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

COLONIE INTERIM STORAGE SITE ENVIRONMENTAL MONITORING REPORT

Colonie, New York

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Bechtel National, Inc.
Advanced Technology Division

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ENVIRONMENTAL MONITORING REPORT FOR THE COLONIE INTERIM STORAGE SITE

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Prepared for

UNITED STATES DEPARTMENT OF ENERGY

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By

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Oak Ridge, Tennessee

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ABSTRACT

During 1984, an environmental monitoring program was initiated for the Colonie Interim Storage Site (CISS), Colonie, New York. The site is part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), a United States Department of Energy (DOE) program to identify, clean up, or otherwise control sites where low-level radioactive contamination remains from the early years of the nation's atomic energy program.

The monitoring program at CISS measures the radium and uranium concentrations in surface water, groundwater, and sediment, and external gamma exposure levels. Radiation doses to the public are also calculated. All environmental samples are analyzed to determine compliance with applicable environmental quality standards. DOE Order 5480.1A, Chapter XI, provides applicable Concentration Guide (CG) limits for radionuclides in controlled and uncontrolled areas.

During 1984, uranium concentrations in surface water were below the DOE CG except for one location upstream of the CISS. Radium concentrations in surface water were below the DOE CG. In groundwater, both uranium and radium concentrations were below the CG. External gamma exposure levels were all below the DOE Radiation Protection Standard.

Radiological exposures to a hypothetical maximally exposed individual from ingestion of surface water with the highest average concentration of depleted uranium would result in a 50-year dose commitment to the bone of approximately 890 mrem. This exceeds the dose commitment of 750 mrem resulting from ingestion of water containing depleted uranium at the DOE CG.

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ABBREVIATIONS

Ci	curie
cm	centimeter
ft	foot
gal	gallon
in.	inch
m	meter
ml	milliliter
mg/l	milligrams per liter
mi	mile
mph	miles per hour
mrem	millirem
mrem/yr	millirem per year
uR/h	microRoentgens per hour
uCi/ml	microcuries per milliliter
pCi/g	picocuries per gram
pCi/l	picocuries per liter
yd^3	cubic yards
yr	year

1.0 INTRODUCTION

1.1 SITE 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 4 mi northwest of downtown Albany and about 3 mi southeast of the Village of Colonie, as shown in Figure 1-1.

The CISS covers 10.5 acres and includes the former National Lead (NL) Industries, Inc. property and buildings where that company manufactured a variety of products from depleted uranium. In recent radiological surveys of the site (Refs. 1 and 2), depleted uranium was found to be the principal contaminant in shallow soil samples. Several vicinity properties are also radioactively contaminated as a result of airborne releases of depleted uranium compounds produced during operations at the plant.

As part of the research and development project authorized by Congress under the 1984 Energy and Water Appropriations Act, the site was assigned for cleanup to DOE under the Formerly Utilized Sites Remedial Action Program (FUSRAP). The FUSRAP Program Management Contractor (PMC), Bechtel National, Inc. (BNI), will carry out remedial action at the site and several residential properties in the area under contract to DOE.

The NL Industries property was purchased by the U.S. Department of Energy (DOE) in February 1984 to serve as an interim storage site for contaminated materials removed from the affected vicinity properties. The CISS and the interim storage area are shown in Figure 1-2. The contaminated materials will be stored at the CISS until such time as a decision is made by DOE regarding their permanent disposition.

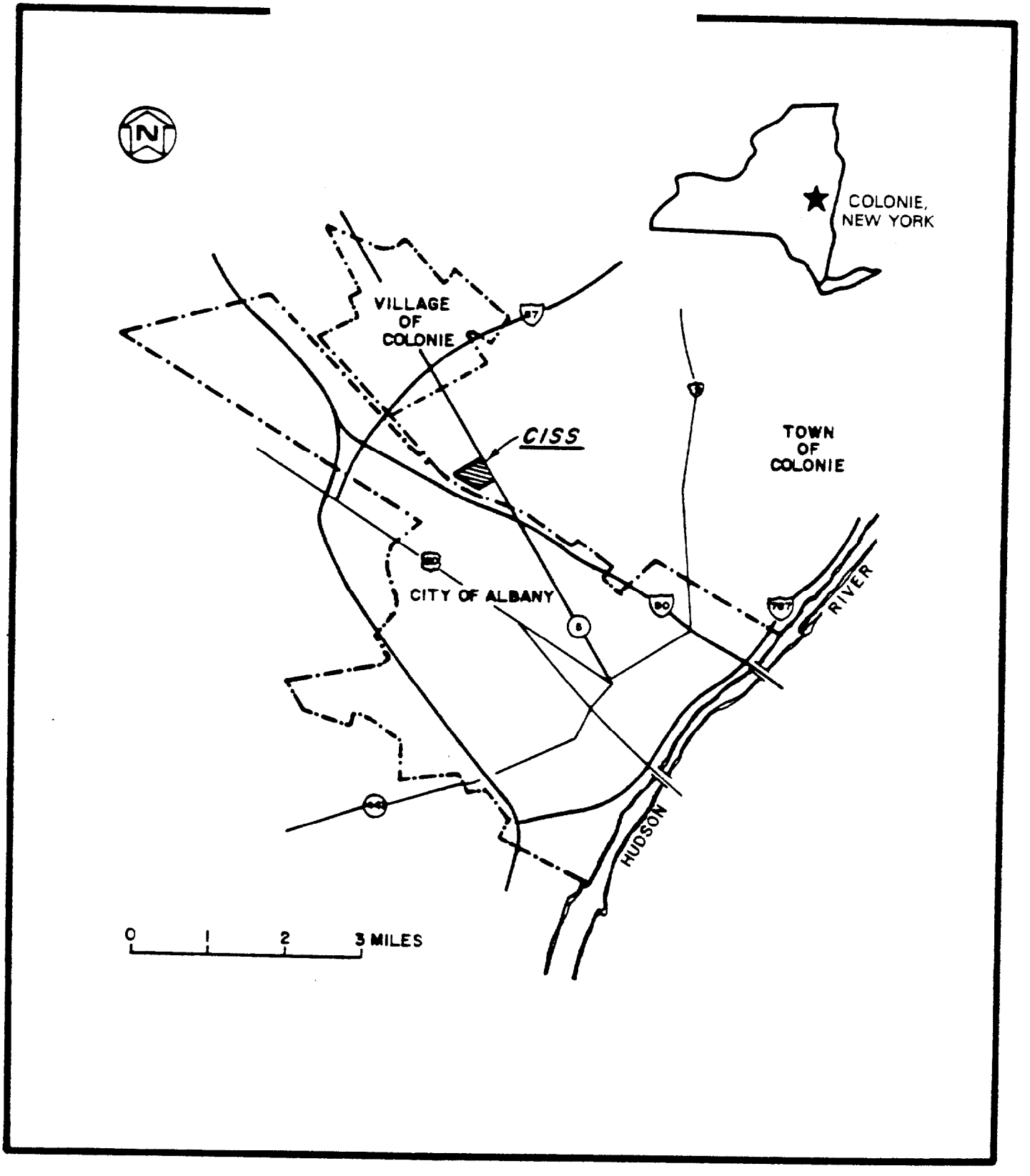

FIGURE 1-1 MAP OF THE CISS AREA

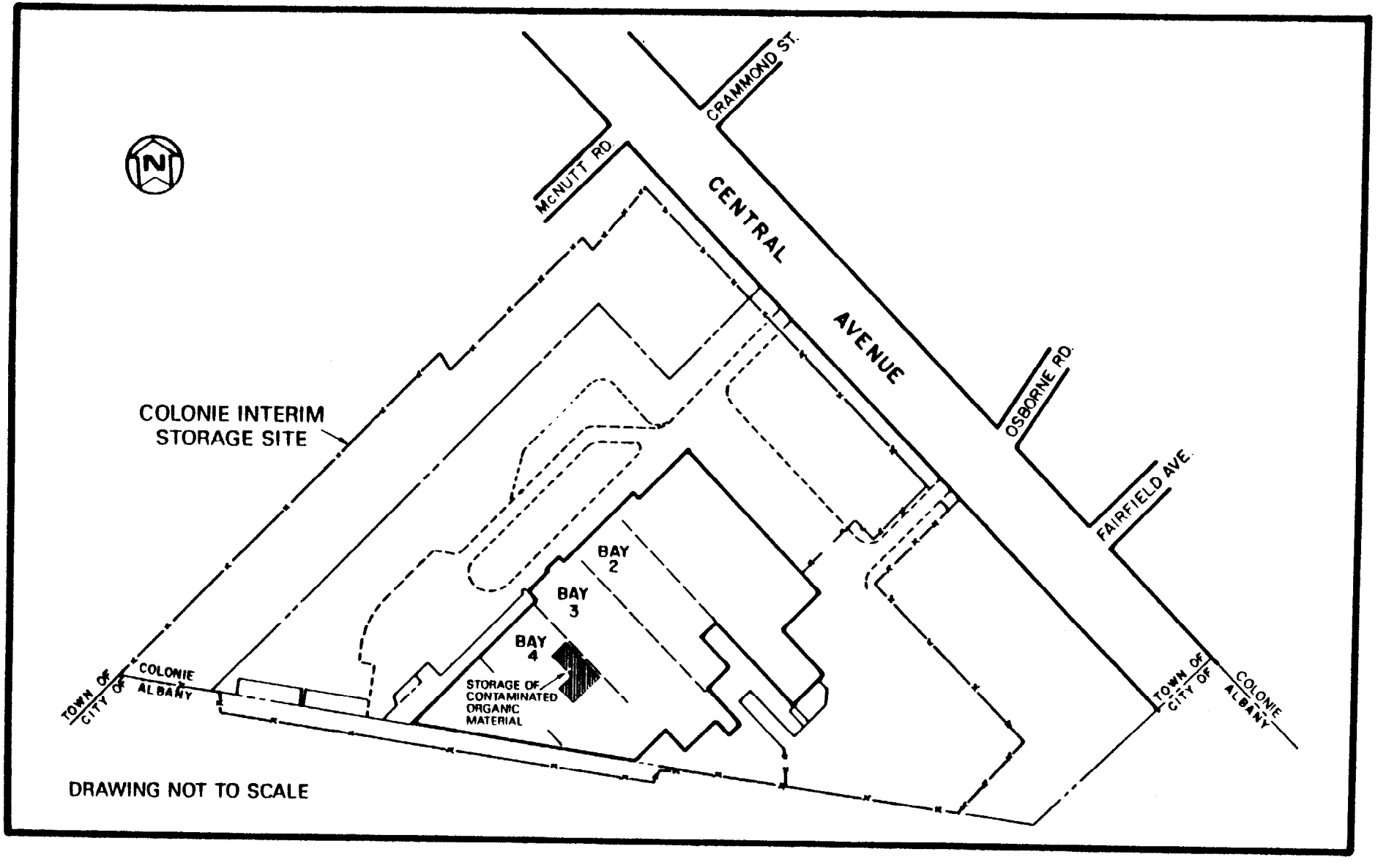

FIGURE 1-2 MAP OF THE CISS SHOWING INTERIM STORAGE AREA

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. The AEC contract was terminated in 1968, and work at the plant afterwards was devoted to fabricating shielding components, counterweights, and artillery projectiles from depleted uranium.

On February 15, 1980, the New York State Supreme Court issued an order temporarily restraining NL Industries from performing any operation 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 conditions that may have been caused to surrounding properties by the airborne discharge of radioactive materials from the plant. In 1980, Teledyne Isotopes was contracted by NL Industries to survey the radioactivity in the environment at the facility and in the surrounding area (Refs. 1 and 2).

In February 1984, the Secretary of Energy accepted an NL Industries offer to sell 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 the DOE on February 29, 1984, and title to it was transferred to DOE. In addition, purchase by DOE of the Niagara Mohawk Power Corporation property, which borders the CISS to the north and northwest, has been approved by Congress.

Since February 1984, the NL Industries property has been maintained by BNI. As part of its duties as PMC, BNI maintains security, performs maintenance as required, and carries out an environmental monitoring program. A brief description of the present condition of the site is provided in the following sections.

1.3 AREA ENVIRONMENTAL CONDITIONS

The CISS is underlain by Ordovician shale of the Normanskill Formation at a depth of about 150 to 200 ft. The bedrock is overlain by thin layers of glacial till and stratified drift. These glacial deposits are overlain by a 100- to 150-ft thick layer of unconsolidated deposits of clay and silt (Ref. 3).

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. 4). The groundwater table around the plant ranged from about 2 to 16 ft below ground during borehole drilling in March 1981 (Ref. 2). Depths to water measured in the four wells on November 1, 1982 ranged from 4 to 10 ft below the ground surface (Ref. 5). The groundwater flows to the southeast or east in the vicinity of the site (Refs. 5 and 6).

The site is located within the Patroon Creek drainage basin about 1.6 mi east of Rensselaer Lake (Figure 1-3). Patroon Creek lies about 0.25 mi south of the NL Industries plant. The surface hydrology of the CISS itself consists of a small stream that 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 Patroon Creek.

The climate of the CISS area is typically humid with cold winters. The mean annual temperature in Albany is 48°F. January is the coldest month, with a mean temperature of 24°F, and July the warmest, with a mean temperature of 72°F. The mean annual precipitation in the area is 37 in., which is evenly distributed throughout the year. Maximum monthly means occur in June, July, and August. Average annual snowfall is 50 in. (Ref. 5). The predominant prevailing summer winds are from the south and south-southeast. The prevailing winter winds are from the north-northwest (Ref. 1).

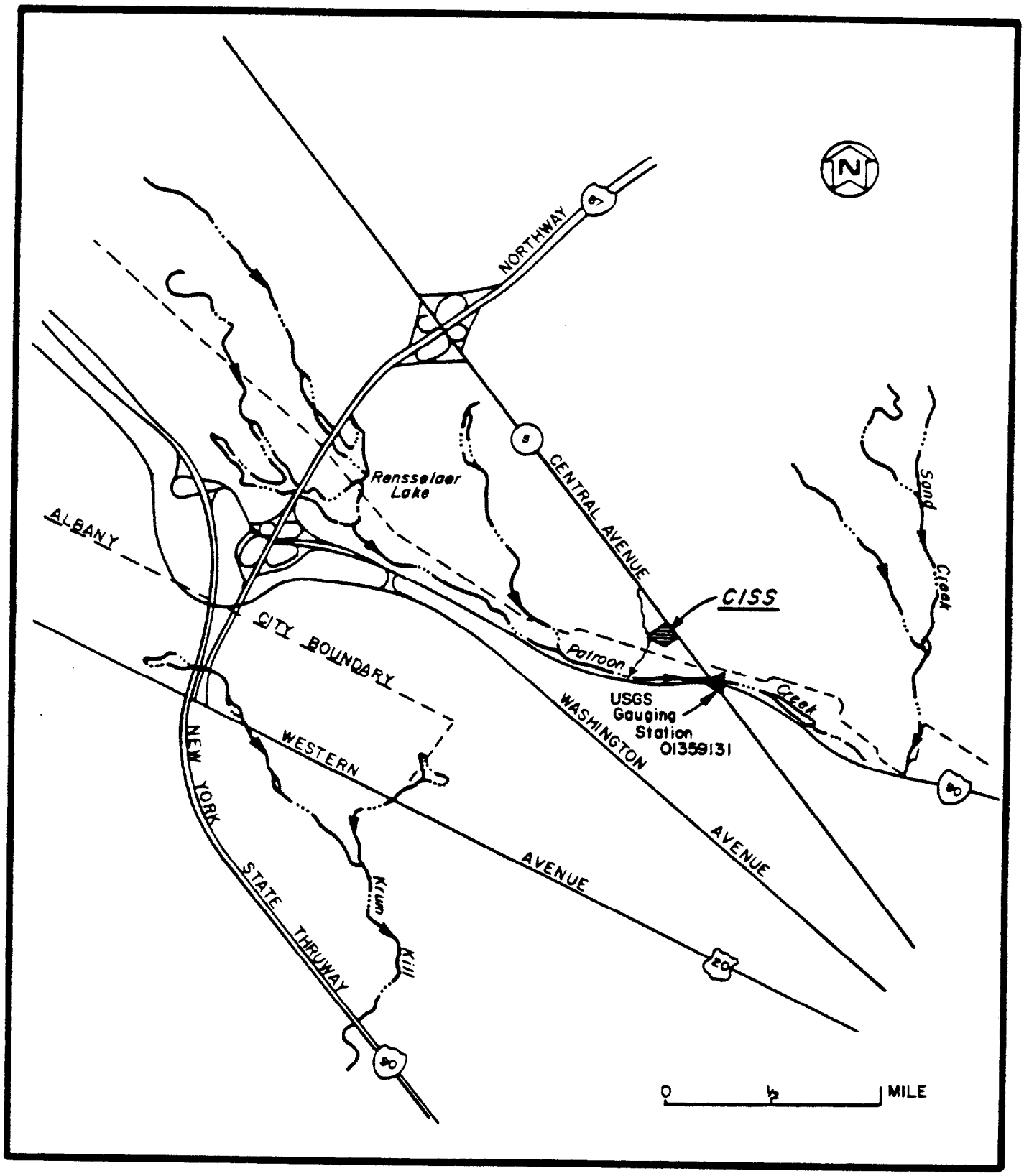

FIGURE 1-3 MAP OF SURFACE WATER DRAINAGE IN THE CISS AREA

The CISS is bordered on the northeast by State Route 5, also called Central Avenue or the Albany-Schenectady Road (Figure 1-1). The area across Central Avenue from the CISS is primarily residential. While there is no reliable estimate of the number of persons living within 1 mile of the site, the 1980 population of the Town of Colonie was approximately 75,000 (Ref. 7).

To the northwest and west, the site is bordered by open land and a power station 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.

1.4 1984 SITE ACTIVITIES

During 1984, about 800 yd^3 of contaminated soil were removed from 11 vicinity properties on Yardboro, Palmer, and Central Avenues in Colonie. The properties were restored through backfilling and landscaping. The contaminated material was taken to the NL plant site building where it is stored in Bay 4 (Figure 1-2) under a protective cover.

Other major activities conducted in 1984 included:

- A geohydrological program was completed which consisted of the drilling of wells to define site geologic conditions and the installation of groundwater monitoring wells.
- A survey team from Oak Ridge National Laboratory continued radiological surveys in the area around the plant. About 25 additional properties have been identified which will require remedial action.

2.0 SUMMARY

An environmental monitoring program began at the CISS in May 1984. Surface and groundwater, sediment, and external gamma rates were monitored to determine the site's compliance with DOE Concentration Guides (CGs) provided in DOE Order 5480.1A, Chapter XI (Ref. 8). The CGs, in most cases, represent the concentration of a radionuclide in air or water that would limit the dose to the most highly exposed individual to equal to or less than accepted radiation protection standards. Radiation doses were calculated to determine hypothetical exposure levels, which were compared to the DOE Radiation Protection Standards (RPS). The DOE CGs for radionuclides of concern at CISS and the DOE RPS values are included in Appendix A of this report.

In surface water, average concentrations of dissolved total uranium (depleted) ranged from 0.2 to 119 percent of the DOE CG of 740 pCi/l for release to uncontrolled areas. The highest total uranium (depleted) concentration was 2632 pCi/l in a sample collected upstream of the CISS. The highest radium-226 concentration measured in surface water was 0.8 pCi/l, with average concentrations ranging from 0.7 to 2 percent of the DOE CG of 30 pCi/l for release to uncontrolled areas. Only baseline samples were taken for sediments, with downstream locations showing higher concentrations of isotopic uranium and radium than the upstream location.

In groundwater, average concentrations of dissolved total uranium (depleted) ranged from 0.3 to 1.2 percent of the DOE CG. The maximum concentration was 21.5 pCi/l. Average concentrations of radium-226 in groundwater ranged from 0.3 to 0.6 percent of the DOE CG. The maximum radium-226 concentration measured was 0.8 pCi/l.

External gamma exposure rates were measured only during the fourth quarter of 1984. The highest rate recorded at the site boundary was 27.1 uR/h, which is approximately 48 percent of the DOE RPS of 60 uR/h. Background, measured at 12.0 uR/h (see Table 3-4), has not been subtracted.

Radiological exposures to a hypothetical maximally exposed individual were calculated, assuming the person resided continuously at the point where the highest exposure could be received. This point was determined to be to the northwest of the site. Ingestion of surface water with the highest average concentration of depleted uranium as the exclusive source of tap water would result in a 50-year dose commitment to the bone of approximately 890 mrem. Ingestion of water containing depleted uranium at the DOE CG of 740 pCi/l would produce a 50 year dose commitment to the bone of 750 mrem.

External gamma radiation at the point of highest total exposure potential (water ingestion and external radiation) would irradiate the whole body at a rate of 130 mrem/yr, compared to the DOE RPS for an individual of 500 mrem/yr.

3.0 DATA COLLECTION, ANALYSIS, AND EVALUATION

This section describes the various environmental sampling, monitoring, and analytical procedures and the extent of conformance with DOE CGs. The CGs in most cases represent the concentration of a radionuclide in air or water that would limit the dose to the most highly exposed individual to equal to or less than accepted radiation protection standards. Radiation doses were calculated to determine hypothetical exposure levels, which were compared to the DOE RPS values.

Environmental monitoring results listed in the individual tables are the arithmetic average of individual results. Individual sources of error, (e.g., analytical or sampling error) 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".

3.1 SURFACE WATER AND SEDIMENT SAMPLING

Surface water sampling locations are illustrated in Figure 3-1. Baseline samples were collected in May and June, 1984, before work began on-site, and routine monitoring was carried out quarterly beginning with the second quarter. Once each quarter, surface water samples were collected, consisting of nominal 1-liter grab samples to fill a 4-liter container. Eberline Analytical Corporation (EAC) analyzed the samples for uranium (by fluorometry), and radium-226 (by radon emanation). Analyses results are reported in Table 3-1, and the DOE CG limits for uncontrolled areas have been applied to all results. Sediments were collected only during baseline sampling, and the results are provided in Table 3-2.

For dissolved total uranium (depleted), surface water average concentrations ranged from 1.5 to 878 pCi/l, or 0.2 to 119 percent, respectively, of the DOE CG of 740 pCi/l for depleted uranium

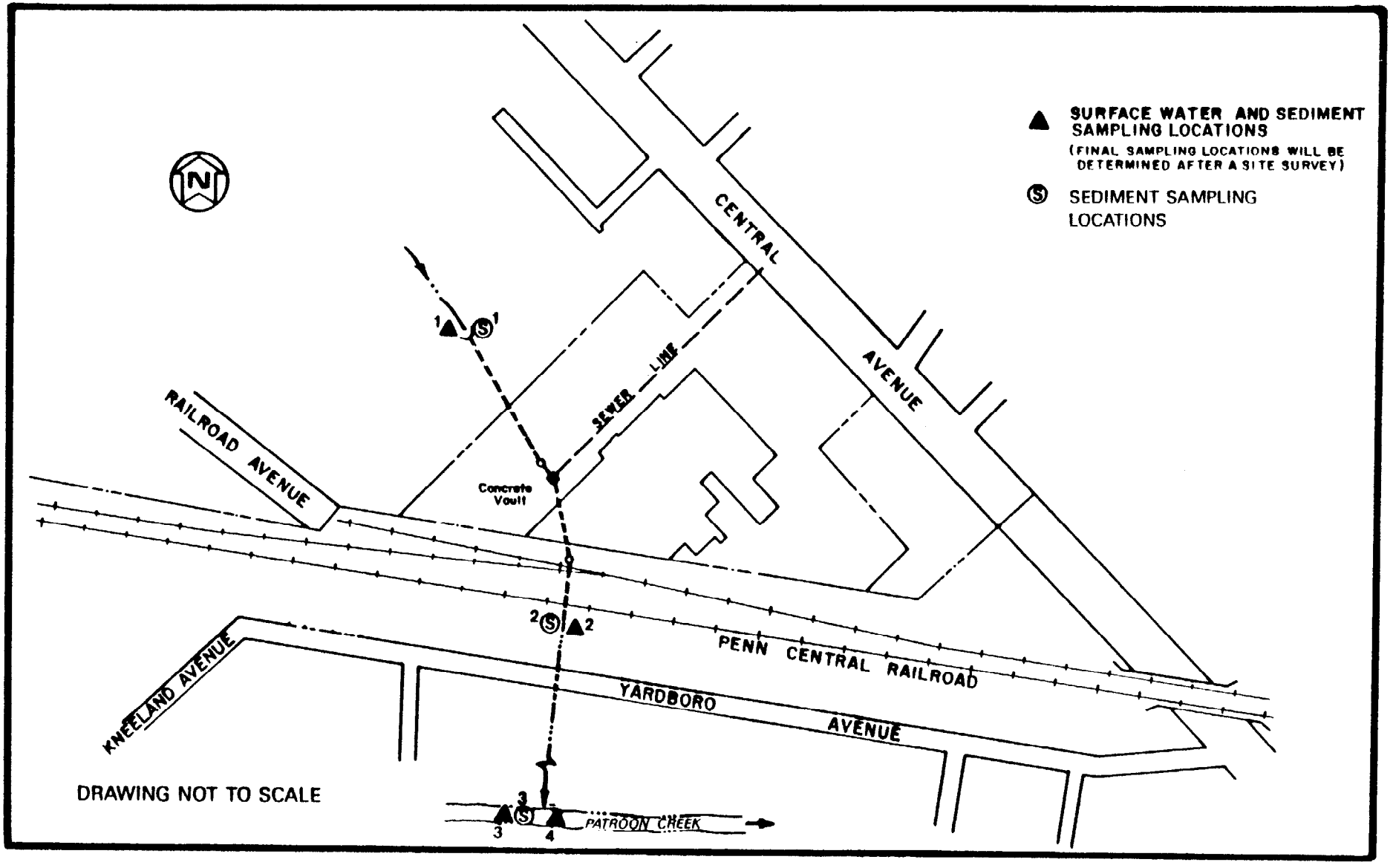

FIGURE 3-1 SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS AT THE CISS

TABLE 3-1

DISSOLVED RADIUM-226 AND TOTAL URANIUM (DEPLETED)
IN SURFACE WATER, CISS, 1984

Sampling Location[a]	Number of Samples[b]	Concentration (pCi/l)				Percent Standar (Average
		Baseline[c]	Minimum	Maximum	Average[d]	
Ra-226						
1	4	0.1	0.2	0.8	0.5	2.0
2	5	0.1/0.3	0.1	0.4	0.2	0.8
3	4	0.1	0.1	0.6	0.4	1.0
4	4	0.2	0.1	0.3	0.2	0.7
Total U (Depleted)						
1	4	129.0	0.6	2632.0	878.0	118.6
2	5	10.0/10.4	7.3	9.8	9.0	1.2
3	4	1.1	0.9	7.3	5.0	0.7
4	4	7.3	1.0	1.9	1.5	0.2

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

[b]Samples collected during baseline, and for 2nd, 3rd, and 4th quarter.

[c]Baseline samples were taken before work began on-site. Locations 1 and 2 were sampled on 5/02/84, and Locations 2, 3, and 4 were sampled on 06/05/84. Baseline concentrations were not included in calculating average values.

[d]In computing the average, quarterly values which are less than the limit of sensitivity are considered as being equal to the limit of sensitivity Average values are reported without the notation "less than."

[e]The DOE CG limit for depleted uranium in uncontrolled areas is 740 pCi/l The limit for radium-226 is 30 pCi/l. Background levels have not been subtracted.

TABLE 3-2

BASELINE RADIONUCLIDE CONCENTRATIONS FOR SEDIMENT SAMPLES TAKEN AT THE CISS, 1984[a]

Sampling Location[b]	Concentration (pCi/g dry)			
	Uranium-234	Uranium-235	Uranium-238	Radium-226
1[c]	1.0	0.06	3.8	0.7
2[c]	1.2	0.06	5.4	1.1
3[d]	3.2	0.1	4.2	0.8

[a]Baseline samples were taken before work commenced on-site. There are no guidelines for radionuclides in sediment. However, for purposes of comparison, the DOE FUSRAP proposed guidelines for radionuclides in soil are 5 pCi/g in the upper 6 in. and 15 pCi/g below 6 in. for radium and thorium, and 75 pCi/g for uranium (Ref. 9).

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

[c]Sample taken May 2, 1984.

[d]Sample taken June 5, 1984.

released to uncontrolled areas. The highest concentration, 2632 pCi/l, occurred at Location 1, which is upstream of the CISS. In other samples taken at the same location, concentrations were no higher than 129.0 pCi/l (see Table 3-2). It is possible the high-concentration sample was contaminated with sediments. However, the sample was not re-analyzed, and the reason for the high concentration cannot be definitively explained.

Radium-226 average concentrations in surface water ranged from 0.2 to 0.5 pCi/l, or 0.7 to 2 percent, respectively, of the CG of 30 pCi/l for release to uncontrolled areas. Baseline sediment sample results showed higher concentrations of uranium and radium downstream of the CISS than were measured upstream.

3.2 GROUNDWATER SAMPLING

Groundwater sampling locations included four existing on-site wells as illustrated in Figure 3-2. Seven additional monitoring wells were installed as part of a geohydrological investigation and will be sampled in 1985. Groundwater samples were obtained using a hand pump. Before the samples were collected, wells were pumped dry or a minimum of one well volume was removed. Four-liter samples were obtained and were then analyzed by EAC for total uranium (by fluorometry) and radium-226 (by radon emanation). The results of groundwater sample analyses are reported in Table 3-3.

Radium-226 average concentrations ranged from 0.3 to 0.6 pCi/l, or 1 to 2 percent, respectively, of the DOE CG of 30 pCi/l for release to uncontrolled areas. Dissolved total uranium (depleted) concentration averages ranged from 2.1 to 8.7 pCi/l, or 0.3 to 1.2 percent, respectively, of the CG of 740 pCi/l for depleted uranium released to uncontrolled areas.

3.3 EXTERNAL GAMMA RADIATION MONITORING

External gamma exposure rates were measured using lithium-flouride (LiF) thermoluminescent dosimeters (TLDs). Each dosimeter contained

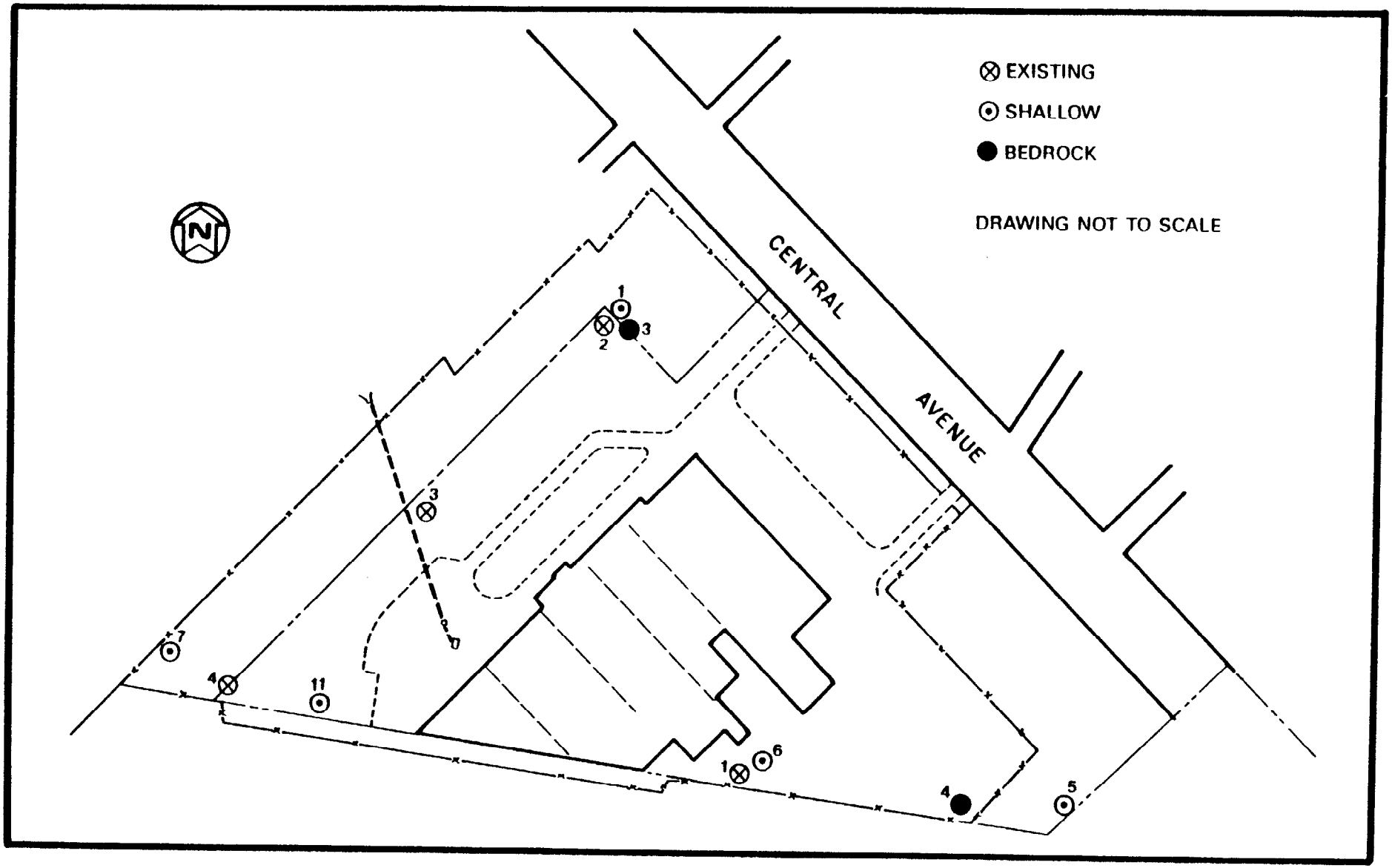

FIGURE 3-2 GROUNDWATER SAMPLING LOCATIONS AT THE CISS

TABLE 3-3

DISSOLVED RADIUM-226 AND TOTAL URANIUM (DEPLETED) CONCENTRATIONS IN GROUNDWATER, CISS, 1984

Sampling Location[a]	Number of Samples[b]	Concentration (pCi/l)				Percent of Standard (Average)[d]
		Baseline[c]	Minimum	Maximum	Average	
Ra-226						
1	4	0.2	0.3	0.4	0.3	1.0
2	4	0.4	0.4	0.6	0.5	2.0
3	4	0.6	0.3	0.7	0.6	2.0
4	4	0.1	0.2	0.8	0.5	2.0
Total U (Depleted)						
1	4	2.9	2.2	21.5	8.7	1.2
2	4	0.3	0.3	2.6	2.1	0.3
3	4	0.6	0.6	7.2	4.1	0.6
4	4	3.2	2.2	20.2	8.6	1.2

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

[b]Samples obtained during baseline (6/5/84) and 2nd, 3rd, and 4th quarter.

[c]Baseline samples were taken before work began on-site. These concentrations were not included in calculating average values.

[d]The DOE CG limit for radium-226 in water released in uncontrolled areas is 30 pCi/l. The limit for depleted uranium is 740 pCi/l. Background levels have not been subtracted.

five individual chips, the responses of which were averaged. Ten TLDs were placed on-site at the locations indicated in Figure 3-3. One background station was deployed in Albany, New York. Exposure rates were measured during the fourth quarter only, and the results, reported in Table 3-4, ranged from 10.1 to 27.1 uR/h, all below the DOE Radiation Protection Standard of 60 uR/h. The background station averaged 12.0 uR/h.

3.4 RADIOLOGICAL EXPOSURE

To assess the impact of the radioactive materials at the CISS on members of the general public, the radiological exposure of a hypothetical, maximally exposed individual was evaluated. An appraisal of potential pathways suggested that ingestion of water containing depleted uranium and external gamma irradiation were the principal exposure modes. For each of the pathways considered, most organs in the body received some radiological exposure. However, depending on the method of internal deposition and the chemical characteristics of the radionuclides, some organs receive a higher exposure than others. These are called "critical organs" because the effect of the exposure is maximized in them.

Uranium taken into the body via ingestion migrates and incorporates into the bone, which is the critical organ for this pathway. Conversion of measured concentrations in water to an internal dose to the bone requires several assumptions. An intake rate must be postulated. For these calculations, the maximum water intake rate (730 ml of tap water per day) of Reference Man was used (Ref. 10). Radionuclide intakes were converted to internal doses to the bone using the methodology described in International Commission on Radiological Protection (ICRP) publications 26 and 30 (Refs. 11 and 12). All reported doses are 50-year dose commitments. The 50 year dose commitment is a concept which provides for the fact that an intake of a radionuclide with a long half-life (such as uranium and radium) may result in an internal exposure for many years.

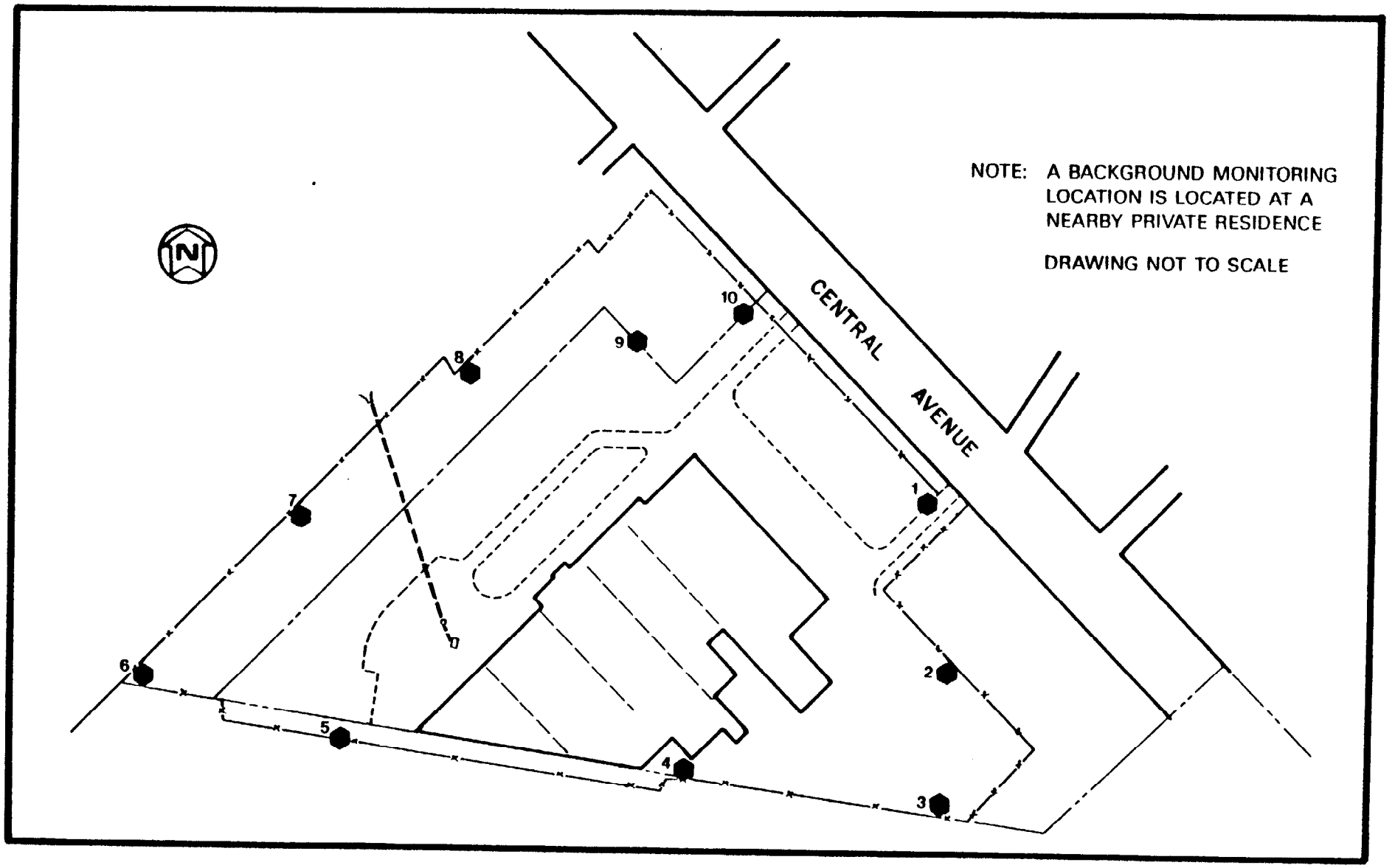

FIGURE 3-3 EXTERNAL GAMMA RADIATION MONITORING LOCATIONS AT THE CISS

TABLE 3-4

EXTERNAL EXPOSURE RATES FROM GAMMA RADIATION MEASURED ON-SITE, CISS, FOURTH QUARTER, 1984

Sample Location[a]	Exposure Rate[b] (uR/h)
01	14.5
02	13.4
03	17.3
04	19.5
05	20.9
06	14.6
07	10.3
08	27.1
09	22.3
10	10.1
11[c]	12.0

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

[b]Exposure rates are based on measurements taken using thermoluminescent dosimeters. Background has not been subtracted.

[c]Background location, located at 3 Fuller Place, Albany, New York.

Gamma radiation from external sources is assumed to irradiate the body uniformly. The total body is therefore the critical organ for external gamma exposure. Internal organs are assumed to be exposed to the same level as the entire body. Exposures of organs resulting from internal and external sources are additive.

3.4.1 Identification of Hypothetical, Maximally Exposed Individual

To identify the hypothetical individual in the vicinity of the CISS who would receive the highest dose from on-site radioactive materials, doses were calculated at various monitoring locations. From these calculations, it was determined that the highest dose would be received by an individual to the northwest of the site. Since this is a residential area, the doses were based on a 168 hour week exposure for 52 weeks.

3.4.2 Radiological Dose to Hypothetical, Maximally Exposed Individual

Surface water sampling location 1 had the highest average concentration of depleted uranium. Although ingestion of water from this source is extremely improbable, this water was used to calculate the committed dose to the maximally exposed individual. If this individual used this surface water as the exclusive source of tap water, the 50 year dose commitment to the critical organ (bone surface) would be 890 mrem. Ingestion of water containing the maximum allowable concentration of depleted uranium by a member of the general public would result in a dose commitment of 750 mrem.

The TLD location nearest the surface water sampling point is 08, at which the exposure rate was 27.1 uR/h. Location 11 is removed from site influences and indicates a background exposure rate of 12.0 uR/h. The radioactive wastes at the CISS therefore increase the exposure rate by 15.1 uR/h. Assuming exposure for 168 hours per week and 52 weeks per year, this relates to an annual dose of 130 mrem. DOE radiation protection standards restrict doses to members of the general public to less than 500 mrem/yr.

3.5 QUALITY ASSURANCE

Established quality assurance procedures were followed in the collection and analysis of environmental samples during 1984. BNI personnel working at the site collected and prepared samples in accordance with internal quality control procedures. Sample analyses conducted by EAC also were governed by an internal quality control program consisting of duplicate, spike, and blank samples. EAC's internal quality control results are compared monthly with EPA crosscheck program results.

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APPENDIX A
ENVIRONMENTAL STANDARDS

The applicable radioactivity Concentration Guides (CGs) provide the limits for maximum permissible radioactivity both on-site (controlled area) and beyond the external perimeter of the site (uncontrolled area). The CGs for the common radionuclides at the CISS are presented in Table A-1, and DOE Radiation Protection Standards are presented in Table A-2. Both tables are derived from DOE Order 5480.1A, Chapter XI.

TABLE A-1
RADIOACTIVITY CONCENTRATION GUIDES
FOR THE CISS

Radionuclide	Media	Controlled Area	Uncontrolled Area
Uranium (depleted)	Water Soluble	24,400 pCi/l	740 pCi/l
Radium	Water Soluble	400 pCi/l	30 pCi/l

TABLE A-2
DOE STANDARDS FOR RADIATION PROTECTION
OF THE PUBLIC

Type of Exposure	Maximum Dose to an Individual in the Population	Average Dose to a Sample of Exposed Population
Whole body, gonads, or bone marrow	500 mrem/yr	170 mrem/yr
Other organs	1500 mrem/yr	500 mrem/yr

[a]Annual dose equivalent or dose commitment above natural background and excluding medical radiation exposures.