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## Westinghouse Hanford Company Environmental Surveillance Annual Report--100 Areas Calendar Year 1989

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WESTINGHOUSE HANFORD COMPANY  
ENVIRONMENTAL SURVEILLANCE ANNUAL  
REPORT--100 AREAS  
CALENDAR YEAR 1989

C. J. PERKINS

ABSTRACT

*Near-field environmental surveillance of the Hanford Site 100 Areas is performed by Westinghouse Hanford Company (Westinghouse Hanford) to assess and control the impacts of operations. This involves sampling and analysis from the major environmental pathways of exposure to onsite workers.*

*Results from the Westinghouse Hanford Environmental Surveillance Program for the Hanford Site 100 Areas are presented in this report. The environmental surveillance program provides sampling and monitoring of several parameters to evaluate the environmental impact of 100-N Area Reactor Facilities and the shutdown reactor facilities and burial grounds in the retired 100 Areas. Discharges to the environment are reported in annual effluent release reports.*

*At the 100-N Area, samples of ambient air, groundwater, vegetation, and surface soil were collected and analyzed. Direct radiation levels were also monitored at several locations. Samples of ambient air, vegetation, surface soil, and sediment were collected to monitor the environmental impact of the 1301-N and 1325-N Liquid Waste Disposal Facilities (LWDF). Direct radiation surveys were conducted for each LWDF and along the Columbia River shoreline.*



**EXECUTIVE SUMMARY**

Near-field environmental surveillance of the Hanford Site 100 Areas is performed by Westinghouse Hanford Company (Westinghouse Hanford) to assess and control the impact of operations. This involves sampling and analysis from the major environmental pathways of exposure to onsite workers.

Results from the Westinghouse Hanford Environmental Surveillance Program for the Hanford Site 100 Areas are presented in this report. The environmental surveillance program provides sampling and monitoring of several parameters to evaluate the environmental impact of 100-N Area reactor facilities and the shutdown reactor facilities and burial grounds in the retired 100 Areas. Discharges to the environment are reported in annual effluent release reports.

At the 100-N Area, samples of ambient air, groundwater, vegetation, and surface soil were collected and analyzed. Direct radiation levels were also monitored at several locations. Samples of ambient air, vegetation, surface soil, and sediment were collected to monitor the environmental impact of the 1301-N and 1325-N Liquid Waste Disposal Facilities (LWDF). Direct radiation surveys were conducted for each LWDF and along the Columbia River shoreline.

At the retired 100 Areas, vegetation and surface soil samples were collected and analyzed. In addition, samples from groundwater monitoring wells located at the 100-K Area were collected and analyzed. The results provided in this report are summarized by the following highlights.

**REGULATORY CONTROLS**

The radiation dose to workers and the offsite population is regulated by a tiered system of controls. The U.S. Department of Energy (DOE) has established the occupational dose limit at 5,000 mrem/yr. The effective dose equivalent limits for any member of the public were set by the DOE at 500 mrem/yr for occasional annual exposures and 100 mrem/yr for continuous exposures. An administrative action level of 25 mrem/yr (to the maximum individual member of the public) has been identified by the DOE to ensure that these dose limits are not exceeded.

Derived concentration guides (DCG) corresponding to the 100 mrem/yr effective dose equivalent standard are used for comparison purposes only in this report. It should be noted that the DCGs are applicable at the point of actual exposure to members of the public and are, therefore, not applicable onsite.

**GENERAL**

The N Reactor was placed in a "standdown" mode on January 7, 1987, and did not operate during calendar years 1988 and 1989. The reactor has been kept in "cold standby" because of recent decisions affecting its role in the production of special nuclear materials.

**AMBIENT AIR MONITORING**

Environmental samples of ambient air collected near the 100-N Area indicated that the concentrations of airborne radionuclides were less than the DCG and that there was no significant release to the environment. The only radionuclide detectable during 1989 was  $^{60}\text{Co}$ .

**GROUNDWATER**

Radionuclide concentrations in the groundwater exceeded the DCG for  $^{90}\text{Sr}$  in monitoring sites near the 1301-N and 1325-N LWDFs during this reporting period. Concentrations of  $^{90}\text{Sr}$  also exceeded the DCG at the N Springs. Groundwater tritium concentrations generally decreased, compared to 1988 in the 100-N and 100-K Areas, and did not exceed the DCG at any time during the reporting period.

**SOIL AND VEGETATION**

Environmental samples of surface soil and vegetation collected at the 100-N Area indicated near-background levels of radionuclides in the immediate environment. Trend analysis revealed generally stable radionuclide concentrations in soil and vegetation samples since 1980. Five additional, downstream vegetation sampling locations were added along the N Springs shoreline in 1988. Generally, these samples contained above-background levels of  $^{90}\text{Sr}$ . Residual concentrations of radionuclides released to the 1301-N LWDF were detected in the surface soil and vegetation adjacent to the facility.

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Since September 1985, the 1301-N LWDF has not received 100-N Reactor liquid effluent. Facility closure plans are being evaluated that will include biotransport and intrusion barriers.

Environmental samples of surface soil and vegetation collected near the retired 100 Area reactor facilities indicated no significant release or biotransport of radionuclides to the immediate environment. Trend analysis, again, revealed generally stable radionuclide concentrations in soil and vegetation samples since 1981.

#### **EXTERNAL RADIATION**

External radiation levels were highest in radiologically controlled areas near the 1301-N and 1325-N LWDFs. Dose rates at thermoluminescent dosimeter locations near the 1301-N LWDF were generally lower than the levels observed since 1986. Dose rates at locations near the 1325-N LWDF were lower by more than 50% from those observed in 1988.

#### **RADIOLOGICAL SURVEYS**

Direct radiation levels measured near the 1301-N LWDF were comparable to those measured in 1988. The 1301-N LWDF is no longer receiving liquid effluent from N Reactor. The absence of shielding (water) resulted in the measurable direct radiation levels.

Direct radiation levels measured near the 1325-N LWDF were significantly lower than those in 1988. Activities in support of reactor configuration supplied increased water levels that resulted in the decreased direct radiation levels.

Direct radiation levels measured along the Columbia River shoreline were lower than those observed since 1986. This is likely attributable to the approaching half-life expiration of  $^{60}\text{Co}$  (year 4 of the 5.3-yr term).

#### LIQUID WASTE DISPOSAL FACILITIES

Sediment samples collected from the 1325-N LWDF crib contained activation and fission products discharged from N Reactor. Discharges to the 1301-N LWDF were discontinued in September 1985; therefore, 1301-N sediment samples were not collected. Residual radionuclide levels will decline as the radionuclides decay.

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WESTINGHOUSE HANFORD COMPANY ENVIRONMENTAL  
SURVEILLANCE ANNUAL REPORT--100 AREAS  
CALENDAR YEAR 1989

1.0 INTRODUCTION

1.1 BACKGROUND

Westinghouse Hanford Company (Westinghouse Hanford), as a prime contractor to the U.S. Department of Energy (DOE) at the Hanford Site, manages the operation of the N Reactor and the storage of spent fuel at 100-K Area and maintains the retired reactor facilities at 100-B/C, -D/DR, -F, -KE/KW, and -H Areas.

The Hanford Site is located within the Pasco Basin in south-central Washington State, approximately 170 mi southeast of Seattle and 125 mi southwest of Spokane. The 100 Areas are located in the north-central part of the Hanford Site, along the southern (right) bank of the Columbia River (Figure 1-1).

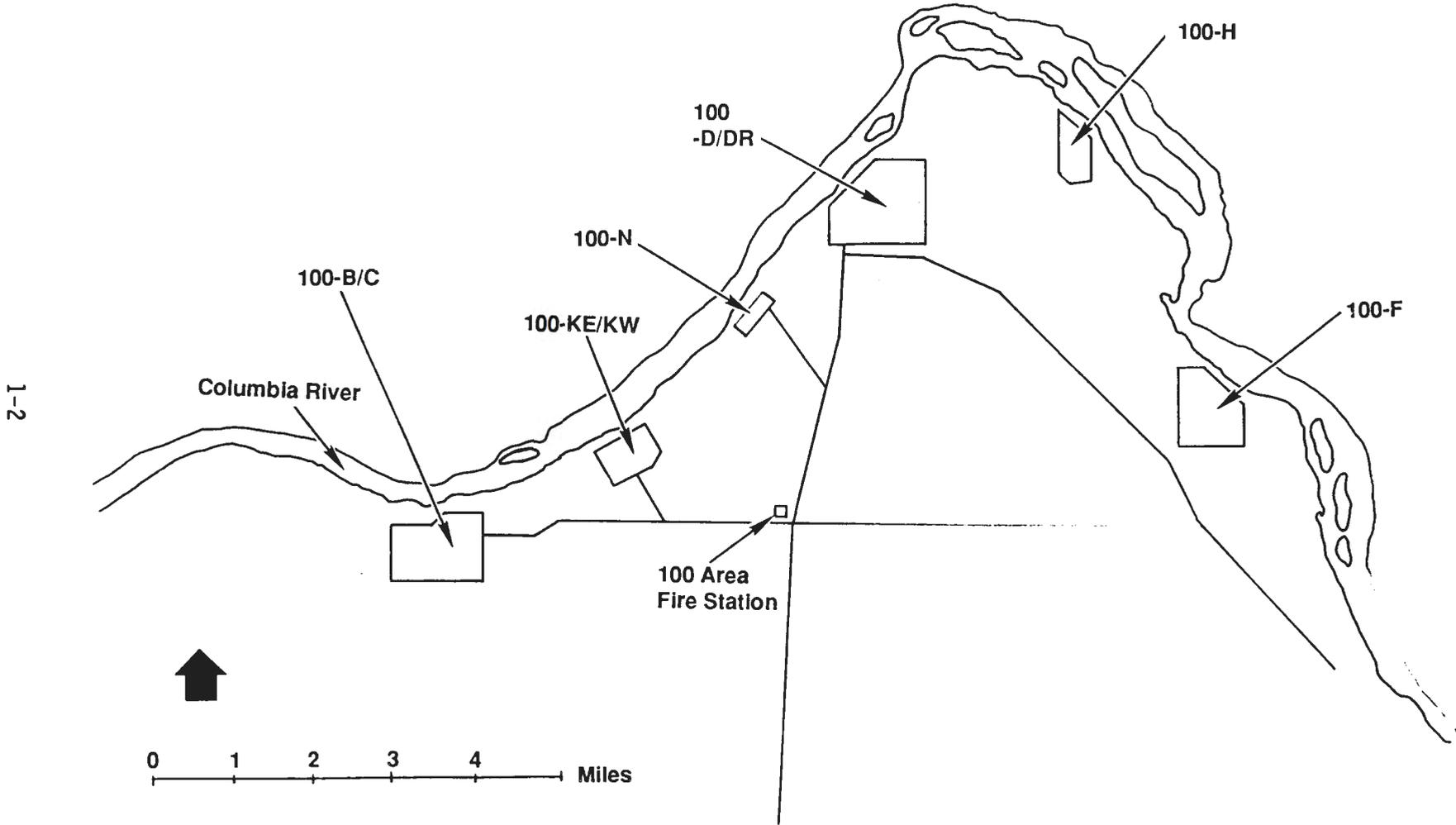
1.2 SCOPE OF THE ENVIRONMENTAL SURVEILLANCE PROGRAM

The Westinghouse Hanford Environmental Surveillance Program for the 100 Areas provides monitoring of specific environmental media. The information is used to assist in evaluating the environmental impact of 100-N Area reactor facilities and the shutdown reactor facilities in the retired 100 Areas (see "Site Characteristics"). The major objectives of the monitoring program are as follows:

- Detect radionuclides in identified radiological release pathways
- Detect and evaluate changes in radionuclide concentrations discharged or existing in the immediate environment
- Maintain a database for trend analyses
- Provide data for after-the-fact release analyses
- Demonstrate compliance with applicable regulations.

This document is used by Westinghouse Hanford to evaluate facility operation and management practices. The report does not include estimates of radiation doses to the public resulting from the operation of 100 Area facilities. Reports of population dose commitments and other environmental information for the Hanford Site are prepared and issued by Battelle's Pacific Northwest Laboratory (PNL). Westinghouse Hanford provides radionuclide release information to PNL for the preparation of such documents.

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Figure 1-1. Map of the 100 Areas.

### 1.3 REGULATORY BASIS

Radiation exposure to workers and the offsite population are regulated by a tiered system of controls. The DOE has established the occupational exposure limit at 5,000 mrem/yr. The exposure limits for any member of the public are set by the DOE at 500 mrem/yr for occasional annual exposures and 100 mrem/yr for annual exposures expected to last longer than 5 yr. An administrative action level of 25 mrem/yr (to the maximum individual member of the public) has been identified by the DOE to ensure that these exposure limits are not exceeded.

Derived concentration guides (DCG) corresponding to the 100-mrem/yr effective dose equivalent standard are used as comparisons in this report. It should be noted that DCGs are applicable at the point of actual exposure to members of the public and are, therefore, not directly applicable onsite. In keeping with Westinghouse Hanford's philosophy to keep doses to workers as low as reasonably achievable (ALARA), the DCGs are compared to onsite data.

### 1.4 FACILITY DESCRIPTIONS

#### 1.4.1 100-N Area Facilities

1. 105-N Reactor--The N Reactor is a graphite-moderated, pressurized light-water cooled reactor that uses slightly enriched uranium fuel in the production of special nuclear materials (SNM) and byproduct steam for use by the Washington Public Power Supply System (Supply System) in the generation of electric power. N Reactor was placed in a "standdown" mode on January 7, 1987, and retained a "cold standby" status during 1989.
2. Liquid Waste Disposal Facilities--Two liquid waste disposal facilities (LWDF), 1301-N and 1325-N, have been used to receive and treat N Reactor liquid wastes containing low-level fission and activation products. The 1301-N LWDF was permanently retired from service in September 1985. The 1325-N LWDF is now the only LWDF receiving radioactive liquid waste discharges.

The LWDF, also referred to as crib and trench, allows influent to percolate downward into an engineered soil column, where a high percentage of radionuclides contained in the influent is removed by adsorption, filtration, and ion exchange.

3. 1314-N Liquid Waste Loadout Facility--The 1314-N Facility receives the radioactive liquid waste from the 1310-N Facility and the 107-N Facility and transfers it into a railway tank car that carries the liquid to the 200 West Area Tank Farms for processing and disposal (see WHC-EP-0145, Section 1.4.2 [WHC 1988]). In 1989, only the wastes from the 107-N were handled at this facility.
4. 1310-N Radioactive Chemical Waste Storage Facility--The 1310-N Facility is used to temporarily store radioactive waste solution used in the internal decontamination of the N Reactor.

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After cooling and neutralization, the solution is subsequently transferred through underground piping to the 1314-N Liquid Waste Loadout Facility. This facility has not received decontamination solution since February 1987.

5. 107-N Fuel Storage Basin Recirculation Facility--The 107-N Facility provides for N Reactor's irradiated fuel storage basin water recirculation and necessary filtration and demineralization to reduce radioactive effluent discharges to the 1325-N LWDF. Ion exchange system regeneration effluent and sand filter backwash water are transferred through underground piping to the 1314-N Liquid Waste Loadout Facility.
6. 1304-N Emergency Dump Tank--The 1304-N Emergency Dump Tank (EDT) is a 1,300,000-gal-capacity steel-walled vessel. In the extremely unlikely event that the thermally hot, pressurized reactor primary coolant system must be rapidly dumped, this tank would provide the necessary quenching to prevent the coolant from flashing to steam. A constant volume of 680,000 gal of unheated water is maintained in the tank. Because of small leakage in the primary coolant system dump valves, the quench water normally contains a small inventory of radioactive materials. As part of the plant configuration for cold standby, this tank was drained in May 1990.
7. 166-N Fuel Oil Storage Facility--The 166-N Facility is an above-ground, 1,135,000-gal-capacity storage tank. The tank is surrounded by an earthen berm capable of retaining approximately 2,300,000 gal. The fuel oil transfer piping is protected against corrosion. Fuel oil is used at the 100-N Area for the boiler system.
8. 1715-N Diesel Oil Storage Facility--The 1715-N Facility consists of four above-ground 105,000-gal-capacity storage tanks. The tanks are located within an earthen berm capable of retaining approximately 730,000 gal. All underground diesel oil transfer piping is protected against corrosion. Diesel oil is used at the 100-N Area to ignite the boiler systems and to fuel the diesel-driven, emergency cooling system pumps.

#### 1.4.2 Retired 100 Area Facilities

1. 105-K East and West Fuel Storage Basins--These fuel storage basins, located in the retired 100 Areas, are 2 mi upstream of N Reactor. Irradiated N Reactor fuel elements are stored in these basins.
2. 100-B, -C, -D, -DR, -F, -H, -KE, and -KW Retired Reactor Sites--These eight retired reactors are located along the Columbia River in the northern-most portion of the Hanford Site (Figure 1-1). Several permanently deactivated liquid and solid waste disposal sites and burial grounds are associated with each facility. Characterization of the remaining radioactivity in the liquid disposal sites was completed and reported in 1978 (*Radiological Characterization of the Retired 100 Areas*, Dorian 1978).

## 1.5 100 AREAS ENVIRONMENTAL SURVEILLANCE PROGRAM

### 1.5.1 100-N Area

Environmental surveillance at the 100-N Area is conducted primarily to monitor and document radionuclides detected in environmental media located near the 100-N Area facilities. The sampling program is designed to monitor the major radiological release pathways of N Reactor. The major release pathways of N Reactor are identified in Figure 1-2.

As a result of release pathway analyses, two basic monitoring programs have been implemented at the 100-N Area. Routine effluent releases are monitored and reported separately as a part of the Effluent Release Program. Environmental media associated with N Reactor release pathways are monitored as part of the Environmental Surveillance Program. These two programs, along with portions of the PNL Environmental Surveillance Program, ensure that all environmental release pathways are monitored at one or more points.

The environmental surveillance sampling for the 100-N Area is summarized in Table 1-1. Sampling methods, frequencies, and analyses are based on characteristics of the environmental parameter being sampled.

The sampling program for the 1301-N and 1325-N LWDFs is summarized in Table 1-2. Sampling methods, frequencies, and analyses are based on characteristics of the parameter being sampled.

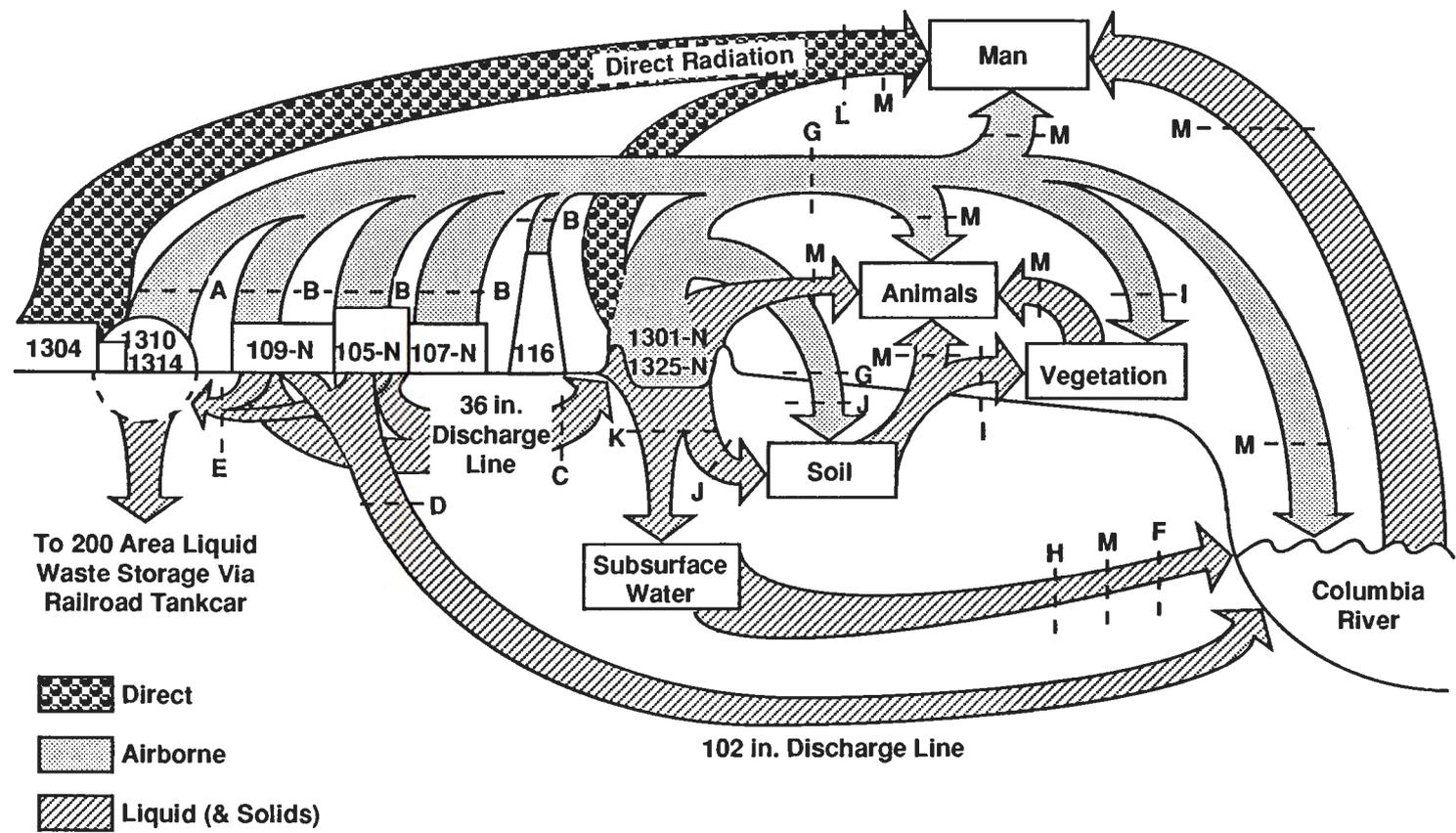
### 1.5.2 Retired 100 Areas

Environmental surveillance in the retired 100 Areas is conducted to monitor radionuclides detected in environmental media located near the retired reactor facilities and 100 Area burial grounds. The program consists primarily of soil and vegetation sampling in each of the retired areas. Groundwater sampling is also conducted at the 100-K Area.

The sampling program for the retired 100 Areas is summarized in Table 1-3. Sampling methods, frequencies, and analyses are based on characteristics of the environmental parameter being sampled.

Surface soil and vegetation samples provide a means of evaluating the distribution of radionuclides from current and past releases to the environment.

The sampling techniques used for the retired 100 Areas samples were identical to those used at the 100-N Area. Soil samples consisting of 150 g each were collected from the top 2.5 cm of the soil surface. Vegetation samples of 500 g each were collected from the growing portions of perennial vegetation. Gray rabbitbrush (*Chrysothamnus nauseosus*) was the predominant species sampled.



To 200 Area Liquid Waste Storage Via Railroad Tankcar

-  Direct
-  Airborne
-  Liquid (& Solids)

**Environmental Monitoring Programs**

Effluent Release Program

- A Air sampler on tank vents
- B Continuous air samplers
- C Flow proportional liquid sampler
- D Continuous large volume liquid sampler
- E Liquid samples during storage and shipment
- F Continuous composite liquid sampler

Environmental Surveillance Program

- G Continuous air samples
- H Ground water samples
- I Vegetation samples
- J Soil samples
- K Sediment samples
- L Direct radiation measurements
- M Pacific Northwest Laboratories Environmental Program

Figure 1-2. Major Radiological Release Pathways Related to 100-N Area Facilities.

Table 1-1. Summary of the Westinghouse Hanford Company Environmental Surveillance Program for the 100-N Area.

Sample	Sampling method	Number of sample locations	Frequency	Analyses
Air	Low-volume continuous sampler with particle filter and charcoal bed	3	Every 4 wk	Gamma-emitting radionuclides
Groundwater	Well samples (4-L) provided by PNL	32	Quarterly	Gamma-emitting radionuclides, strontium, and tritium
Groundwater	Well samples (1-qt)	11	Dependent on well	Oil and grease
Surface soil	Composite sample of about 150 g dry weight	12	Annually	Gamma-emitting radionuclides, strontium, and plutonium
Vegetation	Composite sample of about 500 g dry weight	20	Annually	Gamma-emitting radionuclides, strontium, and plutonium
Direct radiation	TLD-400 Dosimeters (CaF <sub>2</sub> :Mn matrix)	41	Quarterly	Dose rate and integrated dose
Direct radiation (Columbia River shoreline)	Dose rate using hand-held survey instrument	94	Annually	Dose rate

PNL = Pacific Northwest Laboratory  
 TLD = thermoluminescent dosimeter.

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Table 1-2. Summary of the Westinghouse Hanford Company Liquid Waste Disposal Facilities (LWDF) Sampling Program.

Sample	Sampling method	Number of sample locations	Frequency	Analyses
Air	Low-volume continuous sampler with particle filter and charcoal bed	2	Every 4 wk	Gamma-emitting radionuclides
Surface soil	Composite sample of about 150 g dry weight	5	Annually	Gamma-emitting radionuclides, strontium, and plutonium
Vegetation	Composite sample of about 500 g dry weight	5	Annually	Gamma-emitting radionuclides, strontium, and plutonium
1325-N LWDF sediment	Dip samples of bottom sediment	12	Annually	Gamma-emitting radionuclides, and strontium
Direct radiation	Dose rates using hand-held survey instrument	80	Annually	Dose rate

NOTE: The monitoring parameters listed in Table 1-2 for the LWDF sampling program will be included in their respective sections, as listed in the contents. The exception to this listing will be the LWDF sediment sampling discussion in Chapter 6.0.

Table 1-3. Summary of the Westinghouse Hanford Company Environmental Surveillance Program for the Retired 100 Areas.

Sample	Sampling method	Number of sample locations	Frequency	Analyses
Surface soil	Composite sample of about 150 g dry weight	20	Annually	Gamma-emitting radionuclides, strontium, and plutonium
Vegetation	Composite sample of about 500 g dry weight	20	Annually	Gamma-emitting radionuclides, strontium, and plutonium
Groundwater	Well samples (4-L) provided by PNL*	4	Quarterly	Gamma-emitting radionuclides and tritium

NOTE: The monitoring parameters listed in Table 1-3 for the retired 100 Areas sampling program will be included in their respective sections, as listed in the contents.

\*Pacific Northwest Laboratory.

Duplicate samples of both media were collected. One of each duplicate sample was analyzed for gamma-emitting radionuclides at the 100-N Westinghouse Hanford radioanalytical laboratory. The remaining duplicate samples were analyzed for strontium and plutonium by the U.S. Testing Company Inc. (UST). Groundwater is routinely sampled from four wells located near the 105-KE Reactor Building. These samples are collected to detect potential leakage from the 105-KE Reactor Fuel Storage Basin.

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## 2.0 AMBIENT AIR MONITORING

Air sampling provides a means of monitoring radionuclides released to the air from N Reactor facilities. The 100-N Area environmental air sampling stations are shown in Figure 2-1. Tables C-1 through C-6 list the radionuclide concentrations detected in the 100-N Area air samples for the reporting period.

Air samples were collected with continuously operating low-volume sample pumps. Ambient air was drawn through a 1 ft<sup>3</sup>/min orifice into a stainless steel sample cartridge containing a 47-mm millipore filter and a bed of activated charcoal to collect halogens. The sample cartridges were changed approximately every 4 wk and analyzed for gamma-emitting radionuclides at the Westinghouse Hanford radioanalytical laboratory located in the 105-N Reactor Building.

In previous years, comparative data of airborne concentrations of <sup>131</sup>I were presented in this report to provide simplified trend analysis of this contaminant. However, with the shutdown of N Reactor in January 1987, <sup>131</sup>I concentrations in the air have been reduced to below detection limits and continued trend charting of this radionuclide is no longer warranted. Until such time as analysis results dictate otherwise, only <sup>60</sup>Co results will be presented in graph form for this report. The airborne concentrations of radionuclides of concern will continue to be reported in tabular form in Appendix C.

Average radionuclide concentrations detected in the 100-N Area air samples are listed in Table C-1. All averages calculated from two or more values include the standard deviation to indicate the distribution of the data. Minimum and maximum concentrations are also shown to indicate the sample range. All radionuclide concentrations were well below the DOE DCG.

The DCGs are shown for comparison at the bottom of the table. These concentration guides are applicable at the point of actual exposure to members of the public. The radionuclides identified in the 100-N Area ambient air samples are near or below detection limits. Average concentrations of <sup>60</sup>Co detected in the 100-N Area air samples from 1982 to 1989 are presented in Figure 2-2. Ambient air monitoring is conducted for the 1301-N LWDF at a location near the inlet end of the facility (station A1). Average concentration of <sup>60</sup>Co detected near the 1301-N Facility from 1982 to 1989 are presented in Figure 2-3.

An additional air sampling station was put into service during November 1989. This station is located near the 1325-N LWDF. The sample results indicate airborne radionuclide concentrations at or near detection limits.

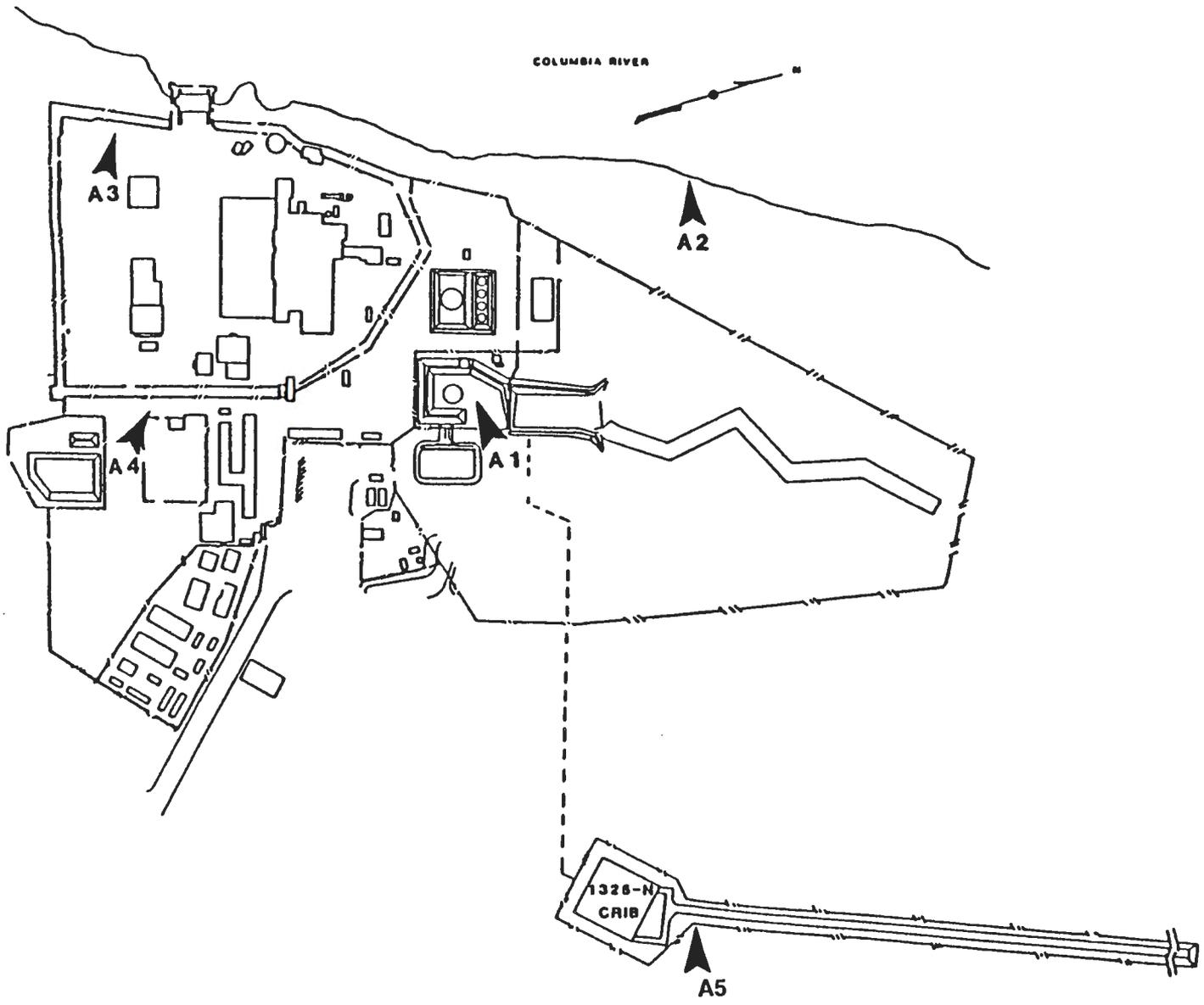
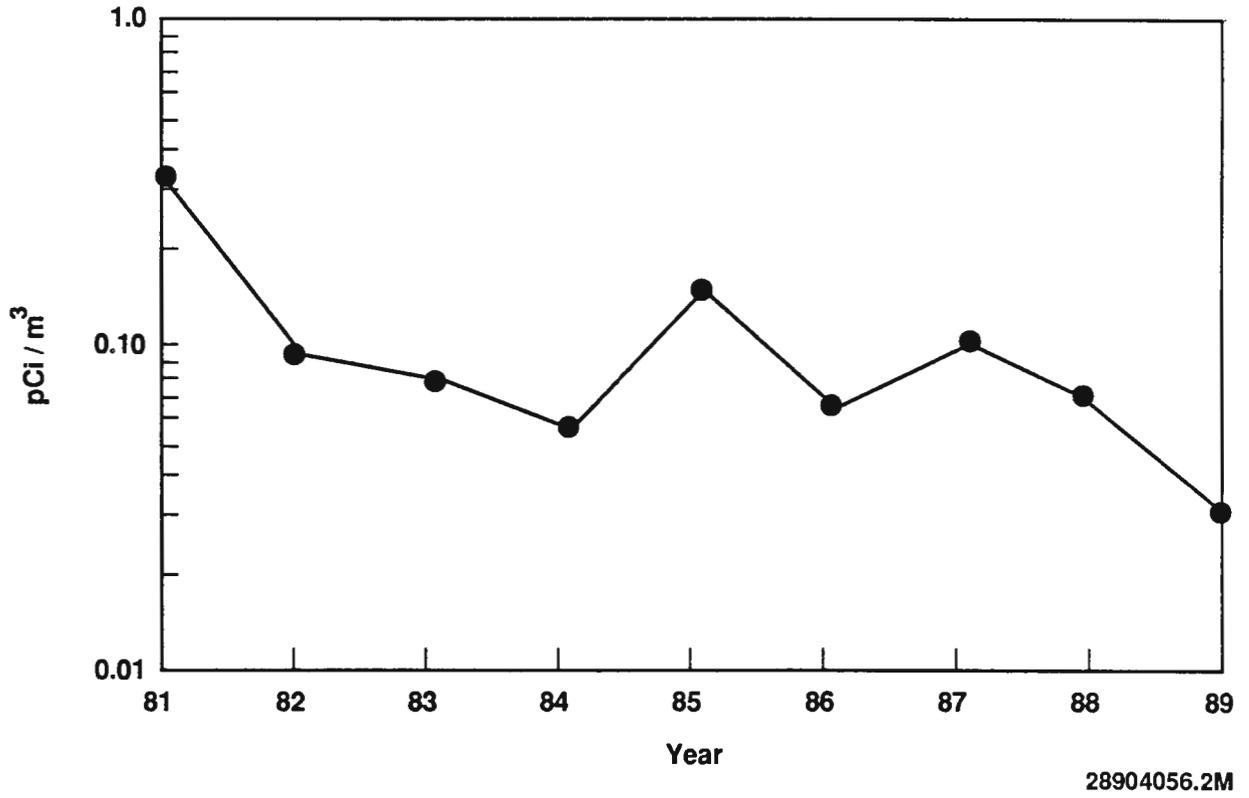


Figure 2-1. Ambient Air Sampling Locations at 100-N Area.

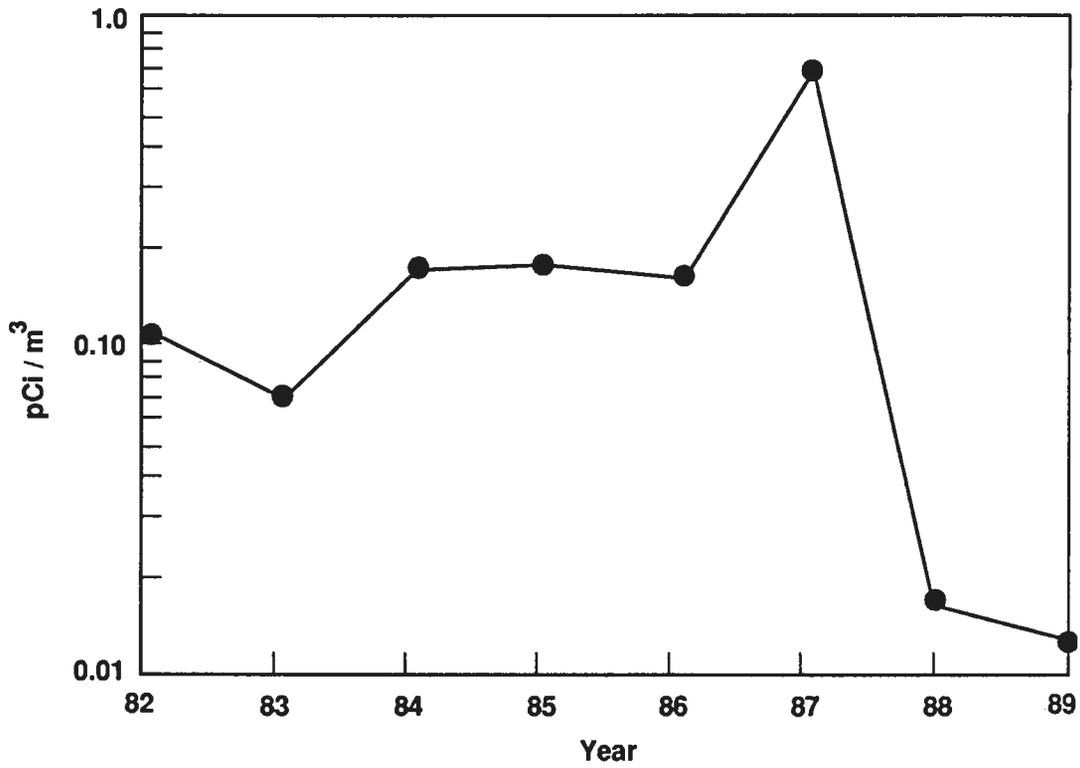
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Figure 2-2. Average Concentrations of  $^{60}\text{Co}$  Detected in 100-N Area Ambient Air from 1981 to 1989.



9 2 1 0 7 0 0 2 1 9

Figure 2-3. Average Concentrations of <sup>60</sup>Co Detected in 1301-N Air Samples from 1982 to 1989.



28904056.1M

9 2 1 3 7 7 1 1 1 1

### 3.0 GROUNDWATER MONITORING

#### 3.1 RADIOLOGICAL GROUNDWATER SAMPLING--100-N AREA

The 100-N Area groundwater sampling is performed to monitor radionuclide concentrations in the groundwater beneath the 1301-N LWDF, the 1325-N LWDF, and other 100-N Area facilities. Groundwater samples are also collected to monitor the integrity of underground piping, basins, and tanks. The locations of the groundwater sampling wells are shown in Figure 3-1. Samples of groundwater (4-L) were collected by PNL and analyzed for gamma-emitting radionuclides at the 100-N Westinghouse Hanford radioanalytical laboratory. Duplicate samples collected by PNL were analyzed for tritium and  $^{89,90}\text{Sr}$  by UST. Radionuclide concentrations detected in the quarterly groundwater samples are presented in Tables D-1 through D-8. The samples contain radionuclides attributable to liquid effluents discharged to the 1325-N LWDF (Rokkan 1986). Radionuclides that are not retained in the soil column beneath the LWDFs are ultimately released to the Columbia River via the N Springs shoreline. This discharge is monitored at well N-8T. The entire length (about 2 mi) of the shoreline between the 100-N and 100-D/DR Areas also is characterized annually. Detailed discussions of these sampling results are reported in annual effluent release reports and N Springs characterization reports, respectively. The only radionuclide with concentrations above the DCG at the N Springs is  $^{90}\text{Sr}$ .

The average concentrations of  $^{60}\text{Co}$ ,  $^{90}\text{Sr}$ , and  $^{131}\text{I}$  detected in well N-2 from 1981 to 1989 are presented in Figure 3-2. These radionuclides are useful as indicators of groundwater contamination and migration. Figure 3-3 shows average concentrations of the same radionuclides detected in well N-33 from 1985 through 1989. These two wells were selected for comparison because of their positions relative to the 1301-N and 1325-N LWDFs.

Concentrations of  $^{60}\text{Co}$  and  $^{131}\text{I}$  decreased in well N-2 for this reporting period. This is to be expected since liquid effluent is no longer discharged to the 1301-N LWDF. Rather, the 1325-N LWDF has been receiving this effluent since September 1985. The minor increase in average  $^{90}\text{Sr}$  concentrations (slightly higher than the DCG) in well N-2 is attributable to the residual inventory of this radionuclide in the soil column beneath the 1301-N LWDF. The trend depicted in well N-33 showed a continued decrease in concentrations. These reduced values are attributable to the decreased liquid effluent discharged to the 1325-N LWDF associated with the lay-up status of N Reactor. Average  $^{90}\text{Sr}$  concentrations in well N-33 remained below the DCG in 1989, and  $^{131}\text{I}$  concentrations were below analytical detection limits. Cobalt-60 concentrations decreased during this period, with the 1989 average value falling below the historic range of well N-33.

#### 3.2 OIL AND GREASE SAMPLING--100-N AREA

Samples of groundwater (1 qt) were collected on a variable frequency from several oil detection wells. After organoleptic inspection, the samples were sent to the Hanford Environmental Health Foundation (HEHF) and analyzed for oil and grease. These data are used to monitor the integrity of underground oil transfer lines and oil storage tanks at 100-N Area.

### N Reactor Monitoring Well Locations

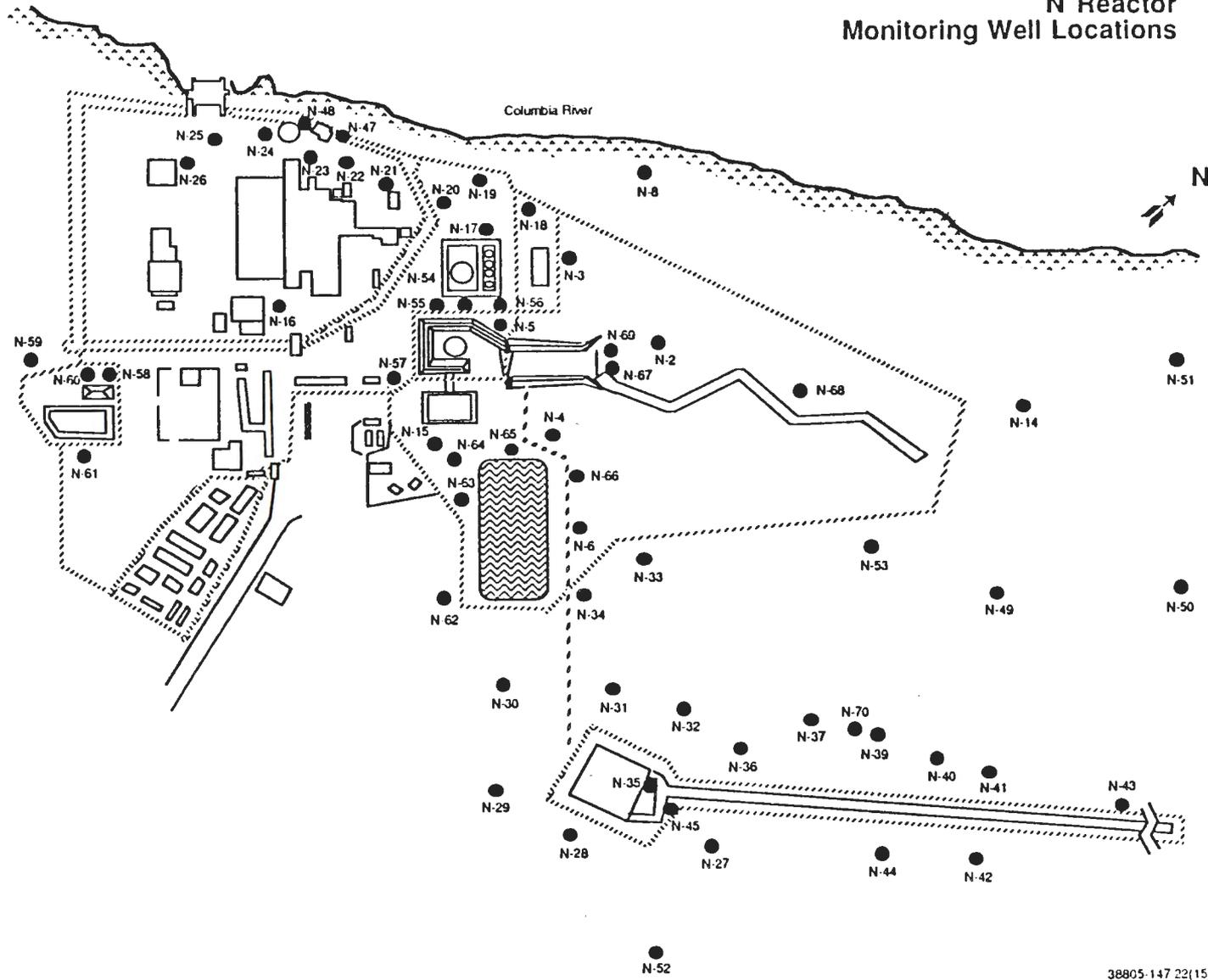
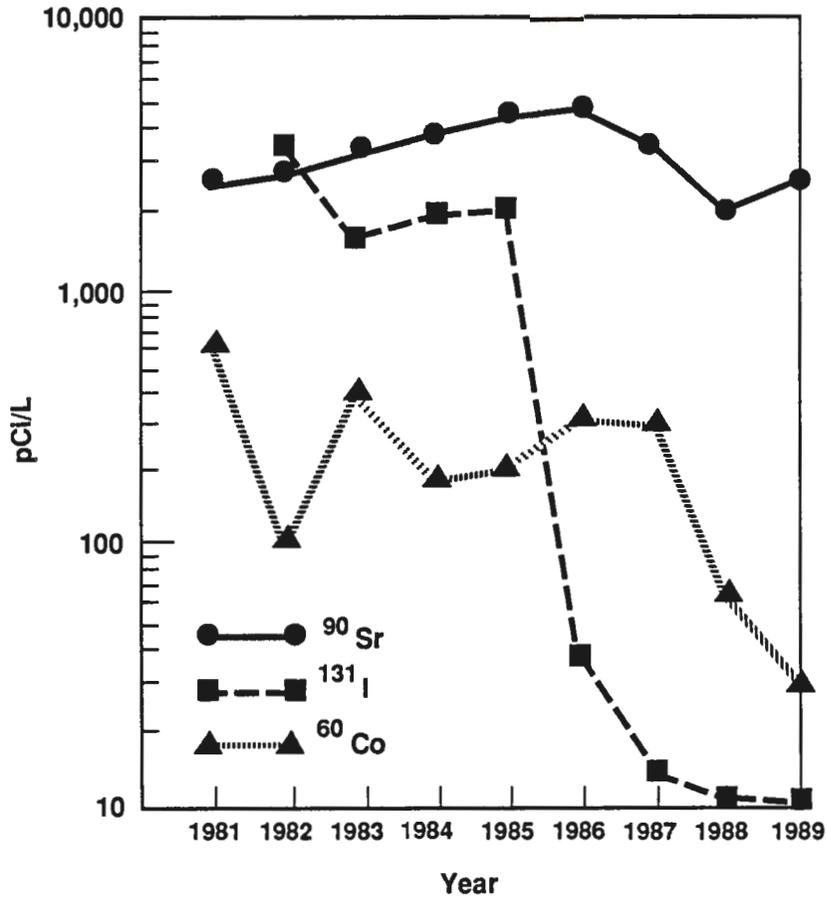


Figure 3-1. Location of Groundwater Wells at 100-N Area.

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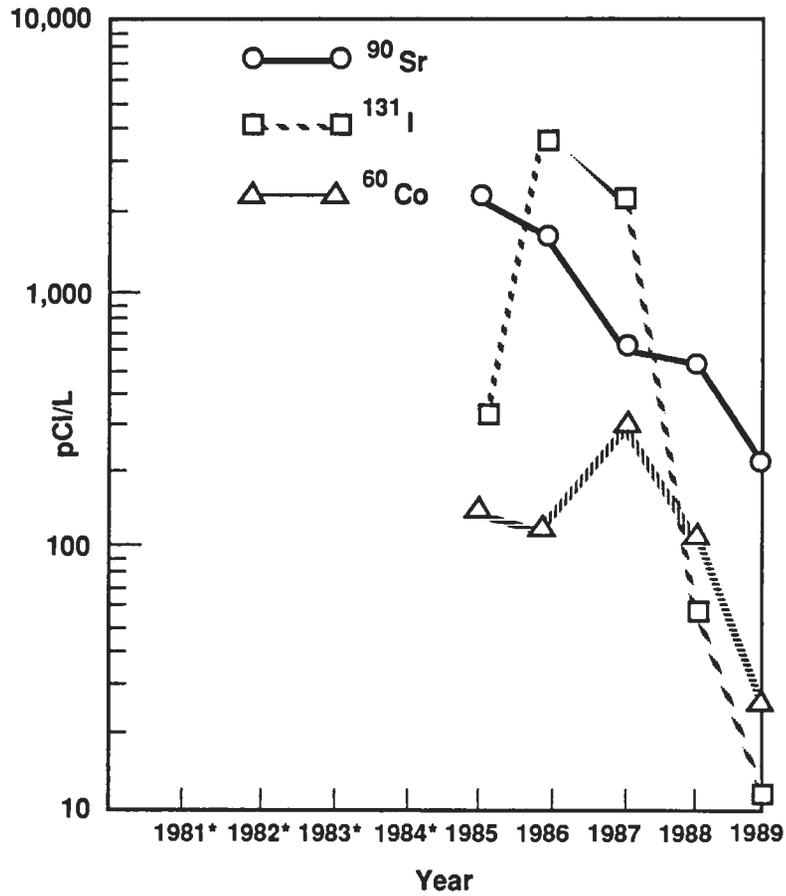
Figure 3-2. Average Concentration of  $^{60}\text{Co}$ ,  $^{90}\text{Sr}$ , and  $^{131}\text{I}$  Detected in Well N-2 from 1981 through 1989.



28904056.4M

9 2 1 2 7 0 1 0 1 3

Figure 3-3. Average Concentration of  $^{60}\text{Co}$ ,  $^{90}\text{Sr}$ , and  $^{131}\text{I}$  Detected in Well N-33 from 1985 through 1989.



\* Well N-33 was not in use preceding 1985.

28904056.3M

Average oil and grease concentrations detected in the 100-N Area groundwater samples are presented in Table 3-1. The lower limit of detection is 1 mg/L. Most samples contained concentrations of oil and grease less than or near the level of detection. Table D-6 lists the oil and grease concentrations detected in 100-N Area groundwater monitoring wells.

### 3.3 RADIOLOGICAL GROUNDWATER SAMPLING--100-K AREA

A leak was detected in the 105-KE Reactor Fuel Storage Basin during the 1970's. The leak was repaired in 1980 and water levels in the basin are now continuously monitored and reveal no detectable leakage. In addition, Westinghouse Hanford samples four groundwater wells located near the 105-KE Reactor Building to provide detection of leakage from the storage basin.

Samples (4-L) were collected and analyzed for gamma-emitting radionuclides at the Westinghouse Hanford radioanalytical laboratory. Duplicate samples collected by PNL were analyzed for tritium by UST. The sampling locations are shown on Figure 3-4. Radionuclide concentrations detected in the 100-K Area groundwater samples are presented in Tables D-1 through D-5. The concentrations of  $^{125}\text{Sb}$  detected in samples from wells K-27 and K-28 indicate residual contamination from past leaks of storage basin water.

Average radionuclide concentrations detected in well K-27 from 1982 through 1989 are presented in Table D-7. The data indicate that concentrations of  $^{125}\text{Sb}$  (2.7-yr half-life) in well K-27 have stabilized.

Tritium concentrations detected in well K-30 have exceeded those of any other 100 Area groundwater monitoring well since 1982. The range of tritium concentrations at this well is large for this period, with the 1989 results showing a decrease of approximately 40%. Well K-27 showed a large increase in tritium concentrations during 1989. Wells K-28 and K-29, located between K-27 and K-30, showed relatively stable concentrations. The explanation for these changes is not known.

The most probable source of tritium in the K-Area wells is from the nearby 115-KE crib (see Figure 3-4) which received significant amounts of tritium from the dryer room condensate in the 100-KE Reactor (operated from 1955 to 1971). Table 3-2 lists average tritium concentrations in each of these 100-K Area wells from 1982 through 1989.

### 3.4 RESOURCE CONSERVATION AND RECOVERY ACT GROUNDWATER MONITORING--100-N AREA

The *Resource Conservation and Recovery Act* (RCRA) groundwater monitoring program is administered in the 100 Areas by PNL. The results of this monitoring program are published quarterly.

Table 3-1. Oil and Grease Concentrations Detected in 100-N Area Groundwater (mg/L).

Well	Number of samples	Maximum	Minimum	Average	Standard deviation
N-16	40	5.7	<1.0	1.8	1.1
N-17	40	4.2	<1.0	1.5	0.8
N-18	11	6.6	<1.0	2.0	1.6
N-19	9	1.2	<1.0	1.0	0.1
N-20	9	1.0	<1.0	1.0	0.0
N-21	10	1.1	<1.0	1.0	0.0
N-22	1	<1.0	<1.0	<1.0	0.0
N-23	21	3.2	<1.0	1.2	0.6
N-24	20	4.8	<1.0	1.3	1.0
N-25	29	3.4	<1.0	1.2	0.5
N-26	21	5.0	<1.0	1.2	0.9

NOTE: Locations identified in Figure 3-1.

9  
0  
0  
7  
1  
2  
6

Table 3-2. Tritium Concentration Detected in 100-KE Groundwater (pCi/L) from 1982 through 1989.

Year	Wells			
	K-27	K-28	K-29	K-30
1982	4.5 E+03	3.4 E+03	8.5 E+03	8.8 E+05
1983	3.1 E+03	2.1 E+03	2.0 E+04	6.8 E+05
1984	3.0 E+03	2.5 E+03	4.9 E+04	4.3 E+05
1985	1.8 E+03	3.6 E+03	4.9 E+04	4.2 E+05
1986	1.5 E+03	3.1 E+01	3.7 E+04	6.4 E+05
1987	1.5 E+03	4.2 E+03	9.9 E+03	8.3 E+05
1988	2.3 E+03	3.2 E+03	1.4 E+04	1.2 E+06
1989	9.2 E+04	2.3 E+03	1.0 E+04	6.8 E+05

Notes: derived concentration guides = 2.0 E+06 pCi/L.  
Locations identified in Figure 3-4.

9 2 1 2 7 0 0 7

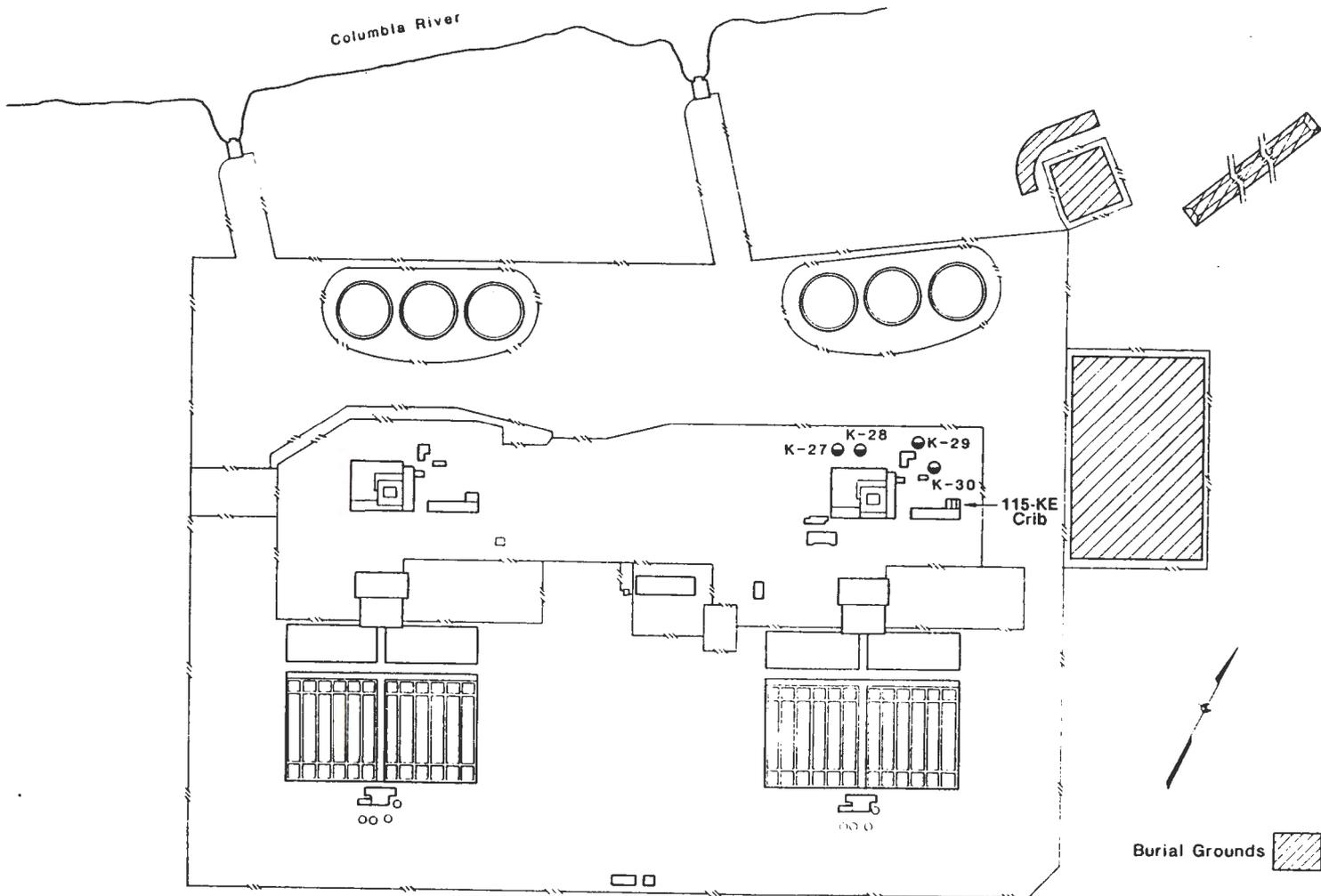


Figure 3-4. Location of Groundwater Wells at 100-K Area.

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## 4.0 SOIL AND VEGETATION MONITORING

### 4.1 SOIL SAMPLING

Surface soil samples provide a means of evaluating the environmental distribution of radionuclides from releases to the air or liquid releases to the soil.

Surface soil was sampled at each of the locations shown in Figure 4-1. Duplicate samples of about 150 g each were collected from the top 2.5 cm of the soil surface. A duplicate of each sample was sent to UST for strontium and plutonium analysis. The remaining sample was analyzed for gamma-emitting radionuclides at the 100-N Westinghouse Hanford radioanalytical laboratory.

#### 4.1.1 100-N Area

Five of the surface soil samples (N1 through N5) were collected at locations near the 1301-N LWDF. Radionuclides contained in the LWDF effluent were detected in the samples. As the data indicate, the concentrations show a large degree of variance depending on sample location. In general, the samples collected nearer the 1301-N crib portion of the facility contained relatively higher concentrations of the contaminants. Average radionuclide concentrations detected in the 100-N Area surface soil from 1980 through 1989 in locations near the 1301-N LWDF (sites N1 through N5) are presented in Table 4-1. Average radionuclide concentrations detected in the 100-N Area surface soil from 1980 through 1989 in locations N6 through N12 are presented in Table 4-2.

Radionuclide concentrations detected in the 100-N Area surface soil are presented in Tables E-1 and E-2. Average radionuclide concentrations for the Hanford Site and offsite, as reported by PNL for 1988, are included for comparison. The 100-N values are comparable to Hanford Site averages.

#### 4.1.2 Retired 100 Areas

Environmental surveillance in the retired 100 Areas is conducted to monitor radionuclides detected in environmental media located near the retired reactor sites and waste disposal facilities. The program consists primarily of soil and vegetation sampling in each of the retired areas. Sample locations were chosen immediately adjacent to retired waste disposal facilities in a manner to maximize the potential for detecting contamination. Environmental samples of surface soil collected near the retired 100 Area reactor facilities indicated no elevated levels of radionuclides when compared to the Hanford Site average concentrations. Surface soil and vegetation sampling locations for the retired 100 Areas are presented in Figures 4-2 through 4-6.

Average radionuclide concentrations detected in surface soil samples for each of the retired 100 Areas from 1980 through 1989 are presented in Tables 4-3 through 4-7. The results of the 1989 surface soil analyses for each sample location in the retired 100 Areas are presented in Tables E-3 through E-7.

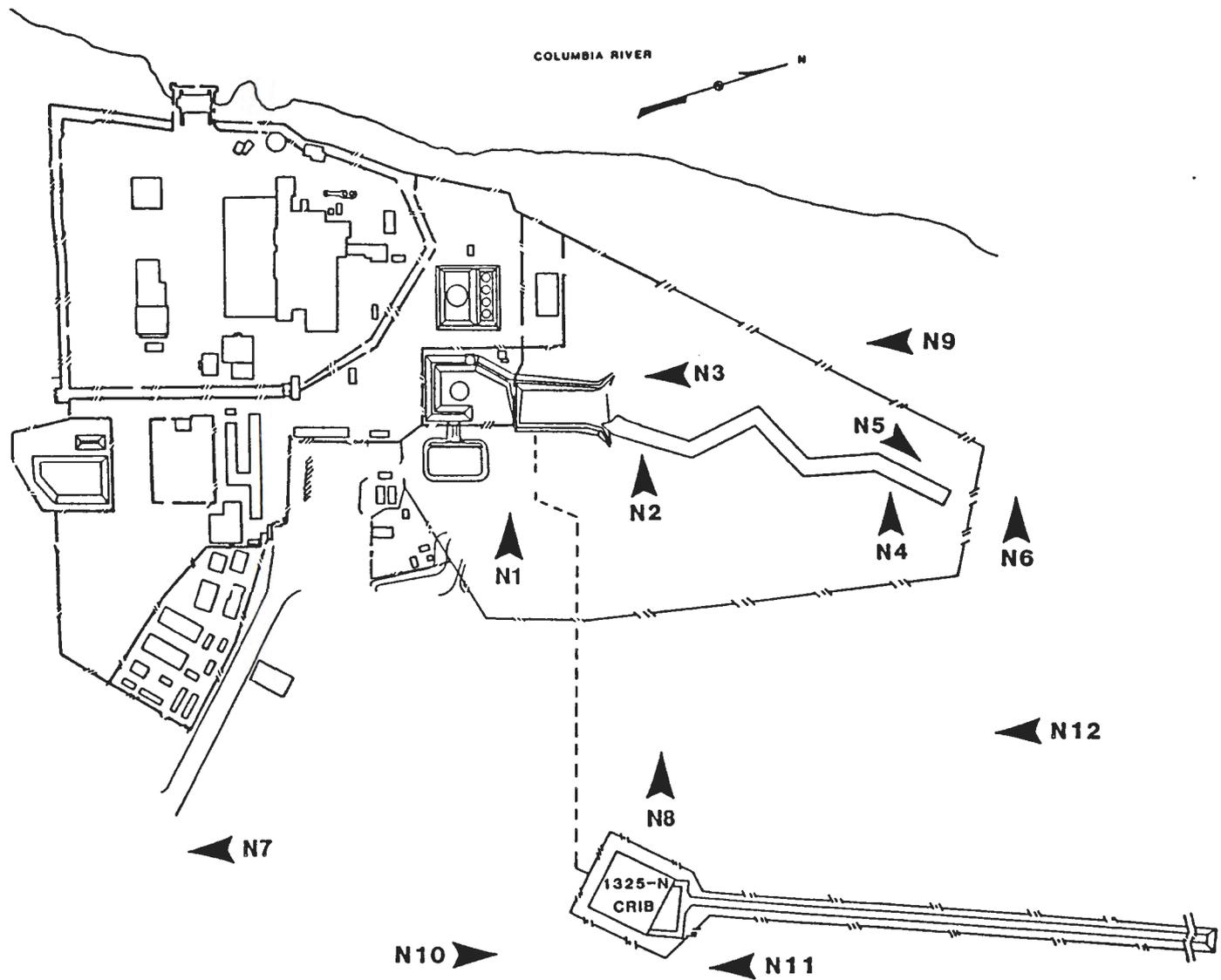


Figure 4-1. Surface Soil Sampling Locations at 100-N Area.

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29011031.12

Table 4-1. Average Radionuclide Concentrations (pCi/g) Detected in Soil Samples Near the 1301-N Liquid Waste Disposal Facility from 1980 through 1989.

Year	<sup>54</sup> Mn	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
1980	2.5 E+00	1.3 E+01	3.5 E-01	4.1 E+00	NR	2.5 E-02
1981	6.6 E+00	4.0 E+00	7.0 E-01	6.1 E+00	NR	4.4 E-02
1982	6.6 E-01	6.3 E+00	2.7 E-01	2.7 E+00	NR	1.8 E-02
1983	4.1 E-01	5.4 E+00	1.3 E+00	3.8 E+00	NR	4.3 E-02
1984	1.8 E-01	2.8 E+00	2.1 E-01	1.1 E+00	NR	1.7 E-02
1985	1.5 E+00	1.3 E+01	6.5 E-01	3.9 E+00	NR	3.2 E-02
1986	1.6 E-01	4.5 E+00	2.2 E-01	2.5 E+00	NR	1.7 E-02
1987	3.2 E-01	5.1 E+00	3.4 E-01	1.6 E+00	5.4 E-03	2.2 E-02
1988	1.4 E-01	7.8 E+00	3.5 E-01	2.0 E+00	2.3 E-03	1.7 E-02
1989	6.5 E-02	2.3 E+00	1.5 E-01	5.0 E-01	6.4 E-03	4.0 E-02

NR = Not reported.

Note: Table E-1 lists the results of the 1989 analysis of 1301-N Liquid Waste Disposal Facility surface soil samples.

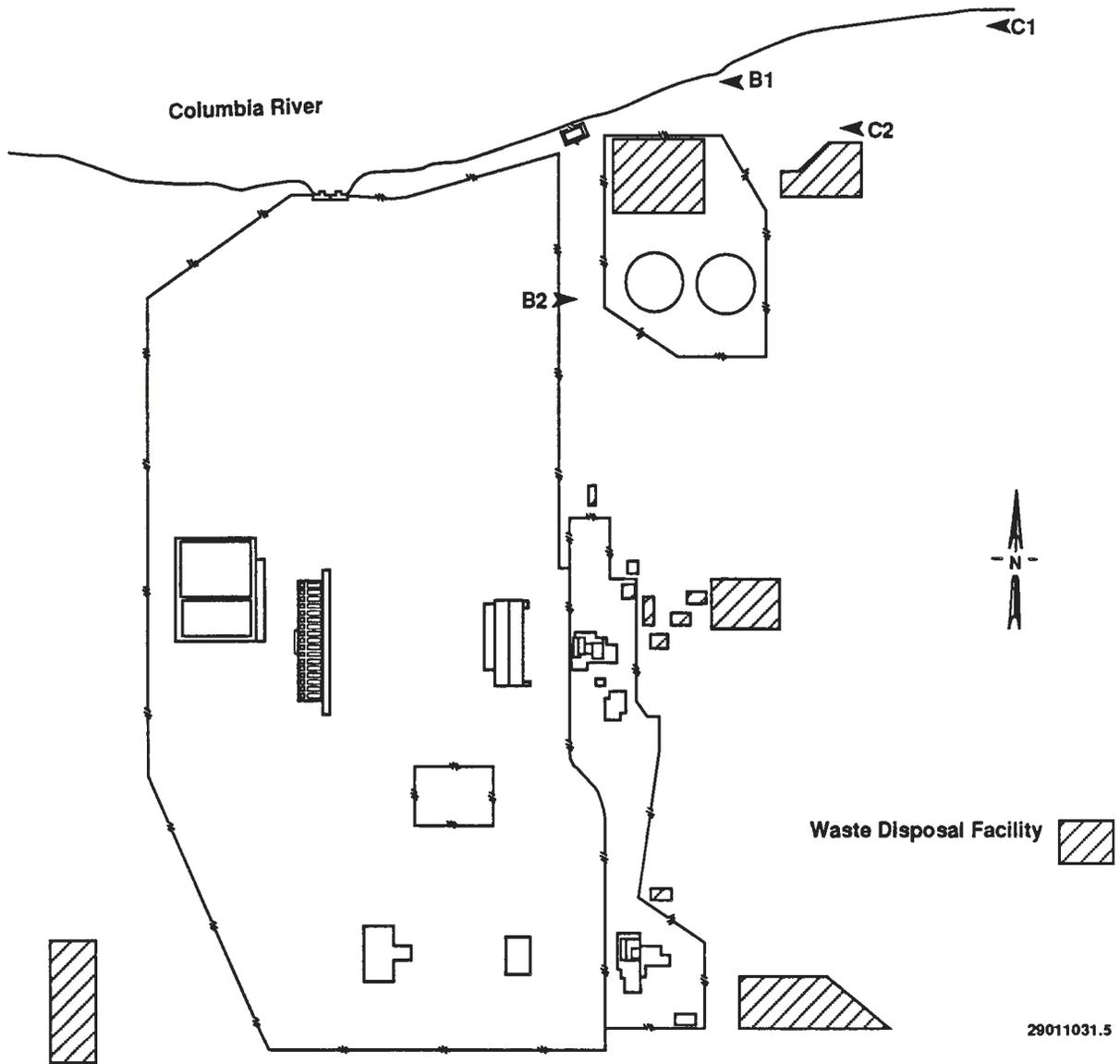
Table 4-2. Average Radionuclide Concentrations (pCi/g) Detected in 100-N Area Surface Soil Samples from 1980 through 1989.

Year	<sup>54</sup> Mn	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
1980	2.4 E-01	8.5 E-01	1.8 E-01	5.0 E-01	NR	1.8 E-02
1981	1.6 E-01	1.3 E+00	2.1 E-01	1.0 E+00	NR	1.1 E-02
1982	1.3 E-01	1.6 E+00	9.9 E-02	3.4 E-01	NR	5.0 E-03
1983	2.1 E-01	2.7 E+00	2.9 E-01	4.4 E-01	NR	8.5 E-03
1984	NR	8.8 E-01	2.8 E-01	6.2 E-01	NR	1.4 E-02
1985	1.2 E-01	1.2 E+00	1.3 E-01	5.2 E-01	NR	1.3 E-02
1986	1.1 E-01	4.1 E-01	8.3 E-02	5.0 E-01	NR	8.2 E-03
1987	9.1 E-02	4.1 E-01	1.1 E-01	3.9 E-01	1.1 E-03	6.7 E-03
1988	6.7 E-02	3.4 E-01	1.6 E-01	3.9 E-01	4.5 E-04	9.5 E-03
1989	<4.2 E-02	1.4 E-01	2.1 E-01	1.3 E-01	1.1 E-03	1.3 E-02

NR = Not reported.

921270001

Figure 4-2. Soil and Vegetation Sampling Locations at 100-B/C Area.



9 2 1 1 2 0 1 0 1 2

Figure 4-3. Soil and Vegetation Sampling Locations at 100-D/DR Area.

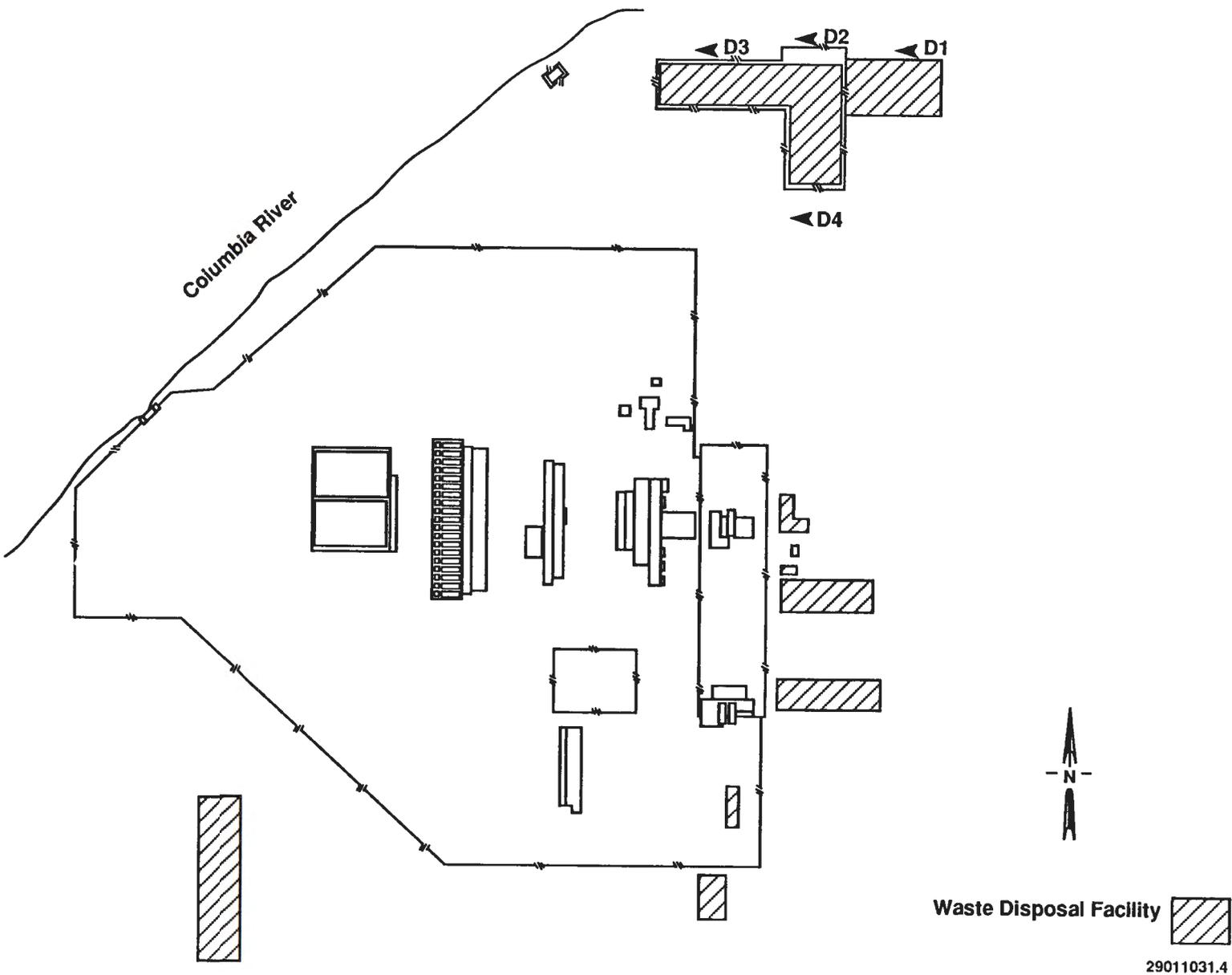
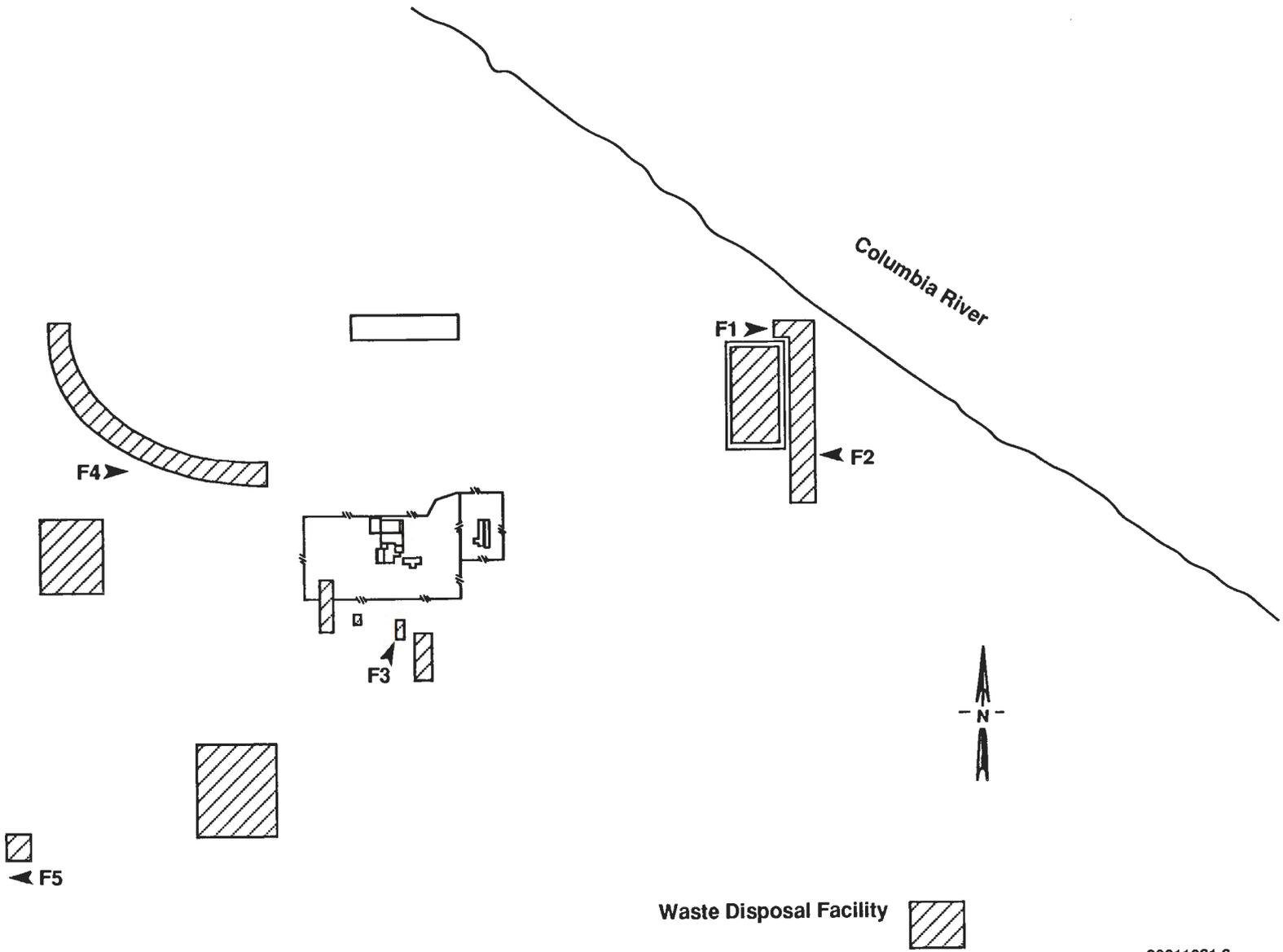
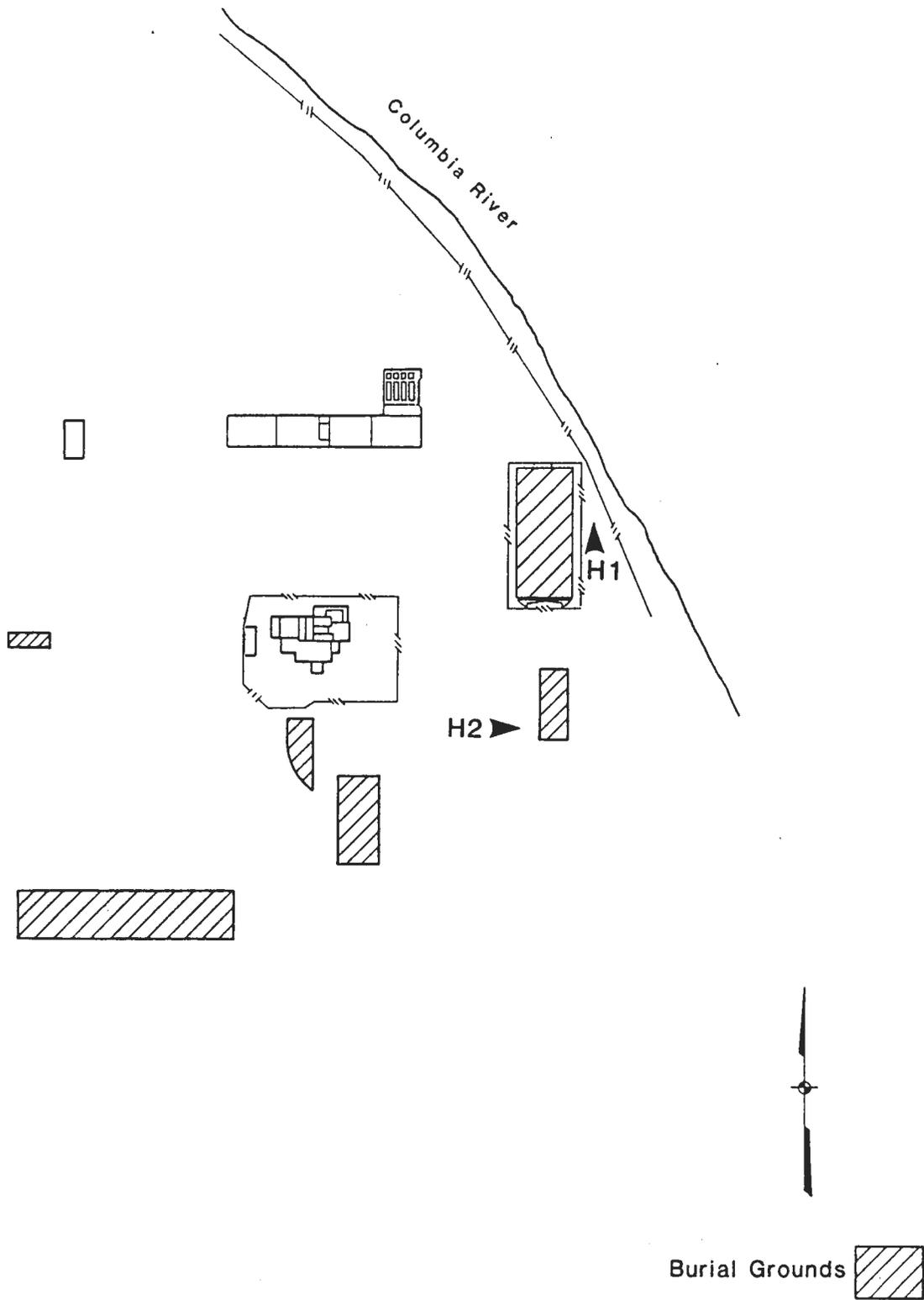


Figure 4-4. Soil and Vegetation Sampling Locations at 100-F Area.



29011031.3

Figure 4-5. Soil and Vegetation Sampling Locations at 100-H Area.



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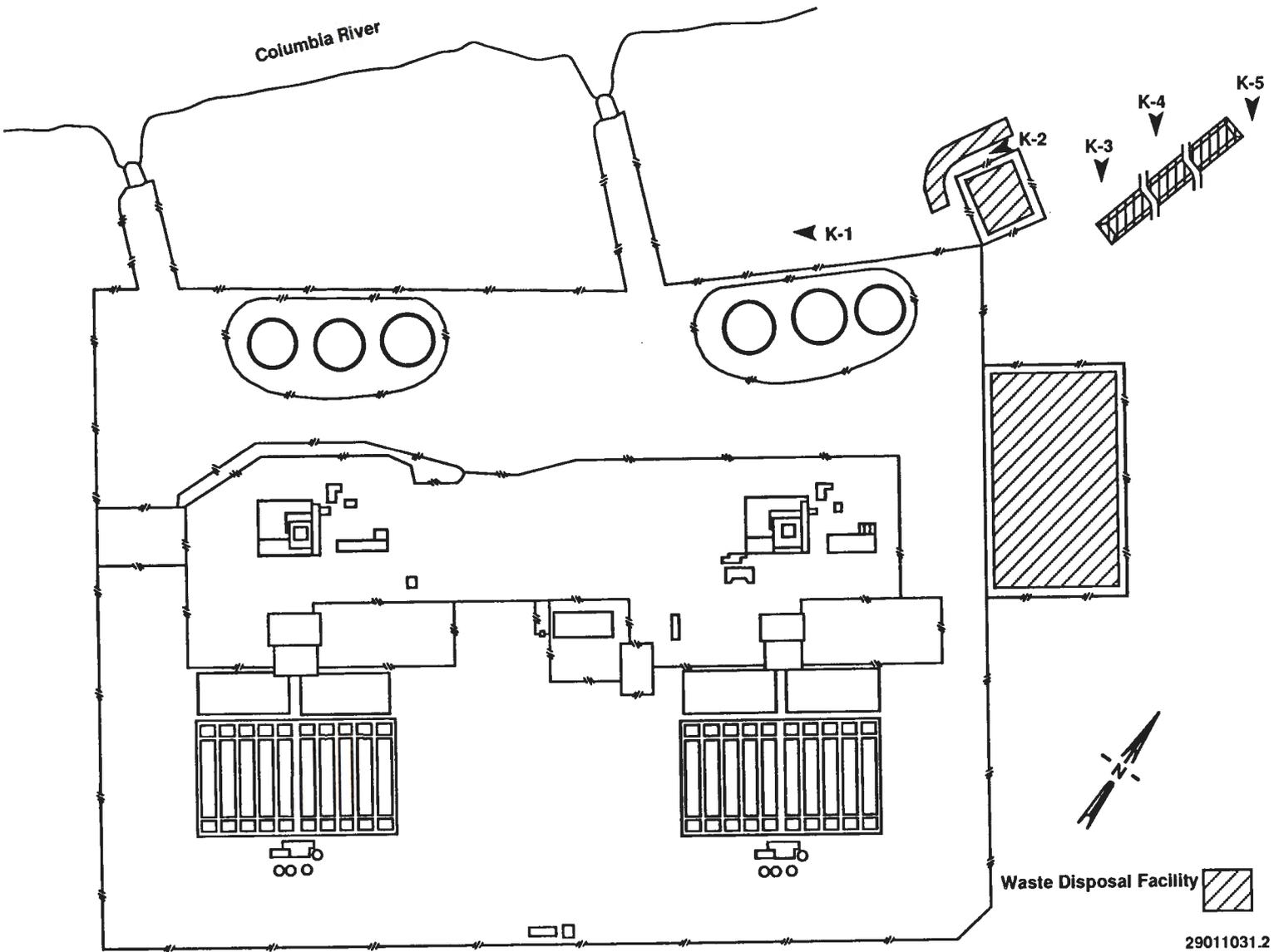


Figure 4-6. Soil and Vegetation Sampling Locations at 100-K Area.

Table 4-3. Average Radionuclide Concentrations (pCi/g) Detected in 100-B/C Area Surface Soil Samples from 1981 to 1989.

Year	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
1981	5.7 E-01	NR	1.2 E+00	NR	NR
1982	8.2 E-01	NR	1.3 E+00	NR	NR
1983	4.2 E-01	NR	1.5 E+00	NR	NR
1984	5.4 E-01	3.2 E-01	1.9 E+00	1.0 E-03	2.4 E-02
1985	2.7 E-01	2.4 E-02	4.5 E-01	2.9 E-04	8.8 E-04
1986	1.8 E-01	1.2 E-01	6.4 E-01	5.5 E-04	8.3 E-03
1987	2.6 E-01	1.1 E-01	9.2 E-01	6.2 E-04	1.4 E-02
1988	2.7 E-01	3.9 E-01	9.5 E-01	6.2 E-04	3.0 E-02
1989	2.6 E-01	3.5 E-01	7.6 E-01	6.2 E-04	5.5 E-02

NR = Not reported.

Note: Table E-3 lists the results of the 1989 analysis of 100-B/C Area surface soil samples.

Table 4-4. Average Radionuclide Concentrations (pCi/g) Detected in 100-D/DR Area Surface Soil Samples from 1981 to 1989.

Year	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
1981	3.6 E-01	NR	4.0 E-01	NR	NR
1982	4.9 E-01	NR	3.2 E-01	NR	NR
1983	4.2 E-01	NR	1.7 E-01	NR	NR
1984	2.2 E-01	1.4 E-01	1.6 E-01	1.4 E-04	9.8 E-03
1985	2.4 E-01	5.6 E-02	2.7 E-01	2.1 E-04	3.0 E-03
1986	2.6 E-01	7.3 E-02	8.7 E-01	3.2 E-04	5.8 E-03
1987	2.8 E-01	2.0 E-01	1.1 E+00	1.6 E-03	1.8 E-02
1988	1.9 E-01	1.5 E-01	9.4 E-01	6.2 E-04	8.2 E-03
1989	2.2 E-01	8.8 E-02	6.7 E-01	6.2 E-04	1.4 E-02

NR = Not reported.

Note: Table E-4 lists the results of the 1989 analysis of 100-D/DR Area surface soil samples.

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Table 4-5. Average Radionuclide Concentrations (pCi/g) Detected in 100-F Area Surface Soil Samples from 1981 to 1989.

Year	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
1981	2.9 E-01	NR	6.0 E-01	NR	NR
1982	1.4 E+00	NR	1.7 E+00	NR	NR
1983	2.7 E-01	NR	8.6 E-01	NR	NR
1984	1.1 E+00	4.4 E-01	7.0 E-01	5.0 E-04	1.0 E-02
1985	3.0 E-01	2.9 E-01	8.3 E-01	6.5 E-04	9.8 E-03
1986	2.3 E-01	2.7 E-01	7.4 E-01	3.8 E-04	1.1 E-02
1987	1.9 E-01	2.4 E-01	5.5 E-01	6.4 E-04	9.3 E-03
1988	1.7 E-01	1.6 E-01	6.2 E-01	1.3 E-03	1.4 E-02
1989	1.3 E-01	1.1 E-01	4.3 E-01	8.0 E-04	1.3 E-02

NR = Not reported.

Note: Table E-5 lists the results of the 1989 analysis of 100-F Area surface soil samples.

Table 4-6. Average Radionuclide Concentrations (pCi/g) Detected in 100-H Area Surface Soil Samples from 1981 to 1989.

Year	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
1981	1.5 E-01	NR	9.0 E-02	NR	NR
1982	1.8 E-01	NR	3.4 E-01	NR	NR
1983	1.6 E-01	NR	4.7 E-01	NR	NR
1984	3.7 E-01	2.4 E-01	1.7 E+00	6.9 E-04	1.5 E-02
1985	1.4 E-01	9.8 E-02	2.3 E-01	1.9 E-04	5.7 E-03
1986	1.8 E-01	7.1 E-02	8.9 E-01	6.1 E-04	1.0 E-02
1987	2.8 E-01	1.9 E-01	2.0 E+00	8.5 E-04	3.1 E-02
1988	1.6 E-01	7.5 E-02	3.6 E-01	6.2 E-04	6.6 E-03
1989	2.0 E-01	5.0 E-02	5.3 E-01	9.2 E-04	6.5 E-03

NR = Not reported.

Note: Table E-6 lists the results of the 1989 analysis of 100-H Area surface soil samples.

Table 4-7. Average Radionuclide Concentrations (pCi/g) Detected in 100-K Area Surface Soil Samples from 1981 to 1989.

Year	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
1981	8.3 E-01	NR	4.4 E+00	NR	NR
1982	2.6 E+01	NR	8.8 E-01	NR	NR
1983	5.5 E+01	NR	5.3 E+01	NR	NR
1984	3.3 E+00	8.4 E-01	1.2 E+01	9.6 E-04	2.9 E-02
1985	7.4 E-01	2.9 E-01	1.1 E+00	1.4 E-03	3.2 E-02
1986	1.0 E+00	1.8 E-01	1.1 E+00	9.1 E-04	2.3 E-02
1987	1.2 E+00	4.3 E-01	1.3 E+00	2.7 E-03	5.5 E-02
1988	3.9 E-01	2.3 E-01	7.3 E-01	7.1 E-04	2.0 E-02
1989	7.7 E-01	6.3 E-01	7.5 E+00	2.8 E-03	7.8 E-02

NR = Not reported.

Note: Table E-7 lists the results of the 1989 analysis of 100-K Area surface soil samples.

9 2 1 2 7 7 1 7 7

## 4.2 VEGETATION SAMPLING

Vegetation samples provide a means of evaluating the distribution of radionuclides deposited on vegetation from airborne releases or the uptake of radionuclides from the soil. Duplicate samples of green vegetation (about 500 g each) were collected from available perennial shrubs at the same locations from which surface soil samples were obtained (Figure 4-1). The vegetation consisted of gray rabbitbrush (*Chrysothamnus nauseosus*). Strontium and plutonium analyses were conducted by UST; gamma analyses were conducted at the 100-N Westinghouse Hanford radioanalytical laboratory.

### 4.2.1 100-N Area

Five of the vegetation samples (N1 through N5) were collected at locations near the 1301-N LWDF. Radionuclide concentrations detected in vegetation samples collected near the 1301-N LWDF are listed in Table E-8. Average radionuclide concentrations detected in the vegetation from 1980 through 1989 are presented in Table 4-8. The concentrations can be attributed to uptake of the radionuclides from the contaminated soil near the 1301-N LWDF.

Radionuclide concentrations detected in the 100-N Area vegetation samples outside the 1301-N LWDF area are presented in Table E-9. Concentrations in 100-N Area vegetation samples were comparable to those reported for the Hanford Site average. Average radionuclide concentrations detected in 100-N Area vegetation from 1980 through 1989, from sampling sites N6 through N12, are presented in Table 4-9.

Vegetation samples were also collected from eight locations in the 100-N Area along the Columbia River shoreline (Figure 4-7). This portion of the shoreline, N Springs, contains small springs affected by underground drainage from the 1301-N and 1325-N LWDF effluent (see explanation in Groundwater Monitoring section). Perennial grass growing near the N Springs was sampled. The plants were growing through the cover of boulders along the shoreline. The samples were collected and analyzed using the methods described previously.

Radionuclide concentrations detected in the N Springs vegetation samples are presented in Table E-10. The average radionuclide concentrations detected on the Hanford Site are again shown for comparison. The N Springs samples contained above-background concentrations of  $^{90}\text{Sr}$ , with the highest concentrations detected in the samples collected from the shoreline area in the most direct groundwater migration path from the LWDFs (i.e., NS-1, -2, -3 locations). Growing plants will assimilate available strontium and cesium from the soil (Kathren 1984). Although liquid effluent discharged to the 1325-N LWDF has decreased since N Reactor was placed in standdown status, residual  $^{90}\text{Sr}$  in the 1301-N LWDF soil column continues to influence the shoreline vegetation. Average radionuclide concentrations detected in N Springs vegetation from 1980 through 1989 are presented in Table 4-10. The concentrations of  $^{90}\text{Sr}$  detected in 1989 were similar to levels reported in 1987 and 1988.

Table 4-8. Average Radionuclide Concentrations (pCi/g) Detected in Vegetation Samples Near the 1301-N Liquid Waste Disposal Facility from 1980 to 1989.

Year	<sup>54</sup> Mn	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
1980	1.4 E+00	4.0 E+00	NR	1.1 E+00	NR	NR
1981	2.5 E+00	1.2 E+01	1.8 E+00	1.8 E+00	NR	7.1 E-03
1982	4.6 E-01	1.6 E+00	1.2 E-01	2.6 E-01	NR	2.6 E-03
1983	4.5 E-01	1.9 E+00	6.0 E-01	3.9 E-01	NR	3.2 E-03
1984	2.9 E-01	1.0 E+00	1.2 E-01	8.3 E-02	NR	8.5 E-04
1985	5.9 E-01	1.7 E+00	1.9 E+00	1.0 E-01	NR	1.5 E-03
1986	6.8 E-01	3.5 E+00	7.3 E-02	6.5 E-01	NR	2.6 E-03
1987	4.9 E-01	2.8 E+00	6.3 E-02	2.0 E-01	1.2 E-03	5.6 E-03
1988	1.5 E-01	2.0 E+00	1.2 E-01	1.3 E-01	4.3 E-04	1.7 E-03
1989	<1.1 E-01	1.3 E+00	3.8 E-02	1.5 E-01	2.8 E-04	2.0 E-03

NR = Not reported.

Note: Table E-8 lists the results of the analysis of 1301-N LWDF vegetation samples.

Table 4-9. Average Radionuclide Concentrations (pCi/g) Detected in 100-N Vegetation Samples from 1980 to 1989.

Year	<sup>54</sup> Mn	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
1980	4.8 E-01	1.0 E+00	NR	2.8 E-01	NR	NR
1981	1.8 E+00	2.5 E+01	5.8 E-01	7.1 E-01	NR	2.1 E-02
1982	4.9 E-01	1.5 E+00	2.0 E-01	1.3 E-01	NR	7.8 E-03
1983	3.6 E-01	1.0 E+00	2.9 E-01	9.0 E-02	NR	8.6 E-03
1984	1.3 E-01	4.6 E-01	8.1 E-02	9.0 E-02	NR	1.3 E-03
1985	3.6 E-01	1.4 E+00	5.1 E-02	1.6 E-01	NR	8.7 E-04
1986	2.6 E-01	9.5 E-01	2.2 E-01	7.9 E-01	NR	1.1 E-03
1987	1.1 E-01	7.0 E-01	2.6 E-01	9.4 E-02	1.3 E-04	5.8 E-04
1988	1.3 E-01	8.0 E-01	2.5 E-01	1.6 E-01	1.7 E-04	6.6 E-04
1989	<7.8 E-02	3.2 E-01	6.8 E-02	1.5 E-01	1.1 E-04	8.7 E-04

NR = Not reported.

Note: Table E-9 lists the results of the analysis of 100-N Area vegetation samples.

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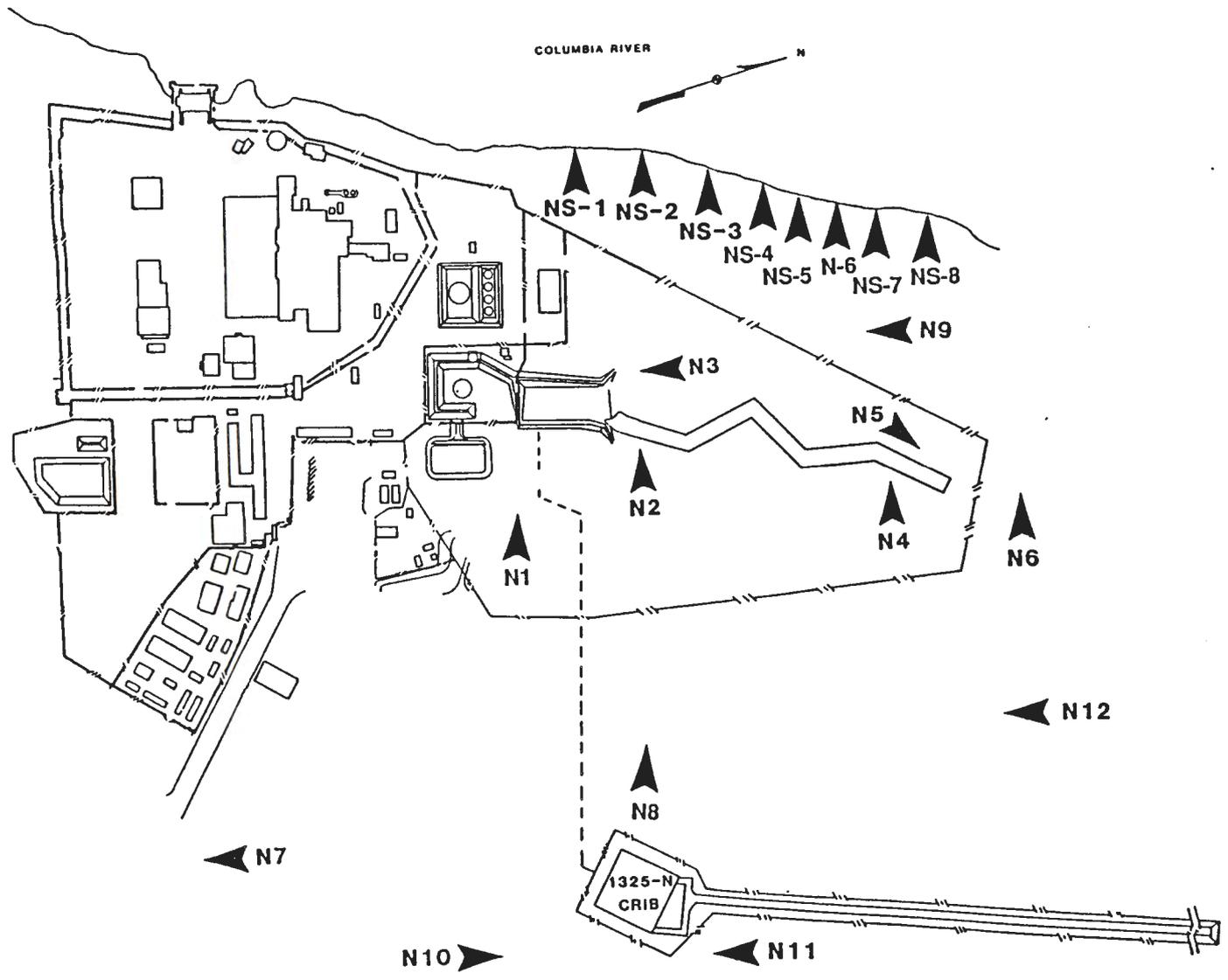


Figure 4-7. Vegetation Sampling Locations at 100-N Area.

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Table 4-10. Radionuclide Concentrations (pCi/g) Detected in N-Springs Vegetation Samples from 1980 to 1989.

Year	<sup>54</sup> Mn	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
1980	1.5 E-01	5.6 E+00	NR	4.4 E-01	NR	NR
1981	NR	3.3 E+00	2.0 E+02	NR	NR	3.7 E-03
1982	1.5 E-01	2.8 E+00	4.8 E+02	NR	NR	8.3 E-03
1983	7.0 E-02	3.0 E+00	3.3 E+02	4.0 E-02	NR	8.0 E-03
1984	NR	NR	NR	NR	NR	NR
1985	7.6 E-02	1.2 E+00	4.2 E+02	1.7 E-01	NR	4.4 E-04
1986	1.6 E-01	1.1 E+00	2.2 E+02	2.1 E-01	NR	4.2 E-04
1987	2.0 E-01	9.0 E-01	2.9 E+02	1.1 E-01	<1.3 E-04	7.6 E-04
1988	2.4 E-01	1.4 E+00	1.2 E+02	2.0 E-01	8.5 E-05	2.0 E-04
1989	<1.3 E-01	4.3 E-01	8.0 E+01	1.5 E-01	1.1 E-03	4.5 E-04

NR = Not reported.

Note: Table E-10 lists the results of the analysis of N-Springs vegetation samples.

#### 4.2.2 Retired 100 Areas

Vegetation sampling locations in the retired 100 Areas coincide with the surface soil locations shown in Figures 4-2 through 4-6. Average radionuclide concentrations detected in vegetation samples for each of the retired 100 Areas from 1980 through 1989 are presented in Tables 4-11 through 4-15. The results of the 1989 vegetation sample analysis for each sample location in the retired 100 Areas are presented in Tables E-11 through E-15. Environmental samples of vegetation collected near the retired 100 Area reactor facilities indicated no elevated levels of radionuclides when compared to the Hanford Site average concentrations.

Table 4-11. Average Radionuclide Concentrations (pCi/g) Detected in 100-B/C Area Vegetation Samples from 1981 to 1989.

Year	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
1981	3.6 E+00	NR	3.6 E-01	NR	NR
1982	1.9 E-01	NR	1.1 E-01	NR	NR
1983	1.8 E-01	NR	8.0 E-02	NR	NR
1984	1.3 E-01	1.4 E+00	8.7 E-02	2.4 E-04	6.0 E-04
1985	4.6 E-01	1.4 E+00	1.2 E-01	2.5 E-04	1.0 E-03
1986	2.5 E-01	2.0 E-01	2.8 E+00	2.5 E-05	6.2 E-04
1987	1.5 E-01	2.3 E-01	1.0 E-01	4.6 E-04	6.5 E-04
1988	3.5 E-01	2.6 E-01	2.1 E-01	1.4 E-04	3.1 E-04
1989	3.2 E-01	1.6 E-01	1.8 E-01	6.5 E-05	2.4 E-04

NR = Not reported.

Note: Table E-11 lists the results of the analysis of 100-B/C Area vegetation samples.

9 2 1 0 2 2 0 1

Table 4-12. Average Radionuclide Concentrations (pCi/g) Detected in 100-D/DR Area Vegetation Samples from 1981 to 1989.

Year	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
1981	1.2 E+00	NR	1.6 E-01	NR	NR
1982	1.1 E-01	NR	2.7 E+00	NR	NR
1983	9.5 E-02	NR	1.4 E-01	NR	NR
1984	2.1 E-01	2.8 E-01	1.7 E+00	1.8 E-03	5.8 E-04
1985	2.4 E-01	6.9 E-02	6.8 E-01	1.2 E-04	7.0 E-04
1986	2.7 E-01	1.5 E-01	1.7 E+00	0.0	3.1 E-04
1987	2.5 E-01	9.5 E-02	6.3 E-01	1.6 E-04	2.8 E-04
1988	2.8 E-01	1.8 E-01	9.6 E-02	3.8 E-05	1.9 E-04
1989	2.6 E-01	1.5 E-01	2.8 E-01	9.6 E-05	1.2 E-04

NR = Not reported.

Note: Table E-12 lists the results of the analysis of 100-D/DR Area vegetation samples.

Table 4-13. Average Radionuclide Concentrations (pCi/g) Detected in 100-F Area Vegetation Samples from 1981 to 1989.

Year	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
1981	9.2 E-01	NR	2.2 E+00	NR	NR
1982	1.6 E-01	NR	7.9 E-01	NR	NR
1983	2.8 E-01	NR	1.0 E+00	NR	NR
1984	2.2 E+00	7.6 E+00	2.0 E+01	4.9 E-04	3.9 E-03
1985	3.3 E-01	1.4 E+00	5.8 E-01	4.9 E-05	5.3 E-04
1986	1.7 E-01	9.3 E-02	1.1 E+00	8.3 E-05	1.2 E-04
1987	2.4 E-01	1.8 E-01	1.9 E-01	3.8 E-04	1.7 E-04
1988	9.9 E-01	8.9 E-02	3.1 E-01	3.3 E-05	1.1 E-04
1989	2.8 E-01	9.6 E-02	2.0 E+00	5.2 E-05	1.4 E-04

NR = Not reported.

Note: Table E-13 lists the results of the analysis of 100-F Area vegetation samples.

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Table 4-14. Average Radionuclide Concentrations (pCi/g) Detected in 100-H Area Vegetation Samples from 1981 to 1989.

Year	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
1981	6.8 E-01	NR	1.5 E-01	NR	NR
1982	NR	NR	NR	NR	NR
1983	1.3 E-01	NR	9.0 E-02	NR	NR
1984	1.8 E-01	2.0 E+00	1.3 E-01	2.0 E-04	1.7 E-03
1985	2.0 E-01	6.0 E-02	4.5 E-02	1.0 E-04	5.1 E-04
1986	2.2 E-01	5.3 E-01	1.3 E+00	1.3 E-04	4.4 E-05
1987	2.6 E-01	2.6 E-01	1.0 E-01	3.5 E-05	2.7 E-04
1988	9.0 E-01	3.9 E-01	1.5 E-01	2.0 E-04	1.5 E-04
1989	6.5 E-01	5.2 E-02	2.1 E-01	8.5 E-05	1.5 E-04

NR = Not reported.

NOTE: Table E-14 lists the results of the analysis of 100-H Area vegetation samples.

Table 4-15. Average Radionuclide Concentrations (pCi/g) Detected in 100-K Area Vegetation Samples from 1981 to 1989.

Year	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
1981	1.2 E+00	NR	1.0 E-01	NR	NR
1982	2.4 E-01	NR	9.7 E-01	NR	NR
1983	1.5 E-01	NR	2.5 E-01	NR	NR
1984	1.8 E-01	1.3 E+00	1.3 E-01	2.9 E-04	6.9 E-04
1985	4.6 E-01	3.9 E-01	1.3 E-01	1.9 E-04	7.1 E-04
1986	2.8 E-01	4.0 E-01	1.5 E+00	2.5 E-04	7.9 E-04
1987	2.3 E-01	1.3 E+00	1.1 E-01	1.9 E-04	2.2 E-04
1988	4.9 E-01	1.2 E+00	1.8 E-01	5.2 E-05	3.8 E-04
1989	3.1 E-01	1.3 E+00	1.6 E-01	1.1 E-04	1.5 E-04

NR = Not reported.

Note: Table E-15 lists the results of the analysis of 100-K Area vegetation samples.

9 2 1 2 7 9 1 3 5

## 5.0 EXTERNAL RADIATION MONITORING

Environmental thermoluminescent dosimeters (TLDs) are used to measure direct radiation and evaluate environmental dose rates at several locations at 100-N Area.

The environmental TLDs (CaF<sub>2</sub>:Mn matrix) are delivered, calibrated, and read every 4 wk by PNL. The locations of the environmental TLDs at the 100-N Area are shown in Figure 5-1. The average dose rate in mrem/h, extrapolated dose rate per work year for each of the TLD locations, and the ALARA occupational exposure guideline for comparison are presented in Table F-1.

The dose per work year is defined as the accumulated dose over a period of 40 h/wk and 52 wk/yr at the site of a specific environmental dosimeter. The value is used only to indicate the significance of background radiation levels. It does not show actual occupational exposure as workers rarely spend large amounts of time at most of these locations, especially inside established radiation zones. In October 1986, five TLD locations were added to the 100-N Area external radiation monitoring program. These sites, numbers 37 through 41, were included to assess dose rates to workers housed in offices located near the 1301-N LWDF. The 1989 results indicate that the ALARA exposure guidelines for nonradiation zone workers (240 mrem/yr) were not exceeded and there is an apparent, overall decreasing trend in dose rates at these locations.

Direct radiation levels were higher near facilities that contained or received liquid effluent from N Reactor. These facilities include the 1304-N EDT, the 1301-N LWDF, and the 1325-N LWDF. The environmental dose rates detected near the 1301-N LWDF were lower than in 1988. There was a 15% overall decrease in dose rates observed in 1989 compared to 1988. This decrease for 1989 may be attributable to the continued decay of <sup>60</sup>Co, which is nearing completion of one half-life (5.3 yr). Plans for permanent closure and stabilization of the 1301-N LWDF are being developed and reviewed. The environmental dose rates detected near the 1325-N LWDF were also lower than in 1988. Effluent discharged to the 1325-N LWDF, which provides shielding from direct radiation, increased during the first half of 1989 due to increased water usage associated with reactor defueling activities. Defueling began in January and was completed in mid-April. Continued increased water usage through July was necessary to maintain water quality requirements within the reactor. Dose rates increased again during the latter half of the year as the effluent discharges decreased. The overall annual dose rate at the 1325-N LWDF decreased by approximately 55% compared to 1988 levels.

A slightly decreasing trend in dose rates was observed at TLD locations 7 and 29 beginning in March 1989. This decrease is attributed to the decontamination activities conducted in the 1304-N EDT.

A table of the monthly dose rate measurements for each environmental TLD location is included in Table F-2.

9 2 1 1 2 0 0 0

◀ 23 SUPPLY SYSTEM CONTROL ROOM  
◀ 24 ON SUPPLY SYSTEM FENCE

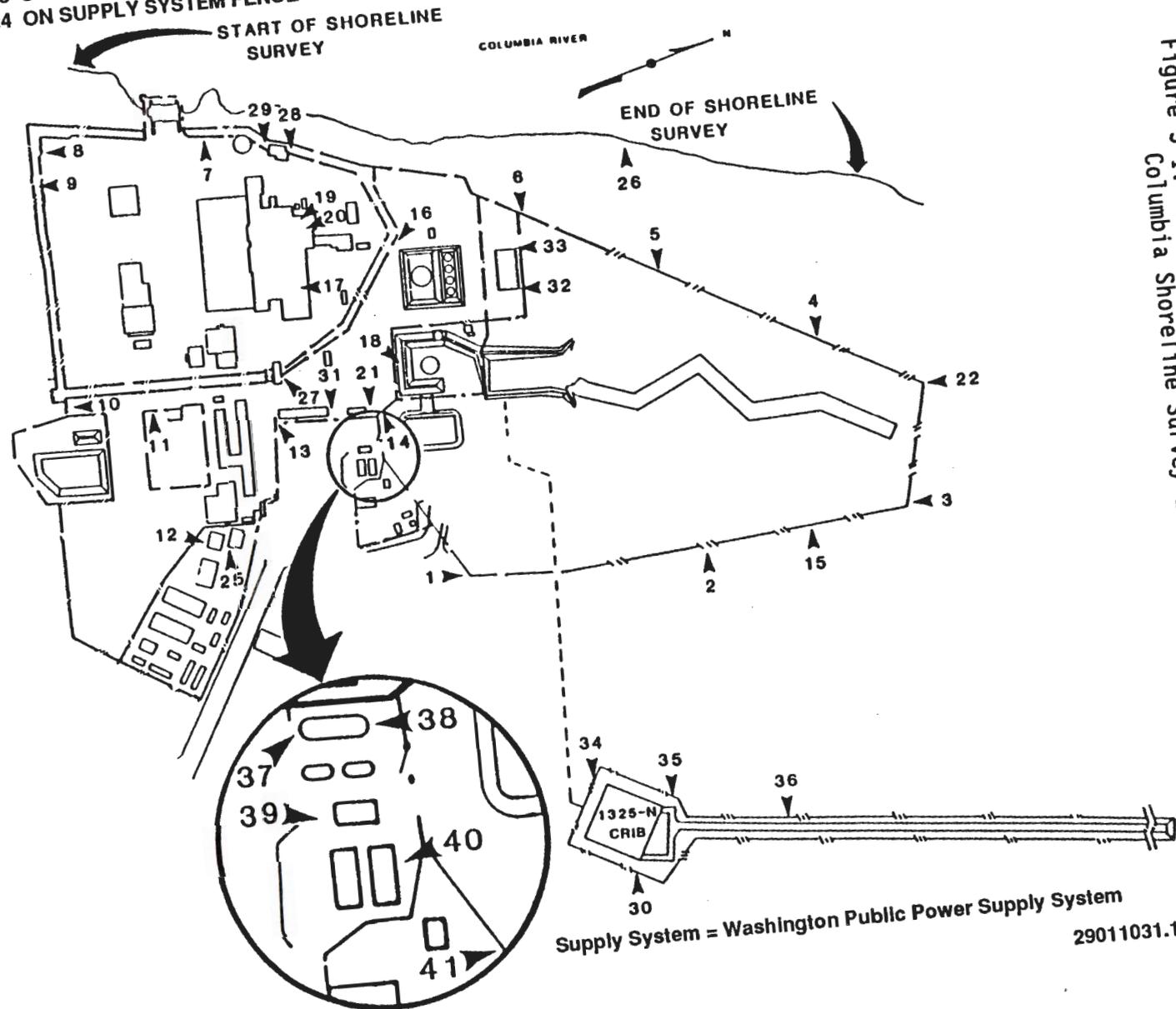


Figure 5-1. Location of Environmental Dosimeters and the Columbia Shoreline Survey at 100-N Area.

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## 6.0 LIQUID WASTE DISPOSAL FACILITY MONITORING

Environmental surveillance of the 1301-N and 1325-N LWDFs is performed to monitor and document the environmental impact associated with these disposal facilities. Several parameters including ambient air, vegetation, surface soil, and bottom sediments are sampled and analyzed. Ambient environmental dose rates are also monitored annually. Ambient air, vegetation, surface soil, and external radiation monitoring for the LWDFs have been included in their respective sections previously. The following section, Radiological Surveys, will address the annual ambient environmental dose rate surveys associated with LWDF monitoring. This section, LWDF monitoring, will discuss the sampling and analysis of the 1325-N LWDF bottom sediments.

The 1325-N LWDF receives liquid effluent from N Reactor. The liquid effluent is discharged to a soil column that retains the radionuclides as the effluent percolates through the subsoil. Samples of surface sediment were obtained from the bottom of the 1325-N LWDF on May 6, 1989. The samples, about 10 g each, were collected by means of several sampling ports located in the cover over the disposal facility (Figure 6-1). At the time of sampling, the 1325-N LWDF was receiving liquid effluent from N Reactor. The samples were analyzed for gamma-emitting radionuclides at the 100-N Westinghouse Hanford radioanalytical lab. The samples were then shipped to UST for  $^{89,90}\text{Sr}$  and plutonium analyses. However, because of contract problems, these samples have not been analyzed. The results of these analyses will be reported in the calendar year 1990 annual environmental surveillance report.

Comparison of radionuclide concentrations detected in the 1325-N LWDF sediments from 1985 to 1989 are presented in Table 6-1. Radionuclide concentrations detected in sediments sampled from the 1325-N LWDF crib are presented in Table G-1. The apparent variation (increase) in concentrations for 1989 are attributable to sampling techniques.

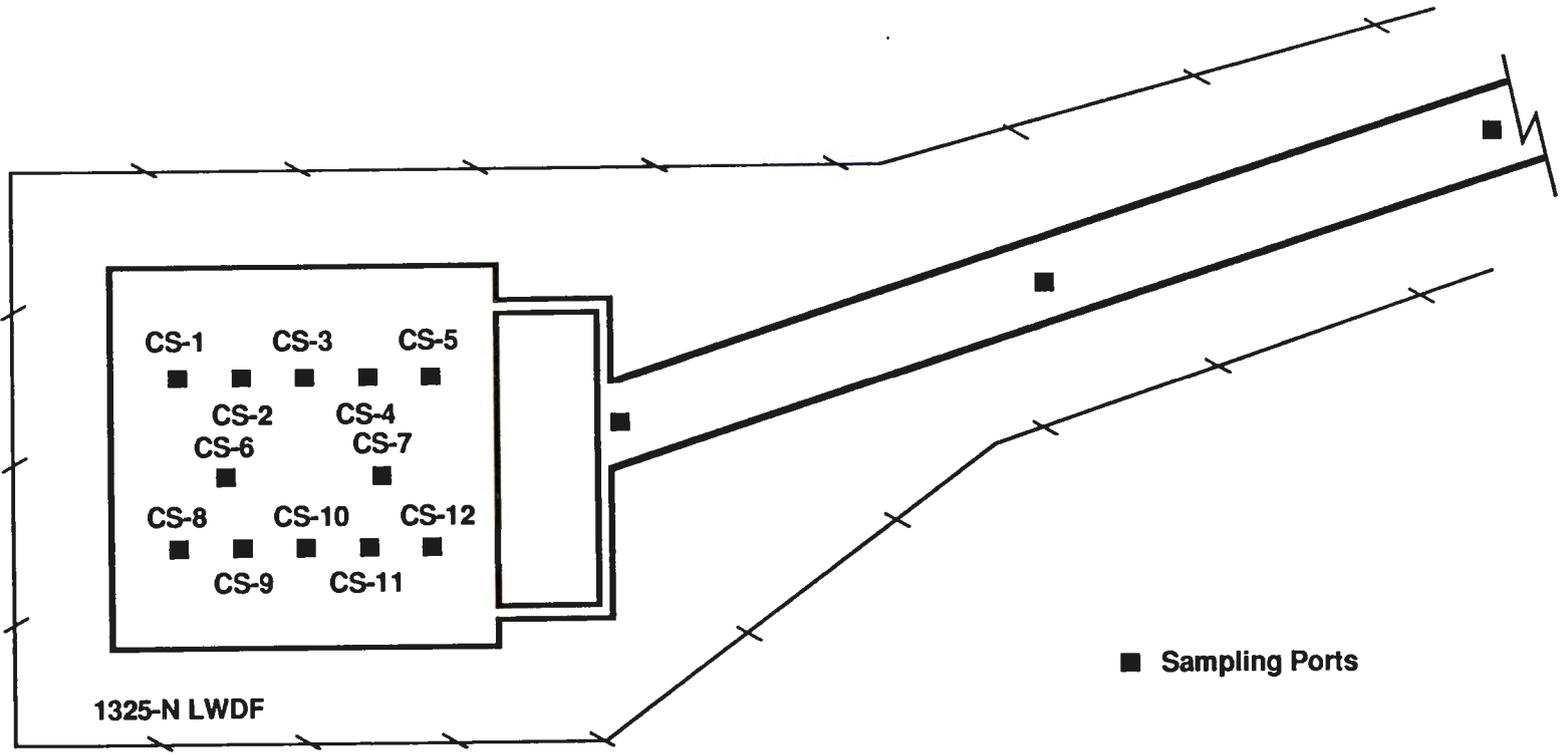
Use of the 1301-N LWDF was discontinued on September 19, 1985. Emphasis on LWDF sediment sampling subsequently shifted to the 1325-N LWDF. As the radionuclides contained in the 1301-N LWDF decay, concentrations will decrease. Stabilization and permanent closure of the facility are being studied at this time.

Table 6-1. Average Radionuclide Concentrations (pCi/g)  
Detected in 1325-N Liquid Waste Disposal Facility  
Sediment Since 1985.

Year	$^{60}\text{Co}$	$^{90}\text{Sr}$	$^{137}\text{Cs}$	$^{239,240}\text{Pu}$
1985	8.3 E+05	5.4 E+04	3.7 E+04	1.3 E+04
1986	2.8 E+06	5.9 E+03	9.3 E+04	NR
1987	8.7 E+05	9.7 E+04	2.3 E+04	3.3 E+04
1988	1.3 E+06	2.3 E+04	5.1 E+04	1.4 E+04
1989	1.3 E+07	NR	3.2 E+05	NR

NR = Not reported.

Figure 6-1. Sediment Sampling Locations for the 1325-N Liquid Waste Disposal Facility.



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## 7.0 RADIOLOGICAL SURVEYS

### 7.1 INTRODUCTION

Direct radiation levels are measured annually along the 100-N Area portion of the Columbia River shoreline. Annual environmental radiation surveys are also conducted at intersecting points of survey grids established around the 1301-N and 1325-N LWDFs to monitor direct radiation levels associated with the disposal facilities.

Each of the surveys relied on the use of a Bicron Model 5050 portable micro-R meter. The meter was calibrated by PNL to a  $^{137}\text{Cs}$  source and the readings were taken at a height of 1 m at 50-ft intervals. The micro-R readings obtained for these surveys reflect relative (to each other) dose rates only, and do not indicate actual whole body penetrating dose rates, as this type of instrument is overly sensitive to nonpenetrating radiation sources.

### 7.2 COLUMBIA RIVER SHORELINE SURVEY

On August 30, 1989, relative dose rates were measured along the Columbia River shoreline starting near the 005 outfall and proceeding downstream past the N Springs (refer to Figure 5-1). A graphic representation of the shoreline survey data is presented in Figure 7-1. The locations of the 100-N Area facilities that potentially contribute to dose rates measured near the river shoreline are shown. At the time of the survey, N Reactor was shut down. The 1304-N EDT was empty. One rail car containing irradiated fuel awaiting shipment to PUREX was located near the 1314-N Facility. The dose rate (at 1 m) from this rail car was 11 mrem/h. Flow to the 1325-N LWDF was about 200 gal/min. The 1310-N Radioactive Chemical Waste Storage Facility was empty.

Relative environmental dose rates detected along the Columbia River shoreline opposite the 1301-N LWDF were similar in shape, but lower than the 1987 and 1988 measurements. The decrease is attributable to the continuing decay of  $^{60}\text{Co}$  (half life 5.3 yr), one of the major residual radionuclides in the 1301-N Facility. This coincides with the reduced TLD measurements near this facility as discussed in Section 5.0 of this report. As of September 19, 1985, this facility was no longer used and no longer contained water that, during operation, shielded direct radiation levels.

The readings at each location obtained during this survey are presented in Table H-1.

### 100-N Area Shoreline Survey Results Relative Dose Rates

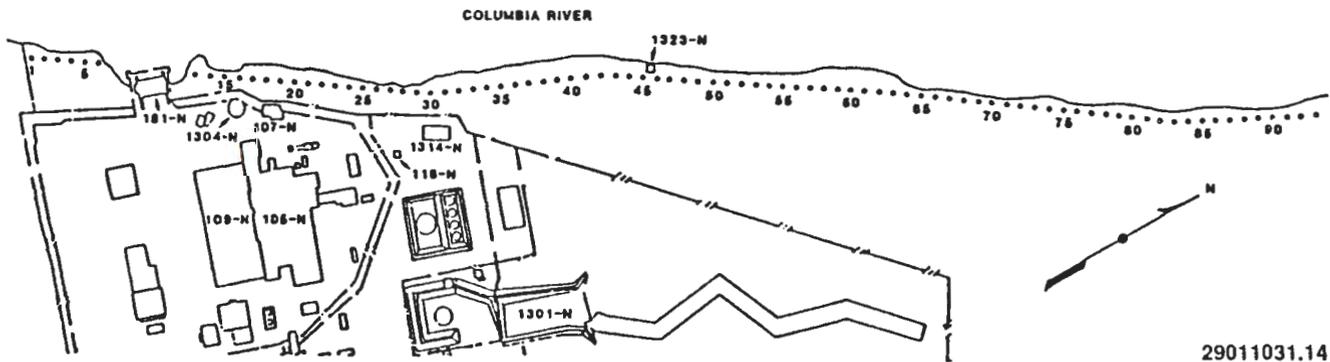
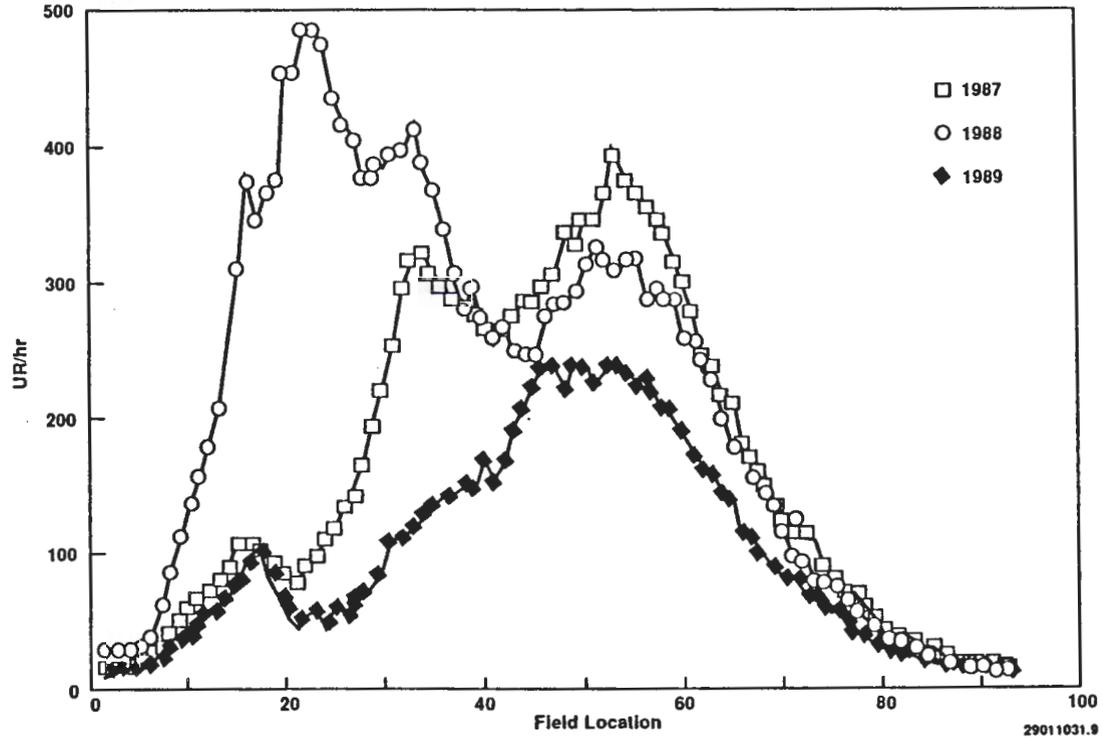


Figure 7-1. Environmental Dose Rates Detected at Survey Points along the Columbia River Shoreline.

## 7.3 LIQUID WASTE DISPOSAL FACILITY RADIATION SURVEYS

### 7.3.1 Introduction

The 1301-N and 1325-N LWDFs are secured facilities posted as radiation zones. Due to the potential for radionuclide contamination and direct radiation exposure, the facilities are surrounded by a security fence. Only trained personnel are allowed access to the disposal facilities. Even then, workers do not spend large amounts of time in these areas.

For convenience of reference, the 1988 LWDF survey results are included in Figures H-1 and H-2. The methods and equipment used for the annual dose rate surveys conducted at the 1301-N and 1325-N LWDFs were identical to those described for the annual Columbia River shoreline survey.

### 7.3.2 1301-N Liquid Waste Disposal Facility Survey Results

Figure 7-2 shows the relative environmental dose rates detected around the 1301-N LWDF on August 29, 1989. The N Reactor was not operating at the time of the survey. The 1325-N LWDF was receiving liquid effluent from the N Reactor at a rate of about 200 gal/min. The 1310-N Radioactive Chemical Treatment Facility was empty.

The data indicate that the areas near the "box weir" (inlet) portion of the 1301-N LWDF and the first leg of the 1301-N trench have the highest background dose rates. The absence of water from the LWDF is the major factor contributing to the dose rates. During operation, water levels in the crib shielded much of the radiation emitted by the contaminated sediments.

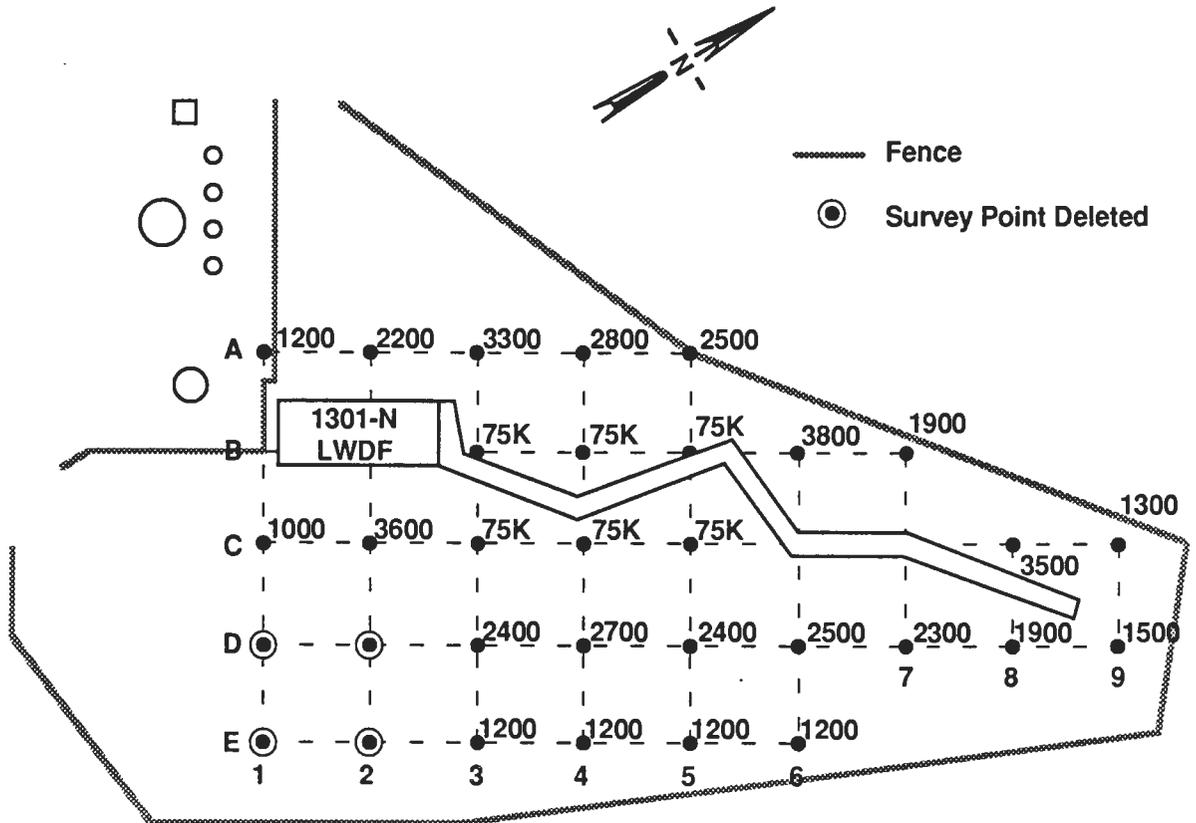
Also, an overall decrease in the relative dose rates measured at this facility was indicated in 1989. The continued decay of the radionuclide inventory contained in the 1301-N LWDF is the apparent cause of this reduction.

### 7.3.3 Liquid Waste Disposal Facility

The relative environmental dose rates detected around the 1325-N LWDF on August 29, 1989, are presented in Figure 7-3. The N Reactor was not operating at the time and the 1325-N LWDF was receiving about 200 gal/min of liquid effluent from N Reactor. The 1310-N Radioactive Chemical Waste Storage Facility was empty. The 1301-N LWDF did not contain liquid effluent.

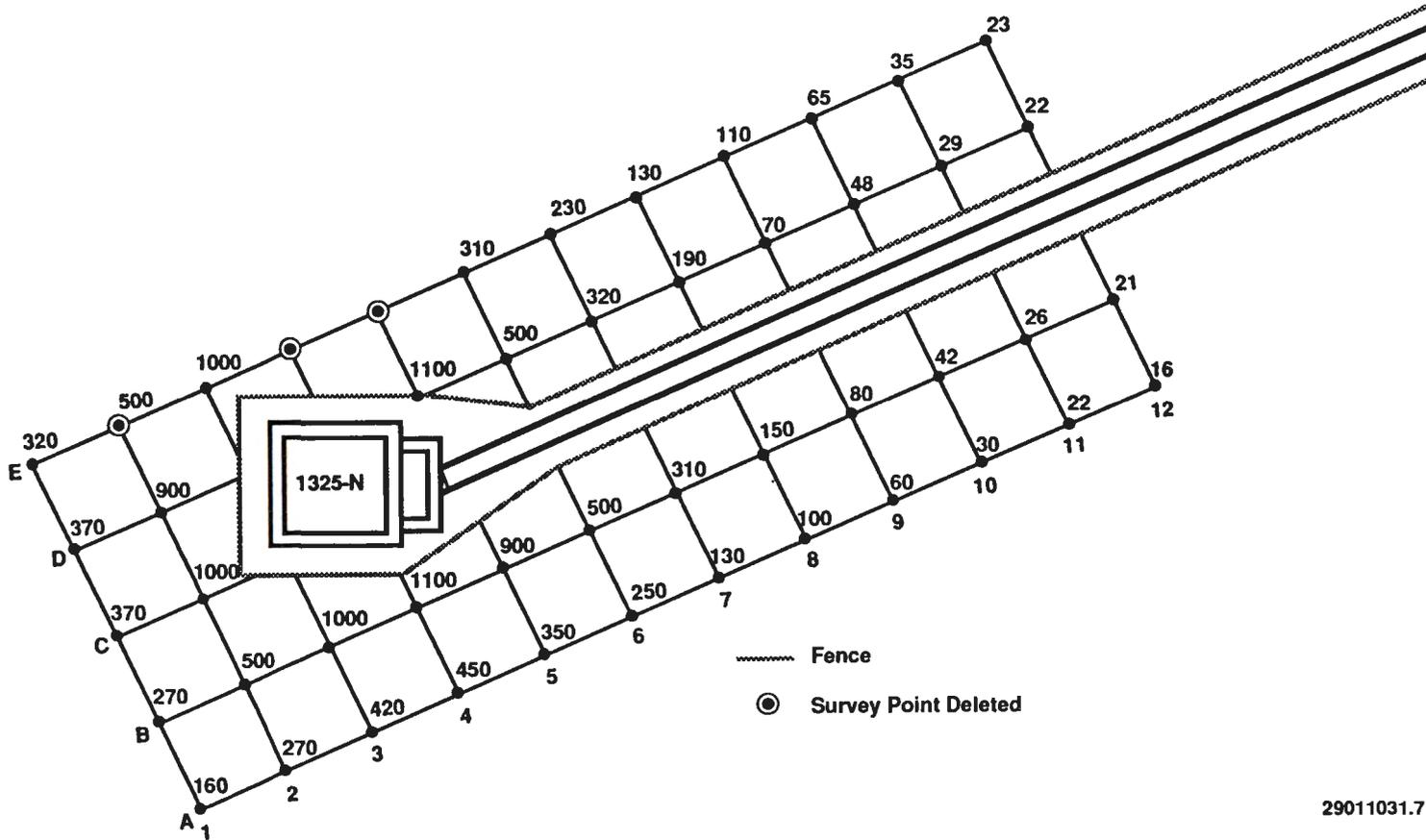
In 1989, the 1325-N LWDF showed a general decrease in relative dose rates compared to the 1988 survey. This coincides with the TLD measurements obtained during this period. This decrease is attributable to the increased (compared to 1988) effluent discharge to the facility and the enhanced shielding thereby provided.

Figure 7-2. 100-N Environmental Dose Rates Measured at Survey Points Around the 1301-N Liquid Waste Disposal Facility in 1989 ( $\mu\text{rem/h}$ ).



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Figure 7-3. 100-N Environmental Dose Rates Survey Around the 1325-N Liquid Waste Disposal Facility ( $\mu\text{rem/h}$ ).



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APPENDIX A  
QUALITY ASSURANCE

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## INTRODUCTION

The Westinghouse Hanford Company (Westinghouse Hanford) surveillance program for the 100 Areas provides monitoring to assist in evaluating the environmental impact of N Reactor facilities, the retired reactor facilities, and burial grounds in the retired 100 Areas. The major objectives of the program are to monitor radionuclide concentrations in radiological release pathways, maintain a database for trend analyses, provide data for accidental release analyses, and demonstrate compliance with applicable regulations.

At the 100-N Area, samples of ambient air, groundwater, vegetation, soil, and sediment are collected and analyzed along with direct radiation measurements around the 1301-N and 1325-N Liquid Waste Disposal Facilities (LWDF) and along the river shoreline. At the retired 100 Areas, soil, vegetation, and groundwater samples are collected and analyzed. Special samples to monitor the potential biotransport of radionuclides may also be included in the surveillance program.

Procedures and guidelines are used to ensure that near-field environmental monitoring techniques and analyses are conducted within established limits of acceptance. The essential components of these manuals as they apply to the 100 Areas environmental surveillance quality assurance (QA) program are briefly outlined below.

## DOCUMENTATION

Record keeping is a vital requirement of the 100 Areas near-field environmental monitoring program. Each phase of the program is documented to ensure regulatory compliance, accurate trend analysis, and optimal monitoring procedures. Pertinent documentation is listed below.

- Sampling Logs--Records of all environmental samples collected by Operational Health Physics (OHP) and N Reactor Operations personnel are kept in these log books.
- Data Records--All analytical data received by 100 Areas Environmental Protection (EP) from the radioanalytical laboratories are recorded on magnetic media and hard-copy printouts.
- Environmental Surveillance Requirements--The procedures and reporting guidelines for these requirements are provided in various company manuals.
- Chain-of-Custody Log--This log records custody of the environmental samples from collection through disposal.

Various reports are generated to document, control, and report the condition of, and impact to, the near-field environment. These reports are listed below.

- 100 Areas Annual Environmental Release Report--This report covers atmospheric and liquid releases of radionuclides and chemicals from the 100 Area facilities.
- Environmental Surveillance Report for the 100 Areas--This annual report summarizes sampling and monitoring completed during the previous year to fulfill the requirements of the Westinghouse Hanford 100 Areas Environmental Surveillance Program.
- Westinghouse Hanford Release Report for the Hanford Site--This monthly report shows the total amounts of potentially hazardous materials released from Westinghouse Hanford facilities for the previous month. Unplanned releases and spills to the environment are included in this report.
- National Pollutant Discharge Elimination System (NPDES) Effluent Monitoring Report--The NPDES Effluent Monitoring Report summarizes the sampling data required by the NPDES permit. The U.S. Department of Energy transmits the report to the Environmental Protection Agency as required by NPDES regulations.
- Environmental Radiological Survey Summary for the 100 Area--This quarterly report summarizes the environmental radiation surveys conducted in the 100 Areas. These surveys are conducted to detect surface contamination at the inactive waste sites located in the 100 Areas.

#### DATA ANALYSIS

Environmental data are reviewed to determine compliance with applicable federal, state, local, and Westinghouse Hanford guidelines. These data are analyzed both graphically and by standard statistical tests to determine trends and impacts on the environment. Newly acquired data are compared with historical data and natural background levels. Routine environmental data are stored on both magnetic media (i.e., in a microcomputer environment) and on hard-copy printouts.

#### TRAINING

To ensure quality and consistency in sample collection and handling, all personnel performing such work receive formal training. Personnel involved in sample analyses receive formal initial and annual followup training in the operation of the radioanalytical laboratory equipment located in the 105-N Building.

### SAMPLE FREQUENCY

The sampling schedules and types are established by 100 Areas Environmental Protection on the basis of detailed review of each effluent stream to ensure that all samples accurately represent the types and concentrations of radionuclides that are being discharged in that effluent stream. The routine monitoring schedule is provided in the applicable company manual. A brief description of the sampling program is presented below.

1. Ambient air sample filters are collected weekly.
2. Liquid effluent samples are composited and collected weekly.
3. Environmental thermoluminescent dosimeters (TLD) are exchanged monthly.
4. Groundwater samples for radiological analysis are collected quarterly. Samples from oil and grease monitoring wells are collected on a location-dependent frequency.
5. Radiological surveys of the LWDFs and Columbia River shoreline are performed annually.
6. The soil, vegetation, and 1325-N LWDF sediment samples are collected annually.

### ANALYTICAL PROCEDURES

Three laboratories provide analytical support to the 100 Areas Environmental Surveillance Program: the U.S. Testing Company Inc. (UST), the Radiation Standards and Engineering Laboratory at Pacific Northwest Laboratory (PNL), and the 100-N Westinghouse Hanford radioanalytical laboratory. The environmental samples are analyzed in accordance with prescribed procedures and quality control guides.

Radioanalyses conducted at the 100-N Westinghouse Hanford radioanalytical laboratory are limited to the detection of gamma-emitting radionuclides. Other analyses, such as gross alpha-beta, tritium, strontium, and plutonium determinations are performed by either UST or PNL, depending on the sample type. The PNL also provides TLD calibration, annealing, and analyses.

Historically, the radioanalytical program at 105-N has provided reliable and accurate analyses of gamma-emitting radionuclides. The laboratory has consistently performed well on Environmental Protection Agency interlaboratory comparisons. The quality control program for the laboratory is documented in the applicable company manual. Quality control for the UST laboratory is overseen by PNL.

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**APPENDIX B**

**GLOSSARY**

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**ACRONYMS**

ALARA	as low as reasonably achievable
DCG	derived concentration guide
DOE	U.S. Department of Energy
EDB	emergency dump basin
EDT	emergency dump tank
EP	Environmental Protection
HEHF	Hanford Environmental Health Foundation
ICRP	International Commission on Radiological Protection
LWDF	liquid waste disposal facility
NPDES	national pollutant discharge elimination system
OHP	Operational Health Physics
PNL	Pacific Northwest Laboratory
PUREX	Plutonium Uranium Extraction (Plant)
SNM	special nuclear material
Supply System	Washington Public Power Supply System
TLD	thermoluminescent dosimeter
UST	U.S. Testing Company Inc.
Westinghouse Hanford	Westinghouse Hanford Company

**DEFINITIONS**

Biological Transport. Concerns one or more of the following processes:

- Movement of subsurface radioactivity to the surface by physiological plant processes
- Dispersion of such plants by the wind
- Contaminated urine and feces deposited by animals that have gained access to and ingested radioactivity
- Contaminated animals themselves that have ingested radioactivity directly or ingested other contaminated animals or plants
- Physical displacement of radioactivity by burrowing animals
- Nests built using contaminated materials.

Background Radiation. Refers to regional levels of radioactivity produced by sources other than those of specific interest (e.g., the nuclear activities at the Hanford Site).

Biota. The plant and animal life of a specific region.

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Chemical Processing. Chemical treatment of material to selectively separate desired components. At the Hanford Site, plutonium, uranium, and fission products are chemically separated from irradiated fuels.

Controlled Area. An area where access is controlled to protect individuals from extra exposure to radiation and radioactive materials.

Crib. A subsurface low-level liquid-waste disposal site that allows liquid waste to percolate into surrounding soil.

Decommissioning. The process of removing a facility or area from operation, often involving decontamination and/or disposal, plus incorporating appropriate controls and safeguards.

Decontamination. The removal of radioactivity from a surface or from within another material.

Environmental Surveillance. A survey and sampling program designed to determine radiological impact due to site operations.

Groundwater. Water that exists below ground surface (i.e., within the zone of saturation).

Less Than Detectable. An analytical term for a radionuclide concentration in a sample that is lower than the minimum detection capabilities of that analytical equipment or process.

Quality Assurance. A program designed to maintain the quality of the results of a program within established limits of acceptance.

Radiation Survey. Evaluation of an area or object with portable instruments to identify radioactive materials and radiation fields present.

Radiological Control Area. An area where access is controlled to protect individuals from exposure to radiation and/or radioactive materials. In the Separations Area, control areas include, but are not limited to, areas posted as Radiation Area, Surface Contamination, and Underground Radioactive Materials--all describing the radiological condition of the area within.

Retired Waste Site. A waste site that is isolated and no longer available to receive waste in any form.

Surface Contamination. A radiological control status that refers to radioactivity on the surface of the ground that exceeds the Soil Contamination Standard.

Thermoluminescent Dosimeter. A chip or series of chips used for measuring external gamma radiation. It consists of a material capable of absorbing energy imparted by ionizing radiation, then emitting light as a result of thermal stimulation. A measure of that light is proportional to the radioactivity absorbed.

Water Table. The upper boundary of an unconfined aquifer below which saturated groundwater occurs.

APPENDIX C  
AMBIENT AIR MONITORING

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Table C-1. Concentrations of Radionuclides Detected in 100-N Area Air Samples (pCi/m3).

Number of samples	Isotopes					
		<sup>54</sup> Mn	<sup>60</sup> Co	<sup>103</sup> Ru	<sup>131</sup> I	<sup>137</sup> Cs
Sample location* A-1						
13	Maximum	<2.0 E-02	1.0 E-01	<1.2 E-01	<1.7 E-02	<1.9 E-02
	Minimum	<7.5 E-03	1.4 E-02	<5.2 E-03	<5.4 E-03	<7.0 E-03
	Average	<1.4 E-02	4.2 E-02	<2.0 E-02	<1.2 E-02	<1.4 E-02
	Stan. Dev.	3.3 E-03	2.4 E-02	2.9 E-02	2.9 E-03	3.4 E-03
Sample location* A-2						
13	Maximum	<2.6 E-02	7.4 E-02	<1.2 E-01	<1.7 E-02	<1.8 E-02
	Minimum	<5.4 E-03	9.5 E-03	<5.7 E-03	<5.6 E-03	<6.4 E-03
	Average	<1.5 E-02	4.1 E-02	<3.6 E-02	<1.3 E-02	<1.4 E-02
	Stan. Dev.	4.5 E-03	1.6 E-02	4.4 E-02	3.0 E-03	3.1 E-03
Sample location* A-3						
13	Maximum	<1.7 E-02	7.6 E-02	<1.4 E-01	<1.7 E-02	<1.8 E-02
	Minimum	<5.6 E-03	7.3 E-03	<4.9 E-03	<5.6 E-03	<3.9 E-03
	Average	<1.3 E-02	3.6 E-02	<2.8 E-02	<1.3 E-02	<1.4 E-02
	Stan. Dev.	2.8 E-03	1.7 E-02	3.9 E-02	2.8 E-03	3.4 E-03
Sample location* A-4						
13	Maximum	<1.9 E-02	6.9 E-02	<1.2 E-01	<1.6 E-02	<1.9 E-02
	Minimum	<7.3 E-03	9.0 E-03	<6.1 E-03	<8.0 E-03	<6.4 E-03
	Average	<1.4 E-02	3.3 E-02	<2.0 E-02	<1.2 E-02	<1.4 E-02
	Stan. Dev.	3.0 E-03	1.8 E-02	2.9 E-02	2.4 E-03	3.5 E-03
Sample location* A-5						
2	Maximum	<1.1 E-02	2.2 E-02	<1.0 E-02	<1.3 E-02	<1.2 E-02
	Minimum	<1.0 E-02	1.4 E-02	<9.3 E-03	<1.0 E-02	<1.2 E-02
	Average	<1.1 E-02	1.8 E-02	<9.7 E-03	<1.2 E-02	<1.2 E-02
	DCG**	2.0 E+03	8.0 E+01	2.0 E+03	4.0 E+02	4.0 E+02

\*Locations identified in Figure 2-1.

\*\*DCG = Derived Concentration Guides (U. S. Department of Energy)

Table C-2. Concentrations of Radionuclides Detected  
in 100-N Area Air Samples at Location A-1 (pCi/m<sup>3</sup>).

Date	Isotopes				
	<sup>54</sup> Mn	<sup>60</sup> Co	<sup>103</sup> Ru	<sup>131</sup> I	<sup>137</sup> Cs
Sample location* A-1					
01/06/89	<1.1 E-02	3.0 E-02	<1.1 E-02	<1.1 E-02	<1.4 E-02
02/01/89	<2.0 E-02	6.3 E-02	<1.6 E-02	<1.7 E-02	<1.9 E-02
03/01/89	<1.7 E-02	1.0 E-01	<1.3 E-02	<1.6 E-02	<1.7 E-02
03/29/89	<1.8 E-02	3.8 E-02	<1.3 E-02	<1.6 E-02	<1.7 E-02
04/26/89	<1.4 E-02	5.2 E-02	<1.2 E-01	<1.2 E-02	<1.2 E-02
05/24/89	<1.2 E-02	3.2 E-02	<1.3 E-02	<1.1 E-02	<1.1 E-02
06/21/89	<1.2 E-02	8.1 E-02	<1.0 E-02	<1.1 E-02	<1.4 E-02
07/19/89	<1.4 E-02	2.0 E-02	<1.2 E-02	<1.2 E-02	<1.4 E-02
08/17/89	<9.2 E-03	2.8 E-02	<1.0 E-02	<1.2 E-02	<1.3 E-02
09/15/89	<1.5 E-02	<3.0 E-02	<1.4 E-02	<1.5 E-02	<1.9 E-02
11/08/89	<7.5 E-03	3.0 E-02	<5.2 E-03	<5.4 E-03	<7.0 E-03
12/11/89	<1.2 E-02	2.5 E-02	<1.0 E-02	<1.1 E-02	<9.5 E-03
01/12/90	<1.4 E-02	1.4 E-02	<1.1 E-02	<1.3 E-02	<1.2 E-02

\*Location identified in Figure 2-1.

Table C-3. Concentrations of Radionuclides Detected  
in 100-N Area Air Samples at Location A-2 (pCi/m<sup>3</sup>).

Date	Isotopes				
	<sup>54</sup> Mn	<sup>60</sup> Co	<sup>103</sup> Ru	<sup>131</sup> I	<sup>137</sup> Cs
Sample location* A-2					
01/06/89	<2.6 E-02	4.5 E-2	<1.2 E-01	<1.2 E-02	<1.5 E-02
02/01/89	<1.4 E-02	4.6 E-02	<1.3 E-02	<1.2 E-02	<1.3 E-02
03/01/89	<1.3 E-02	7.4 E-02	<1.5 E-02	<1.6 E-02	<1.8 E-02
03/29/89	<1.3 E-02	4.4 E-02	<1.2 E-01	<1.4 E-02	<1.4 E-02
04/26/89	<1.9 E-02	3.3 E-02	<1.7 E-02	<1.7 E-02	<1.8 E-02
05/24/89	<1.7 E-02	6.5 E-02	<1.4 E-02	<1.5 E-02	<1.7 E-02
06/21/89	<1.3 E-02	5.6 E-02	<1.1 E-01	<1.4 E-02	<1.4 E-02
07/19/89	<1.6 E-02	<2.5 E-02	<1.3 E-02	<1.4 E-02	<1.7 E-02
08/17/89	<1.5 E-02	3.1 E-02	<1.2 E-02	<1.4 E-02	<1.6 E-02
09/15/89	<1.7 E-02	3.6 E-02	<1.4 E-02	<1.7 E-02	<1.4 E-02
11/08/89	<5.4 E-03	9.5 E-03	<5.7 E-03	<5.6 E-03	<6.4 E-03
12/11/89	<1.3 E-02	3.0 E-02	<1.0 E-02	<1.1 E-02	<1.2 E-02
01/12/90	<1.2 E-02	3.7 E-02	<9.1 E-03	<1.0 E-02	<1.1 E-02

\*Location identified in Figure 2-1.

Table C-4. Concentrations of Radionuclides Detected in 100-N Area Air Samples at Locaton A-3 (pCi/m<sup>3</sup>).

Date	Isotopes				
	<sup>54</sup> Mn	<sup>60</sup> Co	<sup>103</sup> Ru	<sup>131</sup> I	<sup>137</sup> Cs
Sample location* A-3					
01/06/89	<1.3 E-02	7.6 E-02	<1.3 E-02	<1.4 E-02	<1.8 E-02
02/01/89	<1.3 E-02	3.4 E-02	<1.4 E-02	<1.4 E-02	<1.6 E-02
03/01/89	<1.6 E-02	4.7 E-02	<1.6 E-02	<1.5 E-02	<1.5 E-02
03/29/89	<1.2 E-02	2.8 E-02	<1.1 E-02	<1.0 E-02	<1.4 E-02
04/26/89	<1.1 E-02	2.9 E-02	<1.0 E-02	<1.2 E-02	<1.4 E-02
05/24/89	<1.4 E-02	4.8 E-02	<9.2 E-02	<1.3 E-02	<1.5 E-02
06/21/89	<1.4 E-02	3.8 E-02	<1.5 E-02	<1.5 E-02	<1.4 E-02
07/19/89	<1.7 E-02	4.5 E-02	<1.4 E-02	<1.7 E-02	<1.7 E-02
08/17/89	<1.1 E-02	<1.9 E-02	<1.1 E-02	<1.4 E-02	<1.5 E-02
09/15/89	<1.6 E-02	4.9 E-02	<1.4 E-01	<1.6 E-02	<1.2 E-02
11/08/89	<5.6 E-03	7.3 E-03	<4.9 E-03	<5.6 E-03	<3.9 E-03
12/11/89	<1.2 E-02	1.6 E-02	<1.2 E-02	<1.3 E-02	<1.6 E-02
01/12/90	<1.1 E-02	3.2 E-02	<1.1 E-02	<1.1 E-02	<1.2 E-02

\*Location identified in Figure 2-1.

Table C-5. Concentration of Radionuclides Detected in 100-N Area Air Samples at Location A-4 (pCi/m<sup>3</sup>).

Date	Isotopes				
	<sup>54</sup> Mn	<sup>60</sup> Co	<sup>103</sup> Ru	<sup>131</sup> I	<sup>137</sup> Cs
Sample location* A-4					
01/06/89	<1.7 E-02	5.2 E-02	<1.4 E-02	<1.4 E-02	<1.9 E-02
02/01/89	<1.2 E-02	<1.6 E-02	<1.1 E-02	<1.1 E-02	<8.7 E-03
03/01/89	<1.3 E-02	<1.8 E-02	<1.1 E-02	<1.0 E-02	<1.3 E-02
03/29/89	<1.3 E-02	2.9 E-02	<1.1 E-02	<1.1 E-02	<1.5 E-02
04/26/89	<1.9 E-02	6.9 E-02	<1.2 E-01	<1.4 E-02	<1.8 E-02
05/24/89	<1.6 E-02	5.6 E-02	<1.0 E-02	<1.1 E-02	<1.3 E-02
06/21/89	<1.7 E-02	<2.5 E-02	<1.6 E-02	<1.6 E-02	<1.7 E-02
07/19/89	<1.2 E-02	1.7 E-02	<1.1 E-02	<1.0 E-02	<1.3 E-02
08/17/89	<1.5 E-02	5.8 E-02	<8.6 E-03	<1.4 E-02	<1.4 E-02
09/15/89	<1.7 E-02	<2.6 E-02	<1.3 E-02	<1.6 E-02	<1.7 E-02
11/08/89	<7.3 E-03	<9.0 E-03	<6.1 E-03	<8.0 E-03	<6.4 E-03
12/11/89	<1.4 E-02	<2.2 E-02	<1.1 E-02	<1.3 E-02	<1.6 E-02
01/12/90	<1.1 E-02	3.8 E-02	<1.1 E-02	<1.0 E-02	<1.2 E-02

\*Location identified in Figure 2-1.

Table C-6. Concentrations of Radionuclides Detected in 100-N Area Air Samples at Location A-5 (pCi/m<sup>3</sup>).

Date	Isotopes				
	<sup>54</sup> Mn	<sup>60</sup> Co	<sup>103</sup> Ru	<sup>131</sup> I	<sup>137</sup> Cs
Sample location* A-5					
12/11/89	<1.1 E-02	2.2 E-02	<1.0 E-02	<1.3 E-02	<1.2 E-02
01/12/90	<1.0 E-02	1.4 E-02	<9.3 E-03	<1.0 E-02	<1.2 E-02

\*Location identified in Figure 2-1.

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**APPENDIX D**  
**GROUNDWATER MONITORING**

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Table D-1. Concentrations of  $^3\text{H}$  Detected in 100-Area Groundwater (pCi/L) in 1989. (2 sheets)

Well	No. of Samples	Maximum	Minimum	Average	Std. Dev.
N-2	3	9.6 E+04	5.4 E+04	7.2 E+04	1.8 E+04
N-3	3	4.7 E+04	2.3 E+04	3.5 E+04	9.8 E+03
N-4	4	8.9 E+04	2.2 E+04	4.6 E+04	2.6 E+04
N-5	1	5.1 E+04	5.1 E+04	5.1 E+04	
N-6	1	8.9 E+03	8.9 E+03	8.9 E+03	
N-8T	52	1.1 E+05	3.2 E+04	5.9 E+04	2.1 E+04
N-14	5	9.3 E+04	3.5 E+04	4.9 E+04	2.2 E+04
N-16	2	3.0 E+03	1.1 E+03	2.1 E+03	9.5 E+02
N-17	1	1.9 E+04	1.9 E+04	1.9 E+04	
N-18	1	8.7 E+03	8.7 E+03	8.7 E+03	
N-20	1	1.0 E+03	1.0 E+03	1.0 E+03	
N-21	1	1.4 E+04	1.4 E+04	1.4 E+04	
N-22	1	2.8 E+03	2.8 E+03	2.8 E+03	
N-23	2	1.6 E+04	1.5 E+04	1.6 E+04	5.0 E+02
N-24	2	3.7 E+02	1.7 E+02	2.7 E+02	1.0 E+02
N-25	2	2.0 E+02	1.7 E+02	1.8 E+02	1.5 E+01
N-26	1	5.9 E+02	5.9 E+02	5.9 E+02	
N-27	3	1.9 E+05	7.9 E+03	7.9 E+04	7.9 E+04
N-28	1	8.5 E+03	8.5 E+03	8.5 E+03	0.0 E+00
N-29	3	6.7 E+04	4.9 E+03	3.7 E+04	2.5 E+04
N-31	5	2.2 E+05	1.1 E+04	8.6 E+04	7.4 E+04
N-32	4	1.6 E+05	7.8 E+03	6.7 E+04	5.8 E+04
N-33	5	1.7 E+05	1.1 E+04	8.2 E+04	7.0 E+04
N-36	4	2.1 E+05	6.4 E+03	8.0 E+04	7.7 E+04
N-37	1	8.5 E+03	8.5 E+03	8.5 E+03	
N-39	1	5.1 E+04	5.1 E+04	5.1 E+04	
N-50	1	9.3 E+04	9.3 E+04	9.3 E+04	
N-52	1	9.6 E+04	9.6 E+04	9.6 E+04	



Table D-2. Concentrations of <sup>60</sup>Co Detected  
in 100-Area Groundwater (pCi/L) in 1989.  
(2 sheets)

Well	No. of Samples	Maximum	Minimum	Average	Std. Dev.
N-2	4	6.0 E+01	<2.4 E+00	3.7 E+01	2.4 E+01
N-3	3	2.4 E+01	<1.1 E+01	1.8 E+01	5.4 E+00
N-4	5	5.1 E+01	1.5 E+01	3.3 E+01	1.1 E+01
N-5	2	6.4 E+01	1.9 E+01	4.2 E+01	2.3 E+01
N-6	2	2.4 E+01	1.7 E+01	2.1 E+01	3.5 E+00
N-8T	52	5.8 E+01	<3.6 E+00	3.7 E+01	1.3 E+01
N-14	7	5.5 E+01	1.1 E+01	2.8 E+01	1.7 E+01
N-16	3	6.4 E+00	<2.3 E+00	4.5 E+00	1.7 E+00
N-17	1	3.1 E+00	<3.1 E+00	3.1 E+00	
N-18	1	6.7 E+00	6.7 E+00	6.7 E+00	
N-19	1	5.5 E+01	5.5 E+01	5.5 E+01	
N-20	3	2.3 E+01	8.4 E+00	1.5 E+01	6.0 E+00
N-21	1	5.7 E+00	5.7 E+00	5.7 E+00	
N-22	2	5.8 E+00	<3.0 E+00	4.4 E+00	1.4 E+00
N-23	3	9.0 E+00	<1.8 E+00	4.4 E+00	3.2 E+00
N-24	3	1.1 E+01	<1.4 E+00	7.5 E+00	4.3 E+00
N-25	2	8.2 E+00	<4.6 E+00	6.4 E+00	1.8 E+00
N-26	1	4.7 E+00	<4.7 E+00	4.7 E+00	
N-27	3	3.3 E+01	2.0 E+01	2.8 E+01	5.6 E+00
N-28	2	5.7 E+01	1.8 E+01	3.8 E+01	2.0 E+01
N-29	3	3.3 E+01	<1.2 E+01	2.5 E+01	9.5 E+00
N-31	5	1.8 E+01	<8.7 E+00	1.2 E+01	3.3 E+00
N-32	6	7.0 E+01	1.7 E+01	2.9 E+01	1.9 E+01
N-33	5	3.3 E+01	1.3 E+01	2.3 E+01	7.8 E+00
N-36	4	2.2 E+01	1.6 E+01	1.9 E+01	2.5 E+00
N-37	2	2.1 E+01	1.8 E+01	2.0 E+01	1.5 E+00
N-39	2	2.1 E+01	1.7 E+01	1.9 E+01	2.0 E+00

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Table D-2. Concentrations of <sup>60</sup>Co Detected  
 in 100-Area Groundwater (pCi/L) in 1989.  
 (2 sheets)

Well	No. of Samples	Maximum	Minimum	Average	Std. Dev.
N-47	12	4.2 E+01	<1.4 E+01	2.1 E+01	8.1 E+00
N-48	12	3.5 E+01	<1.4 E+01	2.0 E+01	5.4 E+00
N-50	2	4.1 E+01	2.1 E+01	3.1 E+01	1.0 E+01
N-51	2	3.3 E+01	2.8 E+01	3.1 E+01	2.5 E+00
N-52	4	3.5 E+01	<9.7 E+00	1.8 E+01	9.8 E+00
N-70	4	5.1 E+01	1.5 E+01	2.8 E+01	1.4 E+01
K-27	3	1.3 E+01	4.1 E+00	9.7 E+00	4.0 E+00
K-28	3	1.2 E+01		8.8 E+00	2.7 E+00
K-29	3	1.3 E+01		1.0 E+01	2.9 E+00
K-30	3	7.8 E+00	<5.0 E+00	6.4 E+00	1.1 E+00

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Table D-3. Concentrations of <sup>90</sup>Sr Detected in 100-Area Groundwater (pCi/L) in 1989. (2 sheets)

Well	No. of Samples	Maximum	Minimum	Average	Std. Dev.
N-2	3	3.6 E+03	1.8 E+03	2.7 E+03	7.4 E+02
N-3	4	2.6 E+03	5.4 E+02	1.2 E+03	8.3 E+02
N-4	4	9.3 E+00	6.9 E+00	7.9 E+00	9.1 E-01
N-5	1	4.9 E+02	4.9 E+02	4.9 E+02	
N-6	1	4.1 E+01	4.1 E+01	4.1 E+01	
N-8T	51	8.1 E+03	4.4 E+03	5.9 E+03	9.7 E+02
N-14	5	1.1 E+03	1.0 E+03	1.1 E+03	4.9 E+01
N-16	2	<3.9 E-01	<2.5 E-01	<3.2 E-01	7.0 E-02
N-17	1	1.1 E+02	1.1 E+02	1.1 E+02	
N-18	1	4.2 E+02	4.2 E+02	4.2 E+02	
N-20	1	1.3 E+01	1.3 E+01	1.3 E+01	
N-21	1	3.2 E+00	3.2 E+00	3.2 E+00	
N-22	1	<3.9 E-01	<3.9 E-01	<3.9 E-01	
N-23	2	2.0 E+00	1.2 E+00	1.6 E+00	4.0 E-01
N-24	2	1.2 E+01	4.6 E+00	8.3 E+00	3.7 E+00
N-25	2	8.0 E+00	1.2 E-01	4.1 E+00	3.9 E+00
N-26	1	<4.8 E-01	<4.8 E-01	<4.8 E-01	
N-27	3	3.3 E+02	3.8 E+01	2.1 E+02	1.2 E+02
N-28	1	2.7 E+01	2.7 E+01	2.7 E+01	
N-29	3	1.8 E+03	5.9 E+02	1.4 E+03	5.5 E+02
N-31	5	6.1 E+01	3.7 E+01	5.3 E+01	8.7 E+00
N-32	4	2.0 E+02	1.1 E+01	6.6 E+01	7.8 E+01
N-33	4	2.9 E+02	2.1 E+02	2.4 E+02	3.1 E+01
N-36	4	2.2 E+02	6.6 E+01	1.6 E+02	5.7 E+01
N-37	1	5.8 E+01	5.8 E+01	5.8 E+01	
N-39	2	5.3 E+02	4.5 E+02	4.9 E+02	4.0 E+01
N-50	1	<1.7 E-01	<1.7 E-01	<1.7 E-01	1.2 E-09
N-51	1	<1.3 E-01	<1.3 E-01	<1.3 E-01	8.2 E-10



Table D-4. Concentrations of <sup>106</sup>Ru Detected in 100-Area Groundwater (pCi/L) in 1989. (2 sheets)

Well	No. of Samples	Maximum	Minimum	Average	Std. Dev.
N-2	4	<4.9 E+01	<1.1 E+01	<3.0 E+01	1.7 E+01
N-3	4	<4.5 E+01	<1.4 E+00	<1.5 E+01	1.8 E+01
N-4	5	<4.7 E+01	<4.6 E+00	<2.9 E+01	1.6 E+01
N-5	1	<3.7 E+01	<3.7 E+01	<3.7 E+01	
N-6	1	<2.8 E+01	<2.8 E+01	<2.8 E+01	
N-8T	51	<4.9 E+01	<3.7 E+01	<4.1 E+01	2.7 E+00
N-14	7	<4.5 E+01	<1.2 E+00	<2.0 E+01	1.8 E+01
N-16	3	<4.3 E+01	<4.1 E+00	<2.8 E+01	1.7 E+01
N-17	1	9.6 E+01	9.6 E+01	9.6 E+01	
N-18	1	<9.2 E-01	<9.2 E-01	<9.2 E-01	
N-20	3	5.2 E+01	3.9 E+01	4.6 E+01	5.3 E+00
N-21	1	<5.9 E+00	<5.9 E+00	<5.9 E+00	
N-22	2	<4.0 E+01	<9.4 E+00	<2.5 E+01	1.5 E+01
N-23	3	<3.6 E+01	<3.1 E+00	<1.6 E+01	1.4 E+01
N-24	3	<5.5 E+01	<8.4 E+00	<3.4 E+01	1.9 E+01
N-25	2	<3.6 E+01	<3.1 E+01	<3.4 E+01	2.5 E+00
N-26	1	<2.3 E+01	<2.3 E+01	<2.3 E+01	
N-27	3	<4.0 E+01	<1.6 E+01	<2.9 E+01	9.8 E+00
N-28	2	<5.4 E+01	<2.2 E+01	<3.8 E+01	1.6 E+01
N-29	3	<3.9 E+01	<1.2 E+00	<1.5 E+01	1.7 E+01
N-31	5	<4.8 E+01	<3.1 E+00	<2.2 E+01	1.8 E+01
N-32	6	<5.0 E+01	<1.2 E+01	<3.4 E+01	1.2 E+01
N-33	4	<6.5 E+01	<3.9 E+00	<4.3 E+01	2.3 E+01
N-36	4	<4.7 E+01	<4.0 E+00	<1.8 E+01	1.7 E+01
N-37	2	<4.4 E+01	<3.5 E+01	<4.0 E+01	4.5 E+00
N-39	2	<4.4 E+01	<4.2 E+01	<4.3 E+01	1.0 E+00
N-47	12	<1.3 E+02	<8.6 E+01	<1.1 E+02	1.4 E+01
N-48	12	<1.4 E+02	<9.8 E+01	<1.2 E+02	1.1 E+01

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Table D-4. Concentrations of <sup>106</sup>Ru Detected in 100-Area Groundwater (pCi/L) in 1989. (2 sheets)

Well	No. of Samples	Maximum	Minimum	Average	Std. Dev.
N-50	2	<5.2 E+01	<1.5 E+01	<3.4 E+01	1.9 E+01
N-51	2	<4.0 E+01	<8.9 E+00	<2.4 E+01	1.6 E+01
N-52	4	<8.7 E+01	<1.8 E+01	<4.4 E+01	2.7 E+01
N-70	4	<3.4 E+01	<1.0 E+00	<1.4 E+01	1.2 E+01
K-27	3	<4.7 E+01	<4.1 E+01	<4.4 E+01	2.4 E+00
K-28	3	<4.3 E+01	<3.9 E+01	<4.1 E+01	1.7 E+00
K-29	3	<4.3 E+01	<3.6 E+01	<4.0 E+01	2.9 E+00
K-30	3	<3.7 E+01	<2.5 E+01	<3.3 E+01	1.1 E+00

Table D-5. Concentrations of  $^{125}\text{Sb}$  Detected in 100-Area Groundwater (pCi/L) in 1989.

Well	No. of Samples	Maximum	Minimum	Average	Std. Dev.
N-2	1	2.2 E+01	2.2 E+01	2.2 E+01	
N-4	3	4.2 E+01	2.3 E+01	3.4 E+01	8.2 E+00
N-5	1	3.3 E+01	3.3 E+01	3.3 E+01	
N-6	1	6.8 E+01	6.8 E+01	6.8 E+01	
N-8T	52	4.9 E+01	<1.5 E+01	3.6 E+01	6.8 E+00
N-14	2	5.1 E+01	4.1 E+01	4.6 E+01	5.0 E+00
N-16	2	<1.3 E+01	<1.2 E+01	<1.3 E+01	5.0 E-01
N-19	1	1.4 E+01	1.4 E+01	1.4 E+01	
N-20	2	<1.4 E+01	<1.4 E+01	<1.4 E+01	
N-22	1	<1.3 E+01	<1.3 E+01	<1.3 E+01	
N-23	1	1.2 E+01	1.2 E+01	1.2 E+01	
N-24	2	1.3 E+01	7.5 E+00	1.0 E+01	2.8 E+00
N-25	1	<1.3 E+01	<1.3 E+01	<1.3 E+01	
N-28	1	3.2 E+01	3.2 E+01	3.2 E+01	
N-29	1	7.7 E+01	7.7 E+01	7.7 E+01	
N-32	2	9.3 E+01	2.4 E+01	5.9 E+01	3.5 E+01
N-33	1	8.2 E+01	8.2 E+01	8.2 E+01	
N-36	1	4.4 E+01	4.4 E+01	4.4 E+01	
N-37	1	5.5 E+01	5.5 E+01	5.5 E+01	
N-39	1	5.5 E+01	5.5 E+01	5.5 E+01	
N-47	12	<4.7 E+01	<3.2 E+01	<4.1 E+01	4.1 E+00
N-48	12	4.7 E+01	3.5 E+01	4.2 E+01	3.5 E+00
N-50	1	<1.4 E+01	<1.4 E+01	<1.4 E+01	
N-51	1	<1.3 E+01	<1.3 E+01	<1.3 E+01	
K-27	3	1.9 E+02	1.4 E+02	1.6 E+02	2.1 E+01
K-28	3	2.9 E+01	<2.3 E+01	2.7 E+01	2.8 E+00
K-29	3	<1.3 E+01	<1.2 E+01	<1.2 E+01	4.7 E-01
K-30	2	<1.2 E+01	<8.2 E+00	<1.0 E+01	1.9 E+00

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Table D-6. Concentrations of Oil and Grease Detected in 100-N Area Groundwater (mg/L). (3 sheets)

Date	N-16	N-17	N-18	N-19	N-20	N-21	N-22	N-23	N-24	N-25	N-26
01/03/89	1.2							<1.0		<1.0	<1.0
01/10/89		<1.0	<1.0						<1.0		
01/17/89				<1.0	<1.0					<1.0	
01/24/89						<1.0	*		<1.0		
01/31/89								<1.0		<1.0	<1.0
02/07/89	<1.0							1.0		<1.0	<1.0
02/14/89		<1.0	1.2						<1.0		
02/21/89				<1.0	<1.0					<1.0	
02/28/89						<1.0	<1.0				
03/07/89								<1.0		<1.0	<1.0
03/14/89	<1.0							<1.0		<1.0	<1.0
03/21/89		<1.0	1.2						<1.0		
03/28/89				<1.0	<1.0					<1.0	
04/04/89						<1.0	*		<1.0		
04/11/89								<1.0		<1.0	<1.0
04/19/89	3.0							<1.0		<1.0	<1.0
04/25/89									<1.0		
04/28/89		<1.0	<1.0								
05/01/89	<1.0	<1.0									
05/02/89	<1.0	<1.0			<1.0					<1.0	
05/03/89	1.6	<1.0		<1.0							
05/04/89	1.9	<1.0									
05/05/89	1.1	2.4									
05/06/89	1.1	2.4									
05/07/89	1.1	4.1									
05/08/89	5.7	4.2									
05/09/89	<1.0	1.2				<1.0	*		<1.0		
05/10/89	4.0	3.1									

Table D-6. Concentrations of Oil and Grease Detected in 100-N Area Groundwater (mg/L). (3 sheets)

Date	N-16	N-17	N-18	N-19	N-20	N-21	N-22	N-23	N-24	N-25	N-26
05/11/89	1.7	2.2									
05/12/89	2.8	1.1									
05/13/89	1.9	1.0									
05/14/89	2.4	1.1									
05/15/89	3.0	1.8									
05/16/89	3.2	<1.0						<1.0		1.5	1.5
05/17/89	2.8	2.5									
05/18/89	2.8	1.1									
05/19/89	<1.0	<1.0									
05/20/89	1.3	<1.0									
05/21/89	<1.0	<1.0									
05/22/89	<1.0	<1.0									
05/23/89	<1.0	<1.0						1.1		<1.0	<1.0
05/24/89	<1.0	<1.0									
05/25/89	<1.0	2.0									
05/26/89	1.2	<1.0									
05/27/89	1.5	1.1									
05/30/89	1.0	<1.0	<1.0						<1.0		
05/31/89	1.0	1.0									
06/01/89	<1.0	1.4									
06/06/89				<1.0	<1.0					<1.0	
06/13/89						<1.0	*		<1.0		
06/20/89								<1.0		<1.0	<1.0
06/27/89	1.7							<1.0		3.4	<1.0
07/12/89		<1.0	1.6								
07/19/89						<1.0	*		<1.0		
07/26/89								3.2		<1.0	<1.0
08/01/89	<1.0							<1.0		<1.0	<1.0

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Table D-6. Concentrations of Oil and Grease Detected in 100-N Area Groundwater (mg/L). (3 sheets)

Date	N-16	N-17	N-18	N-19	N-20	N-21	N-22	N-23	N-24	N-25	N-26
08/08/89		<1.0	1.5						<1.0		
08/15/89				<1.0	<1.0					<1.0	
08/22/89						<1.0	*		<1.0		
08/29/89								<1.0		<1.0	<1.0
09/05/89	<1.0							1.3		<1.0	<1.0
09/12/89		<1.0	3.8						<1.0		
09/19/89				<1.0	<1.0					<1.0	
09/26/89						<1.0	*		4.8		
10/03/89								<1.0		1.2	<1.0
10/10/89	2.4							<1.0		2.2	<1.0
10/17/89		2.8	6.6						<1.0		
10/24/89				<1.0	<1.0					<1.0	
10/31/89						<1.0	*		<1.0		
11/07/89								3.1	3.4		5.0
11/14/89	2.7							<1.0		1.9	<1.0
11/21/89		1.2	2.1						1.6		
11/28/89				1.2	1.0					1.0	
12/05/89						1.1	*		<1.0		
12/12/89								<1.0		<1.0	<1.0
12/19/89	3.2							<1.0		<1.0	<1.0
12/27/89		<1.0	1.5						<1.0		
# Samples	40	40	11	9	9	10	1	21	20	29	21
Maximum	5.7	4.2	6.6	1.2	1.0	1.1	<1.0	3.2	4.8	3.4	5.0
Minimum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Average	1.8	1.5	2.0	1.0	1.0	1.0	<1.0	1.2	1.3	1.2	1.2
Stan.Dev.	1.1	0.8	1.6	0.1	0.0	0.0		0.6	1.0	0.5	0.9

Locations identified in Figure 3-1.

\*No available sample - well dry.

Table D-7. Average Radionuclide Concentrations Detected in Well K-27\* from 1982 through 1989 (pCi/L).

Year	<sup>60</sup> Co	<sup>103</sup> Ru	<sup>124</sup> Sb	<sup>125</sup> Sb
1982	1.4 E+00	NR	1.1 E+02	1.0 E+02
1983	7.3 E+00	NR	NR	6.4 E+02
1984	9.7 E+00	NR	NR	5.2 E+02
1985	1.4 E+01	3.1 E+00	NR	4.0 E+02
1986	6.6 E+00	6.8 E+00	<8.7 E+00	3.3 E+02
1987	5.0 E+00	<8.0 E+00	<8.8 E+00	4.2 E+02
1988	8.0 E+00	<7.0 E+00	<8.9 E+00	2.0 E+02
1989	9.7 E+00	<1.4 E+01	<1.4 E+01	1.6 E+02
D.C.G.	5.0 E+03	5.0 E+04	2.0 E+04	6.0 E+04

\*Location identified in Figure 3-4.  
 NR = Not reported.

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APPENDIX E  
SOIL AND VEGETATION MONITORING

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Table E-1. Concentrations of Radionuclides Detected in Surface Soil Samples Near the 1301-N Liquid Waste Disposal Facility (pCi/g, dry weight).

Sample Location*	Sample Type	Isotopes					
		<sup>54</sup> Mn	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
N-1	S	<5.1 E-02	2.7 E+00	5.4 E-02	3.4 E-01	3.2 E-05	8.8 E-03
N-2	S	<6.5 E-02	2.3 E+00	2.5 E-01	8.5 E-01	2.8 E-03	1.6 E-03
N-3	S	1.3 E-01	5.9 E+00	2.2 E-01	5.6 E-01	2.8 E-02	1.7 E-01
N-4	S	<3.8 E-02	3.1 E-01	1.7 E-01	5.3 E-01	7.1 E-04	1.6 E-02
N-5	S	4.3 E-02	3.3 E-01	3.8 E-02	2.1 E-01	2.3 E-04	3.3 E-03
Average		6.5 E-02	2.3 E+00	1.5 E-01	5.0 E-01	6.4 E-03	4.0 E-02
Std. Dev.		3.4 E-02	2.0 E+00	8.6 E-02	2.2 E-01	1.1 E-02	6.5 E-02
Hanford Site**		NR	NR	3.1 E-01	2.9 E-00	NR	1.0 E-01
Offsite**		NR	NR	1.6 E-01	5.9 E-01	NR	1.0 E-02

NR = Not reported.  
 \*Locations identified in Figure 4-1.  
 \*\*Average values obtained from Pacific Northwest Laboratory (PNL)-6825.

Table E-2. Concentrations of Radionuclides Detected in 100-N Surface Soil Samples (pCi/g, dry weight).

Sample Location*	Sample Type	Isotopes					
		<sup>54</sup> Mn	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
N-6	S	<4.1 E-02	1.5 E-01	1.3 E-01	8.8 E-02	3.4 E-04	6.4 E-03
N-7	S	<3.3 E-02	8.9 E-02	1.9 E-01	3.0 E-01	5.1 E-04	2.7 E-02
N-8	S	<4.9 E-02	2.3 E-01	3.4 E-01	2.0 E-01	5.7 E-03	4.3 E-02
N-9	S	<3.6 E-02	4.4 E-02	6.6 E-01	5.9 E-02	5.3 E-04	7.0 E-03
N-10	S	<4.6 E-02	<6.6 E-02	8.2 E-02	<6.3 E-02	3.3 E-04	6.2 E-03
N-11	S	<4.2 E-02	2.5 E-01	4.2 E-02	1.7 E-01	1.3 E-04	2.5 E-03
N-12	S	<4.6 E-02	1.4 E-01	1.3 E-02	3.9 E-02	<3.2 E-05	7.3 E-04
Average		<4.2 E-02	1.4 E-01	2.1 E-01	1.3 E-01	1.1 E-03	1.3 E-02
Std. Dev.		5.3 E-03	7.3 E-02	2.1 E-01	8.9 E-02	1.9 E-03	1.5 E-02
Hanford Site**		NR	NR	3.1 E-01	2.9 E+00	NR	1.0 E-01
Offsite**		NR	NR	1.6 E-01	5.9 E-01	NR	1.0 E-02

NR = Not reported.  
 \*Location identified in Figure 4-1.  
 \*\*Average values obtained from Pacific Northwest Laboratory (PNL)-6825.

Table E-3. Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-B/C Area Surface Soil Samples.

Sample location*	Sample Type	Isotopes				
		<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
B-1	S	9.9 E-02	9.0 E-03	4.6 E-02	3.2 E-05	1.7 E-03
B-2	S	2.3 E-01	2.2 E-01	9.9 E-01	5.7 E-04	2.5 E-02
C-1	S	2.1 E-01	4.6 E-01	1.0 E+00	3.0 E-03	1.2 E-01
C-2	S	5.0 E-01	7.0 E-01	1.0 E+00	2.0 E-03	7.4 E-02
Average		2.6 E-01	3.5 E-01	7.6 E-01	6.2 E-04	5.5 E-02
Std. Dev.		1.5 E-01	2.6 E-01	4.1 E-01	1.2 E-03	4.6 E-02
Hanford Site**		NR	3.1 E-01	2.9 E+00	NR	1.0 E-01
Offsite**		NR	1.6 E-01	5.9 E-01	NR	1.0 E-02

NR = Not reported.

\*Locations identified in Figure 4-2.

\*\*Average values obtained from Pacific Northwest Laboratory (PNL)-6825.

Table E-4. Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-D/DR Area Surface Soil Samples.

Sample location*	Sample type	Isotopes				
		<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
D-1	S	9.3 E-02	5.5 E-02	1.9 E-01	4.3 E-04	6.5 E-03
D-2	S	3.3 E-01	1.3 E-01	1.1 E+00	8.5 E-04	2.6 E-02
D-3	S	3.0 E-01	4.8 E-02	1.9 E-01	1.3 E-04	9.1 E-03
D-4	S	1.4 E-01	1.2 E-01	1.2 E+00	1.9 E-04	1.4 E-02
Average		2.2 E-01	8.8 E-02	6.7 E-01	6.2 E-04	1.4 E-02
Std. Dev.		1.0 E-01	3.7 E-02	4.8 E-01	2.8 E-04	7.5 E-03
Hanford Site**		NR	3.1 E-01	2.9 E+00	NR	1.0 E-01
Offsite**		NR	1.6 E-01	5.9 E-01	NR	1.0 E-02

NR = Not reported.

\*Locations identified in Figure 4-3.

\*\*Average values obtained from Pacific Northwest Laboratory (PNL)-6825.

Table E-5. Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-F Area Surface Soil Samples.

Sample Location*	Sample Type	Isotopes				
		<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
F-1	S	1.2 E-01	2.0 E-01	8.4 E-02	2.8 E-04	2.0 E-02
F-2	S	2.2 E-01	7.6 E-02	1.0 E-01	3.5 E-04	8.5 E-03
F-3	S	1.0 E-01	9.5 E-02	7.5 E-01	2.3 E-04	7.8 E-03
F-4	S	1.3 E-01	2.1 E-02	9.9 E-02	<3.2 E-05	1.8 E-03
F-5	S	7.4 E-02	1.7 E-01	1.1 E+00	3.1 E-03	2.6 E-02
Average		1.3 E-01	1.1 E-01	4.3 E-01	8.0 E-04	1.3 E-02
Std. Dev.		4.9 E-02	6.5 E-02	4.2 E-01	1.2 E-03	8.8 E-03
Hanford Site**		NR	3.1 E-01	2.9 E+00	NR	1.0 E-01
Offsite**		NR	1.6 E-01	5.9 E-01	NR	1.0 E-02

NR = Not reported.

\*Locations identified in Figure 4-4.

\*\*Average values obtained from Pacific Northwest Laboratory (PNL)-6825.

Table E-6. Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-H Area Surface Soil Samples.

Sample Location*	Sample Type	Isotopes				
		<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
H-1	S	2.5 E-01	4.3 E-02	4.5 E-01	1.6 E-03	7.0 E-03
H-2	S	1.4 E-01	5.7 E-02	6.0 E-01	2.3 E-04	5.9 E-03
Average		2.0 E-01	5.0 E-02	5.3 E-01	9.2 E-04	6.5 E-03
Std. Dev.		5.5 E-02	7.0 E-03	7.5 E-02	6.9 E-04	5.5 E-04
Hanford Site**		NR	3.1 E-01	2.9 E+00	NR	1.0 E-01
Offsite**		NR	1.6 E-01	5.9 E-01	NR	1.0 E-02

NR = Not reported.

\*Locations identified in Figure 4-5.

\*\*Average values obtained from Pacific Northwest Laboratory (PNL)-6825.

Table E-7. Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-K Area Surface Soil Samples.

Sample Location*	Sample Type	Isotopes				
		<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
K-1	S	3.3 E+00	1.8 E+00	3.6 E+01	1.3 E-02	3.5 E-01
K-2	S	1.6 E-01	7.4 E-01	2.8 E-01	2.4 E-04	1.1 E-02
K-3	S	2.1 E-01	3.8 E-01	6.5 E-01	4.8 E-04	1.5 E-02
K-4	S	<4.9 E-02	1.0 E-01	2.7 E-01	6.0 E-05	5.7 E-03
K-5	S	1.1 E-0	1.1 E-01	2.6 E-01	3.3 E-04	1.0 E-02
Average		7.7 E-01	6.3 E-01	7.5 E+00	2.8 E-03	7.8 E-02
Std. Dev.		1.3 E+00	6.3 E-01	1.4 E+01	5.1 E-03	1.4 E-01
Hanford Site**		NR	3.1 E-01	2.9 E+00	NR	1.0 E-01
Offsite**		NR	1.6 E-01	5.9 E-01	NR	1.0 E-02

NR = Not reported.

\*Locations identified in Figure 4-6.

\*\*Average values obtained from Pacific Northwest Laboratory (PNL)-6825.

Table E-8. Radionuclide Concentrations (pCi/g, dry weight) Detected in Vegetation Samples Near the 1301-N LWDF.

Sample Location*	Sample Type	<sup>54</sup> Mn	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
N-1	V	<1.9 E-01	5.7 E-01	2.2 E-02	<1.8 E-01	1.9 E-04	9.2 E-04
N-2	V	<1.0 E-01	4.3 E+00	4.8 E-02	2.0 E-01	5.7 E-04	5.0 E-03
N-3	V	<9.0 E-02	9.4 E-01	8.3 E-02	6.6 E-02	4.1 E-04	3.3 E-03
N-4	V	<8.7 E-02	4.4 E-01	2.8 E-02	2.4 E-01	<4.0 E-06	4.9 E-04
N-5	V	<1.0 E-01	3.9 E-01	9.2 E-03	7.5 E-02	2.4 E-04	3.9 E-04
Average		<1.1 E-01	1.3 E+00	3.8 E-02	1.5 E-01	2.8 E-04	2.0 E-03
Std. Dev.		3.9 E-02	1.5 E+00	2.6 E-02	7.0 E-02	1.9 E-04	1.8 E-03
Hanford Site**		NR	NR	6.2 E-02	3.3 E-02	NR	7.1 E-04
Offsite**		NR	NR	3.5 E-02	1.1 E-02	NR	2.6 E-04

NR = Not reported.

\*Locations identified in Figure 4-7.

\*\*Average values obtained from Pacific Northwest Laboratory (PNL)-6825.

Table E-9. Radionuclide Concentrations (pCi/g, dry weight)  
Detected in 100-N Vegetation Samples.

Sample Location*	Sample Type	<sup>54</sup> Mn	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
N-6	V	<7.1 E-02	2.8 E-01	1.3 E-02	5.0 E-01	3.4 E-04	8.9 E-04
N-7	V	<8.7 E-02	2.0 E-01	1.0 E-01	1.2 E-01	6.9 E-05	1.2 E-03
N-8	V	<6.3 E-02	2.6 E-01	3.1 E-02	8.9 E-02	9.5 E-05	1.2 E-03
N-9	V	<9.4 E-02	2.9 E-01	1.9 E-01	<9.4 E-02	<8.5 E-06	9.3 E-04
N-10	V	<6.9 E-02	1.6 E-01	5.2 E-02	6.6 E-02	<4.8 E-05	8.2 E-04
N-11	V	<7.3 E-02	7.5 E-01	6.5 E-02	<7.3 E-02	<8.5 E-06	1.0 E-03
N-12	V	<9.1 E-02	2.9 E-01	2.7 E-02	<8.0 E-02	2.0 E-04	4.4 E-05
Average		<7.8 E-02	3.2 E-01	6.8 E-02	1.5 E-01	1.1 E-04	8.7 E-04
Std. Dev.		1.1 E-02	1.8 E-01	5.6 E-02	1.5 E-01	1.1 E-04	3.6 E-04
Hanford Site**		NR	NR	6.2 E-02	3.3 E-02	NR	7.1 E-04
Offsite**		NR	NR	3.5 E-02	1.1 E-02	NR	2.6 E-04

NR = Not reported.

\*Locations identified in Figure 4-7.

\*\*Average values obtained from Pacific Northwest Laboratory (PNL)-6825.

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Table E-10. Radionuclide Concentrations (pCi/g, dry weight) Detected in N-Springs Vegetation Samples.

Sample Location*	Sample Type	<sup>54</sup> Mn	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
NS-1	V	<4.5 E-02	3.3 E-01	1.5 E+02	<5.0 E-02	<1.7 E-05	6.8 E-04
NS-2	V	<4.0 E-02	1.6 E-01	3.3 E+02	7.9 E-02	1.3 E-04	5.5 E-04
NS-3	V	<8.8 E-02	1.1 E-01	7.8 E+01	1.8 E-01	1.9 E-04	2.0 E-04
NS-4	V	<2.1 E-01	5.8 E-01	2.4 E+00	2.2 E-01	8.3 E-03	1.1 E-04
NS-5	V	NR	NR	1.2 E+01	NR	1.8 E-04	2.8 E-04
NS-6	V	<1.6 E-01	7.3 E-01	3.3 E+01	<1.5 E-01	<1.6 E-05	1.8 E-04
NS-7	V	<2.8 E-01	8.3 E-01	2.9 E+01	<2.6 E-01	<6.0 E-05	<8.1 E-04
NS-8	V	<1.2 E-01	2.7 E-01	5.0 E+00	<1.2 E-01	<8.5 E-06	7.8 E-04
Average		<1.3 E-01	4.3 E-01	8.0 E+01	1.5 E-01	1.1 E-03	4.5 E-04
Std. Dev.		8.2 E-02	2.6 E-01	1.1 E+02	7.0 E-02	2.7 E-03	2.7 E-04
Hanford Site**		NR	NR	6.2 E-02	3.3 E-02	NR	7.1 E-04
Offsite**		NR	NR	3.5 E-02	1.1 E-02	NR	2.6 E-04

NR = Not reported.

\*Locations identified in Figure 4-7.

\*\*Average values obtained from Pacific Northwest Laboratory (PNL)-6825.

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Table E-11. Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-B/C Area Vegetation Samples.

Sample Location*	Sample Type	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
B-1	V	1.0 E-01	4.8 E-02	<1.4 E-01	<6.6 E-05	<2.1 E-05
B-2	V	3.1 E-01	6.6 E-02	1.7 E-01	8.5 E-06	3.6 E-04
C-1	V	4.9 E-01	4.1 E-01	2.9 E-01	1.2 E-04	9.2 E-05
C-2	V	3.9 E-01	1.3 E-01	1.2 E-01	6.5 E-05	4.9 E-04
Average		3.2 E-01	1.6 E-01	1.8 E-01	6.5 E-05	2.4 E-04
Std. Dev.		1.4 E-01	1.5 E-01	6.6 E-02	3.9 E-05	1.9 E-04
Hanford Site**		NR	6.2 E-02	3.3 E-02	NR	7.1 E-04
Offsite**		NR	3.5 E-02	1.1 E-02	NR	2.6 E-04

NR = Not reported.

\*Locations identified in Figure 4-2.

\*\*Average values obtained from Pacific Northwest Laboratory (PNL)-6825.

Table E-12. Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-D/DR Area Vegetation Samples.

Sample Location*	Sample Type	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
D-1	V	4.5 E-01	1.6 E-02	<1.4 E-01	6.4 E-05	2.0 E-04
D-2	V	2.1 E-01	<2.6 E-03	1.4 E-01	1.2 E-04	<2.2 E-05
D-3	V	2.6 E-01	7.3 E-02	1.6 E-01	<4.1 E-05	<2.1 E-05
D-4	V	1.0 E-01	4.9 E-01	6.7 E-01	1.6 E-04	2.3 E-04
Average		2.6 E-01	1.5 E-01	2.8 E-01	9.6 E-05	1.2 E-04
Std. Dev.		1.3 E-01	2.0 E-01	2.3 E-01	4.7 E-05	9.7 E-05
Hanford Site**		NR	6.2 E-02	3.3 E-02	NR	7.1 E-04
Offsite**		NR	3.5 E-02	1.1 E-02	NR	2.6 E-04

NR = Not reported.

\*Locations identified in Figure 4-3.

\*\*Average values obtained from Pacific Northwest Laboratory (PNL)-6825.

Table E-13. Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-F Area Vegetation Samples.

Sample Location*	Sample Type	<sup>30</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
F-1	V	2.9 E-01	2.0 E-01	<1.5 E-01	7.7 E-05	<8.9 E-05
F-2	V	2.8 E-01	1.6 E-01	9.2 E+00	1.0 E-04	<2.5 E-05
F-3	V	1.1 E-01	1.0 E-01	<1.3 E-01	<8.5 E-06	3.1 E-04
F-4	V	1.7 E-01	1.1 E-02	<1.4 E-01	<8.5 E-06	7.7 E-05
F-5	V	5.6 E-01	1.1 E-02	<2.2 E-01	6.8 E-05	2.1 E-04
Average		2.8 E-01	9.6 E-02	2.0 E+00	5.2 E-05	1.4 E-04
Std. Dev.		1.5 E-01	7.7 E-02	3.6 E+00	3.7 E-05	1.0 E-04
Hanford Site**		NR	6.2 E-02	3.3 E-02	NR	7.1 E-04
Offsite**		NR	3.5 E-02	1.1 E-02	NR	2.6 E-04

NR = Not reported.

\*Locations identified in Figure 4-4.

\*\*Average values obtained from Pacific Northwest Laboratory (PNL)-6825.

Table E-14. Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-H Area Vegetation Samples.

Sample Location*	Sample Type	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
H-1	V	4.8 E-01	8.3 E-02	1.8 E-01	<4.9 E-05	9.5 E-05
H-2	V	8.2 E-01	2.0 E-02	<2.4 E-01	1.2 E-04	2.1 E-04
Average		6.5 E-01	5.2 E-02	2.1 E-01	8.5 E-05	1.5 E-04
Std. Dev.		1.7 E-01	3.2 E-02	3.0 E-02	3.6 E-05	5.8 E-05
Hanford Site**		NR	6.2 E-02	3.3 E-02	NR	7.1 E-04
Offsite**		NR	3.5 E-02	1.1 E-02	NR	2.6 E-04

NR = Not reported.

\*Locations identified in Figure 4-5.

\*\*Average values obtained from Pacific Northwest Laboratory (PNL)-6825.

Table E-15. Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-K Area Vegetation Samples.

Sample Location*	Sample Type	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu
K-1	V	5.3 E-01	4.7 E-02	<1.2 E-01	1.1 E-04	4.5 E-04
K-2	V	4.6 E-01	5.1 E+00	2.9 E-01	<8.5 E-06	3.8 E-05
K-3	V	1.7 E-01	3.5 E-01	<1.2 E-01	2.0 E-04	<2.1 E-05
K-4	V	1.3 E-01	8.0 E-01	<1.2 E-01	6.5 E-05	9.3 E-05
K-5	V	2.7 E-01	1.9 E-02	<1.4 E-01	1.7 E-04	1.5 E-04
Average		3.1 E-01	1.3 E+00	1.6 E-01	1.1 E-04	1.5 E-04
Std. Dev.		1.6 E-01	1.9 E+00	6.6 E-02	6.9 E-05	1.6 E-04
Hanford Site**		NR	6.2 E-02	3.3 E-02	NR	7.1 E-04
Offsite**		NR	3.5 E-02	1.1 E-02	NR	2.6 E-04

NR = Not reported.

\*Locations identified in Figure 4-6.

\*\*Average values obtained from Pacific Northwest Laboratory (PNL)-6825.

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APPENDIX F  
EXTERNAL RADIATION MONITORING

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Table F-1. The 1989 Thermoluminescent Dosimeter Results from 100-N Area. (2 sheets)

Location <sup>a</sup>	Number of Samples	Dose Rate - mrem/hr <sup>b</sup>			mrem/work year <sup>c</sup>
		Maximum	Minimum	Average	
1 RA	12	0.103	0.061	0.081	169
2 RA	11	0.124	0.067	0.092	191
3 RA	12	0.066	0.030	0.050	103
4 RA	12	0.321	0.147	0.222	462
5 RA	12	0.104	0.057	0.080	166
6 RA	11	0.051	0.021	0.033	69
7 RA	12	0.285	0.103	0.144	300
8	12	0.017	0.001	0.008	16
9	12	0.015	0.001	0.006	13
10	12	0.013	0.003	0.007	15
11	12	0.011	0.004	0.008	16
12	12	0.013	0.004	0.008	17
13	12	0.015	0.006	0.012	25
14	12	0.067	0.045	0.053	109
15 RA	12	0.130	0.061	0.091	190
16	12	0.042	0.025	0.035	73
17	12	0.007	0.001	0.005	11
18 RA	12	0.083	0.043	0.063	132
19	12	0.185	0.008	0.119	248
20	12	0.008	0.001	0.006	12
21	12	0.064	0.033	0.050	105
22 RA	12	0.089	0.047	0.069	143
23	12	0.007	0.003	0.005	10
24	12	0.009	0.001	0.006	12
25	12	0.009	0.001	0.006	13
26	12	0.033	0.018	0.025	52
27	12	0.013	0.002	0.010	21
28 RA	12	0.061	0.035	0.045	93

Table F-1. The 1989 Thermoluminescent Dosimeter Results from 100-N Area. (2 sheets)

Location <sup>a</sup>	Number of Samples	Dose Rate - mrem/hr <sup>b</sup>			mrem/work year <sup>c</sup>
		Maximum	Minimum	Average	
29 RA	12	0.730	0.204	0.301	626
30 RA	12	0.358	0.021	0.170	353
31	12	0.040	0.029	0.033	69
32	12	0.079	0.049	0.062	128
33	12	0.041	0.023	0.031	65
34 RA	12	0.788	0.030	0.313	651
35 RA	12	0.726	0.036	0.297	618
36 RA	12	0.039	0.016	0.027	56
37	12	0.058	0.041	0.048	100
38	11	0.065	0.040	0.051	106
39	12	0.047	0.020	0.031	64
40	12	0.047	0.023	0.038	80
41	11	0.061	0.040	0.050	104
ALARA guideline for occupational exposure to nonradiation zone workers					240

<sup>a</sup>Locations identified in Figure 5-1.

<sup>b</sup>Monthly integrated readings in mrem were converted to hourly dose equivalent rates.

<sup>c</sup>Monthly integrated readings in mrem were converted to work year dose equivalent rates.

RA = Area controlled as a radiation area

ALARA = as low as reasonably achievable

Table F-2. The 1989 Monthly Thermoluminescent Dosimeter Results From 100-N Area. (4 sheets)

Date	Thermoluminescent Dosimeter Location (mrem/hr)*										
	1	2	3	4	5	6	7	8	9	10	11
06-Jan-89 to 10-Feb-89	0.091	NR	0.057	0.281	0.100	0.050	0.285	0.007	0.007	0.008	0.008
10-Feb-89 to 03-Mar-89	0.070	0.085	0.030	0.147	0.057	0.021	0.218	0.007	0.008	0.004	0.006
03-Mar-89 to 31-Mar-89	0.084	0.110	0.066	0.317	0.102	0.040	0.118	0.005	0.005	0.007	0.007
31-Mar-89 to 05-May-89	0.061	0.071	0.039	0.159	0.058	0.024	0.113	0.005	0.005	0.006	0.006
05-May-89 to 26-May-89	0.103	0.116	0.055	0.321	0.088	0.029	0.152	0.008	0.004	0.013	0.011
26-May-89 to 23-Jun-89	0.063	0.067	0.039	0.163	0.084	0.034	0.134	0.017	0.015	0.010	0.011
23-Jun-89 to 28-Jul-89	0.081	0.091	0.061	0.234	0.088	NR	0.117	0.009	0.008	0.010	0.010
28-Jul-89 to 18-Aug-89	0.074	0.087	0.050	0.232	0.081	0.030	0.104	0.001	0.001	0.003	0.004
18-Aug-89 to 15-Sep-89	0.069	0.074	0.044	0.172	0.060	0.030	0.129	0.005	0.006	0.006	0.008
15-Sep-89 to 13-Oct-89	0.099	0.124	0.063	0.286	0.104	0.051	0.130	0.007	0.004	0.005	0.007
13-Oct-89 to 10-Nov-89	0.087	0.094	0.042	0.166	0.058	0.029	0.125	0.008	0.007	0.008	0.008
10-Nov-89 to 22-Dec-89	0.090	0.089	0.049	0.190	0.076	0.030	0.103	0.014	0.007	0.007	0.007
No. of samples	12	11	12	12	12	11	12	12	12	12	12
Maximum	0.103	0.124	0.066	0.321	0.104	0.051	0.285	0.017	0.015	0.013	0.011
Minimum	0.061	0.067	0.030	0.147	0.057	0.021	0.103	0.001	0.001	0.003	0.004
Average	0.081	0.092	0.050	0.222	0.080	0.033	0.144	0.008	0.006	0.007	0.008

Table F-2. The 1989 Monthly Thermoluminescent Dosimeter Results From 100-N Area. (4 sheets)

Date	Thermoluminescent Dosimeter Location (mrem/hr)*										
	12	13	14	15	16	17	18	19	20	21	22
06-Jan-89 to 10-Feb-89	0.007	0.014	0.064	0.108	0.041	0.006	0.081	0.013	0.005	0.064	0.081
10-Feb-89 to 03-Mar-89	0.008	0.011	0.046	0.064	0.031	0.006	0.071	0.014	0.005	0.047	0.047
03-Mar-89 to 31-Mar-89	0.009	0.012	0.067	0.130	0.042	0.005	0.076	0.016	0.005	0.057	0.089
31-Mar-89 to 05-May-89	0.008	0.010	0.045	0.067	0.026	0.003	0.050	0.008	0.004	0.037	0.049
05-May-89 to 26-May-89	0.013	0.015	0.061	0.112	0.041	0.005	0.072	0.168	0.006	0.063	0.088
26-May-89 to 23-Jun-89	0.011	0.014	0.051	0.076	0.035	0.007	0.053	0.185	0.008	0.044	0.056
23-Jun-89 to 28-Jul-89	0.007	0.015	0.053	0.101	0.038	0.006	0.064	0.171	0.006	0.054	0.082
28-Jul-89 to 18-Aug-89	0.004	0.006	0.048	0.098	0.031	0.001	0.052	0.164	0.001	0.049	0.066
18-Aug-89 to 15-Sep-89	0.006	0.010	0.047	0.075	0.033	0.005	0.045	0.185	0.007	0.045	0.060
15-Sep-89 to 13-Oct-89	0.004	0.012	0.051	0.109	0.039	0.004	0.083	0.162	0.006	0.064	0.081
13-Oct-89 to 10-Nov-89	0.008	0.014	0.045	0.061	0.025	0.006	0.043	0.173	0.007	0.033	0.056
10-Nov-89 to 22-Dec-89	0.013	0.014	0.052	0.098	0.040	0.006	0.071	0.173	0.007	0.047	0.072
No. of samples	12	12	12	12	12	12	12	12	12	12	12
Maximum	0.013	0.015	0.067	0.130	0.042	0.007	0.083	0.185	0.008	0.064	0.089
Minimum	0.004	0.006	0.045	0.061	0.025	0.001	0.043	0.008	0.001	0.033	0.047
Average	0.008	0.012	0.053	0.091	0.035	0.005	0.063	0.119	0.006	0.050	0.069

Table F-2. The 1989 Monthly Thermoluminescent Dosimeter Results From 100-N Area. (4 sheets)

Date	Thermoluminescent Dosimeter Location (mrem/hr)*										
	23	24	25	26	27	28	29	30	31	32	33
06-Jan-89 to 10-Feb-89	0.005	0.005	0.006	0.027	0.007	0.059	0.730	0.176	0.035	0.067	0.038
10-Feb-89 to 03-Mar-89	0.005	0.006	0.004	0.020	0.010	0.056	0.600	0.185	0.033	0.059	0.028
03-Mar-89 to 31-Mar-89	0.003	0.005	0.006	0.033	0.011	0.047	0.227	0.057	0.033	0.079	0.033
31-Mar-89 to 05-May-89	0.005	0.008	0.006	0.021	0.010	0.061	0.271	0.129	0.030	0.049	0.023
05-May-89 to 26-May-89	0.004	0.005	0.007	0.029	0.012	0.036	0.229	0.262	0.037	0.067	0.034
26-May-89 to 23-Jun-89	0.006	0.009	0.008	0.021	0.010	0.042	0.229	0.021	0.029	0.052	0.026
23-Jun-89 to 28-Jul-89	0.004	0.008	0.008	0.028	0.013	0.043	0.210	0.026	0.034	0.064	0.033
28-Jul-89 to 18-Aug-89	0.005	0.001	0.001	0.022	0.002	0.038	0.228	0.131	0.029	0.061	0.033
18-Aug-89 to 15-Sep-89	0.006	0.007	0.009	0.021	0.012	0.043	0.245	0.087	0.034	0.053	0.028
15-Sep-89 to 13-Oct-89	0.006	0.005	0.007	0.032	0.013	0.035	0.222	0.272	0.040	0.076	0.041
13-Oct-89 to 10-Nov-89	0.007	0.006	0.007	0.018	0.009	0.037	0.217	0.358	0.030	0.049	0.025
10-Nov-89 to 22-Dec-89	0.004	0.006	0.007	0.026	0.011	0.037	0.204	0.335	0.032	0.062	0.031
No. of samples	12	12	12	12	12	12	12	12	12	12	12
Maximum	0.007	0.009	0.009	0.033	0.013	0.061	0.730	0.358	0.040	0.079	0.041
Minimum	0.003	0.001	0.001	0.018	0.002	0.035	0.204	0.021	0.029	0.049	0.023
Average	0.005	0.006	0.006	0.025	0.010	0.045	0.301	0.170	0.033	0.062	0.031

Table F-2. The 1989 Monthly ThermoLuminescent Dosimeter Results From 100-N Area. (4 sheets)

Date	Thermoluminescent Dosimeter Location (mrem/hr)*							
	34	35	36	37	38	39	40	41
06-Jan-89 to 10-Feb-89	0.334	0.272	0.032	0.056	0.055	0.044	0.046	0.056
10-Feb-89 to 03-Mar-89	0.376	0.349	0.026	0.044	0.046	0.040	0.034	0.049
03-Mar-89 to 31-Mar-89	0.052	0.081	0.027	0.055	0.059	0.047	0.045	0.056
31-Mar-89 to 05-May-89	0.210	0.225	0.024	0.041	0.040	0.030	0.030	0.041
05-May-89 to 26-May-89	0.366	0.415	0.030	0.049	0.061	0.029	0.043	0.060
26-May-89 to 23-Jun-89	0.030	0.041	0.017	0.044	0.045	0.023	0.035	0.044
23-Jun-89 to 28-Jul-89	0.040	0.036	0.016	0.055	0.053	0.028	0.044	0.055
28-Jul-89 to 18-Aug-89	0.261	0.248	0.024	0.045	0.051	0.029	0.040	NR
18-Aug-89 to 15-Sep-89	0.158	0.159	0.022	0.042	0.046	0.021	0.036	0.043
15-Sep-89 to 13-Oct-89	0.438	0.469	0.033	0.058	0.065	0.032	0.047	0.061
13-Oct-89 to 10-Nov-89	0.702	0.544	0.031	0.043	0.044	0.020	0.023	0.040
10-Nov-89 to 22-Dec-89	0.788	0.726	0.039	0.046	NR	0.027	0.040	0.050
No. of samples	12	12	12	12	12	12	12	12
Maximum	0.788	0.726	0.039	0.058	0.065	0.047	0.047	0.061
Minimum	0.030	0.036	0.016	0.041	0.040	0.020	0.023	0.040
Average	0.313	0.297	0.027	0.048	0.051	0.031	0.038	0.050

NR = Not reported.  
 \*Locations identified in Figure 5-1

APPENDIX G  
LIQUID WASTE DISPOSAL FACILITY MONITORING

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Table G-1. Concentrations of Radionuclides Detected in 1325-N Liquid Waste Disposal Facility Sediment Samples--1989 (pCi/g) (dry weight concentrations).

Sample Location*	<sup>54</sup> Mn	<sup>60</sup> Co	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>144</sup> Ce	<sup>238</sup> Pu	<sup>239/240</sup> Pu
CS-1	2.1 E+05	4.3 E+06	NR	1.5 E+05	<1.9 E+05	NR	NR
CS-2	5.0 E+06	7.5 E+07	NR	1.5 E+06	<3.6 E+08	NR	NR
CS-3	2.1 E+05	3.3 E+06	NR	1.7 E+05	<1.8 E+05	NR	NR
CS-4	2.0 E+05	3.4 E+06	NR	2.5 E+05	<1.9 E+05	NR	NR
CS-5	1.9 E+06	3.1 E+07	NR	3.7 E+05	<1.6 E+06	NR	NR
CS-7	4.5 E+05	5.2 E+06	NR	3.4 E+05	<2.9 E+05	NR	NR
CS-8	8.2 E+04	1.4 E+06	NR	2.0 E+05	<7.5 E+04	NR	NR
CS-9	5.3 E+04	7.8 E+05	NR	1.5 E+05	<4.3 E+04	NR	NR
CS-10	2.4 E+04	3.7 E+05	NR	7.6 E+04	<3.0 E+04	NR	NR
CS-11	5.5 E+05	8.4 E+06	NR	1.6 E+05	<3.7 E+05	NR	NR
CS-12	3.3 E+05	6.0 E+06	NR	1.5 E+05	<3.1 E+05	NR	NR
Maximum	5.0 E+06	7.5 E+07	NR	1.5 E+06	<3.6 E+08	NR	NR
Minimum	2.4 E+04	3.7 E+05	NR	7.6 E+04	<3.0 E+04	NR	NR
Average	8.2 E+05	1.3 E+07	NR	3.2 E+05	<3.3 E+07	NR	NR
Stan. Dev.	1.4 E+06	2.1 E+07	NR	3.8 E+05	1.0 E+08	NR	NR

NR = Not reported.  
 \*Locations identified in Figure 6-1.  
 \*\*Wet weight concentration.

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**APPENDIX H**  
**RADIOLOGICAL SURVEYS**

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Table H-1. Environmental Dose Rates (relative  $\mu\text{rem/h}$ )  
Measured at the 100-N Area Shoreline.

Location*	Relative Dose	Location*	Relative Dose	Location*	Relative Dose
1	11	33	120	65	140
2	13	34	130	66	115
3	17	35	135	67	110
4	18	36	145	68	100
5	19	37	145	69	90
6	25	38	150	70	85
7	31	39	150	71	80
8	36	40	170	72	75
9	43	41	160	73	65
10	49	42	170	74	65
11	55	43	195	75	55
12	60	44	210	76	55
13	65	45	225	77	40
14	75	46	240	78	40
15	85	47	240	79	35
16	100	48	225	80	33
17	105	49	240	81	30
18	85	50	240	82	30
19	70	51	230	83	25
20	55	52	240	84	23
21	50	53	245	85	20
22	55	54	235	86	18
23	55	55	230	87	18
24	50	56	230	88	17
25	60	57	225	89	16
26	60	58	210	90	15
27	65	59	205	91	15
28	70	60	190	92	13
29	80	61	175	93	13
30	90	62	165		
31	110	63	160		
32	115	64	145		

\*Locations identified in Figure 7-1.

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Figure H-1. Environmental Dose Rates ( $\mu\text{rem/h}$ ) Measured at Survey Points Around the 1301-N Liquid Waste Disposal Facility in 1989.

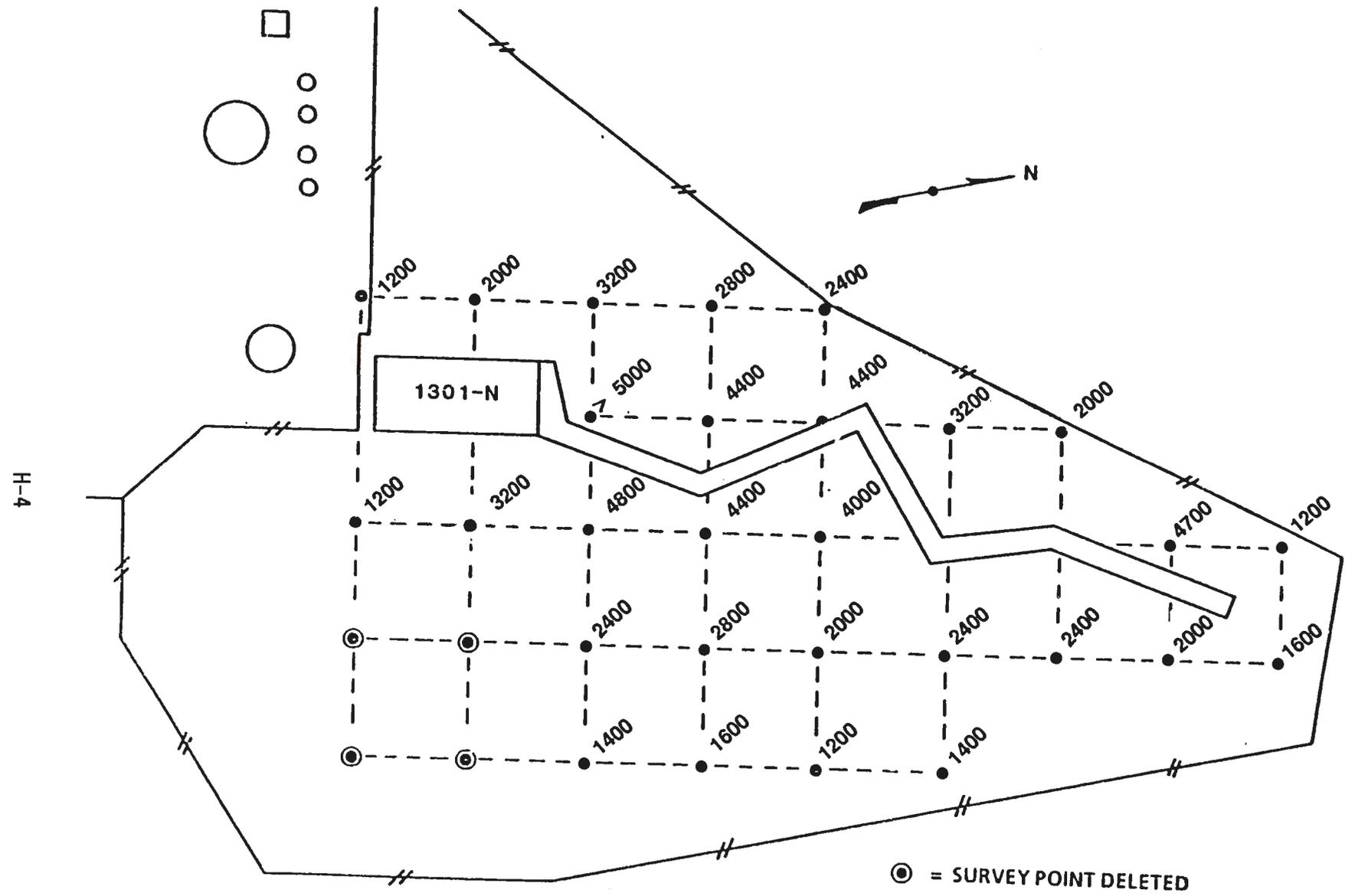
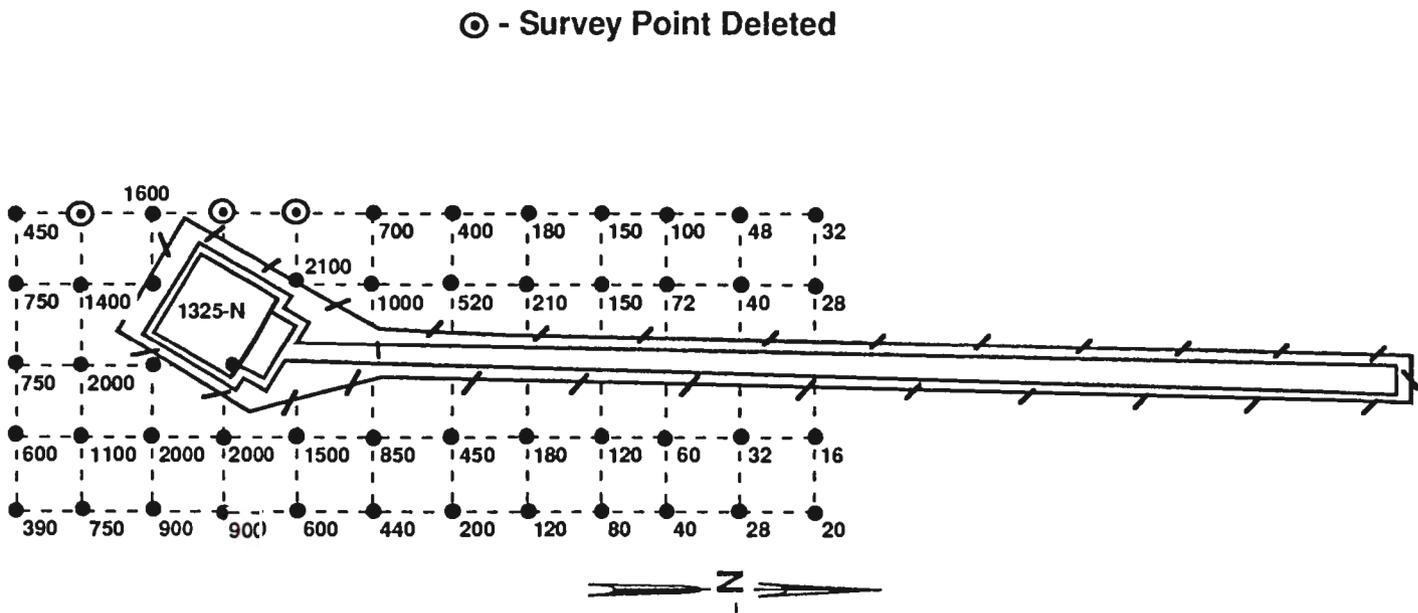


Figure H-2. Environmental Dose Rates ( $\mu\text{rem/h}$ ) Measured at Survey Points Around the 1325-N Liquid Waste Disposal Facility in 1989.



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