

U.S. Department of Energy

**Radionuclide Air Emissions
Annual Report**

Calendar Year 2000

**Rocky Flats Environmental
Technology Site**

ADMIN RECORD

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U.S. Department of Energy

Radionuclide Air Emissions Annual Report for Calendar Year 2000

Prepared in accordance with
40 CFR 61, Subpart H
and
CAQCC Regulation No. 8, Part A, Subpart H

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Executive Summary

As required by Title 40 of the Code of Federal Regulations (CFR), Part 61, Subpart H, and Colorado Air Quality Control Commission Regulation No. 8, Part A, Subpart H, the radiation dose to the public from the Rocky Flats Environmental Technology Site (Site) is determined annually and reported to the U.S. Environmental Protection Agency (EPA) and the Colorado Department of Public Health and Environment (CDPHE). These regulations limit the air pathway dose from Site activities to any member of the public to an annual effective dose equivalent (EDE) of 10 millirem (mrem). The Site was in compliance with the 10-mrem standard during 2000.

For comparison, the average annual EDE for residents of the Denver area from all sources of radiation is approximately 420 mrem, over 80% of which is due to natural background radiation (Roberts, 1998). The health risk associated with 1 mrem of EDE from naturally occurring sources of background radiation (such as uranium or thorium in rock or soil, cosmic rays, and radon emitted from soil or bedrock) is the same as that produced from anthropogenic sources of radiation (such as Site activities or medical x-rays).

Compliance with the 10-mrem standard has been determined by comparing environmental radionuclide air concentration measurements at the critical receptor location with the "Concentration Levels for Environmental Compliance" listed in Table 2 of Appendix E to 40 CFR 61, in accordance with the alternative compliance demonstration method approved by EPA and CDPHE (U.S. Department of Energy, 1997). Compliance is demonstrated when each measured radionuclide air concentration is less than its corresponding compliance level in Table 2 and when the fractional sum of all radionuclides is less than 1. For 2000, each measured radionuclide air concentration was less than 1% of the corresponding concentration level for environmental compliance and the fractional sum of all radionuclides was less than 1.5% of the allowable level at the sampler with the highest fractional sum (the critical receptor).

Airborne radionuclides appear to have been dominated by naturally occurring uranium isotopes in 2000. At the receptor with the largest fractional sum, for example, uranium isotopes characteristic of naturally occurring uranium represented an order-of-magnitude larger contribution to the fractional sum than that contributed by nonuranium isotopes. In addition, the location where the highest total radionuclide levels were measured in 2000 (northwest of the Site) was influenced by off-Site activities that generated dust, such as traffic, sand and gravel removal operations, or quarrying operations. These patterns are consistent with those seen from sampling results in 1997, 1998, and 1999.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	i
ABBREVIATIONS AND ACRONYMS	vi
1.0 INTRODUCTION	1-1
2.0 FACILITY INFORMATION	2-1
2.1 Site Description	2-1
2.2 Radionuclide Air Emissions Source Description	2-5
2.2.1 Radioactive Materials Handling and Processing in Calendar Year 2000	2-5
2.2.2 New Construction and Modifications in Calendar Year 2000	2-9
3.0 AIR EMISSIONS DATA	3-1
3.1 Emission Determination Process	3-1
3.2 Point Sources	3-2
3.2.1 Measured Point Source Emissions	3-3
3.2.2 Calculated Point Source Emissions	3-6
3.2.3 Control Technology for Point Sources	3-7
3.3 Nonpoint Sources	3-8
3.3.1 Nonpoint Source Descriptions	3-8
3.3.2 Control Technology for Nonpoint Sources	3-9
3.4 Release Locations	3-9
4.0 COMPLIANCE ASSESSMENT	4-1
4.1 Compliance Demonstration Based on Environmental Measurements	4-1
4.1.1 Description of Compliance Sampling Network	4-1
4.1.2 Compliance Sampling Network Measurements for 2000	4-3
4.2 Compliance Assessment Results	4-3
4.2.1 Compliance Demonstration	4-3
4.2.2 Statement of Compliance Status	4-7
4.3 Certification	4-8

TABLE OF CONTENTS (continued)

5.0	SUPPLEMENTAL INFORMATION.....	5-1
6.0	REFERENCES CITED.....	6-1
	APPENDIX A: Radioactive Materials Associated with Rocky Flats	
	APPENDIX B: Stack Data for Point Sources	
	APPENDIX C: Effluent Release Points, Calendar Year 2000 and Historical	
	APPENDIX D: Effluent Information System (EIS) Data 2000	
	APPENDIX E: Wind Frequency Distribution for 2000	
	APPENDIX F: Modeling Summary	

LIST OF FIGURES

2-1	Area Map of the Rocky Flats Environmental Technology Site and Surrounding Communities	2-2
2-2	Rocky Flats Environmental Technology Site Location Map.....	2-3
2-3	Central Portion of the Rocky Flats Environmental Technology Site (Industrial Area).....	2-4
3-1	Industrial Area Source Locations.....	3-10
3-2	Surface Soil Contamination Isopleths for Plutonium-239/240.....	3-11
3-3	Surface Soil Contamination Isopleths for Americium-241.....	3-12
3-4	Surface Soil Contamination Isopleths for Uranium-233/234.....	3-13
3-5	Surface Soil Contamination Isopleths for Uranium-235.....	3-14
3-6	Surface Soil Contamination Isopleths for Uranium-238.....	3-15
4-1	Receptor Locations and Nearby Samplers	4-2
4-2	Environmental Measurements of Airborne Radionuclides in 2000.....	4-5
4-3	Isotopic Contribution to the Fractional Sum at the Critical Receptor.....	4-6
4-4	Environmental Measurements of Pu-239 and Am-241 in 2000.....	4-6

LIST OF TABLES

3-1	Measured Point Source Radionuclide Emissions.....	3-5
3-2	Calculated Point Source Radionuclide Emissions	3-7
3-3	Nonpoint Source Radionuclide Emissions.....	3-9
4-1	Annual Average Isotopic Concentrations at Compliance Sampling Network Locations	4-4

ABBREVIATIONS AND ACRONYMS

Am	Americium
Ave	Avenue
Bq	Becquerel(s)
CAP88-PC	Clean Air Act Assessment Package-1988
CAQCC	Colorado Air Quality Control Commission
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Ci	Curies
Ci/m ³	Curies per cubic meter
Ci/yr	Curies per year
cm	Centimeter(s)
cm ²	Square centimeters
D&D	Deactivation and decommissioning
DOE	U.S. Department Of Energy
dpm	Disintegrations per minute
EDE	Effective dose equivalent
EIS	Effluent Information System
EPA	U.S. Environmental Protection Agency
H-3	Tritium
HEPA	High efficiency particulate air (filter)
Hwy	Highway
IHSS	Individual Hazardous Substance Site
km	Kilometer(s)
km ²	Square kilometer(s)
m	Meter(s)
m ³	Cubic meters(s)
MEI	Maximally exposed individual
mrem	Millirem
m/s	Meters per second
mSv	MilliSievert(s)
m ³ /s	Cubic meters per second
NESHAP	National Emission Standards for Hazardous Air Pollutants
ODIS	Off-Site Discharge Information System
pCi/g	Picocuries per gram
Pu	Plutonium
PU&D	Property Utilization and Disposal Yard
RAAMP	Radioactive Ambient Air Monitoring Program
RCRA	Resource Conservation and Recovery Act
Rd	Road
rem	Roentgen equivalent man
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RFFO	Rocky Flats Field Office

ABBREVIATIONS AND ACRONYMS (continued)

Site	Rocky Flats Environmental Technology Site
SNM	Special nuclear material
St	Street
Sv	Sievert(s)
TRU	Transuranic
U	Uranium
USC	United States Code
UTM	Universal Transverse Mercator
°C	Degrees Celsius

1.0 INTRODUCTION

The Rocky Flats Environmental Technology Site (Site) is subject to *National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities* (Title 40 of the Code of Federal Regulations [CFR], Part 61, Subpart H).

Regulation 40 CFR 61, Subpart H, applies to operations at any facility owned or operated by the U.S. Department of Energy (DOE) that emits radionuclides (other than radon-222 and radon-220) into the air. The standard requires that emissions of radionuclides to the ambient air from the Site not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent (EDE) of 10 millirem (mrem) (0.1 milliSieverts [mSv]). Colorado has incorporated 40 CFR 61, Subpart H, by reference as Colorado Air Quality Control Commission (CAQCC) Regulation No. 8, Part A, Subpart H.

Regulation 40 CFR 61, Subpart H, Section 61.94, requires the Site to demonstrate compliance with the standard for the previous calendar year and to submit this information, along with other data, to the U.S. Environmental Protection Agency (EPA) in an annual report (CAQCC Regulation No. 8, Part A, Subpart H, requires submittal to the Colorado Department of Public Health and Environment [CDPHE]). This report fulfills the reporting requirements of 40 CFR 61.94 and CAQCC Regulation No. 8, Part A, Section 61.94, for the 2000 calendar year.

In 1997, DOE filed an application with EPA and CDPHE requesting approval of an alternative compliance demonstration method for 40 CFR 61, Subpart H (DOE, 1997). The alternative method is based on environmental measurements of radionuclide air concentrations at critical receptor locations, rather than the dispersion modeling approach outlined in the regulation itself. In cases where nonpoint sources of emissions are the primary contributors to dose, as has been the case at the Site since before 1995, such an alternative method based on environmental measurements is recommended by EPA (EPA, 1991).

The alternative compliance demonstration method has been approved by CDPHE and EPA. The compliance sampling network, which consists of 14 samplers located around the perimeter of the Site, became fully operational in 1999. The samplers are part of the Site's Radioactive Ambient Air Monitoring Program (RAAMP) network. Compliance has been determined using the alternative method for this annual report.

2.0 FACILITY INFORMATION

This section describes the Rocky Flats Environmental Technology Site, lists the radioactive materials used at the Site, and describes the handling and processing that the radioactive materials undergo. New construction or modifications in calendar year 2000 for which construction approval and startup notification were waived per 40 CFR 61.96 are also identified in this section. Construction approval and startup notification were not required for any new construction or modification in 2000.

2.1 Site Description

The Rocky Flats Environmental Technology Site is operated by Kaiser-Hill Company, L.L.C., with oversight by the Rocky Flats Field Office (RFFO) of the U.S. Department of Energy. Prior to 1989, the Site fabricated nuclear weapons components from plutonium, uranium, beryllium, and stainless steel. Production activities included metal fabrication and assembly, chemical recovery and purification of process-produced transuranic (TRU) radionuclides, and related quality control functions. Plutonium weapons operations were curtailed at the Site in 1989 due to safety concerns, and in February 1992, the Site's weapons production mission was discontinued. The Site is now undergoing decontamination, decommissioning, and cleanup and is moving toward final closure.

The Site occupies an area of 26.5 square kilometers (km²) in northern Jefferson County, Colorado, about 25.7 kilometers (km) northwest of Denver. The Site is located at approximately 1,829 meters (m) above mean sea level on the eastern edge of a geological bench known locally as Rocky Flats. This bench, about 8.1 km wide in an east-west direction, flanks the eastern edge of the Rocky Mountains.

Over 2.8 million people live within 80 km of the Site. Adjacent land use is a mixture of agriculture, open space, industry, and residential housing. Surrounding communities include the city of Golden to the south of the Site; the cities of Arvada, Broomfield, and Westminster to the east; and the city of Boulder to the north. An area map is shown in Figure 2-1.

The former production facilities are located near the center of the Site within a fenced security area of 1.6 km². The remaining Site area contains support facilities and serves as a buffer zone for former production facilities. A map of the Site is shown in Figure 2-2; a simplified map of the central portion of the Site (the "industrial area") showing the location of the former production facilities is shown in Figure 2-3.

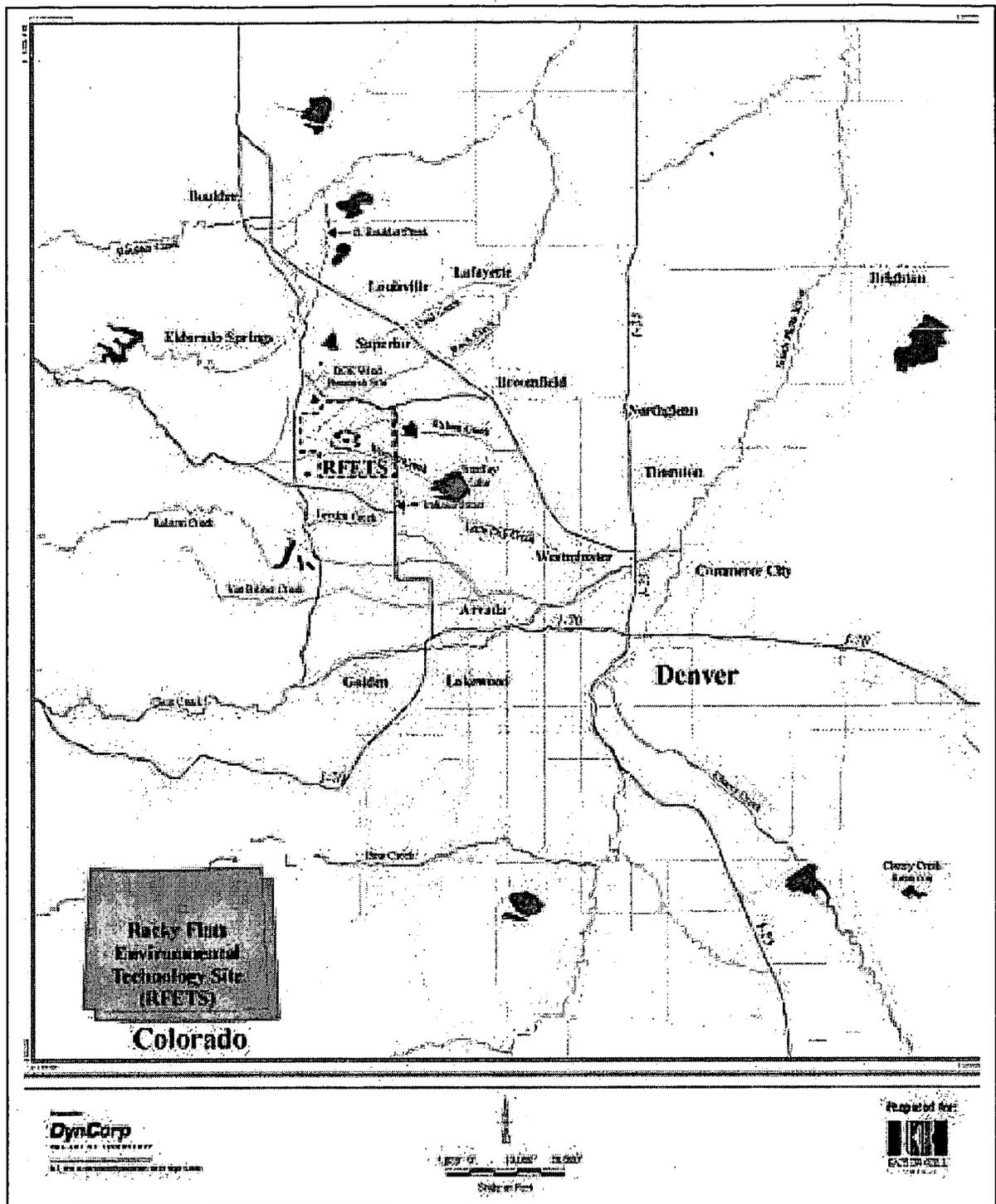


Figure 2-1. Area Map of the Rocky Flats Environmental Technology Site and Surrounding Communities

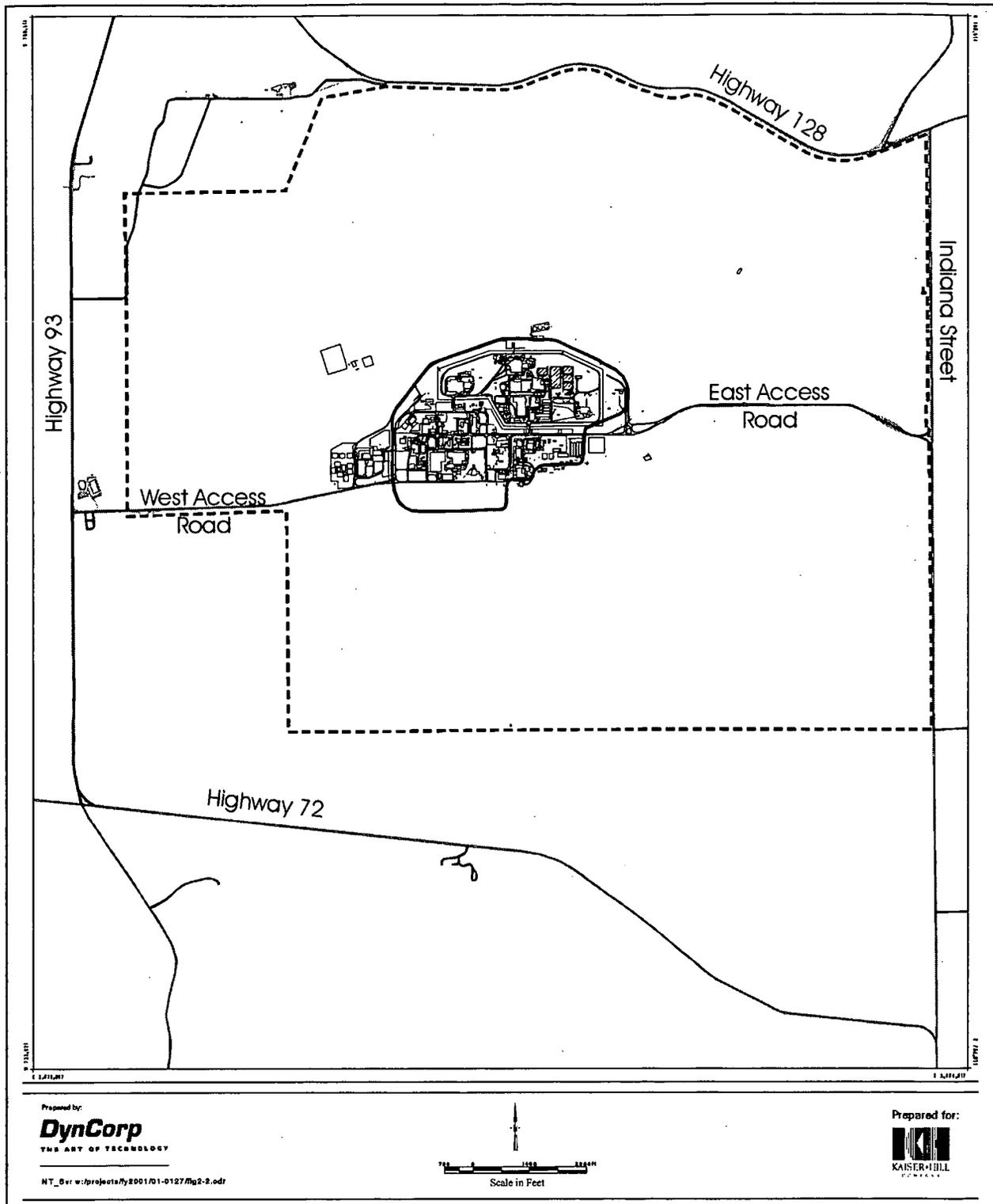


Figure 2-2. Rocky Flats Environmental Technology Site Location Map

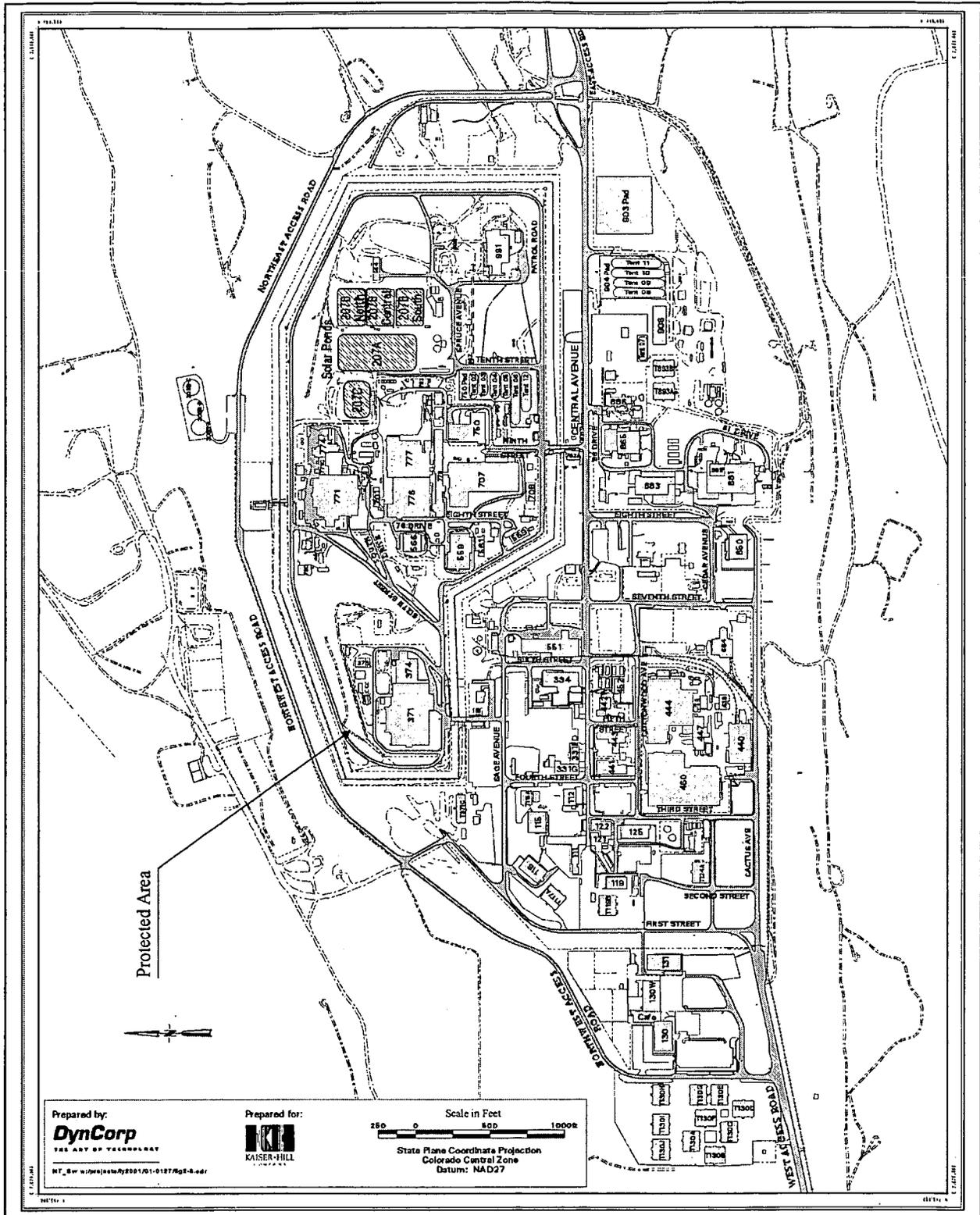


Figure 2-3. Central Portion of the Rocky Flats Environmental Technology Site (Industrial Area)

The central portion of the Site, which houses the former production facilities, can be roughly divided into halves. The Protected Area, generally located in the northern half of the central area (see Figure 2-3), historically housed plutonium processing operations. The rest of the industrial area housed uranium, beryllium, and stainless steel operations.

2.2 Radionuclide Air Emissions Source Description

Radioactive material handling at the Site is currently focused on material consolidation, environmental restoration, building decontamination and demolition, radioactive residue repackaging, waste processing, and analytical operations. Most of the radionuclide air emissions from the Site result from nonpoint (diffuse) sources, primarily mechanical and natural disturbances of contaminated soil. Soil contamination was caused by past radioactive material spills and other releases. In addition, the soils on and around the Site contain small quantities of naturally occurring radionuclides.

Radioactive material processing can result in radionuclides becoming entrained in ventilation air (effluent) that is released through vents or stacks (point sources). However, because no routine nuclear weapons-related processing has occurred at the Site since 1989, the majority of radionuclide point source emissions result from the resuspension of residual radioactive material in ventilation systems and from decontamination and deactivation activities taking place in process buildings.

Air exhausted from process buildings is cleaned prior to release by passing it through multiple stages of high efficiency particulate air (HEPA) filters. As a result, radionuclide point source emissions from the Site are very low.

2.2.1 Radioactive Materials Handling and Processing in Calendar Year 2000

In 2000, radionuclide emissions from the Site occurred from several activities that either disturbed resident contamination in buildings or in soil, or that processed or used radionuclide-containing substances such that emissions to the atmosphere resulted. Appendix A lists radioactive materials associated with the Site. The list of radionuclides includes plutonium (Pu)-239/240, americium (Am)-241, uranium (U)-233/234, U-235, and U-238. The Site also has some small quantities of beta- and gamma-emitting sealed sources and low activity analytical stock solutions, powders, and plated sources; emissions from these sources were negligible.

The major Site activities and sources that handled or processed radionuclides in calendar year 2000, with resulting radionuclide emissions, are described below.

Hold-up in Ducts

Radionuclide emissions were generated through disturbance of radionuclide-contaminated dust and other deposits on the surfaces of ventilation ducts exiting process areas. These materials were deposited on duct walls and in rapidly decreasing amounts on the successive stages of HEPA filters during many years of weapons component production. Routine air movement and pressure changes in the ducts entrain a small amount of this contamination on an ongoing basis. In addition, decontamination and equipment removal or reconfiguration activities disturbed a portion of the hold-up in certain ducts in 2000, resulting in additional emissions to the atmosphere. Ducts containing hold-up were vented through multiple stages of HEPA filters.

Resident Contamination

In some process areas, contamination may be found on glovebox surfaces and floors, and, in limited cases, in the rooms themselves. This contamination has been surveyed and estimated using surface swipes in the areas. As with hold-up, resident contamination was emitted in 2000 due to routine exposure to ventilation air and due to active disturbance by project activities, particularly decontamination and equipment movement. Ducts venting areas with significant contamination were exhausted through multiple stages of HEPA filters.

Consolidation of Special Nuclear Material (SNM)

SNM is plutonium and enriched uranium contained in weapons components, metals, metal alloys, and oxides. SNM-related consolidation activities continued in calendar year 2000 and included metal brushing, size reduction of metal, thermal stabilization of oxide, and packaging and interim storage of SNM. These consolidation activities are defined as follows:

- **Metal brushing:** Mechanical removal of metal oxide from metal surfaces.
- **Size reduction:** Reduction of material size by breaking, cutting, sawing, or pressing to accommodate storage container requirements.
- **Thermal stabilization of oxide:** Treatment of unstable forms of metal oxides in furnaces operating in the range of 800 to 1,200 degrees Celsius (°C) to remove moisture and to fully oxidize the metal to stable form.
- **Packaging and storage:** Placement of material in approved, inert atmosphere, storage containers, which in turn are placed in "storage vaults" or "vault-type rooms." Storage vaults are repositories of SNM materials that satisfy required safety and risk criteria.

Consolidation activities resulted in radionuclide emissions in 2000 through exposure of SNM to ventilation air, as well as through mechanical and thermal disturbance of SNM. Consolidation was performed in areas where ventilation air was exhausted through HEPA filters.

Waste Handling

Most of the low-level, low-level mixed, and TRU waste materials at the Site were generated during plutonium weapons component production and radionuclide recovery operations conducted prior to 1989. In 2000, some solid waste forms, including contaminated gloveboxes and duct work, were segregated and size reduced prior to packing for storage and disposal. Such activities disturbed the radioactive contamination in the waste, resulting in radioactive particles in the room air.

Radioactive wastes were handled (segregated, size reduced, and packaged) inside buildings or other structures. Venting the air through HEPA filters controlled emissions from these operations.

In addition to solid waste forms, liquid waste in tanks and pipes may also release radionuclides to the atmosphere, either through routine passive venting, or when liquid waste is exposed to the atmosphere when systems are drained or the materials treated. In addition to routine emissions from tank vents, liquid waste movement projects in several buildings contributed to emissions during 2000. These activities all took place in areas that vented through HEPA filters.

Waste Storage

Packaged low-level, low-level mixed, and TRU wastes are commonly stored in drums at various locations on the Site. Drums are vented to prevent pressure buildup from hydrogen gas generated as a product of radiolytic activity affecting packaged materials. While hydrogen is routinely vented, radionuclide emissions would only occur from these drums if the inner packaging failed. To minimize emissions should the inner packaging fail, the drums were equipped with small filter cartridges that functioned like HEPA filters. For purposes of estimating emission potential for compliance with 40 CFR 61, Subpart H, the packaged materials inside these drums were considered sealed sources (in accordance with Appendix D to 40 CFR 61).

Waste Repackaging

Radionuclide emissions were generated in 2000 from waste characterization and repackaging activities that are ongoing at the Site in support of proposed waste shipment plans. Proposed shipment plans required the characterization and repackaging of various radionuclide-contaminated waste and residues in preparation for shipment and final

disposition at the Nevada Test Site, Savannah River Site, the Waste Isolation Pilot Plant, or other off-Site facilities. All of the waste repackaging activities that occurred in 2000 took place in areas that were vented through HEPA filters.

Building Cluster Demolition Projects

Demolition projects at the Site are performed in accordance with the Rocky Flats Cleanup Agreement (RFCA). RFCA is a negotiated, interagency agreement governing Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) cleanup activities at the Site. RFCA states that all contaminated buildings at the Site will be decontaminated, as required, and unneeded buildings will be demolished. In most cases, contaminated systems and areas will be decontaminated and removed prior to demolition.

In 2000, the Building 779 Cluster was demolished. Contamination in the cluster was removed or fixed prior to demolition. Emissions during demolition were controlled using water spray as a dust suppression technique.

Miscellaneous Point Sources

In late 1997, several laboratory operations were transferred from Buildings 881 and 123 to a new modular laboratory. The modular analytical laboratory continued operations in 2000, with low-level radionuclide emissions from the handling of contaminated media (such as filters).

Other miscellaneous point sources that were initiated in 2000 included a crusher at the 750 Pad, Tent 5 and laboratory operations in Building 559 (to test plutonium fluoride residue blend material). These operations are described in more detail in Section 2.2.2.

Miscellaneous Nonpoint Sources

Another contributor to Site radionuclide emissions in 2000 was the resuspension of contaminated soils. Contaminated soils were resuspended by wind erosion, vehicle traffic, and other mechanical soil disturbances not directly associated with specific remediation projects. Miscellaneous nonpoint sources that emitted radionuclides in 2000 included modifications to the 904 Pad, installation of a fork truck path, well installations, drilling to support under-building characterization, installation of a drainage channel, and installation of surface water monitoring stations (these sources are described in more detail in Section 2.2.2). Emissions generated by wind erosion were uncontrolled, while radionuclide emissions from vehicle traffic and mechanical disturbances were sometimes controlled using dust suppression techniques.

2.2.2 New Construction and Modifications in Calendar Year 2000

Fourteen new or modified activities that contributed to the Site air pathway dose in calendar year 2000 are described below. As part of the project evaluation process (prior to the startup of each project), the maximum annual (controlled) off-Site EDE that could result from each new or modified activity was calculated to determine approval and notification requirements. Maximum potential radionuclide emissions were estimated using emission and control factors from Appendix D to 40 CFR 61, combined with information regarding radionuclide contaminant levels and material forms, radionuclide release mechanisms, and the radionuclide emission controls employed. In cases where HEPA filters were employed, credit was taken for a maximum of two stages, although up to four stages may actually have been employed. Emissions were modeled using the Clean Air Act Assessment Package-1988 (CAP88-PC), and recent Site meteorological data to estimate annual EDEs at the most impacted off-Site residence and business locations.

To place the reported EDE values in context, it should be noted that the emission estimation and modeling methods used in this exercise are designed to generate "worst case" dose estimates. The emission factors, control device efficiencies, and modeling approach are mandated by 40 CFR 61, Appendix D, to ensure that project dose will not be underestimated. In fact, actual emissions and dose will often be much lower than the estimates used to determine approval and notification requirements.

Detailed data and calculations used to develop emission estimates and resulting dose projections are maintained in Site files. The estimated EDE (shown below) for each new construction or modification was less than 1% of the 10-mrem (0.1 mSv) standard, and construction approval and startup notification were unnecessary under 40 CFR 61.96. The project- or process-specific EDEs used in making regulatory applicability decisions regarding approval requirements are discussed below.

750 Pad, Tent 5 Drum Crusher: In 2000, a drum crusher was installed and operated within the Tent 5 permacon at the 750 Pad. Operation of the drum crusher was limited to empty drums with contamination levels less than or equal to 20 disintegrations per minute (dpm) per 100 square centimeters (cm²). The maximum process rate of the drum crusher was approximately 30 drums per hour.

The permacon air exhausted through a single-stage HEPA filter. Dose calculations were based on the conservative assumptions that the crusher would operate at the maximum process rate 24 hours per day, 5 days per week, 52 weeks per year; that each drum was contaminated at 20 dpm/100 cm² over the entire surface area; and on emission factors from 40 CFR 61, Appendix D. The maximum annual (controlled) off-Site EDE for this project was estimated to be 2.4×10^{-10} mrem (2.4×10^{-12} mSv).

Repackaging and Shipment of Enriched Uranium: In 2000, 63 blocks of 4.5% enriched uranium were repackaged in Buildings 371 and 707 prior to shipment to the Nevada Test Site for disposal. The uranium repackaging was accomplished in one week.

The repackaging enclosures vented through at least two stages of HEPA filters, through vents that were continuously sampled for radionuclide emissions. The off-Site EDE was calculated based on the known uranium content in the materials, the process rate, and an emission factor from Appendix D to 40 CFR 61. The maximum annual (controlled) off-Site EDE from this activity was estimated to be 1.8×10^{-9} mrem (1.8×10^{-11} mSv).

Building 559 Plutonium Fluoride Residue Blend Material Testing: In 2000, laboratory tests were performed to develop a blend material for encapsulating plutonium fluoride residues. Testing was done on approximately 200 grams of residues. The testing process operated for one shift per day, for approximately one week.

Testing took place in a glovebox that exhausted through four stages of HEPA filters, and through a vent that was continuously sampled for radionuclide emissions. The off-Site EDE was calculated based on the known plutonium content in the materials, the process rate, and an emission factor from Appendix D to 40 CFR 61. The maximum annual (controlled) off-Site EDE from this activity was estimated to be 3.4×10^{-8} mrem (3.4×10^{-10} mSv).

Building 448 Ruptured Fire Main Repair: In 2000, the fire main for Building 448 ruptured, requiring excavation within Individual Hazardous Substance Site (IHSS) 157.2, which is potentially contaminated with uranium. The total volume of soil excavated did not exceed 37 cubic yards (28.3 cubic meters [m^3]), and uranium contamination levels in the soil did not exceed RFCA Tier II soil action levels. RFCA defines Tier I and Tier II soil action levels based on concentrations of various contaminants in the soil, where contamination above the higher Tier I action levels suggests cleanup may be necessary, while contamination above Tier II represents contaminant concentrations that require further evaluation. Contamination below Tier II action levels does not require further action.

Dose calculations from excavation and backfilling activities were based on estimated conservative concentrations of radionuclides in the soil (Tier II action levels), the volume of soil excavated and backfilled, and emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42 (EPA, 1995). The maximum annual off-Site EDE from these activities was estimated to be 4.2×10^{-6} mrem (4.2×10^{-8} mSv).

750 Pad Fence Repairs and Upgrades: To support the Protected Area Closure Project, approximately 100 feet (30.5 m) of new fence was installed around the 750 Pad. The total volume of soil excavated did not exceed 40 cubic yards ($30.6 m^3$), and radionuclide contamination levels in the soil did not exceed RFCA Tier II action levels.

Dose calculations from excavation and backfilling activities were based on estimated conservative concentrations of radionuclides in the soil (Tier II action levels), the volume of soil excavated and backfilled, and emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42. The maximum annual off-Site EDE from these activities was estimated to be 4.6×10^{-6} mrem (4.6×10^{-8} mSv).

904 Pad Asphalt Repair: Damaged asphalt pavement in and around the tents on the 904 Pad was repaired in 2000. The total volume of soil disturbed or excavated during this project did not exceed 5 cubic yards (3.8 m^3), and radionuclide contamination levels in the soil did not exceed RFCA Tier II action levels.

Dose calculations from excavation and backfilling activities were based on estimated conservative concentrations of radionuclides in the soil (Tier II action levels), the volume of soil excavated and backfilled, and emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42. The maximum annual off-Site EDE from these activities was estimated to be 2.3×10^{-13} mrem (2.3×10^{-15} mSv).

904 Pad Facility Modifications: In 2000, a 50-foot (15-m) portion of a concrete curb was removed, a new asphalt loading dock was installed, and the drainage area on the southeast side of the 904 Pad was upgraded. The total volume of soil disturbed or excavated during this project did not exceed 35 cubic yards (27 m^3), and radionuclide contamination levels in the soil did not exceed RFCA Tier II action levels.

Dose calculations from excavation, backfilling, and grading activities were based on estimated conservative concentrations of radionuclides in the soil (Tier II action levels), the volume of soil disturbed, and emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42. The maximum annual off-Site EDE from these activities was estimated to be 6.8×10^{-5} mrem (6.8×10^{-7} mSv).

Installation of a Fork Truck Path at Building 664: In 2000, a fork truck path and concrete aprons were constructed at Building 664. The fork truck path was 100 feet long, 10 feet wide, and 6 inches deep (30.5 m by 3 m by 0.15 m). The concrete aprons were 10 feet by 15 feet (3 m by 4.6 m), and 30 feet by 20 feet (9.1 m by 6 m). Soils in the area were not contaminated above RFCA Tier II action levels.

The EDE estimation used emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42; the volume of soil excavated; and estimated conservative isotopic contamination levels in the soil (Tier II action levels). The maximum annual off-Site EDE from the project was estimated to be 1.6×10^{-4} mrem (1.6×10^{-6} mSv).

Fiscal Year 2000 Well Abandonment and Replacement Program: In 2000, approximately 28 monitoring wells were installed at the Site. The wells were installed in support of deactivation and decommissioning (D&D) activities at Buildings 371/374,

707, 776/777, 779, 865, and 883; and in support of contaminant plume studies at the Property Utilization and Disposal (PU&D) yard. Installation of the wells is required by RFCA. The wells were installed using hollow stem auger and Geoprobe® technologies.

The EDE estimation used emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42; the maximum volume of soil excavated; and conservative isotopic contamination levels in the soil (Tier I action levels). The maximum annual off-Site EDE from the project was estimated to be 1.9×10^{-6} mrem (1.9×10^{-8} mSv).

Buildings 123 and 886 Under-Building Characterization: In 2000, the Site used horizontal directional drilling to characterize under-building contamination at Buildings 123 and 886. Horizontal bore-holes were drilled approximately 40 to 200 feet (12 to 61 m) under the building slabs to verify the presence or absence of contaminants of concern.

The EDE estimation used emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42; the maximum volume of soil excavated; and conservative isotopic contamination levels in the soil (Tier II action levels). The maximum annual off-Site EDE from the project was estimated to be 4.7×10^{-6} mrem (4.7×10^{-8} mSv).

Repair of Leaking Underground Pipe at Building 776: In 2000, a subsurface water pipe extending from Building 776/777 to a cooling tower ruptured. An excavation in the vicinity of the ruptured water line was conducted to define the position of the leak and to allow for its repair.

Dose calculations from excavation and backfilling activities were based on estimated conservative concentrations of radionuclides in the soil (Tier II action levels), the volume of soil excavated and backfilled, and emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42. The maximum annual off-Site EDE from these activities was estimated to be 1.2×10^{-4} mrem (1.2×10^{-6} mSv).

Building 779 Cluster Decontamination and Demolition: Building 779 Cluster demolition was completed in early 2000. During 1999, plenum Building 729 was demolished and the remaining buildings in the cluster were decontaminated. Demolition of the remaining buildings took place in 2000.

Radionuclide emissions from these activities were measured by an ambient network activated for the demolition and the emissions were found to be negligible (well below the 0.1 mrem threshold for notification and construction approval) because buildings were decontaminated to unrestricted release criteria levels prior to demolition.

Building 707 Drainage Plan: In 2000, the Site prepared a drainage plan for the area located on the west side of Building 707. Water accumulated there during inclement

weather and flooded Modules J and K. The project involved grading and the installation of a conveyance channel.

Dose calculations from excavation, backfilling, and grading activities were based on estimated conservative concentrations of radionuclides in the soil (Tier II action levels), the volume of soil disturbed, and emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42. The maximum annual off-Site EDE from these activities was estimated to be 1.3×10^{-5} mrem (1.3×10^{-7} mSv).

Installation of Surface Water Monitoring Stations: In 2000, Site gaging stations GS50 and SW119 were installed east of the patrol road within the Protected Area (west of Solar Pond 207B and north of Solar Pond 207A, respectively). They were installed as performance monitoring locations per the Industrial Area Interim Measures/Interim Remedial Action decision document, to monitor the effects of demolition and environmental restoration activities on the water quality of surface water runoff.

The EDE estimation used emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42; the volume of soil excavated; and estimated conservative isotopic contamination levels in the soil (Tier II action levels). The maximum annual off-Site EDE from the project was estimated to be 9.1×10^{-8} mrem (9.1×10^{-10} mSv).

3.0 AIR EMISSIONS DATA

This section discusses and quantifies radionuclide emissions from the Site for calendar year 2000. The stacks, vents, and other points where radioactive materials were released to the atmosphere are described, and the effluent controls employed by the Site to minimize emissions are discussed.

3.1 Emission Determination Process

The emission data presented in this section represent an estimate of Site radionuclide air emissions in calendar year 2000. In many cases, air effluent exiting buildings through stacks or vents was continuously sampled and radionuclide emissions measured. Where such data were available, they are presented here. In other cases, emissions from activities that generated airborne radionuclides were not measured. For these activities, emissions were estimated based on project- or process-specific information, combined with emission factors from various sources. In a few cases, emission sources that were clearly negligible were not quantified.

Where emissions reported in this section were estimated, rather than directly measured, the emission estimates were based on:

- The radionuclide content of materials handled or processed;
- The form of the radioactive material (gas, liquid, solid, or particulate);
- The mechanisms by which radionuclides were released to the atmosphere;
- The time over which the activities that released radionuclides occurred or the time that the radioactive material was exposed to the atmosphere;
- The control measures employed to reduce radionuclide emissions (a maximum of two stages of HEPA filters were credited, even if additional stages were actually employed); and
- Process- or activity-specific emission factors.

Emission factors were derived from several sources. Radionuclide emission factors listed in Appendix D to 40 CFR 61 were used to calculate emissions due to exposure of radioactive material to the atmosphere during processing or handling. Additional emissions resulting from the release of radionuclide-contaminated particles through handling or processing soil and debris were based on emission factors in EPA's *Compilation of Air Pollutant Emission Factors*, AP-42 (EPA, 1995). Where appropriate, emission data from a DOE publication, *Airborne Release Fractions/Rates and Respirable*

Fractions for Nonreactor Nuclear Facilities (DOE, 1994), were also used. The appropriate emission factors were combined with project- or process-specific information to yield estimated radionuclide emissions.

In addition to emissions from specific projects or processes, an ongoing source of radionuclide emissions from the Site is the resuspension of contaminated surface soils by wind erosion. Emissions from this source were estimated by combining information regarding Site-wide surface soil concentrations of radionuclide contaminants with a Site-specific soil resuspension factor. The development of the Site-specific soil resuspension factor used in emission calculations was discussed in detail in a previous annual report (DOE, 1996).

Historical surface soil radionuclide concentration data from a Site-specific soil sampling database were used to develop a set of radionuclide concentration isopleths spanning the entire Site. The soil resuspension emissions reflect information based on plutonium and americium concentration isopleths that were updated in 1999 and uranium concentration isopleths that were updated in 1998.

The emissions discussed in this section include the isotopes that currently or historically have had the potential to contribute 10% or more to the Site's total air pathway EDE. These include:

- Uranium isotopes typical of the depleted and enriched uranium that have been used at the Site, as well as other uranium isotopes that are present in Site soils;
- Pu-239/240, which contributes more than 97% of the alpha activity in Site plutonium;
- Am-241, a decay product of Pu-241; and
- Tritium.

Because potential tritium emissions from the Site have decreased to negligible levels in recent years, tritium will not be reported in future annual reports.

3.2 Point Sources

Radionuclide emissions released through stacks and vents are termed "point" sources. In 2000, radionuclide point sources at the Site included measured releases from stacks and vents in the industrial area, as well as several sources where emissions were calculated rather than measured.

Point source emissions for calendar year 2000 and the control technology used on each point source are described in this section. Detailed information regarding stack and vent characteristics is given in Appendix B.

3.2.1 Measured Point Source Emissions

During calendar year 2000, radionuclide emissions were collected and measured at two types of point sources: significant release points and insignificant release points. Significant release points are those that have the potential to discharge radionuclides into the air in quantities that would result in an annual EDE to the public greater than 1% of the 10-mrem standard, based on uncontrolled emissions (without considering HEPA filtration). Insignificant release points are those that have the potential to discharge radionuclides in lesser quantities. Significant release points must be continuously monitored or sampled, while insignificant release points require periodic confirmatory measurements to verify low emissions (40 CFR 61.93).

Prior to 1999, periodic confirmatory measurements to verify low emissions were made at the insignificant release points using the effluent sampling systems described below. Most effluent sampling was discontinued at insignificant locations during 1999 and the compliance sampling network (an ambient air monitoring network that is described in Section 4.1.1) has been used since then to confirm low emissions. The only insignificant release points that were sampled with effluent systems during calendar year 2000 were systems in Buildings 776 and 374 where continuing effluent measurements were requested by project staff for reasons unassociated with 40 CFR 61.93 requirements. By mid-November 2000, sampling at all insignificant release points had been discontinued.

Effluent Sampling Methods

Point source emissions are measured at the Site with a sampling system that continuously draws a portion of the duct or vent airstream through a filter. Radioactive particles collect on the filters, which were exchanged weekly at the significant sampling locations and monthly at the insignificant locations in 2000. Following collection, the filters are screened for long-lived alpha and beta radiation to check for elevated radionuclide emissions.

Following alpha/beta screening, the samples are composited by location and analyzed for plutonium, americium, and uranium isotopes. All radionuclides that could contribute greater than 10% of the potential EDE for a release point were measured during calendar year 2000. Monthly composites were analyzed for each significant location. A composite of all of the filters collected while a given release point was designated as insignificant in calendar year 2000 was analyzed for each insignificant location in Buildings 776 and 374.

Tritium, which is emitted as a gas, has historically been sampled continuously at several locations on Site. Tritium is collected by bubbling the duct or vent airstream through purified water. Tritium samples were analyzed as they were collected, three times a week, at a single location in 2000.

Calendar Year 2000 Effluent Sampling

In calendar year 2000, particulate samples were collected at 22 routine sampling locations, representing 22 release points. Seventeen of these points were considered significant release points all year. Five points were sampled as insignificant release points at the beginning of the year; four of those were redesignated as significant in November as discussed below. Sampling at the final insignificant release point was discontinued late in calendar year 2000. Appendix C contains a table that lists the release points monitored in calendar year 2000.

Historically, particulate samples were collected at many release points that have been identified as insignificant sampling locations. These locations, while not currently monitored, are still considered release points. However, the quantities of radionuclides emitted from these locations in 2000 were negligible, and low emissions from these points were verified using the ambient sampler network. Appendix C contains a table that lists the insignificant release point locations previously monitored.

During 2000, several changes in point source emission measurements took place. Due to changes in activities in Building 440, sampling was discontinued from June through mid-November; sampling resumed on November 15, 2000. Also in November, four sampling locations were proactively changed from insignificant points to significant; the locations were: 776-202, -250, -251, and -252. Due to scheduled decommissioning activities, these four locations will have the potential to emit radionuclides into the air in quantities that could result in an annual EDE to the public greater than 1% of the 10-mrem standard.

Measured calendar year 2000 emissions of plutonium, americium, and uranium are shown in Table 3-1. One release point was also sampled for tritium in 2000, as identified in Table 3-1. In response to a re-evaluation of tritium emissions potential in Building 776, tritium sampling at this location was discontinued in November 2000.

In calendar year 1997, 18 particulate sampling locations were upgraded from multi-point sampling systems to single-point shrouded probe sampling systems, as required by a 1994 agreement between DOE and EPA (Brockman, 1995). Single-point shrouded probe sampling systems were also installed at locations 371-N01, 371-N02, and 371-SSS, and have been operated concurrently with the pre-existing multi-point sampling systems. Because the airflow patterns within the ducts in Building 371 did not produce uniform mixing, the data from the shrouded probe samplers were not included in Table 3-1; instead the multi-point sampling system data were used for this report.

Table 3-1. Measured Point Source Radionuclide Emissions

Building / Location ^a	Isotope Emissions (Ci/yr) ^{b,c,d}					
	Pu-239	Am-241	U-233/234	U-235	U-238	H-3
Significant Release Points						
371-N01	3.4E-09	2.2E-09	1.0E-08	1.4E-09	7.2E-09	--
371-N02	6.9E-09	2.2E-09	7.1E-09	1.9E-09	1.9E-09	--
371-SSS	1.2E-09	3.7E-10	4.7E-09	5.2E-10	3.7E-09	--
374-MAI	6.2E-09	1.6E-09	1.1E-08	2.6E-09	7.8E-09	--
440-101 ^e	1.5E-09	6.0E-10	1.2E-09	2.6E-10	6.9E-10	--
559-561	3.9E-09	2.6E-09	1.7E-08	1.9E-09	1.6E-08	--
707-101	4.7E-11	6.9E-11	1.7E-10	1.7E-11	1.8E-10	--
707-102	1.7E-10	6.6E-11	5.6E-10	9.2E-11	4.7E-10	--
707-105	7.7E-10	5.9E-10	4.1E-09	3.9E-10	4.0E-09	--
707-106	3.0E-09	3.9E-10	5.1E-10	7.7E-11	7.9E-10	--
707-107	1.2E-09	1.4E-09	5.1E-09	6.3E-10	3.3E-09	--
707-108	9.6E-10	5.4E-10	2.3E-09	7.1E-10	2.0E-09	--
771-MAI	1.9E-08	1.2E-08	4.8E-08	1.3E-08	4.3E-08	--
774-202	8.4E-10	2.8E-10	1.5E-09	3.1E-10	1.5E-09	--
776-201	6.2E-11	5.9E-11	1.2E-10	2.9E-11	2.4E-10	--
776-202 ^f	1.3E-10	3.9E-11	< 0	1.1E-10	2.3E-10	--
776-204	1.3E-09	8.3E-10	2.8E-09	1.2E-09	2.7E-09	--
776-205	2.9E-09	7.0E-10	6.9E-09	6.0E-10	7.5E-09	--
776-206T ^g	--	--	--	--	--	1.0E-03
776-250 ^f	8.0E-09	8.6E-10	2.7E-09	4.7E-09	2.1E-08	--
776-251 ^f	1.8E-09	8.6E-10	< 0	0.0E+00	1.4E-09	--
776-252 ^f	4.6E-10	1.2E-10	7.2E-10	2.7E-10	5.0E-10	--
Insignificant Release Points						
374-SPD ^g	2.6E-09	1.2E-09	< 0	4.9E-11	4.1E-11	--

^a The first number in this column designates the building cluster, the second set of characters designates the specific duct(s) or vent(s). The location of each release point is shown in Figure 3-1 of this report.

^b Values were corrected for filter blanks.

^c All measured point sources were controlled by HEPA filters with a tested control efficiency of at least 99.97 percent.

^d All isotopes that could contribute greater than 10% of the potential EDE for a release point were measured. Isotopes not analyzed are shown as "--".

^e Release point 440-101 was inactive from 6/18/00 through 11/15/00, as its status changed during the year.

^f Release point changed from insignificant to significant on 11/20/00.

^g Sampling discontinued on 11/6/00.

Notes:

- | | |
|---|-------------------|
| Am = Americium | H-3 = Tritium |
| Ci/yr = Curies per year, 1 Ci = 3.7 x 10 ¹⁰ Becquerel (Bq) | Pu = Plutonium |
| E# = x 10 [#] | U = Uranium |
| EDE = Effective dose equivalent | -- = Not analyzed |
| HEPA = High efficiency particulate air | |

Due to an analytical error, the September results for 371-N01 and 707-105 were estimated. The alpha screening results indicated that the September filter activities for these locations were within typical ranges, using alpha results that dated as far back as January 1997. As a conservative estimate of September 2000 releases from these locations, the highest measured effluent stack concentrations for their respective locations (that were observed during the previous 12-month period) were used to calculate their releases.

Appendix D shows calendar year 2000 measured point source emissions data that would historically have been contained in DOE's Effluent Information System (EIS)/Off-Site Discharge Information System (ODIS). DOE did not publish an EIS/ODIS report for 2000.

3.2.2 Calculated Point Source Emissions

During 2000, several point sources operated at the Site that did not trigger continuous sampling requirements because they had low emission potential or were of short duration. These sources included emissions from a drum crusher in Tent 5 at the 750 Pad, which was described in Section 2.2.2. Point sources with calculated emissions that continued operation from 1999 are described below.

Emissions were calculated for these insignificant release points as described in Section 3.1. Table 3-2 shows calculated point source emission estimates for calendar year 2000.

904 Pad, Tent 11 Repackaging of Waste Chemicals: In 1999 and in 2000, drums of waste chemicals at the Site were repackaged in the Tent 11 permacon on the 904 Pad. The drums were evaluated, characterized, and repackaged for off-Site disposal, or returned to on-Site storage.

The permacon air exhausted through two stages of HEPA filters. Emission estimates for this project were based on the conservative assumption that all drums were at the maximum allowable concentration for low-level waste (100 nanocuries plutonium per gram waste), and on the assumption that there would be 20 drums within the permacon open to the atmosphere at all times.

Thermo NUtech Modular Analytical Laboratory: As a result of tritium standards preparation and use, tritium emissions were calculated for 2000. All the tritium contained in the standard solutions used in 2000 was assumed to have been emitted, as no emission controls were employed.

Unmonitored Building Stacks and Vents: Small amounts of radionuclides continued to be released from various building stacks and vents that were previously

Table 3-2. Calculated Point Source Radionuclide Emissions

Activity or Building	Isotope Emissions (Ci/yr) ^a					
	Pu-239/ 240	Am-241	U-233/234	U-235	U-238	H-3
750 Pad, Tent 5 Drum Crusher ^b	9.4E-12	--	--	--	--	--
904 Pad, Tent 11 Waste Chemical Repackaging ^b	2.2E-06	2.3E-07	--	--	--	--
Thermo NUtech Modular Analytical Laboratory ^c	--	--	--	--	--	1.3E-06

^a Emissions of all isotopes that could contribute greater than 10% of the potential EDE for a release point were estimated. Isotopes for which emissions were not estimated are shown as "--". The locations of the release points listed are shown in Figure 3-1 of this report.

^b HEPA filtration used with a control efficiency of at least 99.97 percent.

^c Assumed uncontrolled.

Notes:

- Am = Americium
- Ci/yr = Curies per year, 1 Ci = 3.7 x 10¹⁰ Becquerel (Bq)
- E# = x 10[#]
- EDE = Effective dose equivalent
- HEPA = High efficiency particulate air
- H-3 = Tritium
- Pu = Plutonium
- U = Uranium
- = Not estimated/negligible

sampled as insignificant release points. Individually, none of these release points had the potential to release radionuclides in amounts that could result in an off-Site EDE in excess of 1% of the 10 mrem standard, even if the emissions were uncontrolled. These formerly sampled release points were generally controlled by at least two stages of HEPA filters; consequently, actual emissions would have been a fraction of a percent of the standard limitation. As a result, no attempt has been made to estimate emissions from these sources; instead, the compliance sampling network data have been used to demonstrate that none of these points released significant quantities of radionuclides during calendar year 2000 (see Section 4.1 of this report).

3.2.3 Control Technology for Point Sources

HEPA filters are used to control radioactive particulate emissions from air effluent systems. All of the point source locations listed in Table 3-1 used HEPA filtration in 2000. Air effluent from areas where plutonium or plutonium-contaminated waste were processed was typically cleaned by a minimum of four stages of HEPA filters. Air effluent from uranium processing areas was generally cleaned by a minimum of two stages of HEPA filters. HEPA filters are bench tested prior to installation in the buildings to ensure that they would meet a minimum filter efficiency of 99.97% (Novick, et al., 1985). Filter assemblies are tested again for leaks following installation.

Waste repackaging activities at the 904 Pad, Tent 11, were controlled by two stages of HEPA filters. The drum crushing activities at the 750 Pad, Tent 5 were controlled by a single-stage HEPA filter. Thermo NUtech activities were generally uncontrolled, except for the waste storage area, which vents through a HEPA filter. Tritium emissions shown in Tables 3-1 and 3-2 were uncontrolled (HEPA filters do not control tritium, which is released as a gas).

3.3 Nonpoint Sources

Radionuclide emissions that are not released through specific stacks or vents are termed “nonpoint” (or diffuse) sources. In calendar year 2000, nonpoint sources of radionuclide emissions at the Site included resuspension of contaminated soils by wind erosion and by mechanical disturbance due to excavation, handling, and vehicle traffic. Mechanical disturbance of contaminated soils was associated with:

- Building 448 ruptured fire main repair;
- 750 Pad fence repairs and upgrades;
- 904 Pad asphalt repair;
- 904 Pad facility modifications;
- Installation of a fork truck path at Building 664;
- The well abandonment and replacement program;
- Buildings 123 and 886 under-building characterization;
- Repair of a leaking underground pipe at Building 776;
- Installation of a conveyance channel at Building 707; and
- Installation of surface water monitoring stations.

Calendar year 2000 nonpoint sources also included the Building 779 Cluster demolition project. Emissions were measured by an ambient network activated for the B779 demolition and the emissions were found to be negligible, as discussed in Section 2.2.2.

Nonpoint sources with emissions that continued from 1999, and methods used to minimize nonpoint source emissions, are described below. Table 3-3 summarizes emissions from nonpoint sources for calendar year 2000.

3.3.1 Nonpoint Source Descriptions

Resuspension of Contaminated Soils by Wind Erosion: As described in Section 3.1, an ongoing source of radionuclide emissions from the Site is the resuspension of contaminated soil. Calendar year 2000 emissions from wind erosion of contaminated soil are summarized in Table 3-3.

Table 3-3. Nonpoint Source Radionuclide Emissions

Source or Project ^b	Isotope Emissions (Ci/yr) ^a				
	Pu-239/240	Am-241	U-233/234	U-235	U-238
Resuspension by Wind Erosion ^c	4.8E-05	1.5E-05	2.2E-07	3.2E-08	1.5E-07
Building 448 Ruptured Fire Main	7.2E-08	5.4E-09	4.3E-08	3.4E-09	1.5E-08
750 Pad Fence Repair	7.7E-08	5.8E-09	4.7E-08	3.7E-09	1.6E-08
904 Pad Modifications	9.6E-07	7.1E-08	5.8E-07	4.5E-08	1.9E-07
904 Pad Asphalt Repair	4.8E-10	7.3E-11	5.9E-10	4.6E-11	2.0E-10
Building 664 Fork Truck Path	2.2E-06	1.6E-07	1.3E-06	1.0E-07	4.4E-07
Well Abandonment & Replacement Program	4.6E-08	3.4E-09	2.8E-08	2.2E-09	9.4E-09
Building 123/886 Under-Building Characterization	6.6E-08	5.0E-09	4.0E-08	3.1E-09	1.4E-08
Building 776 Underground Pipe Repair	1.9E-06	1.5E-07	1.2E-06	9.2E-08	3.9E-07
Surface Water Monitor Installations	1.4E-09	1.1E-10	8.8E-10	6.9E-11	3.0E-10
Building 707 Drainage Plan	2.1E-07	1.6E-08	1.3E-07	1.0E-08	4.3E-08

^aEmissions of all isotopes that could contribute greater than 10% of the potential EDE for a release point were estimated. Isotopes for which emissions were not estimated are shown as "--". The locations of the nonpoint release emission sources are shown in Figures 3-1 through 3-6 of this report.

^bEmissions assumed to be uncontrolled.

^cBased on 1998 and 1999 soil isopleth data.

Notes:

- Am = Americium
- Ci/yr = Curies per year, 1 Ci = 3.7 x 10¹⁰ Becquerel (Bq)
- E# = x10[#]
- EDE = Effective dose equivalent
- Pu = Plutonium
- U = Uranium

3.3.2 Control Technology for Nonpoint Sources

Particulate emissions from significant earth-moving activities at the Site and from D&D activities, such as the Building 779 Cluster demolition, are controlled by water spray or other dust suppression measures, with an estimated control efficiency of 50 percent. Fugitive dust control plans that specify the control measures to be used to minimize emissions of contaminated dust are developed for each project with the potential to generate significant radionuclide emissions from soil or debris handling, or from demolition activities. For calendar year 2000, the projects listed in Section 3.3 that involved relatively minor earth-moving or debris handling activities, such as repair and maintenance operations, were assumed to be uncontrolled.

3.4 Release Locations

Figure 3-1 shows the location of various emission sources listed in Tables 3-1 through 3-3. Figures 3-2 through 3-6 show source areas for wind erosion of radionuclides.

See separate file for Fig 3-1

Figure 3-1. Industrial Area Source Locations

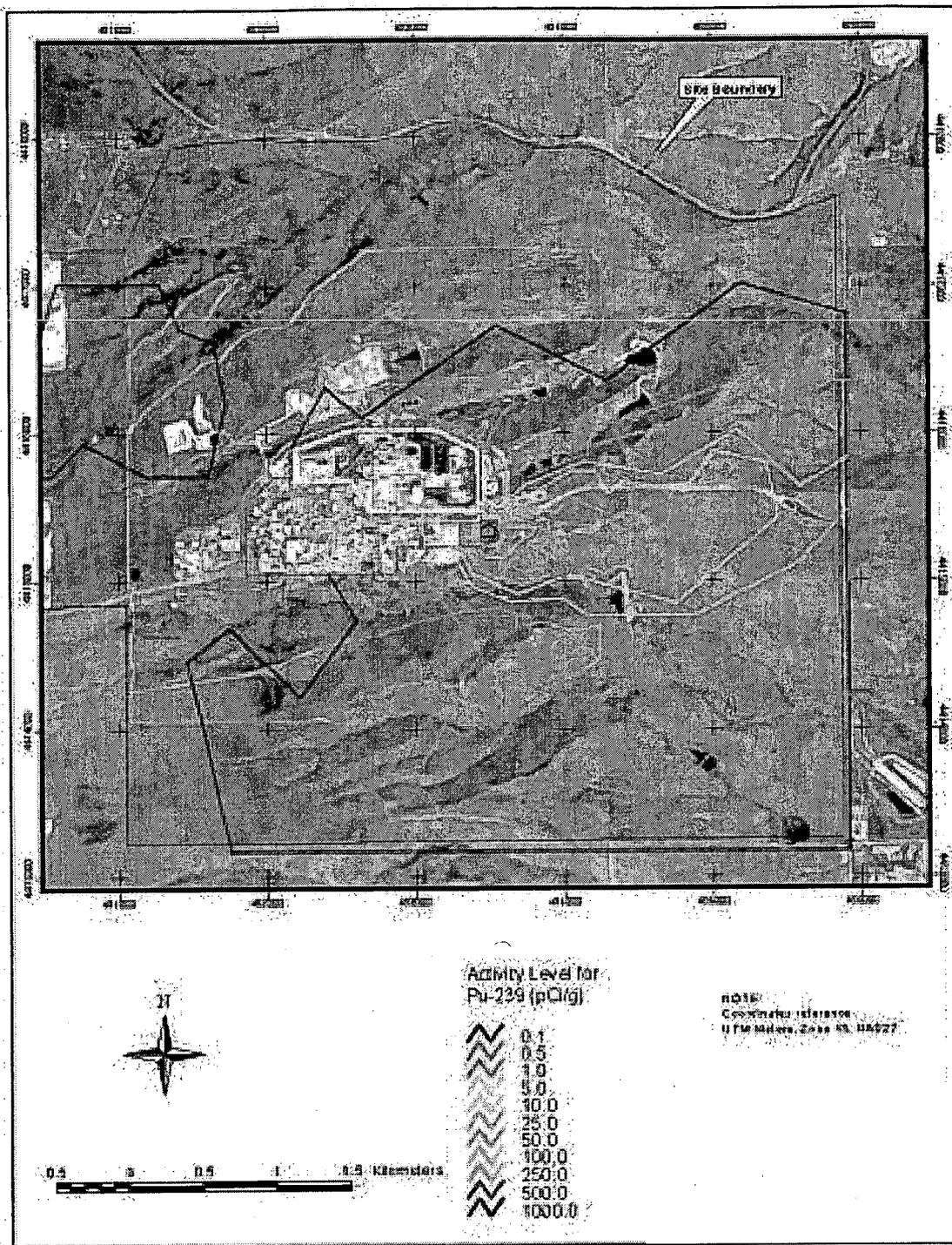


Figure 3-2. Surface Soil Contamination Isopleths for Pu-239/240

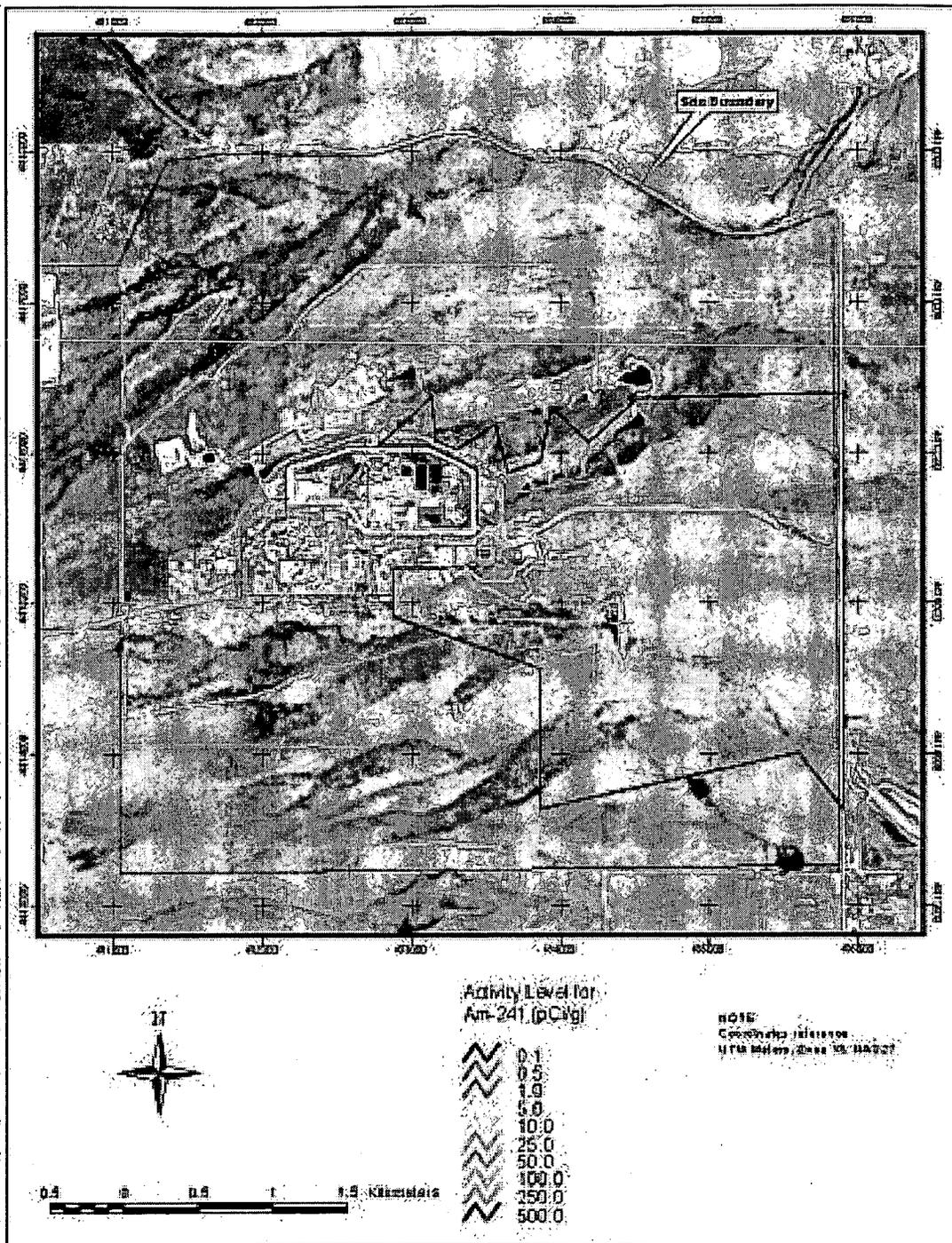


Figure 3-3. Surface Soil Contamination Isopleths for Am-241



Figure 3-4. Surface Soil Contamination Isopleths for U-233/234

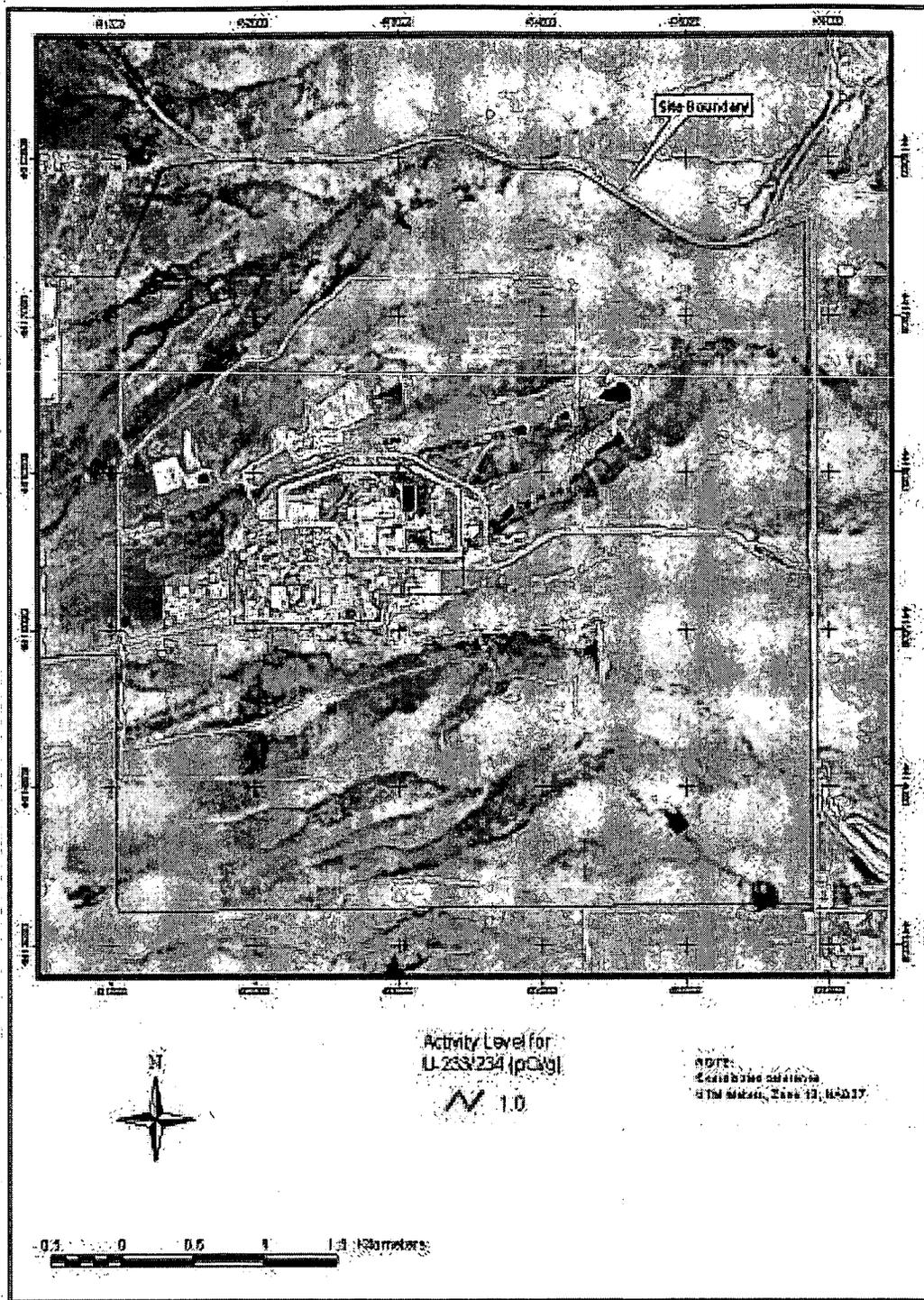


Figure 3-5. Surface Soil Contamination Isopleths for U-235

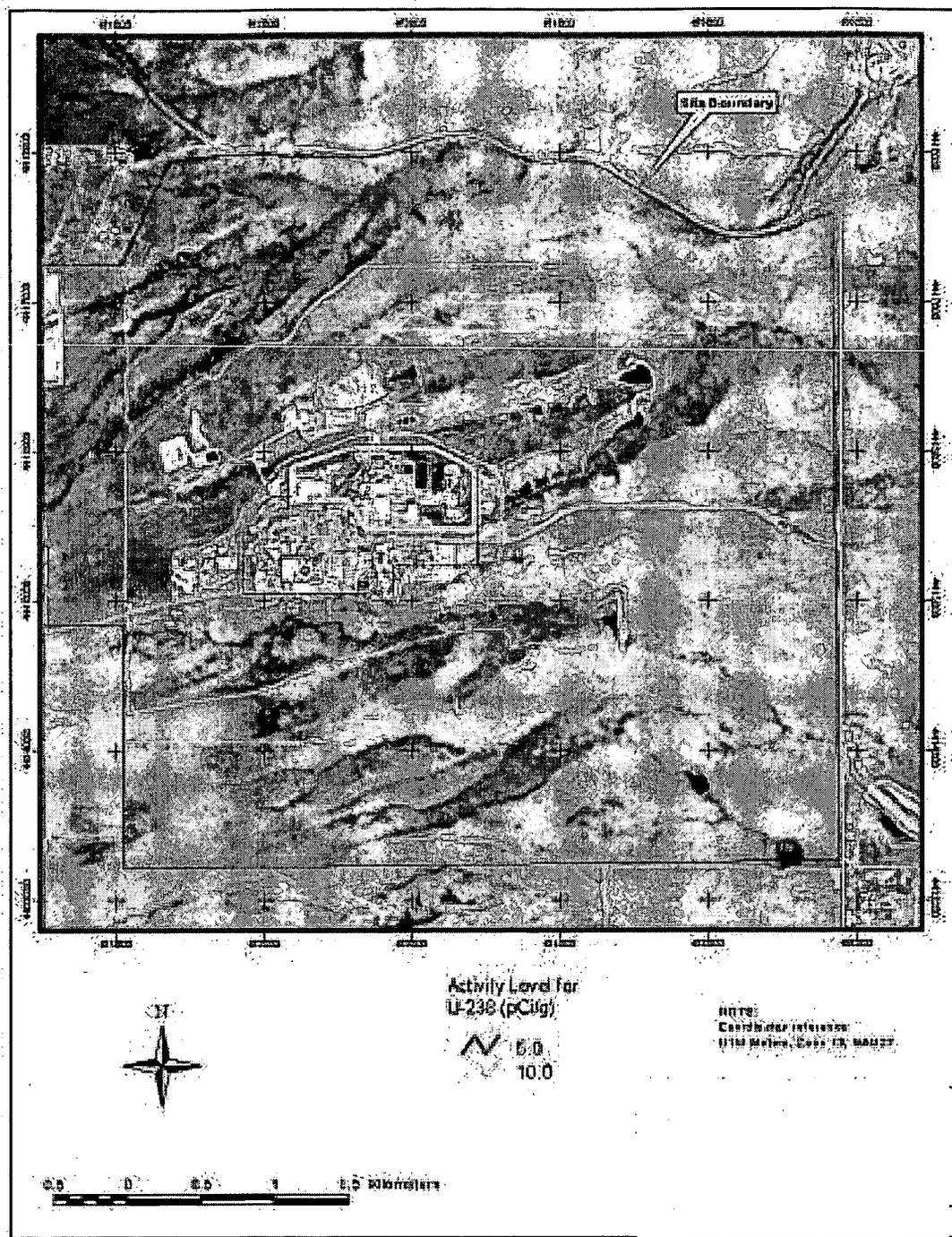


Figure 3-6. Surface Soil Contamination Isopleths for U-238

4.0 COMPLIANCE ASSESSMENT

This section describes the compliance assessment performed for the Site for the 2000 calendar year.

4.1 Compliance Demonstration Based on Environmental Measurements

Historically, the Site has demonstrated compliance with the annual 10-mrem public dose standard in 40 CFR 61, Subpart H, through measurement and dispersion modeling of the measured point source emissions and emission estimation and dispersion modeling of the nonpoint and calculated point source emissions, to determine the dose to the most impacted off-Site resident. Beginning with calendar year 1998, the Site transitioned to an alternative compliance demonstration method based on environmental measurements, as allowed by 40 CFR 61.93(b)(5). The calendar year 2000 compliance assessment is based on the alternative method, which is described below.

4.1.1 Description of Compliance Sampling Network

The Site operates an existing network of environmental air samplers (the RAAMP network) that consists of 37 high-volume, size-fractionating ambient air samplers located on and around the Site, and in nearby communities. The compliance sampling network consists of 14 of these samplers located along the Site perimeter. Eleven of these samplers have operated for several years in their current locations. A 12th sampler located at the intersection of Highway 72 and Indiana Street ceased operation and a new sampler began operation to the north along Indiana Street during 1999. In addition, two new samplers were installed during 1999 to complete the compliance sampling network, one at the northeast corner of the Site fence line near the intersection of Highway 128 and Indiana Street and the other due north of the center of the Site, on South 66th Street. The compliance sampling network is shown in Figure 4-1, along with nearby businesses or residences (receptors).

The ambient air samplers continuously collect both fine and coarse particulate fractions on filters and removable impactor surfaces that are exchanged and analyzed on a monthly schedule. The samples are analyzed for the plutonium, americium, and uranium isotopes that represent most of the radioactive materials handled at or residing on the Site. These isotopes account for all materials that have the potential to contribute 10% or more of the dose to the public.

Residential and commercial development on and around the Site are reviewed on a quarterly basis. If new development or privatization projects warrant additional or revised sampler locations, EPA and CDPHE will be notified. Sampler installation will be scheduled so that samplers will be operational when the new residence or business is

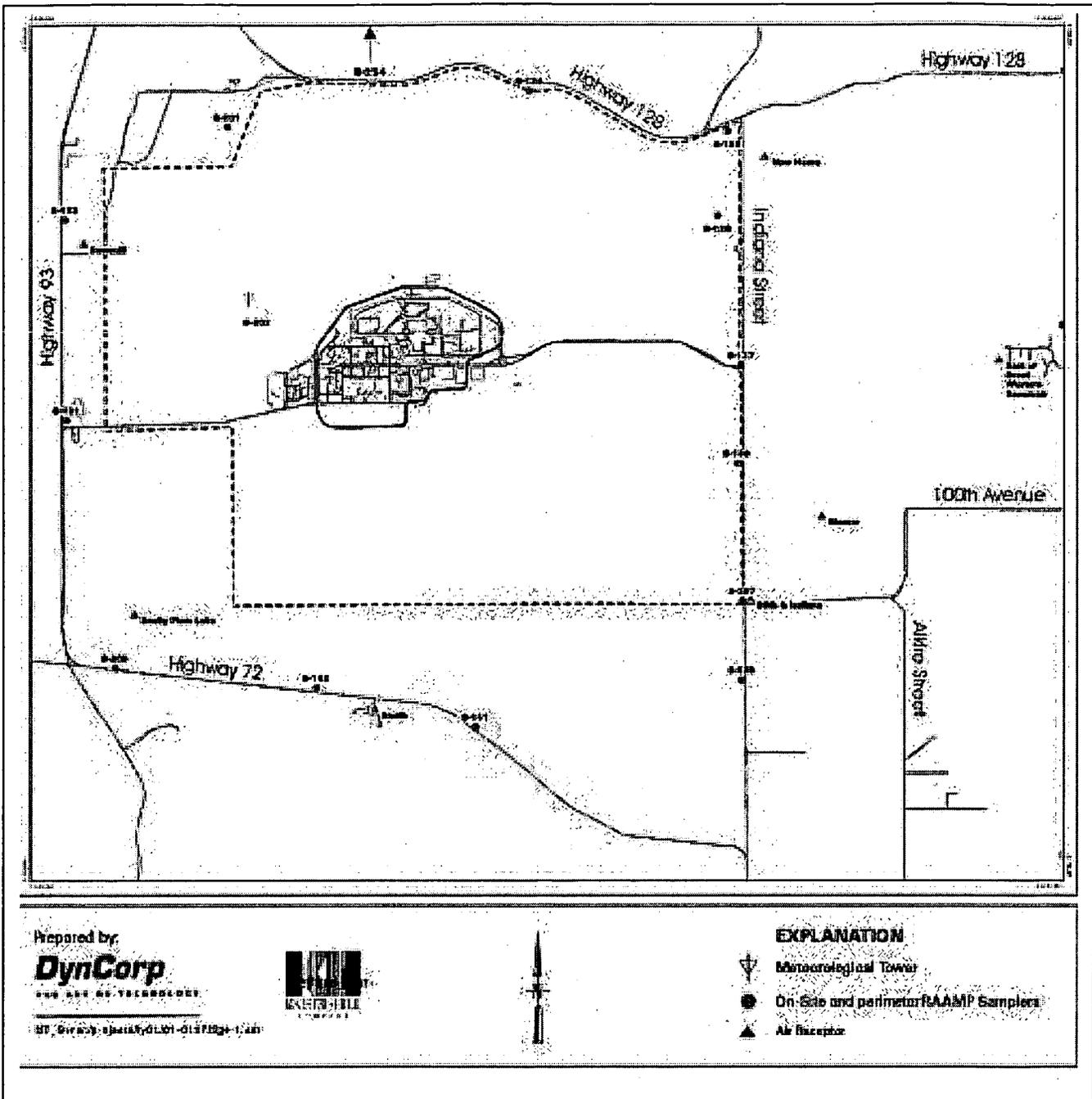


Figure 4-1. Receptor Locations and Nearby Samplers

occupied. No development that warranted additional or revised sampler location occurred in calendar year 2000.

Following the transition to the alternative compliance demonstration method, effluent collection and measurement were discontinued for most insignificant release points on Site and the ambient network is now used to verify low emissions from these locations, as required by Section 61.93(b)(4). Emissions from significant release points will continue to be measured with the existing effluent sampling systems. These effluent samplers will remain operational until the buildings are actively being decommissioned or until the operations that exceeded the 0.1 mrem trigger have ceased.

4.1.2 Compliance Sampling Network Measurements for 2000

Filters from the compliance sampling network were exchanged monthly during 2000, then analyzed for Pu-239/240, Am-241, U-233/234, U-235, and U-238. These isotopes accounted for all materials that had the potential to contribute 10% or more of the dose to the public. Annual average isotopic concentrations were calculated at each sampler from the monthly concentration and air volume data. The annual average isotopic concentrations for each of the compliance demonstration samplers are shown in Table 4-1.

A *fractional sum* was calculated for each sampler location by dividing each annual isotopic concentration by that isotope's corresponding *compliance level* as listed in Table 2 of Appendix E to 40 CFR 61, then summing the fractions. The fractional sums are also shown in Table 4-1.

4.2 Compliance Assessment Results

This section discusses the results of the environmental measurement-based compliance assessment for calendar year 2000.

4.2.1 Compliance Demonstration

As reported in Section 4.1 of this report, the maximum annual concentrations of Pu-239/240, Am-241, U-233/234, U-235, and U-238 measured at the compliance sampling network were compared to the compliance levels listed in Table 2 of Appendix E to 40 CFR 61. In each case, the maximum measured or estimated concentration of each isotope, as shown in Table 4-1, was less than 1% of the corresponding compliance level. In addition, the fractional sum of all isotopes at the *critical receptor* location (the sampler showing the highest concentrations in 2000) was determined to be 0.013. The facility is in compliance when the annual concentration of each isotope is less than its corresponding Table 2 compliance level and when the fractional sum of all isotopes is less than 1.

Table 4-1. Annual Average Isotopic Concentrations at Compliance Sampling Network Locations

Sampler	Pu-239/240 (Ci/m ³)	Am-241 (Ci/m ³)	U-233/234 (Ci/m ³)	U-235 (Ci/m ³)	U-238 (Ci/m ³)	Fractional Sum
S-131	5.1E-19	4.3E-19	2.5E-17	1.1E-18	2.6E-17	0.0073
S-132	5.7E-19	1.1E-18	4.6E-17	3.1E-18	4.4E-17	0.0130
S-134	4.2E-19	1.3E-19	2.0E-17	1.3E-18	2.0E-17	0.0056
S-135	3.9E-19	2.3E-21	3.3E-17	1.7E-18	3.3E-17	0.0090
S-136	2.8E-19	3.2E-19	1.6E-17	1.2E-18	1.7E-17	0.0048
S-137	4.5E-19	3.0E-19	2.3E-17	1.2E-18	2.4E-17	0.0067
S-138	5.6E-19	1.8E-19	2.0E-17	1.3E-18	2.0E-17	0.0058
S-139	4.0E-20	2.9E-19	2.9E-17	1.4E-18	2.7E-17	0.0078
S-141	4.2E-19	1.1E-19	2.4E-17	1.4E-18	2.3E-17	0.0066
S-142	3.4E-19	4.2E-20	2.0E-17	1.5E-18	2.0E-17	0.0057
S-201	3.6E-19	1.2E-19	2.5E-17	1.7E-18	2.6E-17	0.0071
S-207	3.1E-19	1.7E-19	3.0E-17	2.0E-18	2.8E-17	0.0081
S-209	1.9E-19	2.4E-19	2.3E-17	1.6E-18	2.3E-17	0.0064
S-254	3.3E-19	1.8E-19	2.9E-17	2.2E-18	2.8E-17	0.0080
Compliance Level (Ci/m³)^a	2.0E-15	1.9E-15	7.1/7.7E-15	7.1E-15	8.3E-15	1

^a Compliance levels are listed for each isotope in Table 2 of Appendix E to 40 CFR 61.

Notes:

- Am = Americium
- Ci/m³ = Curies per cubic meter; 1 Ci = 3.7 x 10¹⁰ Becquerel (Bq)
- E# = x 10[#]
- Pu = Plutonium
- U = Uranium

Figure 4-2 shows data from the 2000 compliance sampling network at all locations. The data are presented as percentages of the compliance level for each isotope; the total height of each bar in Figure 4-2 represents the fractional sum expressed as a percent of the allowable sum (percent of 1). Data are presented for each sampler, beginning with S-131 at the west gate of the Site, and continuing around the Site perimeter in a clockwise direction. Sampler locations are shown in Figure 4-1.

The maximum measured radionuclide levels occurred to the northwest of the Site, at sampler S-132. This location also showed the highest radionuclide levels measured at the perimeter samplers during calendar years 1997, 1998, and 1999.

Examination of the isotopic data presented in Table 4-1 and Figure 4-2 shows that the higher overall radionuclide level (fractional sum) at S-132, relative to other samplers in the compliance sampling network, was primarily due to higher levels of U-233/234 and U-238. The ratio of U-233/234 to U-238 activities at S-132 (and at other compliance samplers as well) was approximately 1:1, which is characteristic of naturally occurring

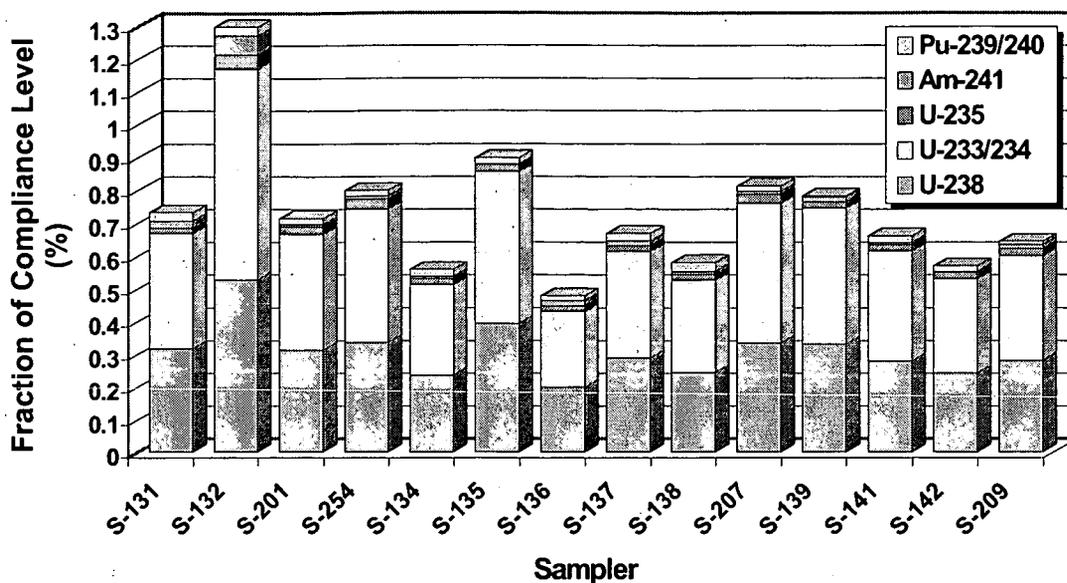


Figure 4-2. Environmental Measurements of Airborne Radionuclides in 2000

uranium. (In contrast, depleted or enriched uranium that might be emitted from on-Site sources would show either lower or higher isotopic ratios.) S-132 is located in an area that might be expected to show elevated dust levels due to quarrying activities, sand and gravel removal, and turbulence caused by nearby traffic. The soils surrounding Rocky Flats contain naturally occurring uranium, which may explain the elevated activities at this sampler. Figure 4-3 shows the isotopic breakdown at S-132 as a percentage of the total fractional sum at that location; almost 90% of the fractional sum is due to U-233/234 and U-238.

Naturally occurring uranium isotopes appear to have dominated the airborne radionuclide levels at all the compliance samplers in 2000. In fact, the fraction of the compliance levels represented by U-233/234 and U-238 was nearly an order-of-magnitude greater than that represented by the sum of the fractions of the other three radionuclides sampled (Pu-239/240, Am-241, and U-235).

Figure 4-4 shows the measured levels of Pu-239/240 and Am-241 at the compliance sampling network locations, also presented as percentages of the compliance level for each isotope. These two isotopes are characteristic of the weapons grade plutonium that was used in nuclear weapon component production operations at the Site. Pu-239/240 and Am-241 present a slightly different pattern than U-233/234 and U-238. A modest increase in concentrations is apparent at the samplers to the east and

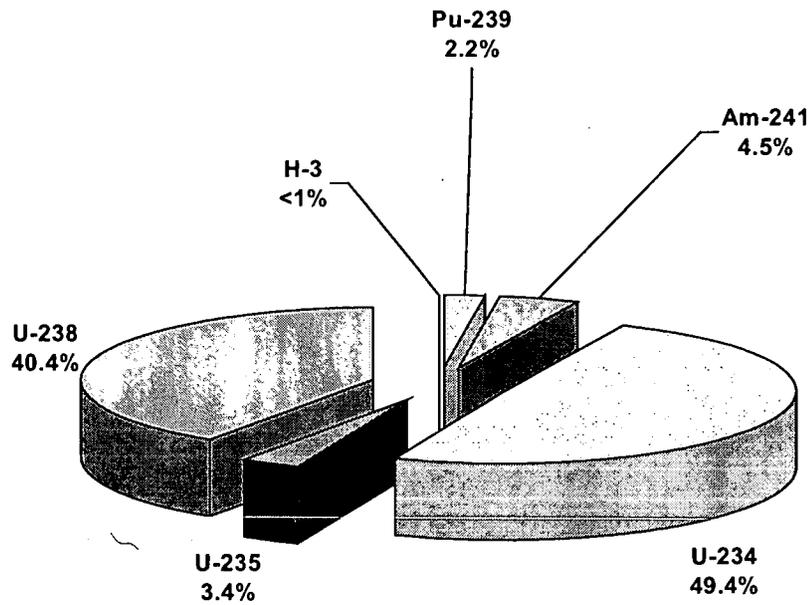


Figure 4-3. Isotopic Contribution to the Fractional Sum at the Critical Receptor

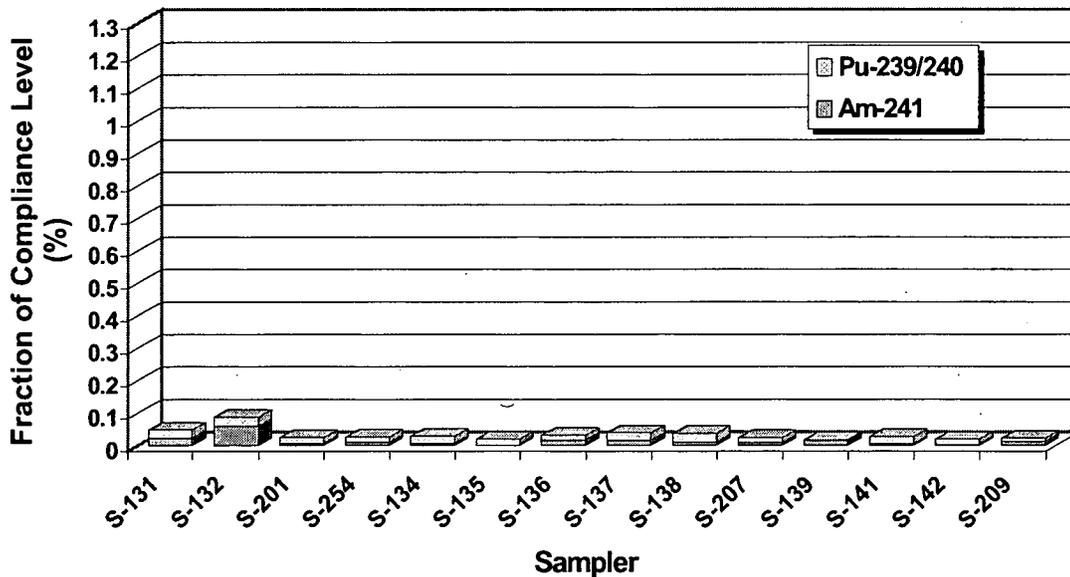


Figure 4-4. Environmental Measurements of Pu-239 and Am-241 in 2000

east-southeast of the Site (samplers S-137, S-138, S-139, and S-207) relative to the samplers to the north and south of the Site. Based on annual average wind patterns (see Appendix E), these samplers are generally downwind of the 903 Pad and surrounding areas, which have represented a major source of plutonium emissions from the Site in recent years due to resuspension of contaminated surface soils.

However, maximum Pu-239/240 and Am-241 concentrations actually occurred to the west and northwest of the Site in 2000, at samplers S-131 and S-132. A somewhat similar pattern was apparent in 1999; both years represent a departure from years prior to 1999. No explanation for the pattern has been found and it may be largely due to random variation in samples that are near background levels of these radionuclides due to atmospheric fallout and also at or below their analytical detection levels. Both Pu-239/240 and Am-241 concentrations were uniformly lower in 2000 than in 1999 at all samplers, which was not the case for the three uranium isotopes, which increased slightly at some samplers and decreased at others.

Sampler S-132 and, to a lesser extent, sampler S-131 recorded somewhat elevated americium concentrations, relative to the other compliance sampling network locations, for unknown reasons. No laboratory errors were apparent from the data, nor were there any known project emission events that would have produced the elevated Am-241 that were recorded at these locations. Monthly concentration data from these samplers showed higher than average concentrations several times during the year, not just in a single period where a specific project could be the cause. Although the resulting Am-241 concentrations at the fence line were very low, they represent a departure from the usual pattern seen for this airborne radionuclide in the past (prior to 1999).

The fractional sum information for calendar year 2000 can be compared with the 10-mrem dose limit and with data from prior years. As noted previously, the fractional sum at the critical receptor location in 2000 was 0.013, which is nearly two orders of magnitude below the allowable level (fractional sum of 1). The fractional sum can be directly related to the allowable dose limit of 10 mrem in 40 CFR 61, Subpart H. As a result, the maximum dose recorded at the compliance sampling network in 2000 was nearly two orders of magnitude below the 10-mrem limit and approximately 90% of the dose was due to uranium isotopes that are largely naturally occurring in the Site environment. For comparison, the fractional sum at the critical receptor was 0.0145 in 1999, 0.0141 in 1998, and 0.0128 in 1997.

4.2.2 Statement of Compliance Status

Compliance with the 10-mrem standard has been determined by comparing environmental radionuclide air concentration measurements at the critical receptor location with the "Concentration Levels for Environmental Compliance" listed in Table 2 of Appendix E to 40 CFR 61. Compliance is demonstrated when each measured

radionuclide air concentration is less than its corresponding compliance level in Table 2 and when the fractional sum of all radionuclides is less than 1. For 2000, each measured radionuclide air concentration was less than 1% of its corresponding compliance level and the fractional sum of all radionuclides was less than 1.5% of the allowable level at the critical receptor (the sampler with the highest fractional sum). The Site was in compliance with the 10-mrem standard during 2000.

4.3 Certification

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment. (See 18 USC 1001.)

Joseph A. Legare
Assistant Manager
for Environment and
Infrastructure
Department of Energy

David C. Shelton
Vice President
of Environmental Systems and
Stewardship
Kaiser-Hill Company, L.L.C.

Signature

Date

Signature

Date

5.0 SUPPLEMENTAL INFORMATION

The following information is provided pursuant to DOE guidance or EPA request and is not required by 40 CFR 61, Subpart H, reporting requirements.

- **Calendar year 2000 collective dose:** DOE facilities such as the Site are required to estimate the collective dose to the surrounding population on an annual basis by DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. While not a requirement of 40 CFR 61, Subpart H, the collective dose calculation for the air pathway has typically been reported in this annual report. Collective dose is defined as the sum of the EDEs of all individuals in an exposed population within an 80-km radius of the center of the Site (DOE, 1990).

For calendar year 2000, the population distributions that form the basis of the collective dose calculation were updated to reflect 2000 census data. The collective dose was calculated with CAP88-PC, as described in Appendix F. The collective dose for calendar year 2000 was 0.28 person-rem (0.0028 person-Sv).

- **Other radionuclide regulations:** 40 CFR 61, Subparts T and Q (CAQCC Regulation No. 8, Part A, Subparts T and Q) are not applicable to this Site. Subparts T and Q contain standards for radon emissions from specific facilities.
- **Unplanned releases:** There were no unplanned releases of radionuclides to the atmosphere from the Site during 2000.

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Appendix A

Radioactive Materials Associated with Rocky Flats

RADIOACTIVE MATERIALS ASSOCIATED WITH ROCKY FLATS

A. RADIOACTIVE MATERIALS HANDLED IN KILOGRAM QUANTITIES

1. Plutonium

Isotopic Composition of Rocky Flats Plutonium

<u>Isotope</u>	<u>Relative Weight (percent)</u>	<u>Specific Alpha Activity (Curies/gram)</u>	<u>Specific Beta Activity (Curies/gram)</u>	<u>Relative Activity (Curies/gram)^a</u>
Pu-238	0.01	17.01	---	0.00171
Pu-239	93.79	0.0622	---	0.05834
Pu-240	5.80	0.228	---	0.01322
Pu-241	0.36	---	103.5	0.37260
Pu-242	0.03	0.00393	---	1.18x10 ⁻⁶
Am-241	^b	3.42	---	---

^a Relative activity is obtained by multiplying the percent by weight by the specific activity. The total activity for the Plutonium Isotopes is: Alpha, 0.0732 curies/gram; and Alpha plus Beta, 0.446 curies/gram.

^b Am-241 is a radioactive decay product of Pu-241.

2. Enriched Uranium

Common Name: Oralloy
Normal Isotopic Composition: >90% U-235

3. Depleted Uranium

Common Names: Tuballoy, D-38, U-238
Normal Isotopic Composition: <0.71% U-235

4. Americium (Am-241)

Am-241 is a radioactive decay product of Pu-241.

5. Natural Uranium (Thorium and Uranium-233)

Rocky Flats has both the capability and potential to handle these in kilogram quantities. Some of these materials have been handled in the past.

B. RADIOACTIVE MATERIALS HANDLED IN GRAM QUANTITIES (<1Kg)

Curium-244
Neptunium-237
Uranium-233
Plutonium-238,-242

These radioisotopes may be handled at Rocky Flats primarily for research and analytical activities.

C. RADIOISOTOPES UTILIZED AT ROCKY FLATS AS ACCOUNTABLE AND/OR TRACEABLE/NONACCOUNTABLE SOURCES

1. Registered Sources (Twice-Yearly Leak Test and Physical Audit)

Sealed solids >Appendix E values.¹
Plated solids >Appendix E values.
Liquids > 10⁻³ µCi

Americium	(Am-241)	Iridium	(Ir-192)
Antimony	(Sb-124)	Plutonium	(Pu-238,-239)
Barium	(Ba-133)	Selenium	(Se-75)
Cadmium	(Cd-109)	Strontium	(Sr-90)
Californium	(Cf-252)	Uranium	(U-234,-235,-238)
Cesium	(Cs-137)		
Cobalt	(Co-57,60)		
Europium	(Eu-152, -154)		

¹ Accountability is determined by 10 CFR 835, Appendix E. Sealed radioactive sources with activities equal to or greater than Appendix E values are accountable. The activities are individual for each isotope and are not all equal in value.

2. Traceable (Nonaccountable) Sources

Sealed solids < Appendix E values
Plated solids < Appendix E values

Americium	(Am-241, 243)
Barium	(Ba-133)
Bismuth	(Bi-207, -210m)
Cadmium	(Cd-109)
Californium	(Cf-252, -250)
Carbon	(C-14)
Cerium	(Ce-139)
Cesium	(Cs-137)
Chlorine	(Cl-36)
Cobalt	(Co-56, -57, -60)
Curium	(Cm-244)
Europium	(Eu-152, -154)
Gadolinium	(Gd-148)
Hydrogen (Tritium)	(H-3)
Iridium	(Ir-192)
Iron	(Fe-55)
Lead	(Pb-210)
Manganese	(Mn-54)
Mercury	(Hg-203)
Neptunium	(Np-237)
Nickel	(Ni-63)
Plutonium	(Pu-238, -239, 240)
Polonium	(Po-210)

Proactinium	(Pa-234)
Promethium	(Pm-147)
Radium	(Ra-226)
Selenium	(Se-75)
Silver	(Ag-110m)
Sodium	(Na-22)
Strontium	(Sr-85-90)
Technetium	(Tc-99)
Thallium	(Tl-204)
Thorium	(Th-230)
Tin	(Sn-113)
Uranium	(U-232, -234, -235, -236, -238)
Yttrium	(Y-88)
Zinc	(Zn-65)

D. RADIUM SOURCES HANDLED AND STORED AT ROCKY FLATS

TS*	RFETS ID	Nuclide	Location	Original Activity (μ Ci)
TS	138	Ra-226	126	6.00000
TS	866	Ra-226	126	10.95
TS	1734	Ra-226	126	0.0182
TS	1779	Ra-226	125	0.9
TS	3938	Ra-226	T441A	0.0315
TS	3939	Ra-226	T441A	0.0135

*TS = Traceable Source

Appendix B

Stack Data for Point Sources

Stack Data for Point Sources

Building/ Location	Height (m)	Diameter (m)	Width (m)	Length (m)	Volumetric Flow Rate (m ³ /s)	Stack Type	Vent No.
371-SSS	16.00	-	1.54	5.76	13.95	Penthouse	2
371-NO1 ^a	16.00	1.22	-	-	6.98	Penthouse	1
371-NO2 ^a	16.00	1.22	-	-	7.14	Penthouse	1
374-MAI	23.77	-	1.83	1.37	9.71	Penthouse	7, 8, 9
374-SPD	9.14	0.42	-	-	2.78	90°	3
440-101	13.46	0.51	-	-	2.52	Open	1
559-561	7.00	-	2.29	1.52	18.03	Mixing Box	36
707-101/103 ^b	11.33	-	0.46	0.30	0.27	Mixing Box	36
707-102/104 ^c	11.33	-	1.37	0.91	0.79	Mixing Box	9, 10
707-105	11.33	-	1.37	0.91	2.40	Mixing Box	28
707-106	11.33	-	0.91	0.61	1.10	Mixing Box	55
707-107	11.33	-	1.60	1.07	5.94	Mixing Box	65
707-108	11.33	-	1.37	0.91	3.36	Mixing Box	75
771-MAI	50.14	3.12	-	-	80.56	Open	86
774-202	7.11	-	0.91	0.61	2.92	Mixing Box	4
776-201 ^d	12.00	0.35	-	-	0.22	Penthouse	24
776-202	16.10	0.52	-	-	2.31	Rain Cap	17
776-204 ^d	12.00	-	1.83	0.61	5.13	Penthouse	24
776-205/206/207 ^e	12.00	-	1.6	1.07	7.23	Mixing Box	32
776-250 ^d	12.00	-	4.88	1.62	12.47	Penthouse	24
776-251	13.00	-	0.81	1.52	10.43	Wall penetration	45
776-252	13.20	-	0.91	0.56	2.76	90° Wall penetration	44

^a 371-NO1/NO2 combined to one penthouse.

^b 707-101/103 combined into one stack.

^c 707-102/104 combined into one stack.

^d 776-201/204/250 combined to penthouse vent No. 24.

^e 776-205/206/207 combined to penthouse vent No. 32.

Notes:

m = Meters
m³/s = Cubic meters per second
- = Not applicable

Appendix C

Effluent Release Points

**Calendar Year 2000
and
Historical**

**Release Points
Calendar Year 2000**

Building/ Location	Number of Release Points	Regulatory Status	Notes
371-N01	1	S	
371-N02	1	S	
371-SSS	1	S	
374-MAI	1	S	
374-SPD	1	I	Sampling discontinued on 11/6/00 in recognition of insignificant status
440-101	1	S	No sampling conducted between 6/19/2000 and 11/14/2000, while waste repackaging operations were inactive (no potential to emit)
559-561	1	S	
707-101/103	1	S	
707-102/104	1	S	
707-105	1	S	
707-106	1	S	
707-107	1	S	
707-108	1	S	
771-MAI	1	S	
774-202	1	S	
776-201	1	S	776-201, -204, & -250 vent into a common penthouse, but are still considered 3 release points
776-202	1	S ^a	Upgraded to "significant" on 11/20/00 due to decommissioning work
776-204	1	S	776-201, -204, & -250 vent into a common penthouse, but are still considered 3 release points
776-205	1	S	776-205, -206, & -207 combine to a common mixing plenum prior to discharge; the mixing plenum sampling location is identified as 776-205
776-250	1	S ^a	776-201, -204, & -250 vent into a common penthouse, but are still considered 3 release points. Upgraded to "significant" on 11/20/00 due to decommissioning work
776-251	1	S ^a	Upgraded to "significant" on 11/20/00 due to decommissioning work
776-252	1	S ^a	Upgraded to "significant" on 11/20/00 due to decommissioning work
Total	22		

^a These locations were insignificant between 1/01/00 and 11/19/00, but were proactively declared "significant" and assigned to the appropriate sampling schedule on 11/20/00 based on potential emissions associated with future decommissioning activities in this building.

Notes:

- S = Significant release point
- I = Insignificant release point

**Release Points
Historical (since 1995)**

Building/ Location	Number of Release Points	Regulatory Status	Notes
444-D05	1	I	Sampling discontinued on 1/14/00 in recognition of insignificant status
444-MAI	1	I	Sampling discontinued on 1/14/00 in recognition of insignificant status
447-MAI	1	I	Sampling discontinued on 1/14/00 in recognition of insignificant status
707-R21A/B	2	I	Sampling discontinued on 1/12/00 in recognition of insignificant status
707-R22A/B	2	I	Sampling discontinued on 1/12/00 in recognition of insignificant status
707-R23A/B	2	I	Sampling discontinued on 1/12/00 in recognition of insignificant status
707-R24A/B	2	I	Sampling discontinued on 1/12/00 in recognition of insignificant status
707-R25A/B	2	I	Sampling discontinued on 1/12/00 in recognition of insignificant status
707-R26A/B	2	I	Sampling discontinued on 1/12/00 in recognition of insignificant status
707-R27A/B	2	I	Sampling discontinued on 1/12/00 in recognition of insignificant status
707-R45A/B	2	I	Sampling discontinued on 1/12/00 in recognition of insignificant status
707-R46A/B	2	I	Sampling discontinued on 1/12/00 in recognition of insignificant status
771-CMA	1	I	Sampling discontinued on 1/17/00 in recognition of insignificant status
771-CRM	1	I	Sampling discontinued on 1/17/00 in recognition of insignificant status
778-LDY	1	I	Sampling discontinued in 1998
779-404	1	I	Sampling discontinued in 1999; building was demolished
779-405	1	I	Sampling discontinued in 1999; building was demolished
779-729	1	S	Sampling discontinued in 1999; building was demolished
779-782	1	S	Sampling discontinued in 1999; building was demolished
865-EEE	1	I	Sampling discontinued in 1999 in recognition of insignificant status
865-WWW	1	I	Sampling discontinued in 1999 in recognition of insignificant status
881-MA1	1	I	Sampling discontinued on 1/04/00 in recognition of insignificant status
881-MA2	1	I	Sampling discontinued on 1/04/00 in recognition of insignificant status
881-MA3	1	I	Sampling discontinued on 1/04/00 in recognition of insignificant status
881-MA4	1	I	Sampling discontinued on 1/04/00 in recognition of insignificant status
883-AAA	1	I	Sampling discontinued in 1999 in recognition of insignificant status
883-BBB	1	I	Sampling discontinued in 1999 in recognition of insignificant status
883-CCC	1	I	Sampling discontinued in 1999 in recognition of insignificant status
991-985	1	I	Sampling discontinued in 1998
991-MAI	1	I	Sampling discontinued in 1998
Total	39		

Notes:

- S = Significant release point
- I = Insignificant release point

Appendix D

**Effluent Information System (EIS) Data
2000**

Summary Table For The EIS/ODIS Report^{a,b}
2000-Release (Ci)

00_ODIS Location	ODIS Location Code	N	Effluent Volume (m ³)	Plutonium- 239	Americium-241 ^c	Uranium-233/234	Uranium-235	Uranium-238	Tritium
707-101	AFGHB707005	12	8.149E+06	3.307E-11	5.094E-11	1.214E-10	-8.220E-12	1.509E-10	--
707-102	AFGHB707006	12	2.321E+07	1.548E-10	3.171E-11	4.472E-10	2.785E-11	4.248E-10	--
707-105	AFGHB707003	12	7.812E+07	6.475E-10	5.244E-10	3.396E-09	1.931E-10	3.660E-09	--
707-106	AFGHB707001	12	3.458E+07	3.019E-09	3.382E-10	2.964E-10	-3.690E-11	7.597E-10	--
707-107	AFGHB707004	12	1.865E+08	9.393E-10	1.202E-09	2.384E-09	-1.623E-10	1.644E-09	--
707-108	AFGHB707002	12	1.059E+08	7.135E-10	3.550E-10	1.785E-09	4.400E-10	1.801E-09	--
776-201	AFGHE776003	12	6.748E+06	5.729E-11	4.708E-11	6.614E-11	2.201E-11	2.186E-10	--
776-202 ^c	AFGHE776008	3	7.576E+07	8.072E-11	2.912E-11	-2.543E-10	7.358E-11	-6.279E-10	--
776-204	AFGHE776005	12	1.628E+08	1.116E-09	7.154E-10	2.088E-09	6.114E-10	1.569E-09	--
776-205 ^d		12	2.263E+08	2.853E-09	1.288E-11	6.424E-09	-2.789E-10	5.300E-09	--
776-206T ^{c,f}	AFGHE776002		--	--	--	--	--	--	1.005E-03
776-250 ^c	AFGHE776001	3	3.934E+08	7.746E-09	6.525E-10	-3.768E-09	4.652E-09	1.673E-08	--
776-251 ^c	AFGHE776006	3	3.291E+08	1.713E-09	8.628E-10	-3.480E-09	-2.133E-10	-1.948E-09	--
776-252 ^c	AFGHE776007	3	8.708E+07	3.780E-10	1.109E-10	7.025E-10	2.738E-10	4.980E-10	--
559-561	AFGHA559001	12	5.834E+08	2.856E-09	2.016E-09	1.319E-08	-1.161E-09	9.187E-09	--
771-MAI	AFGHC771001	12	2.618E+09	1.371E-08	9.197E-09	2.783E-08	6.795E-09	2.400E-08	--
774-202	AFGHD774001	12	9.245E+07	6.634E-10	2.006E-10	2.602E-10	1.438E-10	8.888E-10	--
374-MAI	AFGHJ374001	12	3.076E+08	5.910E-09	6.901E-10	9.416E-09	1.850E-09	5.325E-09	--
371-NNN	AFGHC371001	24	4.481E+08	9.827E-09	3.401E-09	8.513E-09	4.200E-10	-3.851E-09	--
371-SSS	AFGHC371002	12	3.794E+08	1.103E-09	2.522E-10	4.419E-09	1.393E-10	3.165E-09	--
374-SPD ^f	AFGHD374002	1	7.393E+07	2.557E-09	1.164E-09	-4.453E-10	4.904E-11	4.119E-11	--
440-101 ^g		7	2.732E+07	1.487E-09	5.946E-10	1.180E-09	2.146E-10	6.873E-10	--
RFETS		205	6.220E+09	5.608E-08	2.185E-08	7.338E-08	1.383E-08	6.893E-08	1.005E-03

^a No longer report Pu-238.

^b Several locations were removed from this report, as sampling no longer was required or the building no longer exists.

^c Release point changed from insignificant to significant on 11/20/00.

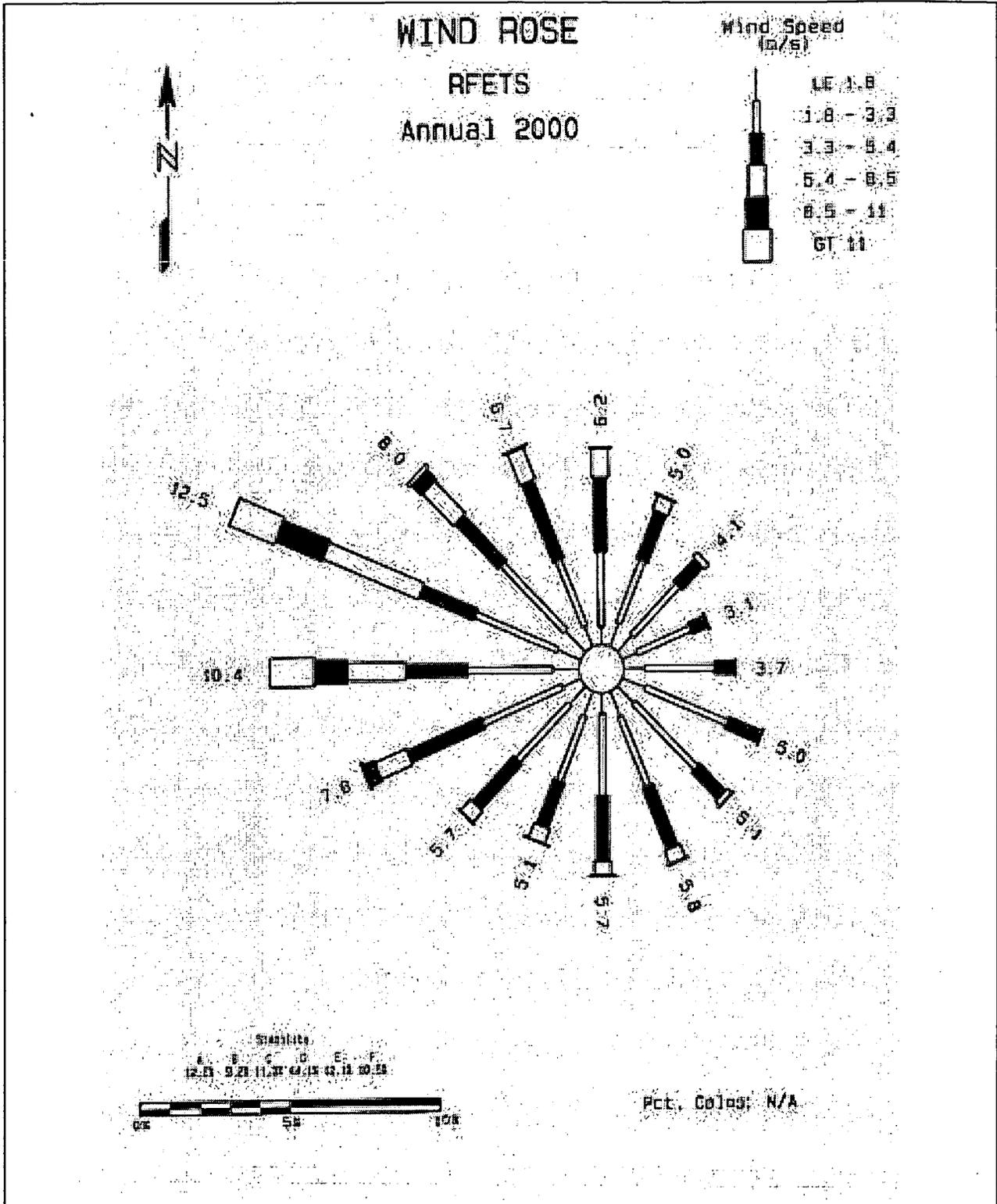
- ^d Release points 776-205, -206, and -207 are combined through a mixing plenum and are sampled with one shrouded probe identified as 776-205.
- ^e The tritium sampling occurs before the mixing plenum described in footnote d. The location name was altered to denote it as tritium sampling point.
- ^f Release point became inactive on 11/6/00.
- ^g Location 440-101 became inactive from 6/18/00 through 11/15/00, as its status changed during the year.

Notes:

- Ci = Curies
- EIS = Effluent Information System
- m³ = Cubic meters
- N = Number of filters analyzed
- ODIS = Off-Site Discharge Information System
- RFETS = Rocky Flats Environmental Technology Site
- = Not analyzed

Appendix E

Wind Frequency Distribution for 2000



Wind Frequency Distribution for 2000

Appendix F
Modeling Summary

MODELING SUMMARY

Model Description and Use

CAP88-PC is a dispersion and dose model that has historically been used for calculating EDE to both individual members of the public and to the surrounding population within 80 km of a DOE facility. The model simulates the dispersion of airborne radionuclide emissions from point and nonpoint (termed "area") sources to user-specified receptor locations, then calculates an annual, multipathway EDE for a person living or working at each specified receptor location. When combined with population distribution information, CAP88 estimates the collective dose to the surrounding population.

Summary of Model Input Data

The model accounts for dose received from Site emissions through inhalation and ingestion of radionuclides in air and deposited on the ground surface. To simulate pollutant dispersion and calculate dose, the model requires the following types of input data:

- Distance and direction from emission sources to receptor locations.
- Source release characteristics including stack locations, stack heights, exhaust gas velocities and temperatures, and the size of each stack or vent opening for point sources, and the size and location of each area source.
- The amount of each radioactive isotope released from each source.
- Meteorological data including the annual distribution of wind speed, wind direction, and atmospheric stability at the Site, and annual precipitation and temperature information. The model also requires information about the average height of regional temperature inversions (mixing height).
- Agricultural data used in calculating radionuclide ingestion rates including the location, distribution, and utilization of local sources of meat, milk, and vegetables.
- Miscellaneous data regarding the size and solubility of the particles emitted.

To calculate the calendar year 2000 collective dose, Site emissions (sum of all emissions shown in Tables 3-1, 3-2, and 3-3, by isotope) were modeled from a single area source located at the center of the Site. The source was assumed to have an area of $5.3 \times 10^6 \text{ m}^2$ (about 20% of the total Site area), release height of 0.0 m, and no momentum plume rise

(exit velocity of 0.0 m/s). These release characteristics were appropriate for the major source of radionuclide emissions in calendar year 2000, which was resuspension of contaminated soil.

Meteorological data for calendar year 2000 were collected from a tower located in the western portion of the Site (the tower location is shown in Figure 2-2). A joint frequency distribution of wind speed, wind direction, and stability was processed for input to CAP88-PC. A "wind rose" graphic representation of the meteorological data is shown in Appendix E.

Annual precipitation and temperature data collected on Site for 2000 show:

- Total precipitation in 2000: 33.07 centimeters (cm); and
- Annual average temperature: 10.44 °C.

An average mixing height for the Denver, Colorado, area of 1,405 m was used in the model (EPA, 1972).

The CAP88-PC model calculated EDEs over a polar coordinate receptor grid. The grid consisted of 16 compass sectors and eleven distances from the center of the Site: 3 km, 6 km, 10 km, 15 km, 20 km, 25 km, 30 km, 40 km, 50 km, 65 km, and 80 km. CAP88-PC estimates an EDE at the midpoint of each grid cell, then multiplies each EDE by the population within the grid cell to calculate collective dose. Population data for the 2000 census were obtained, organized by census tract, and each whole or partial census tract within 80 km of the Site was assigned to a grid cell to generate the population distribution file.

Model default values were used for the median aerodynamic diameter (1.0 micrometers) and solubility class. Urban agricultural data were used in the model. Default values were also used for the origin of food products. The shortest distance between a Site radionuclide release point and farmland producing agricultural products is 720 m for beef cattle, 1,063 m for dairy cattle, and 1,063 m for cropland.

The total collective dose was calculated as the sum of the contributions from Pu-239/240, Am-241, U-233/234, U-235, and U-238.