) but are not definitive. For example, the volumes may change as the extent of contamination is defined by radiological characterization.

[b]Includes building rubble.

[c]Includes actual volumes for FY 1984 and FY 1985.

2.0 SUMMARY OF MONITORING RESULTS

The environmental monitoring program at the CISS continued during 1986. Water and sediment samples were collected, and external gamma radiation levels were measured to verify compliance with the DOE radiation protection standard of 100 mrem/yr (Ref. 10). The external radiation dose was calculated to determine the degree of compliance with the radiation protection standard.

During 1986, average annual external radiation levels at the CISS property boundary ranged from 1 to 61 mR/yr above background. The average background for the CISS area was 78 mR/yr. External radiation levels are discussed in Subsection 3.1. There has been no overall trend in external gamma radiation levels measured since 1984 (see Subsection 3.5.1) (Refs. 11 and 12).

In surface water, the highest average concentrations of uranium and radium-226 were 1.38×10^{-8} uCi/ml (13.8 pCi/l) and 4×10^{-10} uCi/ml (0.4 pCi/l), respectively (see Subsection 3.2.1). Since 1984, there has been a slight upward trend in the concentrations of uranium measured in surface water.

In groundwater (see Subsection 3.2.2), the highest average concentration of uranium was 6.7×10^{-9} uCi/ml (6.7 pCi/l). For radium-226, the highest average concentration was 5×10^{-10} uCi/ml (0.5 pCi/l). There has been no significant trend in the concentrations of radionuclides in groundwater (see Subsection 3.5.3) (Refs. 11 and 12).

Concentrations of radionuclides in surface water and groundwater may be compared with the levels of radioactivity in the commonly consumed liquids listed in Appendix D, Radiation in the Environment.

In stream sediments, the average concentration of total uranium and radium-226 was 15.8 and 0.5/pCi/g, respectively (see

Subsection 3.3). These concentrations may be compared with the levels of radioactivity in phosphate fertilizers listed in Appendix D.

Calculations were made of radiological doses received by the maximally exposed individual. This individual is one who is assumed, when all potential routes of exposure are considered, to receive the greatest dose. Exposure to external gamma radiation was the exposure pathway quantified. The calculated exposure to the maximally exposed individual at the CISS from this pathway was 5 mR/yr above background. Since 1 mR is approximately equivalent to 1 mrem, this exposure is approximately equivalent to 5 percent of the DOE radiation protection standard. The cumulative dose to the population within an 80-km (50-mi) radius of the CISS that would result from radioactive materials present at the site would be indistinguishable from the dose the same population would receive from naturally occurring radioactive sources (see Subsection 3.4.2).

Results of 1986 monitoring show that the CISS is in compliance with the DOE radiation protection standard.

3.0 DATA COLLECTION, ANALYSIS, AND EVALUATION

This section provides the results of environmental monitoring activities at the CISS during 1986 (Ref. 13). A description is also given of the sampling, monitoring, and analytical procedures used. Calculations were made to determine the estimated maximum possible radiation dose based on environmental conditions, measurements recorded, and evaluation of potential exposure pathways.

Data are presented in summary tables which include number of data points collected, minimum and maximum values recorded, and average value. The average value for a given sampling location is the average of the individual results for that location. Individual sources of error (e.g., analytical error or sampling error) were not estimated. The "less than" notation (<) is used to denote sample analysis results that are below the limit of sensitivity of the analytical method, based on a statistical analysis of parameters. In computing the averages, where no more than one value is less than the limit of sensitivity of the analytical method, that value is considered as being equal to the limit of sensitivity and the average value is reported without the "less than" notation.

During 1986, the routine environmental monitoring program for the CISS included external gamma radiation measurements, surface water and sediment sampling, and groundwater sampling of monitoring wells within the site boundary (which is a fenced and posted area).

Trend tables are provided for external gamma radiation levels, surface water, and groundwater. These tables list annual averages for each monitoring location for 1984, 1985, and 1986 to allow for comparisons of data and identification of trends in monitoring results (see Subsection 3.5).

3.1 EXTERNAL GAMMA RADIATION LEVELS

External gamma radiation levels were measured at eleven on-site monitoring locations and one off-site location. Ten of the on-site

locations are spaced at approximately equal intervals on the site boundary. Of the two remaining locations, one is on the site, and the other is a background monitoring station (Figure 3-1).

The external gamma radiation levels were measured using lithium fluoride (LiF) thermoluminescent dosimeters (TLDs), exchanged quarterly. Each dosimeter contains five individual chips, the responses of which are averaged. Analysis is performed by Thermo Analytical/Eberline (TMA/E).

The results of external gamma radiation monitoring are presented in Table 3-1. External radiation data for the first and third quarters of 1986 were invalidated because the dosimeters were exposed to radiation during shipment to the laboratory. The magnitude and nonuniformity of the exposure prevented a correction of the data. In the fourth quarter of 1986 procedures were implemented to reduce the probability of such in-transit exposures occurring in the future.

The average annual background radiation level for the CISS area (78 mR) has been subtracted from the measured radiation levels shown in Table 3-1 to provide an estimate of the effect of radioactivity emanating from the site on measured radiation levels at the site boundary. The highest annual average external radiation level at the CISS in 1986 was 61 mR/yr above background at Location 7. Because the area adjacent to the site is vacant, a 14-h/week, 52-week/yr occupancy factor was used. On this basis, the exposure to an individual on this property would be 5 mR/yr.

To compare the 1986 external radiation levels reported in Table 3-1 with those measured in 1985 (Ref. 12), the 1986 values for minimum, maximum, and average should be divided by 4 since they are expressed as annual values, whereas the 1985 values are expressed as quarterly values.

For comparisons of external radiation levels measured from 1984 through 1986, see Subsection 3.5.1.

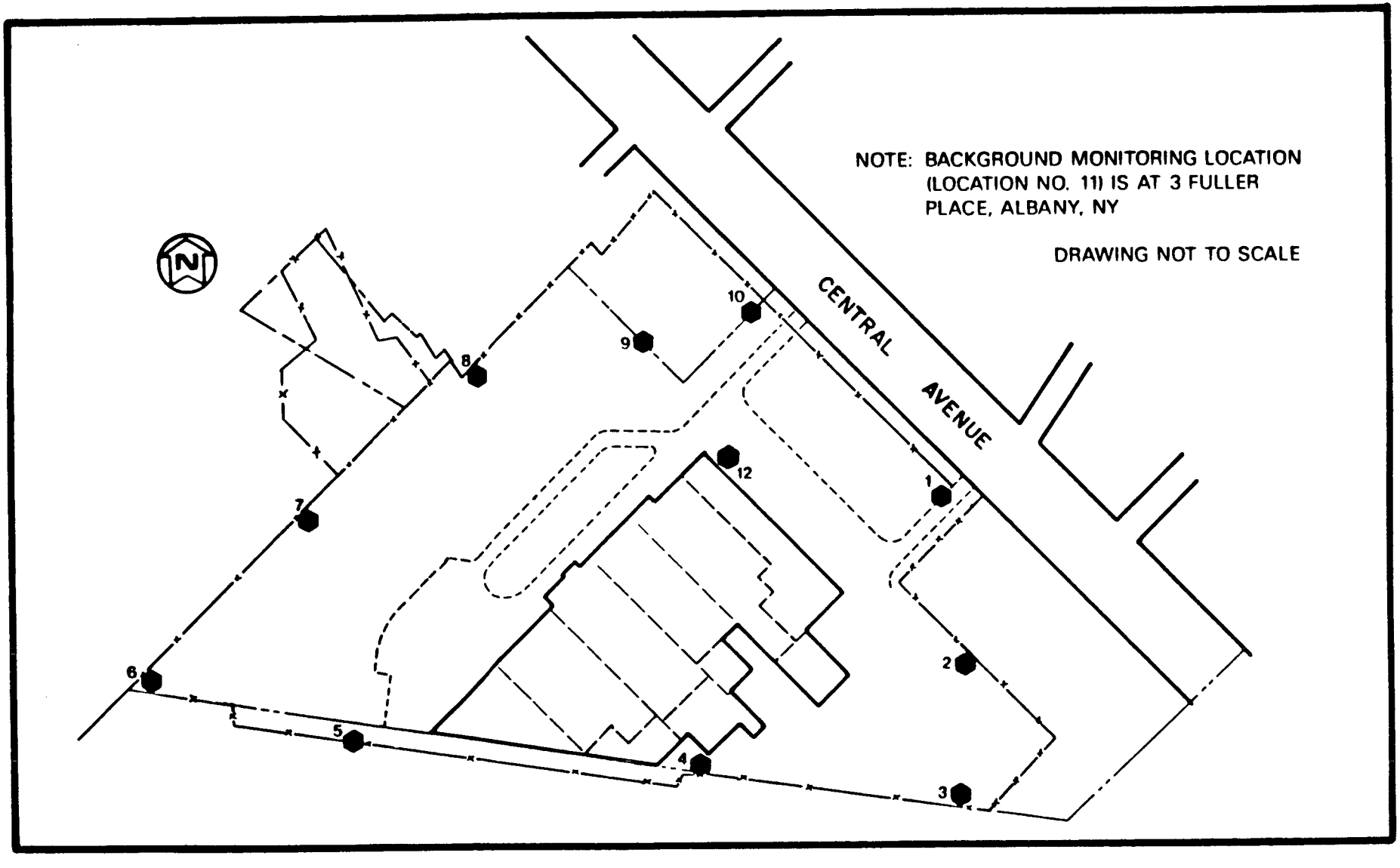


FIGURE 3-1 EXTERNAL GAMMA RADIATION MONITORING LOCATIONS AT THE CISS

TABLE 3-1

EXTERNAL GAMMA RADIATION LEVELS AT THE CISS, 1986

Sampling Location[a]	Number of Measurements[b]	Radiation Level (mR/yr)[c,d]		
		Minimum	Maximum	Average
1	2	0[e]	3	1
2	1[f]	36	36	-
3	2	27	75	51
4	2	40	76	58
5	2	0[e]	14	7
6	2	0[e]	5	25
7	2	54	68	61
8	2	11	43	27
9	2	0[e]	8	4
10	2	0[e]	6	3
12	2	26	46	36
Background				
11[g]	2	70	87	78

[a]Sampling locations are shown in Figure 3-1.

[b]First and third quarter data invalidated by in-transit exposure.

[c]Measured background has been subtracted.

[d]Divide by 4 to compare with 1985 mrem/quarter values.

[e]Measurement was less than or equal to the measured background value.

[f]Detector lost in fourth quarter during repair of fence.

[g]Located at 3 Fuller Place, Albany, New York.

3.2 WATER SAMPLING

During 1986, sampling was performed to determine the concentrations of uranium and radium-226 in off-site surface water and on-site groundwater.

3.2.1 Surface Water

Surface water samples were collected quarterly from three off-site locations (Figure 3-2). These sampling locations are downstream of the CISS so that the effect of runoff from the site on surface waters in the vicinity can be determined.

Nominal 1-liter (0.26-gal) grab samples were collected to fill a 4-liter (1-gal) container. The samples were analyzed by TMA/E. The concentration of total uranium was determined by a fluorometric method. Radium-226 concentrations in water were determined by radon emanation. This method consists of precipitating radium-226 as the sulfate and transferring the treated sulfate to a radon bubbler, wherein the radon-222 is allowed to come to equilibrium with its radium-226 parent. The radon-222 gas is then withdrawn into a scintillation cell and counted using the gross alpha technique. The quantity of radon-222 detected in this manner is directly proportional to the quantity of radium-226 originally present in the sample.

Analysis results for off-site surface water samples are presented in Table 3-2. The annual average concentration of total uranium ranged from 5×10^{-9} to 1.38×10^{-8} uCi/ml (5 to 13.8 pCi/l). The annual average concentration of radium-226 ranged from 2×10^{-10} to 4×10^{-10} uCi/ml (0.2 to 0.4 pCi/l). These values may be compared with the levels of radioactivity in the commonly consumed liquids listed in Appendix D.

For comparisons of radionuclide concentrations measured in surface water from 1984 through 1986, see Subsection 3.5.2.

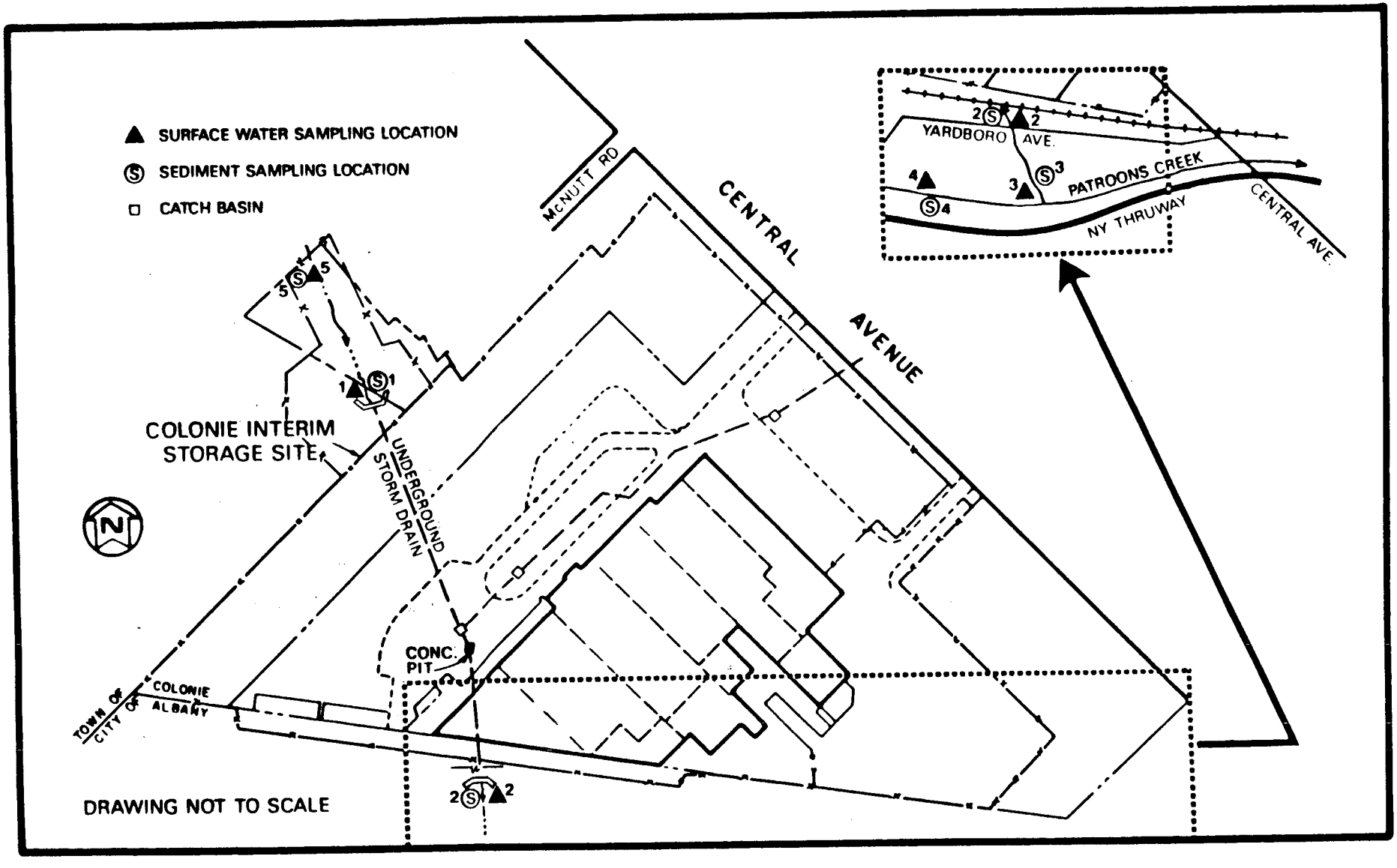


FIGURE 3-2 SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS AT THE CISS

TABLE 3-2

CONCENTRATIONS OF TOTAL URANIUM AND

RADIUM-226 IN SURFACE WATER AT THE CISS, 1986

Sampling Location[a]	Number of Samples	Concentration (10^{-9} uCi/ml)[b] Minimum	Maximum	Average[c]
Total Uranium				
2	4	9.3	18.7	13.8
3	4	10.0	17.3	13.2
4	4	3.3	10.0	5.0
Radium-226				
2	4	0.3	0.7	0.4
3	4	0.1	0.5	0.3
4	4	0.1	0.5	0.2

[a]Sampling locations are shown in Figure 3-2. Locations 1 and 5 are on the site.

[b]1 x 10^{-9} uCi/ml is equivalent to 1 pCi/l.

[c]Where values are less than the limit of sensitivity of the analytical method, values are considered equal to the limit of sensitivity, and the average value is reported without the notation "less than."

3.2.2 Groundwater

In 1986, groundwater samples were collected quarterly from seven on-site wells installed as part of a geohydrologic investigation conducted at the site in 1984 (Ref. 4). The locations of these wells are shown in Figure 3-3. Samples were collected with a hand bailer after the wells had been bailed dry or two well casing volumes had been removed. Nominal 1-liter (0.26-gal) grab samples were collected to fill a 4-liter (1-gal) container. Using the analysis methods described for surface water, TMA/E analyzed the samples for dissolved total uranium and radium-226.

Analysis results for groundwater samples are presented in Table 3-3. The highest annual average concentration of total uranium for all samples was 6.7×10^{-9} uCi/ml (6.7 pCi/l). The highest annual average radium-226 concentration was 5×10^{-10} uCi/ml (0.5 pCi/l). These values may be compared with the levels of radioactivity in commonly consumed liquids listed in Appendix D.

For a discussion of the comparisons of radionuclide concentrations in groundwater mesured from 1984 through 1986, see Subsection 3.5.3.

3.3 SEDIMENT SAMPLING

Sediment samples consisting of composites weighing approximately 500 g (1.1 lb) were collected quarterly at one of the sampling locations established for sediment and surface water (Figure 3-3, Location 2). TMA/E analyzed the samples for isotopic uranium and radium-226. Total uranium concentration was determined by summing the results of analyses for isotopic uranium. Isotopic uranium concentration was determined by alpha spectrometry, in which uranium is leached, organically extracted, and electroplated on a metal substrate. Radium-226 concentrations were determined by the radon emanation method described for surface water sampling.

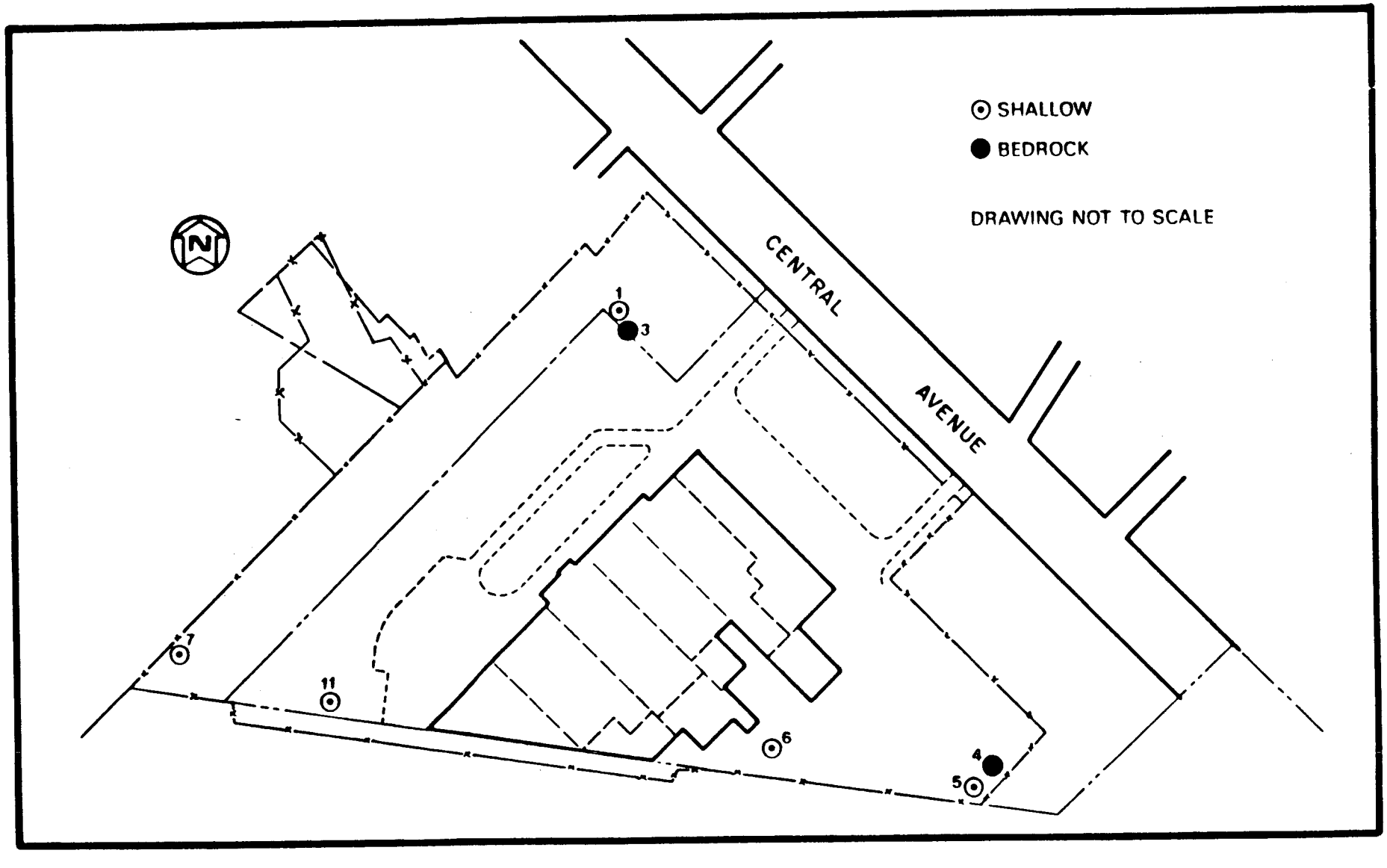


FIGURE 3-3 GROUNDWATER SAMPLING LOCATIONS AT THE CISS

TABLE 3-3

CONCENTRATIONS OF TOTAL URANIUM AND

RADIUM-226 IN GROUNDWATER AT THE CISS, 1986

Sampling Location[a]	Number of Samples	Concentration (10^{-9} uCi/ml)[b] Minimum	Maximum	Average[c]
Total Uranium				
1	4	<3.3	7.3	5.0
3	4	<3.3	11.3	6.2
4	4	<3.3	10.0	6.7
5	4	<3.3	5.3	3.8
6	4	<3.3	7.3	4.3
7	4	<3.3	10.0	5.0
11	4	<3.3	8.0	4.5
Radium-226				
1	4	0.1	0.4	0.3
3	4	0.1	0.5	0.3
4	4	0.1	1.1	0.4
5	4	0.1	0.6	0.3
6	4	0.4	0.6	0.5
7	4	0.2	0.5	0.3
11	4	0.1	0.6	0.3

[a]Sampling locations are shown in Figure 3-3.

[b]1 x 10^{-9} uCi/ml is equivalent to 1 pCi/l.

[c]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."

Data were collected from Location 2 to measure the potential for migration of contaminated sediments to off-site areas. Results of the analyses, based on dry weight, are presented in Table 3-4. These data indicate that the uranium is depleted of uranium-235.

The average annual concentration of total uranium in sediment measured at Location 2 was 15.8 pCi/g, while the average annual radium-226 concentration was 0.5 pCi/g. These concentrations may be compared with the levels of radioactivity in phosphate fertilizers listed in Appendix D.

3.4 RADIATION DOSE

To assess the impact of the radioactive materials stored at the CISS, radiological exposure pathways were evaluated to calculate the dose to the maximally exposed individual. This individual is one who is assumed, when all potential routes of exposure are considered, to receive the greatest dose. An appraisal of potential pathways (ingestion of water or exposure to external gamma radiation) suggested that external gamma radiation was the principal exposure mode.

The dose from ingesting groundwater or surface water from sources on the CISS property was not calculated because it was considered unrealistic to assume that ingestion of this water would occur. The CISS is fenced and locked, and security is well maintained, and a member of the public could only consume water on the site by trespassing on the property every day to gain access to the water. To consume groundwater from a well at the site, the member of the public would also have to be equipped with a means of removing the well cap, a power source, a pump, and a hose.

3.4.1 Dose to the Maximally Exposed Individual

To identify the individual in the vicinity of the CISS who would receive the highest dose from on-site radioactive materials, the

TABLE 3-4

CONCENTRATIONS OF ISOTOPIC URANIUM AND RADIUM-226
IN SEDIMENT AT THE CISS, 1986

Sampling Location[a]	Number of Samples	Concentration [pCi/g (dry)] Minimum	Maximum	Average
Uranium-234				
2	4	1.3	4.9	2.7
Uranium-235				
2	4	0.2	0.2	0.2
Uranium-238				
2	4	7.2	19.0	12.8
Total Uranium[b]				
2	4	8.7	24.1	15.8
Radium-226				
2	4	0.4	0.6	0.5

[a]Sampling location is shown in Figure 3-2.

[b]Total uranium concentration was calculated by summing the concentrations of all three isotopes.

dose from exposure to external gamma radiation was calculated for various monitoring locations that could be accessible by the public. This dose was then reviewed with regard to land use and occupancy factors for areas adjacent to the monitoring points. For the properties surrounding the CISS, the highest overall dose would be received by an individual directly to the northwest of the site.

The average annual radiation level at monitoring Location 7 (Figure 3-1) was 61 mR/yr above background. Because gamma radiation levels decrease rapidly with distance, it would be expected that at the nearest occupied residence external radiation would not exceed the background level. However, because Location 7 adjoins a vacant, wooded area, exposure to the maximally exposed individual was calculated assuming that an individual walked through this vacant area at the site fence for 2 h/day, 7 days/week, 52 weeks/yr. Under these assumptions, the annual exposure to this individual would be 5 mR. Since 1 mR is approximately equivalent to 1 mrem, this exposure is approximately equivalent to 5 percent if the DOE radiation protection standard of 100 mrem/yr. This is approximately equivalent to the exposure a person would receive during a round-trip by air from Los Angeles to New York due to increased cosmic radiation at higher altitudes (see Appendix D).

3.4.2 Dose to the Population in the Vicinity of the CISS

The dose to the population represents the conceptual cumulative radiation dose to all residents within a 80-km (50-mi) radius of a given site. This calculated dose includes contributions from all potential pathways. For the CISS, there are two potential pathways: direct exposure to gamma radiation and ingestion of water containing radioactivity.

The contribution to the population dose made by gamma radiation from on-site radioactive materials is too small to be measured since gamma radiation levels decrease rapidly as distance from the source of contamination increases. For example, if the gamma exposure rate

at a distance of 0.9 m (3 ft) from a small-area radioactive source were 100 mR/yr, the exposure rate at a distance of 6.4 m (21 ft) from the source would be indistinguishable from naturally occurring background radiation (Ref. 14).

On the basis of radionuclide concentrations measured in water leaving the site, it also appears that there is no predictable pathway by which ingestion of water could result in a significant dose to the population. As water migrates farther from the source, radionuclide concentrations are further reduced, thereby lowering potential doses to even less significant levels. Since the contributions to population dose from both potential exposure pathways are inconsequential, calculation of the dose to the population is not warranted. The cumulative dose to the population within an 80-km (50-mi) radius of the CISS that would result from radioactive materials present at the site would be indistinguishable from the dose that the same population would receive from naturally occurring radioactive sources.

3.5 TRENDS

The environmental monitoring program at the CISS has been established to allow an annual assessment of the environmental conditions at the site, provide a historical record for comparisons from year to year, and permit detection of trends over time. In the following subsections, 1986 annual averages for each monitoring location for external gamma radiation and surface water are compared with results for 1984 and 1985. Because new monitoring wells were installed in 1985, groundwater data available for comparisons cover only 1985 and 1986. As the environmental monitoring program continues at the CISS and more data are collected, comparisons and analyses of trends will become more valid.

3.5.1 External Gamma Radiation Levels

As shown in Table 3-5, there has not been an identifiable overall trend in external gamma radiation levels measured at the CISS since

TABLE 3-5

ANNUAL AVERAGE EXTERNAL GAMMA RADIATION LEVELS AT THE CISS, 1984-1986*

Sampling Location[a]	Radiation Level (mR/yr)[b] 1984	1985	1986
1	22	1	1
2	12	27	36
3	46	56	51
4	65	71	58
5	27	9	7
6	23	5	25
7	0[c]	66	61
8	131	60	27
9	90	1	4
10	0[c]	1	3
12	-[d]	36	36
Background			
11	104	87	78

[a]Sampling locations are shown in Figure 3-1.

[b]Measured background has been subtracted.

[c]Equal to or less than background.

[d]Location 12 added in 1985.

*Sources for 1984 and 1985 data are the Annual Site Environemental Reports for the two years (Refs. 11 and 12). In some cases, previous years' data have been reported in different units of measurement. For ease of comparison, all data in trend tables are reported in the units used in the 1986 report. Applicable conversion factors are listed in Appendix B of this report.

1984. While some monitoring locations (Locations 1, 5, 8, and 9) have shown definite decreases, other locations (Locations 2 and 7) have shown increases. Others have remained stable or fluctuated. More definite comparisons or trends may become apparent as the monitoring program continues.

3.5.2 Surface Water

As shown in Table 3-6, concentrations of radium-226 in surface water at the CISS have remained basically stable since 1984. However, concentrations of uranium in surface water at the CISS have increased slightly since 1984. This increase is not surprising because of the contamination known to exist at the CISS and for which remedial action is scheduled. Also, concentration levels are extremely low, and there is no plausible pathway for consumption of the surface water.

3.5.3 Groundwater

In 1984, the groundwater monitoring program at the CISS depended upon four wells that had existed at the site prior to the property being obtained by DOE. In 1985, the present monitoring wells were installed to upgrade the quality of the monitoring program.

In 1984, concentrations of radium-226 in groundwater ranged from 3×10^{-10} uCi/ml (0.3 pCi/l) to 6×10^{-10} uCi/ml (0.6 pCi/l). Concentrations of uranium ranged from 2.1×10^{-9} uCi/ml (2.1 pCi/l) to 8.7×10^{-9} uCi/ml (8.7 pCi/l). Because these data were obtained from different wells, they are not directly comparable to 1985 and 1986 data. However, the 1984 data support the general statement that there is no identifiable trend in concentrations of radium-226 or uranium in groundwater at the CISS. As the present monitoring program continues, comparisons and trend analyses may become more accurate.

TABLE 3-6

ANNUAL AVERAGE CONCENTRATIONS OF TOTAL URANIUM AND RADIUM-226 IN SURFACE WATER AT THE CISS, 1984-1986•

Sampling Location[a]	Concentration (10^{-9} uCi/ml)[b] 1984	1985	1986
Total Uranium			
2	9.0	16.0	13.8
3	5.0	8.0	13.2
4	1.5	4.0	5.0
Radium-226			
2	0.2	0.1	0.4
3	0.4	0.3	0.3
4	0.2	0.1	0.2

[a]Sampling locations are shown in Figure 3-3.

[b]1 x 10^{-9} uCi/ml is equivalent to 1 pCi/l.

•Sources for 1984 and 1985 data are the Annual Site Environemental Reports for the two years (Refs. 11 and 12). In some cases, previous years' data have been reported in different units of measurement. For ease of comparison, all data in trend tables are reported in the units used in the 1986 report. Applicable conversion factors are listed in Appendix B of this report.

TABLE 3-7

ANNUAL AVERAGE CONCENTRATIONS OF TOTAL URANIUM AND RADIUM-226 IN GROUNDWATER AT THE CISS, 1985-1986*

Sampling Location[a]	Concentration (10-9 uCi/ml)[b] 1985	1986
Total Uranium		
1	<3.0	5.0
3	<3.0	6.2
4	<3.0	6.7
5	<3.0	3.8
6	<3.0	4.3
7	<3.0	5.0
11	<3.0	4.5
Radium-226		
1	0.2	0.3
3	0.2	0.3
4	0.1	0.4
5	0.1	0.3
6	0.4	0.5
7	0.2	0.3
11	0.2	0.3

[a]Sampling locations are shown in Figure 3-5.

[b]1 x 10^{-9} uCi/ml is equivalent to 1 pCi/l.

*Source for 1985 data is the Annual Site Environemental Report for the year (Ref. 12). In some cases, previous years' data have been reported in different units of measurement. For ease of comparison, all data in trend tables are reported in the units used in the 1986 report. Applicable conversion factors are listed in Appendix B of this report.

4.0 RELATED ACTIVITIES AND SPECIAL STUDIES

4.1 RELATED ACTIVITIES

In 1986, a detailed inventory of the chemicals left at the CISS by NL Industries was completed. More than 4,000 liters (1,040 gal) of cyanide solutions and approximately 3,200 liters (832 gal) of nitric acid were neutralized. In addition, stabilization of plating tank sludges commenced, and unidentified chemicals were analyzed to determine appropriate methods of disposal. Approximately 12,000 liters (3,120 gal) of uranium-contaminated, emulsified oils were treated to remove the uranium. The oil and uranium will be incinerated at the DOE Oak Ridge facilities; the water was certified as meeting discharge requirements and was transported to the Albany County Sewer District for release. The chemicals that are not radioactively contaminated will be disposed of in 1987 by appropriately licensed commercial waste disposers.

To ensure that automatic fire suppression systems inside the building were functional, to reduce fire hazards, and to improve the standby condition of the building, the sprinkler system was repaired and reactivated, roof repairs were made, and general cleanup of the building was begun.

4.2 SPECIAL STUDIES

In 1986 the **Closure Plan for the Colonie Interim Storage Site** was revised to reflect a new approach to closure of the site (Ref. 14). The original approach was based on disposal of chemicals in the plant building according to the areas in which they are stored. The revised approach provides for classification of the chemicals in functional groups and systematic disposal of the chemicals according to functional classification. The revised closure plan also contains an updated inventory of the chemicals in the building.

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APPENDIX A
QUALITY ASSURANCE

APPENDIX A
QUALITY ASSURANCE

A comprehensive quality assurance program was maintained to ensure that the data collected were representative of actual concentrations in the environment. First, environmental data were obtained from a number of locations to prevent reliance on only a few results, which might not be representative of the existing range of concentrations. Second, current monitoring data were compared with historical data for each environmental medium to ensure that deviations from previous conditions were identified and evaluated. Third, samples at all locations were collected using published procedures to ensure consistency in sample collection. Fourth, each analytical laboratory verified the quality of the data by conducting a continuing program of analytical quality control, participating in interlaboratory cross-checks, and performing replicate analyses. Fifth, chain of custody procedures were implemented to maintain traceability of samples and corresponding analytical results. This program ensures that the monitoring data can be used to evaluate accurately the environmental effects of site operations.

The majority of the routine radioanalyses for the FUSRAP Environmental Monitoring Program were performed under subcontract by the Thermo Analytical/Eberline, Albuquerque, New Mexico. This laboratory maintained an internal quality assurance program that involved routine calibration of counting instruments, source and background counts, routine yield determinations of radiochemical procedures, and replicate analyses to check precision. The accuracy of radionuclide determination was ensured through the use of standards traceable to the National Bureau of Standards, when available. The laboratory also participated in the Environmental Protection Agency's (EPA) Laboratory Intercomparison Studies Program. In this program, samples of different environmental media (water, milk, air filters, soil, foodstuffs, and tissue ash) containing one or more radionuclides in known amounts were prepared

and distributed to the participating laboratories. After the samples were analyzed, the results were forwarded to EPA for comparison with known values and with the results from other laboratories. This program enabled the laboratory to regularly evaluate the accuracy of its analyses and take corrective action if needed.

Interlaboratory comparison of the TLD results was provided by participation in the International Environmental Dosimeter Project sponsored jointly by the Department of Energy, the Nuclear Regulatory Commission, and the EPA.

To provide for assurance of the quality of dose calculations, all computed doses were double checked by the originator and by an independent third party who also checked all input data and assumptions used in the calculations.

APPENDIX B
ENVIRONMENTAL STANDARDS

APPENDIX B
ENVIRONMENTAL STANDARDS

The DOE long-term radiation protection standard is 100 mrem/yr (Ref. 10). Evaluation of exposure pathways and resulting dose calculations are based on assumptions such as occupancy factors in determining the dose from external gamma radiation; subtraction of background concentrations of radionuclides in air, water, and soil before calculating dose; closer review of water use, using the data that most closely represents actual exposure conditions rather than maximum values as applicable; and using average consumption rates of food and water per individual rather than maximums. Use of such assumptions will result in calculated doses that more accurately reflect the exposure potential from site activities.

TABLE B-1

CONVERSION FACTORS

1 year	=	8760 hours
1 liter	=	1000 ml
1 mR	$\cong$	1 mrem
1 mrem	$\cong$	1000 uR
1 mrem/yr	$\cong$	8.7 uR/hr (assuming 8760 hours of exposure per year)
1 uCi	=	1,000,000 pCi
1 pCi	=	0.000001 uCi
1 pCi/l	=	10^{-9} uCi/ml
1 pCi/l	=	0.000000001 uCi/ml
1 uCi/ml	=	1,000,000,000 pCi/l
10^{-6}	=	0.000001
10^{-7}	=	0.0000001
10^{-8}	=	0.00000001
10^{-9}	=	0.000000001
10^{-10}	=	0.0000000001
7×10^{-10}	=	0.0000000007

APPENDIX C
ABBREVIATIONS

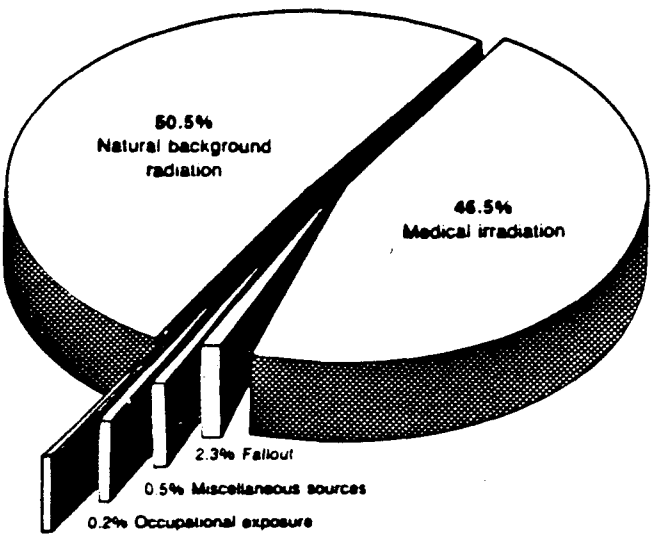
APPENDIX C
ABBREVIATIONS

cm	centimeter
cm/sec	centimeters per second
ft	foot
g	gram
gal	gallon
h	hour
ha	hectare
in.	inch
km	kilometer
km/h	kilometers per hour
lb	pound
m	meter
m^3	cubic meters
mg	milligram
mg/l	milligrams per liter
mi	mile
ml	milliliter
mph	miles per hour
mR	milliroentgens
mrem	millirem
mR/yr	milliroentgens per year
mrem/yr	millirem per year
m.s.l.	mean sea level
uCi/ml	microcuries per milliliter
pCi	picocurie
pCi/g	picocuries per gram
pCi/l	picocuries per liter
yd^3	cubic yards
yr	year

APPENDIX D
RADIATION IN THE ENVIRONMENT

Radiation in the Environment

Radiation is a natural part of our environment. When our planet was formed, radiation was present—and radiation surrounds it still. Natural radiation showers down from the distant reaches of the cosmos and continuously radiates from the rocks, soil, and water on the Earth itself.



Source National Academy of Sciences, 1980.
National Council of Radiation Protection and Measurement

During the last century, mankind has discovered radiation, how to use it, and how to control it. As a result, some manmade radiation has been added to the natural amounts present in our environment.

Many materials—both natural and manmade—that we come in contact with in our everyday lives are radioactive. These materials are composed of atoms that are unstable. The unstable atoms release particles or waves as they change into more stable forms. These particles and waves are collectively referred to as *radiation*, and a quantity of the unstable atoms is referred to as *radioactivity*.

Types of Ionizing Radiation

Radiation that has enough energy to disturb the electrical balance in the atoms of substances it passes through is called *ionizing radiation*. There are three basic forms of ionizing radiation.

Alpha

Alpha particles are the largest and slowest moving type of radiation. They are easily stopped by a sheet of paper or the skin. Alpha particles can only move through the air a few inches before being stopped by air molecules. However, alpha radiation is dangerous to sensitive tissue inside the body.

Beta

Beta particles are much smaller and faster moving than alpha particles. Beta particles pass through paper and can travel in the air for about 10 feet. However, they may be stopped by thin shielding such as a sheet of aluminum foil.

Gamma

Gamma radiation is a type of electromagnetic wave that travels at the speed of light. It takes a thick wall of steel, lead, or concrete to stop gamma rays. X rays and cosmic rays are similar to gamma radiation. X rays are produced by manmade devices; cosmic rays reach Earth from outer space.

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Units of Measure

Radiation can be measured in a variety of ways. Typically, units of measure show either the total amount of radioactivity present in a substance, or the level of radiation being given off.

The radioactivity of a substance is measured in terms of the number of transformations (changes into more stable forms) per unit of time. The *curie* is the standard unit for this measurement and is based on the amount of radioactivity contained in 1 gram of radium. Numerically, 1 curie is 37 billion transformations per second. The amounts of radioactivity that people normally work with are in the millicurie (one-thousandth of a curie) or microcurie (one-millionth of a curie) range. Quantities of radioactivity in the environment are in the picocurie, or pCi (one-trillionth of a curie) range.

Levels of radiation are measured in various units. The level of gamma radiation in the air is measured by the *roentgen*. This is a relatively large unit, so measurements are often calculated in milliroentgens. Radiation absorbed by humans is measured in either *rad* or *rem*. The rem is the most descriptive because it measures the ability of the specific type of radiation to do damage to biological tissue. Again, typical measurements will often be in the millirem, or mrem (one-thousandth of a rem) range. On the average, people receive about 180 mrem of radiation a year. Most of this radiation is from natural radiation and medical exposure.

RADIATION IN THE ENVIRONMENT

Cosmic Radiation

Cosmic radiation is high-energy gamma radiation that originates in outer space and filters through our atmosphere.

Sea Level (add one for each additional 100 feet in elevation)	26 mrem/year
Atlanta, GA (1,050 feet)	37 mrem/year
Denver, CO (5,300 feet)	79 mrem/year
Minneapolis, MN (815 feet)	34 mrem/year
Salt Lake City, UT (4,400 feet)	70 mrem/year
Spokane, WA (1,890 feet)	45 mrem/year

Terrestrial Radiation

Terrestrial sources are naturally radioactive elements in the soil and water such as thorium, radium, uranium, and carbon.

United States (average)	26 mrem/year
Denver, Colorado	90 mrem/year
Nile Delta, Egypt	350 mrem/year
Paris, France	350 mrem/year
Coast of Kerala, India	400 mrem/year
McAipe, Brazil	2,558 mrem/year
Pocos de Caldas, Brazil	7,000 mrem/year

Buildings

Based on occupancy 75 percent of the time.

Wood House	35 mrem/year
Brick House	45 mrem/year
Concrete House	45 mrem/year
Stone House	50 mrem/year

Specific Buildings

U.S. Capitol Building	85 mrem/year
Base of Statue of Liberty	325 mrem/year
Grand Central Station	525 mrem/year
The Vatican	800 mrem/year

Radon

Radon levels in buildings vary, depending on geographic location, from 0.1 to 200 pCi/liter.

Typical Radon Level	1.5 pCi/liter
Occupational Working Limit	100.0 pCi/liter

The numbers given here are approximate or represent an average since samples vary.

mrem = millirem

pCi = picocurie

Foods

Food contributes an average of 20 mrem/year, *mostly from carbon-14, hydrogen-3, potassium-40, radium-226, and thorium-232.*

Beer	390 pCi/liter
Domestic Tap Water	20 pCi/liter
Milk	1,400 pCi/liter
Salad Oil	4,900 pCi/liter
Whiskey	1,200 pCi/liter
Brazil Nuts	14 pCi/g
Flour	0.14 pCi/g
Peanuts and Peanut Butter	0.12 pCi/g
Tea	0.40 pCi/g

Medical Treatment

The exposures from medical diagnosis vary widely according to the required procedure, the equipment and film used for x rays, and the skill of the operator.

Chest X Ray	20 mrem
Dental X Ray, Whole Mouth	900 mrem

International Nuclear Weapons Test Fallout

Average for a U.S. citizen	1 mrem/year

Consumer Goods

Cigarettes (2 packs/day) (Polonium-210)	8,000 mrem/year
Color Television	1 mrem/year
Gas Lantern Mantle (thorium-232)	3 mrem/hour
Highways	4 mrem/year
Jet Airplane Travel/1,500 miles (cosmic)	1 mrem
Natural Gas Stove (radon-222)	6-9 mrem/year
Phosphate Fertilizers*	4 mrem/year
Porcelain Dentures (uranium salts)	1,500 mrem/year
Radioluminescent Clock (radium-226)	9 mrem/year
Smoke Detector (americium-241)	0.2 mrem/year

* **Natural Radioactivity in Florida Phosphate Fertilizers (in pCi/gram)**

Material	Ra-226	U-238	Th-230	Th-232
Normal Superphosphate	21.3	20.1	18.9	0.6
Concentrated Superphosphate	21.0	58.0	48.0	1.3
Gypsum	33.0	6.0	13.0	0.3

APPENDIX E

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APPENDIX E

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