

U.S. Department of Energy

Radionuclide Air Emissions Annual Report for Calendar Year 1997

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, 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. 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).

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.

The 1997 air dose due to Site activities was determined using the EPA-approved CAP88-PC dispersion model to simulate transport of emissions from buildings and contaminated soils at the Site. The dose was calculated for the most impacted off-Site resident. The EDE for the 1997 calendar year to the maximally exposed individual was 0.004 mrem, which is less than one percent of the standard. Individuals living or working at other off-Site locations received a lower dose.

In 1997, the major contributors to dose were resuspension of contaminated soils by wind and activities that disturbed contaminated soils. Project emissions and wind-blown soil contamination accounted for over 99% of the maximum off-Site EDE. In contrast, the combined emissions from Site buildings contributed less than one percent to the maximum 1997 off-Site dose. The 1997 dose was dominated by plutonium and americium isotopes present in contaminated surface soil downwind of the 903 Pad and in the soils handled in backfill operations at the Sewage Treatment Plant.

These results are consistent with the patterns seen in previous years. In 1996, over 97% of the maximum off-Site dose was attributable to remediation and other cleanup activities that disturbed contaminated soil and sludge. In 1995, approximately 95% of the

maximum off-Site dose resulted from wind-blown soil and other soil disturbances.

As cleanup of the Site continues, the Site air emission and dose profile will be increasingly dominated by projects that disturb contaminated soil or debris. In many cases, these cleanup activities will involve much smaller amounts of radionuclides than are stored or handled inside Site buildings. However, the nature of remediation and other cleanup activities is such that emissions cannot be reduced to the same extent as emissions from activities taking place under controlled conditions inside structures.

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**ADDENDUM TO RADIONUCLIDE AIR EMISSIONS ANNUAL REPORT,
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Abbreviations and Acronyms

Am	Americium
ANSI	American National Standards Institute
ARM	Alternate Reference Methodology
Ave	Avenue
Blvd	Boulevard
Bq	Becquerel(s)
CAP88-PC	Clean Air Act Assessment Package-1988 (Version 1.0)
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/m³	Curies per cubic meter
Ci/yr	Curies per year
cm	Centimeter(s)
COV	Coefficient of variation
CWTS	Caustic Waste Treatment System
DOE	U.S. Department Of Energy
E	East
EDE	Effective dose equivalent
EIS	Effluent Information System
ENE	East-northeast
EPA	U.S. Environmental Protection Agency
ESE	East-southeast
GIS	Geographic information system
HEPA	High efficiency particulate air (filter)
H-3	Tritium
IHSS	Individual Hazardous Substance Site

Abbreviations and Acronyms (continued)

km	Kilometer(s)
km²	Square kilometer(s)
LLW	Low-level waste
m	Meter(s)
m²	Square meter(s)
m³	Cubic meters(s)
MEI	Maximally exposed individual
mrem	Millirem
m/s	Meters per second
mSv	MilliSievert(s)
N	North
NE	Northeast
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NNE	North-northeast
NNW	North-northwest
NW	Northwest
ODIS	Off-Site Discharge Information System
Pu	Plutonium
RAAMP	Radioactive Ambient Air Monitoring Program
RCRA	Resource Conservation and Recovery Act
Rd	Road
rem	Roentgen equivalent man
RES	Representative Effluent Sampler
RFCA	Rocky Flats Cleanup Agreement
RFFO	Rocky Flats Field Office
S	South
SE	Southeast

Abbreviations and Acronyms (continued)

Site	Rocky Flats Environmental Technology Site
SNM	Special nuclear material
SSE	South-southeast
SSW	South-southwest
St	Street
Sv	Sievert(s)
SW	Southwest
T-3	Trench 3
T-4	Trench 4
TDU	Thermal desorption unit
TRU	Transuranic
U	Uranium
USC	United States Code
VOC	Volatile organic compound
W	West
WNW	West-northwest
WSW	West-southwest
μm	Micrometer(s)
°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 calculate the EDE 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 1997 calendar year.

Attached to this report is an addendum to the *Calendar Year 1996 Radionuclide Air Emissions Annual Report* (DOE, 1997). Information developed subsequent to the submission of the 1996 report indicated that the radionuclide release from one of the projects discussed in that report (the draining of underground storage tanks near Building 774) was greater than originally estimated. The addendum discusses the new information and revises the calendar year 1996 maximum public dose estimate from 0.182 mrem to 0.3 mrem, approximately three percent of the 10 mrem standard.

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 1997 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 modifications in 1997.

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 (Pu), uranium (U), 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, approximately 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 2.1 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

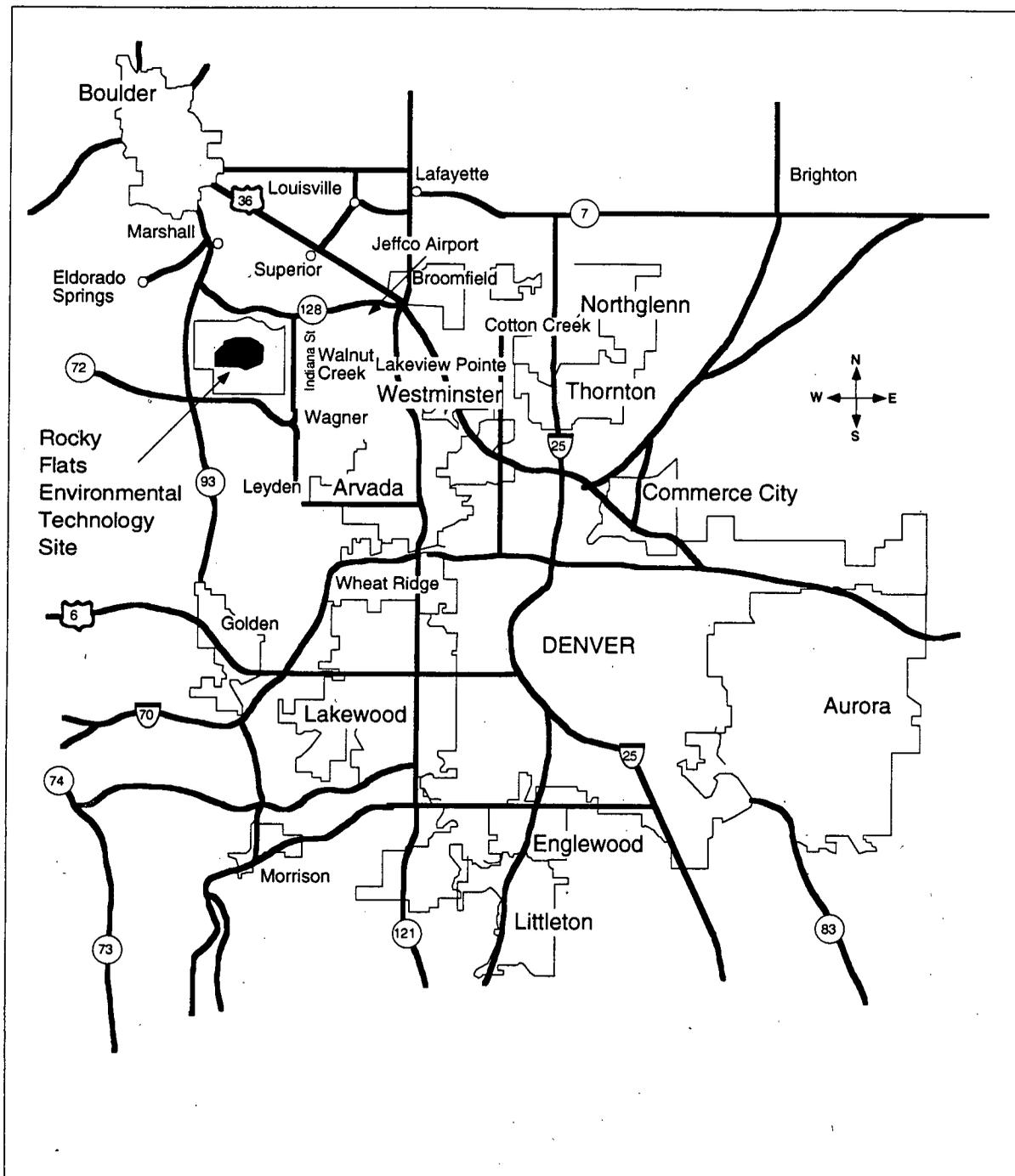


Figure 2-1. Area Map of the Rocky Flats Environmental Technology Site and Surrounding Communities

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.

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 was involved with 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, cleanup, radioactive residue stabilization, 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 1997

In 1997, radionuclide emissions from the Site occurred from several activities that either disturbed resident contamination in buildings or in soil, or that processed or used

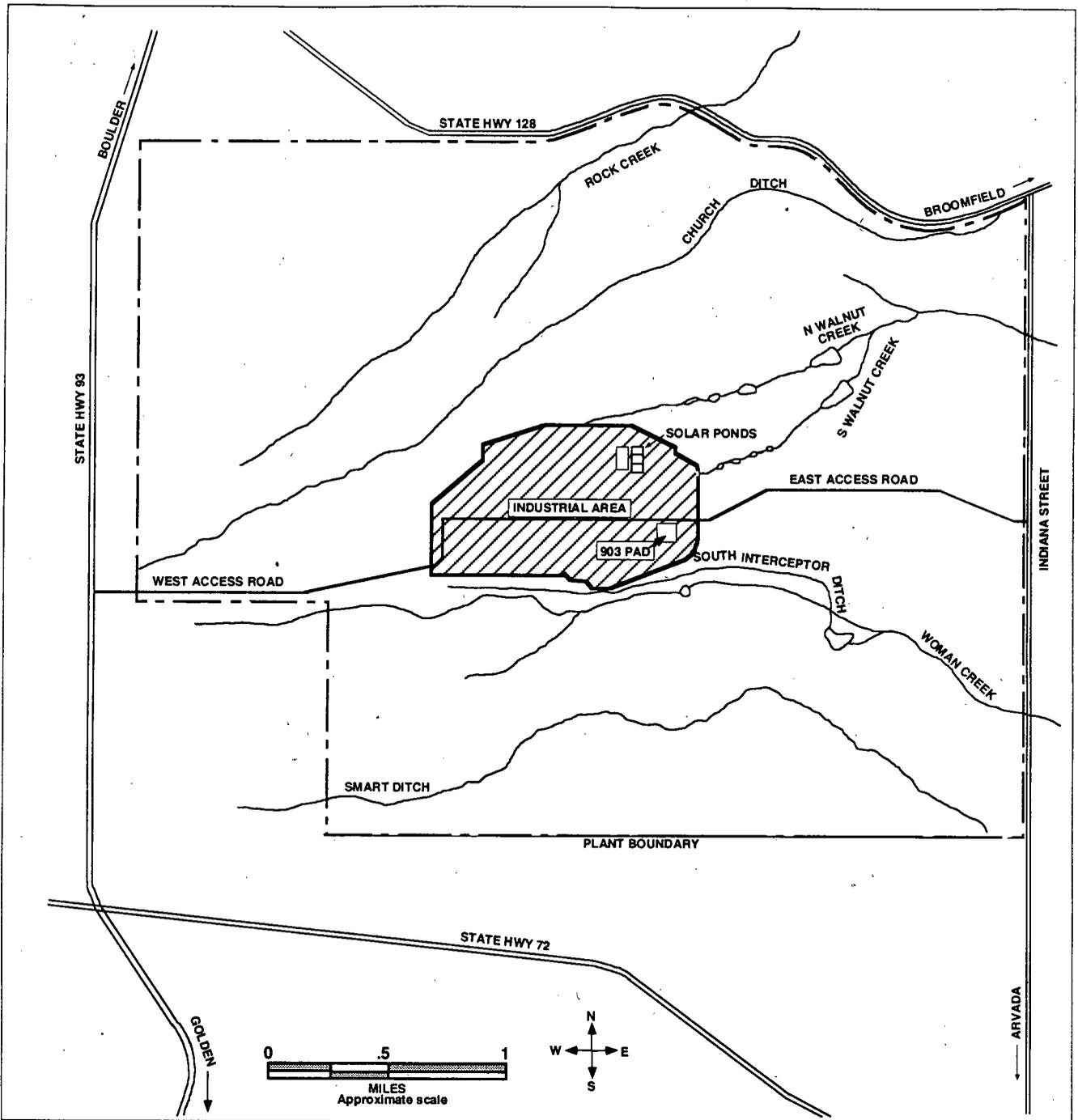


Figure 2-2. Rocky Flats Environmental Technology Site Location Map

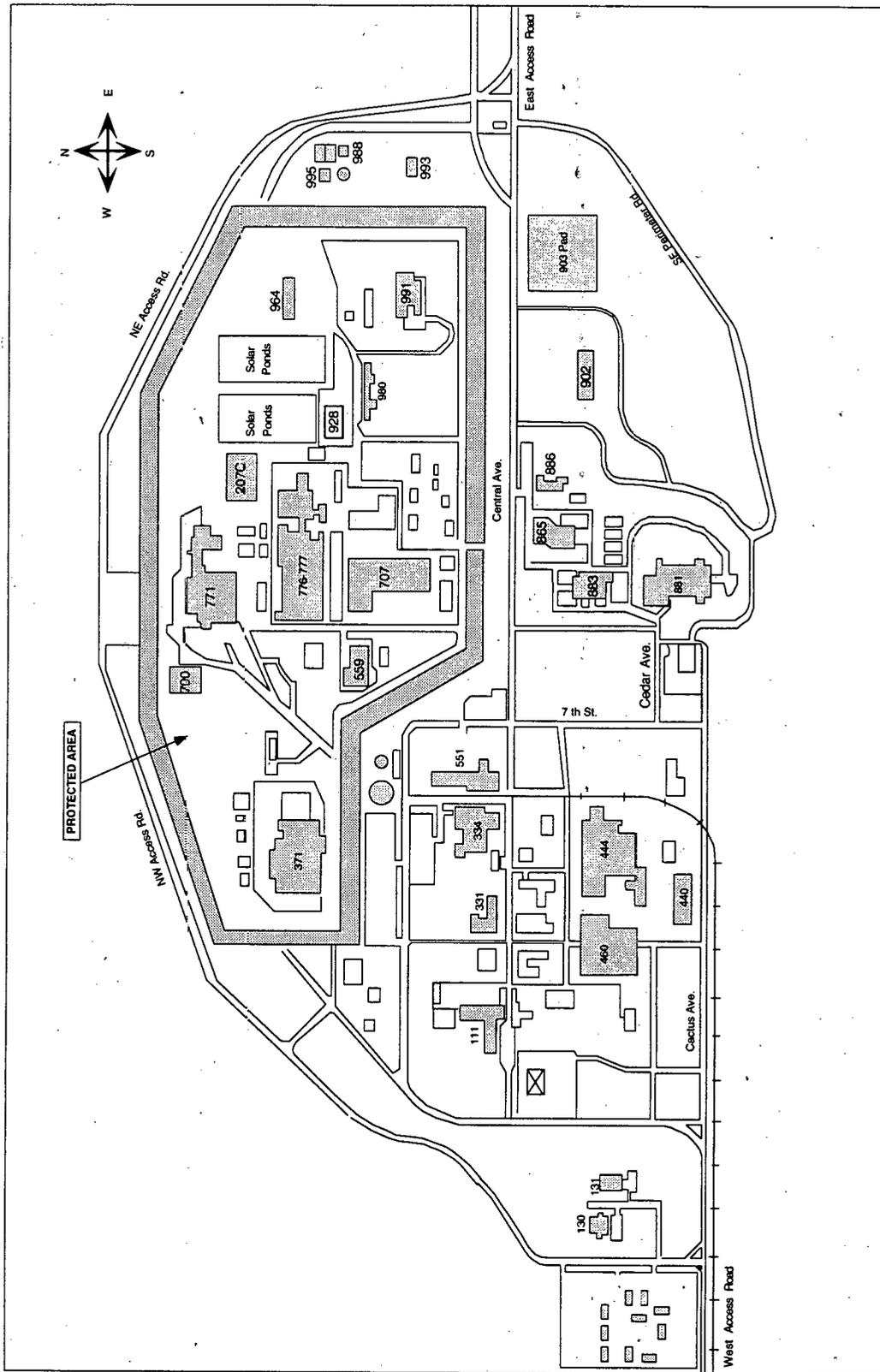


Figure 2-3. Central Portion of the Rocky Flats Environmental Technology Site

radionuclide-containing substances such that emissions to the atmosphere resulted. Appendix A lists radioactive materials associated with the Site. The list of radionuclides includes Pu-239/240, americium (Am) -241, U-233/234, U-235, U-238, and tritium. 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 1997, with resulting radionuclide emissions, are described below.

Hold-up in Ducts

Radionuclide emissions were generated through disturbance of contaminant radionuclide 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 1997, 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 1997 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.

Waste Handling and Storage

Packaged low-level, low-level mixed, and TRU wastes are commonly stored in drums at various locations on the Site. In 1997, many drums were vented to prevent pressure buildup from hydrogen gas generated as a product of the reactions associated with

radioactive decay of 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 function 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 of 40 CFR 61).

To reduce waste volumes and to comply with waste storage and shipping requirements, some drums of waste were repackaged in 1997 following waste material separation and consolidation. In addition, some waste forms, including contaminated gloveboxes and duct work, were segregated and size reduced prior to packing for storage and disposal. Such activities exposed the radioactive contamination in the waste to the atmosphere, with resulting emissions.

Radioactive wastes were handled (segregated, size reduced, and repackaged) inside enclosed structures. Emissions from these operations were controlled by venting the air through HEPA filters.

Consolidation of Special Nuclear Material (SNM)

SNM is plutonium and enriched uranium contained in weapons parts, metal and alloy, and oxide. Calendar year 1997 consolidation activities related to SNM 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 to accommodate storage containers by breaking, cutting, sawing, and pressing.
- **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 1997 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 Treatment Projects

Radionuclide emissions were generated in 1997 from waste characterization, research and development activities related to waste processing, and waste treatment projects. Most of the treatable 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.

Laboratory-scale and pilot-scale research and development projects are ongoing at the Site in support of proposed waste treatment plans. Proposed technologies and treatment systems that were evaluated in 1997 included thermal stabilization and cementation. In addition, a program to sample and characterize plutonium-containing residues so that decisions can be made regarding the final disposition of the materials was initiated in 1995 and continued during 1996 and 1997. Other treatability studies, which were initiated in 1996 and continued during 1997, were conducted to determine the physical and chemical changes that occur to radionuclide-containing ash residues as they are heated to various temperatures. The waste treatment-related activities that occurred in 1997 took place in areas where ventilation air was exhausted through HEPA filters.

Waste treatment operations that took place in 1997 included electrolytic decontamination of uranium hemishells and treatment of reactive chemicals. In addition, leaded rubber glove washing continued in 1997 to remove potentially reactive, yellow crystalline lead nitrate substances that were produced from the reaction of nitric acid and lead oxide on the gloves. This operation was performed within the Building 776 Advanced Size Reduction Facility's Barrel Dump Glovebox that exhausted through four stages of HEPA

filters. Emissions from decontamination of uranium hemishells were also controlled with HEPA filters, as were emissions from some, but not all, of the reactive chemical treatment projects that took place in 1997.

Remediation Projects

As cleanup of the Site continues, remediation activities also contribute to the resuspension of contaminated soils and debris. In 1997, remediation activities at the Site included excavation, handling, and thermal treatment of contaminated soil, as well as heavy equipment traffic. Emissions from these activities were controlled using dust suppression techniques and HEPA filtration, where feasible.

Miscellaneous Nonpoint Sources

Another contributor to Site radionuclide emissions in 1997 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. Emissions generated by wind erosion were uncontrolled, while radionuclide emissions from vehicle traffic and mechanical disturbances were generally controlled using dust suppression techniques.

In addition to the resuspension of contaminated soils, one other nonpoint source contributed to Site radionuclide emissions in 1997. The drum crushing operation initiated in 1996 within the Protected Area continued during 1997. This operation created small amounts of radionuclide emissions by disturbing low levels of radiological contamination on the drum surfaces. This operation was described in greater detail in the calendar year 1996 annual report (DOE, 1997).

2.2.2 New Construction and Modifications in Calendar Year 1997

Thirteen new or modified activities that contributed to the Site air pathway dose began operation during the 1997 calendar year.

As part of the project evaluation process, the maximum annual (controlled) off-Site EDE expected from each new or modified activity was estimated to determine approval and notification requirements. Expected radionuclide emissions were calculated using

emission and control factors from Appendix D of 40 CFR 61, combined with information regarding radionuclide contaminant levels and material forms, radionuclide release mechanisms, and the radionuclide emission controls employed. Emissions were modeled using the Clean Air Act Assessment Package-1988 (CAP88-PC), Version 1.0, and recent Site meteorological data to estimate annual EDEs at the nearest off-Site residence and business locations. For emissions that were subsequently collected and measured, the measured radionuclide concentrations were used to calculate the 1997 air pathway dose, as described in Sections 3.0 and 4.0 of this report.

The detailed data and calculations used to develop emission estimates and resulting dose projections are maintained in Site files. The project- or process-specific EDEs used in making regulatory applicability decisions regarding approval requirements are reported below.

For each new construction or modification in 1997, the estimated EDE (shown below) was less than one percent of the 10 mrem (0.1 mSv) standard, and construction approval and startup notification were unnecessary under 40 CFR 61.96. In addition, several 1997 projects were undertaken in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). CERCLA projects are exempt from the administrative requirements of other regulations, including requirements for preconstruction approval or notification.

The 1997 new or modified activities are described below. (Emissions used in calculating the 1997 off-Site dose, as well as the location for each activity, are discussed in Sections 3.0 and 4.0 of this report.)

Sewage Treatment Plant Phase III Upgrade: Installation of two partial in-ground concrete storage tanks at the Sewage Treatment Plant was completed in 1996. During excavation, radionuclide contamination was found in soils surrounding a vitrified clay waste line that ran through the area where the storage tanks were to be installed. Approximately 115 cubic meters (m³) of soil contaminated with radionuclides were excavated from this area and placed in 10 roll-off containers. With the exception of one container (C5), the radionuclide concentrations in the soil did not exceed the Rocky Flats Cleanup Agreement (RFCA) Tier II action levels. (RFCA is a negotiated, interagency agreement governing CERCLA and Resource Conservation and Recovery Act [RCRA]

cleanup activities at the Site. RFCA defines Tier I and Tier II action levels based on concentrations of various contaminants in soil or water, 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.)

In 1997, all of the soil that was below the RFCA Tier II action levels (approximately 99 m³) was used as additional backfill around the tanks. The off-Site EDE from this activity was calculated based on the volume of contaminated soil handled, the maximum levels of radionuclides measured in the roll-off containers (other than C5), radionuclide emission factors from Appendix D of 40 CFR 61, and fugitive dust emission factors from a DOE handbook (DOE, 1994). The maximum annual off-Site EDE from this project was estimated to be 1.1×10^{-3} mrem (1.1×10^{-5} mSv) (the backfill operation did not employ radionuclide controls).

Low-Level Waste Repackaging: During 1997, repackaging of low-level waste was conducted within a containment structure at the 750 Pad, called the Tent 5 Permacon®. This repackaging operation was performed to bring the packaging into conformance with shipping requirements and waste acceptance criteria. The off-Site EDE from repackaging operations was calculated assuming a maximum of 2,000 drums of waste, containing a maximum plutonium concentration of 100 nanocuries per gram (approximately 0.5 grams of plutonium per drum), would be processed in 1997.

The wastes were sorted in a glovebag located within the Tent 5 Permacon®. Effluent from Tent 5 exhausted through a single HEPA filter. The maximum annual (controlled) off-Site EDE from the low-level waste repackaging project was estimated to be 4.0×10^{-5} mrem (4.0×10^{-7} mSv).

HEPA Filter Sampling: During 1997, used HEPA filters were sampled within the Tent 5 Permacon® on the 750 Pad to characterize the filters for potential radionuclide and hazardous material contamination. The HEPA filters were individually wrapped in plastic, and no more than 12 filters were present in the Tent 5 Permacon® at any one time. HEPA filters were unwrapped and sampled one at a time. Emissions were generated through exposure of contaminated filter surfaces to the air and possible disturbance of contamination by the sampling process. Each HEPA filter contained a

maximum plutonium concentration of 100 nanocuries per gram, and 63 filters were sampled in 1997.

Effluent from Tent 5 exhausted through a single HEPA filter. The maximum annual (controlled) off-Site EDE for the HEPA filter sampling operations was estimated to be 2.0×10^{-6} mrem (2.0×10^{-8} mSv).

Steam Line Between Buildings 549 and 559: A steam line that runs adjacent to but outside of the Protected Area, between Buildings 549 and 559, was excavated for inspection and repair during calendar year 1997. The size of the excavation measured approximately 3 m by 3 m by 1.8 m deep and was located within several radiological Individual Hazardous Substance Sites (IHSSs). Based on surface soil sampling data, the soil was potentially contaminated with plutonium and americium at levels below the RFCA Tier II action levels. The project used tarps and dust suppressants to control particulate emissions and associated radionuclide emissions from the stockpile.

The off-Site EDE was calculated based on the maximum amount of soil excavated/backfilled (17 m^3), RFCA Tier II plutonium and americium levels, radionuclide emission factors from Appendix D of 40 CFR 61, and fugitive dust emission factors from a DOE handbook (DOE, 1994). The maximum annual (controlled) off-Site EDE from this project was estimated to be 3.8×10^{-6} mrem (3.8×10^{-8} mSv).

Remediation of the Mound Site, IHSS 113: Between April 1954 and September 1958, the Mound Site, IHSS 113, was used as a disposal site for approximately 1,405 drums containing depleted uranium, beryllium, hydraulic oil, carbon tetrachloride, perchloroethylene, and low levels of plutonium. Prior to the removal of the drums in 1970, some of the drums leaked and contaminated approximately 300 to 750 m^3 of soil, primarily with volatile organic compounds (VOCs). In 1997, the contaminated soil was excavated from the Mound Site and treated in a thermal desorption unit (TDU) to remove VOCs.

The on-Site mobile TDU heated the contaminated soils to a temperature between 49 and 371°C, sufficient to volatilize the VOCs. The offgases were passed through a 3.0 micrometer (μm) air filter, cooled in a condenser, and finally passed through a HEPA

filter. During soil excavation and handling, water spray was used to control fugitive dust emissions. Chemical dust suppressants were used to control fugitive dust emissions generated from wind erosion of soil stockpiles.

The off-Site EDE was calculated based on the maximum soil volume, maximum radionuclide contamination levels, and emissions from four activities: excavating, stockpiling, thermal treatment, and backfilling soil. Emission factors for these activities were obtained from Appendix D of 40 CFR 61 and from EPA-approved reference materials (EPA, 1995). The maximum annual (controlled) off-Site EDE from the Mound Site remediation project was estimated to be 4.2×10^{-5} mrem (4.2×10^{-7} mSv).

“Hot Spot” Removal from the Mound Site: As part of the Mound Site backfilling operations discussed above, approximately 0.75 m^3 of soil that originated from the Trench 3 and Trench 4 (T-3/T-4) remediation project conducted in 1996 was also placed into the Mound Site excavation as backfill. Based on initial sampling results, this soil was originally determined to be below the RFCA Tier II subsurface soil action levels for radionuclides and could be used as backfill for the Mound Site. However, after soil was placed and backfilling was complete, it was determined that the initial analyses were in error and reanalysis of the samples indicated that the soil was actually above the Tier I subsurface soil action levels.

As a result, a decision was made to remove the soil “hot spot” from the Mound Site. In 1997, approximately 2.3 m^3 of soil were removed from the excavation and placed into two half crates. This soil was shipped off Site for final disposition. Subsequent sampling of the area around the “hot spot” was also conducted to ensure that all of the contaminated material was removed.

The off-Site EDE from this activity was calculated based on the volume of contaminated soil handled, the maximum levels of radionuclides measured in the soil, radionuclide emission factors from Appendix D of 40 CFR 61, and fugitive dust emission factors from a DOE handbook (DOE, 1994). The maximum annual off-Site EDE from this project was estimated to be 8.0×10^{-5} mrem (8.0×10^{-7} mSv) (the “hot spot” removal did not employ radionuclide controls).

Raschig Ring Removal: In 1997, approximately 6,000 liters of radionuclide-contaminated Raschig rings were removed from nine, "operationally empty," highly enriched uranyl nitrate tanks in Building 886. Each of these tanks had previously been drained and contained only residual amounts of uranyl nitrate solutions. Prior to removing the Raschig rings, each tank was physically isolated from the other tanks and from all other sources from which solution could enter the tanks. The Raschig rings were then removed in accordance with Site procedures.

Effluent from Building 886 was exhausted through four stages of HEPA filters. Due to the small amount of residual contamination on the Raschig rings, an EDE was not calculated for this process. However, maximum controlled emissions were expected to be well below the 0.1 mrem (0.001 mSv) approval threshold.

Decontamination of Enriched Uranium Hemishells: An electrolytic decontamination process was performed in Building 707 during 1997 to remove a minute layer of plutonium from the outer surface of enriched uranium hemishells. Through this decontamination process, approximately 20 to 25 grams of enriched uranium and 2 milligrams of plutonium were removed from each hemishell. One of the by-products of the process was a precipitated sludge containing enriched uranium, nitrate salt, and plutonium contamination. For handling and disposal purposes, the sludge was dried in a pan on a hot plate at a maximum temperature of 200°C. Emissions were estimated assuming a maximum of 320 hemishells would be decontaminated during 1997.

In 1996, EPA provided guidance by granting approval to the DOE, RFFO for an alternate procedure for estimating source terms (particulate solid or liquid) for three projects that heated plutonium-contaminated residues to temperatures up to 1,000°C (McGraw, 1996). Based on the similarities between the sludge drying portion of the electrolytic decontamination process and the residue stabilization processes, and the relatively low hot plate temperature (maximum of 200°C), EPA and CDPHE agreed that the previously negotiated emission factor was also valid for the electrolytic decontamination project (Patnoe, 1997). The decontamination process and sludge drying were conducted within a glovebox that exhausted through four stages of HEPA filters. Based on the maximum throughput of hemishells, the maximum amount of uranium and plutonium removed from each hemishell, and the alternate procedure for estimating the

source term, the maximum annual (controlled) off-Site EDE from the electrolytic decontamination project was estimated to be 7.7×10^{-7} mrem (7.7×10^{-9} mSv).

Actinide Solution Processing: In 1997, approximately 4,300 liters of actinide solutions, containing up to 150 grams of plutonium per liter, were transported from Building 771 to Building 371 to be treated in the existing Caustic Waste Treatment System (CWTS). The actinide solutions were drained from the Building 771 tanks into bottles, packaged into drums, and shipped to Building 371, where the solutions were vacuum pumped into the CWTS holding tanks. Because the maximum processing level for the CWTS is 6 grams of plutonium per liter, the Building 771 actinide solutions remained in the holding tanks for dilution with other actinide solutions that were already being processed through the CWTS. During calendar year 1997, only transport of the Building 771 actinide solutions to Building 371 was completed. Actual processing of the Building 771 actinide solutions through the CWTS is scheduled for calendar year 1998.

The effluent from both Building 771 and Building 371 was exhausted through at least four stages of HEPA filters. Because the transfer of the actinide solutions was a relatively closed process and treatment of the solutions did not take place in 1997, no EDE was calculated for this project for calendar year 1997. However, maximum controlled emissions from the actinide solution transfer operations were expected to be well below the 0.1 mrem (0.001 mSv) approval threshold.

Decontamination of Building 371, Room 3559: Room 3559 in Building 371 was decontaminated during 1997 using a hydrolaser high pressure water sprayer. The walls and floor of Room 3559 were contaminated with a total of 195 grams of plutonium. The water collected from the decontamination process was treated through the existing CWTS in Building 371. Effluent from Room 3559 was exhausted through four stages of HEPA filters. Based on the maximum contamination levels and radionuclide emission factors from Appendix D of 40 CFR 61, the maximum annual (controlled) off-Site EDE from the decontamination process was estimated to be 4.1×10^{-5} mrem (4.1×10^{-7} mSv).

Treatment of Reactive Chemicals: During 1997, small quantities of potentially reactive chemicals were treated to stabilize the chemicals for final disposal. Most of the reactive chemical treatment operations were conducted within fume hoods, although some were conducted outdoors. Due to the location of many of these chemicals, they were

considered to be radioactive by default. However, radiological surveys conducted prior to treatment did not reveal any detectable quantities of radioactive contamination.

Therefore, emissions of radionuclides from the treatment of reactive chemicals, if any, were expected to be well below the 0.1 mrem (0.001 mSv) approval threshold.

RCRA Closure of Wastewater Tank Systems: As part of a RCRA closure agreement, a series of wastewater tank systems located in Buildings 866 and 883 were drained, rinsed, and/or dismantled in 1997 to prepare them for disposal or to render them "RCRA stable." Nine tanks were completely drained, dismantled, size reduced, and packaged for disposal. Five additional tanks were not dismantled, but were drained and rinsed for RCRA closure. The uranium contained in the sludge of two of these tanks was precipitated out of solution and the liquor was pumped to the Building 374 Waste Water Treatment Facility for treatment and disposal. The residual precipitate was pumped into 55-gallon drums for disposal. The other three tanks were triple-rinsed and the rinsate was also pumped to the Building 374 Waste Water Treatment Facility for treatment and disposal.

Although the effluent from the tank rinsing and dismantling activities was exhausted through at least one stage of HEPA filtration, the maximum annual off-Site EDE was estimated based on uncontrolled emissions because the exact location of some of the proposed activities was subject to change. Based on the maximum uranium and plutonium levels in each tank and radionuclide emission factors from Appendix D of 40 CFR 61, the maximum annual off-Site EDE was estimated to be 2.0×10^{-4} mrem.

Strip-out and Demolition of Modules D, E, and F in Building 707: Activities involved in the strip-out and demolition of Modules D, E, and F in Building 707 were conducted during 1997. The 1997 activities consisted of the removal of glovebox equipment. Size reduction of equipment was performed using a Sawz All™.

Prior to removal and size reduction, a stripcoat decontamination material was applied to the equipment surfaces to reduce the contamination levels. The stripcoat decontamination material controlled 90% of the potential emissions of removable contamination and material hold-up on the surfaces by removing contaminant particles or

by sealing them to the equipment surfaces. Effluent streams from Modules D, E, and F were exhausted through four stages of HEPA filters.

The strip-out and demolition of each module was conducted as a separate project, and radionuclide emissions were calculated for each activity based on contamination levels in or on the equipment affected. The following maximum annual (controlled) off-Site EDEs were estimated for the strip-out and demolition activities: Module D, 3.9×10^{-6} mrem (3.9×10^{-8} mSv); Module E, 2.7×10^{-6} mrem (2.7×10^{-8} mSv); and Module F, 2.3×10^{-6} mrem (2.3×10^{-8} mSv).

3.0 AIR EMISSIONS DATA

This section discusses and quantifies radionuclide emissions from the Site for calendar year 1997. 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 the radionuclide emissions used in determining Site compliance with the annual 10 mrem (0.1 mSv) public dose standard for calendar year 1997. In most cases, air effluent exiting buildings through stacks or vents was continuously sampled and radionuclide emissions measured in 1997. Where such data were available, the measured emissions were used in compliance modeling (discussed in Section 4.0 of this report). 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.

As described in Section 2.2.2, expected radionuclide emissions must be evaluated for proposed new or modified sources of radionuclide air emissions to determine compliance requirements and to evaluate the need for additional controls. For projects or processes whose emissions were not subsequently measured, this initial emission estimate was used for the annual Sitewide compliance demonstration modeling, as long as the project or process was conducted consistent with the assumptions on which the initial emission estimate was based.

Where emissions reported in this section were calculated, 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; and
- Process- or activity-specific emission factors.

Emission factors were derived from several sources. Radionuclide emission factors listed in Appendix D of 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* (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 the emission estimates calculated for 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 Sitewide surface soil concentrations of radionuclide contaminants with a Site-specific soil resuspension factor. The development of the Site-specific soil resuspension rate 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. No new soil samples were added to the database in 1997; therefore, the soil resuspension emissions for 1997 were the same as those reported in the 1996 calendar year report.

3.2 Point Sources

Radionuclide emissions released through stacks and vents are termed "point" sources. In

calendar year 1997, radionuclide point sources at the Site included releases from buildings in the industrial area, as well as emissions from HEPA filter sampling and low-level waste repackaging in Tent 5 at the 750 Pad, and thermal desorption of contaminated soils excavated from the Mound Site.

Point source emissions for calendar year 1997 and the control technology used on each point source are described in this section.

3.2.1 Measured Point Source Emissions

During 1997, 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 one percent 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).

Point sources 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 1997. Following collection, the filters were screened for long-lived alpha and beta radiation to check for elevated radionuclide emissions.

Following alpha/beta screening, the samples were composited by location and analyzed for plutonium, uranium, and americium isotopes. All radionuclides that could contribute greater than 10% of the potential EDE for a release point were measured. Monthly composites were analyzed for each significant location. An annual composite was analyzed for each insignificant location.

Tritium, which is emitted as a gas, is also sampled continuously at some locations. 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.

Due to the complexity of the building ventilation systems at the Site, the number of sampling probes used is not a one-to-one match with the number of release or emission points. In some cases, effluent streams that are sampled separately are combined prior to release to the atmosphere. At other locations, a single probe may monitor an effluent stream that is released through multiple stacks or vents.

In calendar year 1997, particulate samples were collected at 52 locations representing 57 release points. Through the month of July 1997, 23 of these sampling locations were identified as significant locations. Due to changes in activities or material handled, three of these locations became insignificant in August; the specific locations are indicated in Table 3-1. Particulate emissions were also measured at 29 additional insignificant point source locations in 1997. Measured emissions of plutonium, uranium, and americium for 1997 are shown in Table 3-1.

In calendar year 1997, 18 particulate sampling locations were upgraded to single-point shrouded probe sampling systems as required by a 1994 agreement between DOE and EPA (Brockman, 1995). Data from the new samplers were used for the 1997 data set when a complete month of samples had been collected and analyzed. Data from the following shrouded probe systems were used in the 1997 data set: 374-MAI and 559-561, November and December; 771-MAI and 774-202, December.

Five emission points were also sampled for tritium, as indicated in Table 3-1.

Low emissions were verified in accordance with 40 CFR 61.93(b)(4)(i) using alternate measurement methods at several locations that did not require continuous monitoring or sampling in 1997. In Building 991, locations 985 and MAI, the samplers only ran during January, yet filters were exchanged and samples collected monthly for the entire year. The samples were composited for an annual analysis. The calculated emissions shown in Table 3-1 have therefore been annualized using a measured concentration based on January sampler flow.

In Building 778, location 778-LDY (also an insignificant release point), there was no effluent flow through the duct during 1997. However, the samplers continued to

Table 3-1.

Measured Point Source Radionuclide Emissions for Calendar Year 1997

Building/ Location ^a	Isotope Emissions (Ci/yr) ^{b, c, d}					
	Pu-239/240	Am-241	U-233/234	U-235	U-238	H-3
Significant Release Points						
371-N01	1.44 E-09	3.35 E-10	- 4.29 E-09	7.00 E-10	- 1.54 E-09	--
371-N02	2.92 E-09	7.33 E-10	- 1.67 E-09	7.92 E-10	- 1.17 E-09	--
371-SSS	7.55 E-10	- 8.67 E-12	4.64 E-10	8.46 E-11	1.08 E-09	--
374-MAI ^e	2.03 E-08	2.19 E-09	- 3.33 E-09	1.42 E-09	8.05 E-10	--
559-561 ^e	4.42 E-09	7.06 E-11	8.82 E-09	6.15 E-10	8.51 E-09	--
707-101	3.44 E-10	8.75 E-11	- 1.26 E-10	2.16 E-11	- 2.49 E-10	--
707-102	3.56 E-10	- 1.42 E-10	- 1.38 E-09	- 4.03 E-11	- 4.17 E-10	--
707-105	2.31 E-10	- 7.56 E-11	- 2.53 E-10	- 4.30 E-13	- 5.15 E-11	--
707-106	1.78 E-10	8.52 E-11	- 4.36 E-10	3.12 E-11	- 6.55 E-10	--
707-107	1.99 E-10	- 4.15 E-11	- 2.55 E-10	2.84 E-10	- 6.66 E-10	--
707-108	6.46 E-10	8.88 E-11	- 4.69 E-10	- 1.98 E-11	- 6.77 E-10	--
707-R45A/B ^f	8.40 E-10	3.31 E-10	- 2.85 E-09	- 3.69 E-12	- 1.67 E-10	--
771-MAI ^e	1.04 E-07	6.90 E-09	- 1.84 E-07	- 6.44 E-09	- 1.92 E-07	--
774-202 ^e	1.28 E-09	2.21 E-10	- 1.87 E-10	8.50 E-11	2.15 E-10	--
776-201	5.46 E-10	4.63 E-11	1.54 E-10	3.24 E-11	9.08 E-11	--
776-202 ^f	3.31 E-09	4.01 E-09	- 5.67 E-10	5.95 E-11	- 4.88 E-10	--
776-204	3.01 E-09	3.71 E-11	- 5.69 E-10	3.89 E-10	2.49 E-11	--
776-205	1.18 E-09	5.12 E-10	- 5.78 E-10	- 1.27 E-10	- 7.80 E-10	1.40 E-04
776-206	3.39 E-09	1.27 E-09	- 9.20 E-10	- 1.15 E-10	8.48 E-10	8.80 E-04
776-207	1.54 E-09	1.10 E-10	- 6.30 E-10	3.31 E-10	- 8.27 E-10	--
776-250 ^f	2.06 E-08	- 2.98 E-09	4.23 E-08	1.69 E-09	5.12 E-08	1.00 E-03
779-729	7.16 E-10	- 3.36 E-10	- 1.15 E-09	- 1.77 E-10	- 5.42 E-10	--
779-782	5.67 E-09	- 9.51 E-10	- 4.48 E-09	5.73 E-10	1.39 E-09	1.27 E-03
Insignificant Release Points						
374-SPD	1.30 E-09	6.96 E-10	8.12 E-10	3.13 E-11	8.19 E-10	--
444-DO5	1.19 E-11	- 1.58 E-10	- 2.54 E-10	1.82 E-10	8.42 E-10	--
444-MAI	7.52 E-10	3.69 E-09	1.81 E-09	3.18 E-11	1.87 E-09	--
447-MAI	3.26 E-10	- 4.98 E-10	- 2.88 E-09	- 3.66 E-10	- 3.71 E-09	--
707-R21A/B	- 9.30 E-11	- 2.79 E-10	2.24 E-09	6.34 E-11	7.27 E-10	--
707-R22A/B	3.30 E-10	- 3.89 E-10	7.96 E-10	- 2.54 E-11	2.41 E-09	--
707-R23A/B	- 4.23 E-12	2.11 E-11	1.14 E-09	- 1.48 E-10	1.43 E-09	--
707-R24A/B	6.33 E-11	- 4.86 E-10	5.74 E-10	- 3.38 E-11	1.83 E-09	--
707-R25A/B	- 1.10 E-10	- 1.40 E-10	4.78 E-10	- 6.35 E-11	5.16 E-10	--
707-R26A/B	5.50 E-11	- 4.90 E-10	1.29 E-09	- 8.88 E-11	1.18 E-09	--
707-R27A/B	5.29 E-10	- 3.81 E-10	6.77 E-10	- 3.22 E-10	1.37 E-09	--

Table 3-1.

(Continued)

Building/ Location ^a	Isotope Emissions (Ci/yr) ^{b, c, d}					
	Pu-239/240	Am-241	U-233/234	U-235	U-238	H-3
Insignificant Release Points						
707-R46A/B	1.56 E-10	- 2.54 E-10	2.25 E-09	- 2.58 E-10	2.47 E-09	--
771-CMA	1.31 E-10	4.29 E-11	1.84 E-10	- 2.44 E-11	5.53 E-10	--
771-CRM8/10	1.28 E-09	2.18 E-10	4.19 E-10	- 2.37 E-11	7.80 E-10	--
776-251	3.28 E-10	4.14 E-10	- 3.79 E-10	- 3.19 E-12	2.64 E-09	4.10 E-04
776-252	1.14 E-10	8.45 E-12	- 1.64 E-10	- 4.79 E-11	7.42 E-11	--
778-LDY	6.10 E-14	2.50 E-14	2.20 E-14	1.00 E-15	1.34 E-13	--
865-EEE	6.00 E-10	- 2.94 E-10	- 1.39 E-09	4.32 E-10	- 1.17 E-09	--
865-WWW	3.98 E-10	1.33 E-10	- 2.94 E-09	1.36 E-09	- 7.73 E-10	--
881-MA1	1.72 E-09	- 4.84 E-09	- 1.82 E-08	- 1.94 E-09	- 5.62 E-09	--
881-MA2	3.76 E-10	- 7.07 E-09	- 9.61 E-09	- 2.35 E-10	- 1.21 E-08	--
881-MA3	- 3.28 E-10	- 1.33 E-09	- 2.44 E-08	- 1.14 E-09	- 3.33 E-08	--
881-MA4	6.32 E-09	- 5.09 E-09	- 1.83 E-08	- 8.44 E-10	- 1.97 E-08	--
883-AAA	1.14 E-10	- 1.81 E-10	- 5.62 E-10	1.20 E-10	- 2.94 E-10	--
883-BBB	1.34 E-10	- 7.03 E-10	2.30 E-09	5.29 E-10	4.53 E-09	--
883-CCC	5.94 E-10	- 3.49 E-10	- 3.19 E-09	- 2.56 E-10	- 3.84 E-09	--
886-875	5.45 E-10	1.00 E-10	- 7.48 E-10	3.82 E-10	- 1.23 E-09	--
991-985	2.32 E-09	- 4.24 E-10	- 1.82 E-09	3.03 E-10	5.63 E-09	--
991-MAI	1.46 E-08	1.16 E-10	1.14 E-09	- 9.98 E-10	1.38 E-08	--

^aThe 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 4-2 of this report.

^b Values were corrected for filter blanks. Negative values resulted when observed measurements were less than average filter blank values. Locations showing negative values were modeled with an emission rate of 0 Ci/yr.

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

^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 These locations became insignificant in August 1997.

^f Shrouded probe data were used when available.

Notes:

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

withdraw a portion of the airstream and filters were collected monthly and composited for an annual analysis. To calculate a release from this duct, effluent flow was estimated by calculating the air expansion and contraction due to average daily temperature changes in the building.

Appendix B shows 1997 measured point source emissions data normally contained in DOE's Effluent Information System (EIS)/Off-Site Discharge Information System (ODIS). DOE did not publish an EIS/ODIS report for 1997.

3.2.2 Calculated Point Source Emissions

In calendar year 1997, several point sources operated at the Site that were not subject to emission measurement. These sources included the Mound Site TDU, low-level waste repackaging operations, and HEPA filter sampling. In addition, Buildings 123, 881, and 790 had low-level tritium emissions. Calendar year 1997 emissions from these point sources and the methods used to minimize emissions are described below. These projects and operations are described in greater detail in Sections 2.2.1 and 2.2.2 of this report.

Emissions were calculated for these insignificant release points as described in Section 3.1. Table 3-2 shows emission estimates for these point sources for calendar year 1997.

Mound Site Thermal Desorption: In 1997, contaminated soil was excavated from the Mound Site and treated in a TDU to remove VOCs. The on-Site mobile TDU heated the contaminated soils to a temperature between 49 and 371°C, sufficient to volatilize the VOCs. The offgases were passed through a 3.0 µm air filter, cooled in a condenser, and finally passed through a HEPA filter.

Low-Level Waste Repackaging: During 1997, repackaging of low-level waste was conducted in the Tent 5 Permacon® on the 750 Pad. Emissions were estimated assuming a maximum of 2,000 drums of waste, containing a maximum plutonium concentration of 100 nanocuries per gram (approximately 0.5 grams of plutonium per drum), would be processed in 1997. The wastes were sorted in a glovebag located within the Tent 5 Permacon®. Effluent from Tent 5 exhausted through a single HEPA filter.

Table 3-2.

Calculated Point Source Radionuclide Emissions for Calendar Year 1997

Activity or Building	Isotope Emissions (Ci/yr) ^a					
	Pu-239/ 240	Am-241	U-233/234	U-235	U-238	H-3
HEPA Filter Sampling - 750 Pad Tent 5 ^b	5.54 E-08	5.74 E-09	--	--	--	--
LLW Repackaging - 750 Pad Tent 5 ^b	6.41 E-07	6.63 E-08	--	--	--	--
Mound Site TDU ^b	1.92 E-09	3.69 E-10	1.93 E-08	1.57 E-09	1.01 E-07	--
123 ^c	--	--	--	--	--	1.80 E-07
881-MAI ^c	--	--	--	--	--	1.00 E-08
790 ^c	--	--	--	--	--	1.24 E-05

^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 Figures 4-2 and 4-3 of this report.

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

^c Uncontrolled for tritium.

Notes:

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

HEPA Filter Sampling: During 1997, HEPA filters were sampled within the Tent 5 Permacon® on the 750 Pad to characterize the filters for potential radionuclide and hazardous material contamination. The HEPA filters were individually wrapped in plastic, and no more than 12 filters were present in the Tent 5 Permacon® at any one time. HEPA filters were unwrapped and sampled one at a time. Emission estimates assumed that each HEPA filter contained a maximum plutonium concentration of 100 nanocuries per gram; 63 filters were sampled in 1997. Effluent from Tent 5 exhausted through a single HEPA filter.

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 1997. Air effluent from plutonium processing areas was cleaned by a minimum of four stages of HEPA filters. Air effluent from areas that processed plutonium-contaminated waste was typically cleaned by two 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 99.9 percent. Filter assemblies are tested again for leaks following installation.

Emissions from the TDU that was used to treat soil during the Mound Site remediation activities, and low-level waste repackaging and HEPA filter sampling activities in the Tent 5 Permacon®, were controlled using single-stage HEPA filtration. The 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 1997, 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. In 1997, mechanical disturbance of contaminated soils was associated with the Mound Site

excavation project, the T-3/T-4 "hot spot" soil removal project, the Sewage Treatment Plant soil backfill project, and the Buildings 549 and 559 steam line excavation and backfill project. Finally, calendar year 1997 nonpoint sources also included a drum crushing operation inside the Protected Area.

Calendar year 1997 emissions from nonpoint sources and the methods used to minimize emissions are described below. The projects and operations that generated nonpoint air emissions of radionuclides in 1997 are described in greater detail in Sections 2.2.1 and 2.2.2 of this report. Table 3-3 summarizes emissions from nonpoint sources for calendar year 1997. The emissions shown in Table 3-3 include the uranium isotopes typical of the depleted and enriched uranium that has been used at the Site, as well as other isotopes that are present in Site soils. Pu-239/240 constitutes more than 97% of the alpha activity in plutonium used at the Site. Consequently, emissions for selected plutonium isotopes (Pu-238, -241, and -242) were not included in the 1997 dose calculation because each has the potential to contribute much less than 10% of the total EDE.

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 1997 emissions from wind erosion of contaminated soil are summarized in Table 3-3 and are labeled as isopleths. Each isopleth encompasses an area of equal soil resuspension emission potential for a given isotope.

Remediation of the Mound Site, IHSS 113: In 1997, contaminated soil was excavated from the Mound Site and treated in a TDU to remove VOCs. Fugitive dust emissions were generated from excavation, stockpiling, and backfilling of soil. During soil excavation and handling, water spray was used to control fugitive dust emissions. Chemical dust suppressants were used to control fugitive dust emissions generated from wind erosion of soil stockpiles.

"Hot Spot" Removal from the Mound Site: During Mound Site backfilling operations, 0.75 m³ of soil from the excavation of T-3/T-4 in 1996 that was contaminated above RFCA Tier I subsurface soil action levels was erroneously placed into the Mound Site excavation as backfill. In 1997, approximately 2.3 m³ of soil were removed from the

Table 3-3.

Nonpoint Source Radionuclide Emissions for Calendar Year 1997

Isopleth or Project ^a	Isotope Emissions (Ci/yr) ^b				
	Pu-239/240	Am-241	U-233/234	U-235	U-238
Isopleth 1	8.26 E-07	3.17 E-07	6.49 E-09	2.32 E-08	1.00 E-10
Isopleth 2	3.55 E-08	5.55 E-09	4.90 E-08	2.00 E-09	2.21 E-09
Isopleth 3	8.61 E-07	4.24 E-07	4.84 E-09	2.37 E-08	1.57 E-08
Isopleth 4	4.10 E-08	1.57 E-08	3.09 E-08	9.79 E-10	1.37 E-08
Isopleth 5	2.33 E-06	8.21 E-10	5.76 E-08	2.01 E-08	5.02 E-09
Isopleth 6	9.53 E-08	8.06 E-09	6.58 E-09	--	5.92 E-10
Isopleth 7	1.62 E-07	1.20 E-06	3.37 E-08	--	2.88 E-09
Isopleth 8	3.31 E-06	6.00 E-08	7.25 E-08	--	--
Isopleth 9	3.43 E-08	8.44 E-09	6.27 E-09	--	--
Isopleth 10	3.25 E-06	1.02 E-08	9.58 E-08	--	--
Isopleth 11	3.89 E-07	4.18 E-07	8.33 E-08	--	--
Isopleth 12	4.18 E-08	5.11 E-08	3.80 E-09	--	--
Isopleth 13	5.13 E-07	5.59 E-07	8.80 E-08	--	--
Isopleth 14	1.99 E-06	1.00 E-07	--	--	--
Isopleth 15	1.94 E-07	6.03 E-07	--	--	--
Isopleth 16	2.76 E-06	6.86 E-07	--	--	--
Isopleth 17	5.12 E-06	8.81 E-07	--	--	--
Isopleth 18	5.17 E-06	5.44 E-07	--	--	--
Isopleth 19	5.17 E-06	--	--	--	--
Isopleth 20	3.26 E-06	--	--	--	--
T-3/T-4 "Hot Spot" ^c	--	--	--	--	6.74 E-06
Buildings 549/559 Steam Line ^c	1.05 E-07	1.64 E-08	--	--	--
Sewage Treatment Plant Backfill ^c	4.94 E-06	2.08 E-05	--	--	--
Mound Site Excavation/Backfill ^c	4.39 E-08	8.44 E-09	4.42 E-07	3.59 E-08	2.31 E-06
Drum Crushing ^d	4.06 E-08	--	--	--	--

^a Isopleths are specific to each isotope and indicate zones of equal radionuclide emission potential for contaminated surface soils.

^b 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 nonpoint emission sources listed are shown in Figures 4-2 through 4-8 of this report.

^c Water spray/dust suppression used with a control efficiency of 50 percent.

^d Uncontrolled.

Notes:

- Ci/yr = Curies per year; 1 Ci = 3.7 x 10¹⁰ Becquerel (Bq).
- Pu = Plutonium
- Am = Americium
- EDE = Effective dose equivalent
- U = Uranium
- = Not estimated
- E# = x 10[#]

excavation and placed into two half crates. Subsequent sampling of the area around the "hot spot" was also conducted to ensure that all of the contaminated material was removed. The soil removal operation did not employ radionuclide controls.

Sewage Treatment Plant Phase III Upgrade: In 1997, approximately 99 m³ of soil originally excavated during the installation of two partial in-ground concrete storage tanks at the Sewage Treatment Plant was used as additional backfill around the tanks. The radionuclide concentrations in the soil did not exceed the RFCA Tier II action levels. The backfill operation did not employ radionuclide controls.

Steam Line Between Buildings 549 and 559: A steam line that runs adjacent to but outside of the Protected Area, between Buildings 549 and 559, was excavated for inspection and repair during calendar year 1997. The size of the excavation measured approximately 3 m by 3 m by 1.8 m deep and was located within several radiological IHSSs. Based on surface soil sampling data, the soil was potentially contaminated with plutonium and americium at levels below the RFCA Tier II action levels. The project used tarps and dust suppressants to control particulate emissions and associated radionuclide emissions from the soil stockpiles.

Drum Crushing: To reduce waste volume, a drum crushing operation was conducted adjacent to Building 991 within the Protected Area. Emission estimates assumed that this drum crushing operation would process up to 500 nonhazardous drums in 1997. The drums may have been contaminated with low levels of radionuclides. The operation did not employ emission controls.

3.3.2 Control Technology for Nonpoint Sources

Particulate emissions from earth moving activities at the Site, such as those involved in the remediation of the Mound Site, were controlled by water spray or other dust suppression measures, with an estimated control efficiency of 50 percent. Fugitive dust control plans that specified the control measures to be used to minimize emissions of contaminated dust were developed for each project with the potential to generate radionuclide emissions from soil or debris handling.

4.0 DOSE ASSESSMENT

This section describes the dose assessment performed for the Site for the 1997 calendar year.

4.1 Description of Dose Model

The Site used the dose model CAP88-PC (Version 1.0) for calculating EDE to the public. 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.

The model accounts for dose received from Site emissions through inhalation and ingestion of radionuclides, as well as through irradiation from 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, 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 particles emitted.

The input data used in calculating the calendar year 1997 Site dose to the public are discussed in Section 4.2.

4.2 Summary of Model Input Data

This section describes the dose model input data used to calculate EDE to the public for calendar year 1997.

4.2.1 Receptors

Compliance with the 10 mrem (0.1 mSv) public dose standard of 40 CFR 61.92 is determined by calculating the highest EDE to any member of the public at any off-Site point where there is a residence, school, business, or office. Modeling was performed for seven receptor locations, shown on Figure 4-1. These locations represent the residences, businesses, schools, and office buildings nearest the Site. Modeling determined that the maximally exposed individual (MEI) for 1997 was located at a distance of 4,143 m to the east-southeast of the central, industrial portion of the Site. The model input data described in the rest of Section 4.2 are those values used to calculate the MEI dose for 1997.

4.2.2 Point Source Input Data

Based on previous Site dose assessments, it was expected that routine emissions from point sources at the Site would contribute a small amount to the total 1997 dose. Therefore, to streamline the modeling analysis, most 1997 point source emissions were conservatively combined and modeled from a single location within the central area of the Site. In addition, the radionuclide emissions from one nonpoint source, the drum crushing operation described in Section 2.2.2, were also included in the combined point source due to the very small emissions generated by the drum crushing operation and its close proximity to the point sources that were combined for the modeling analysis. Only the HEPA filter sampling and low-level waste repackaging operations at Tent 5, 750 Pad; the Mound TDU; and the calculated tritium releases were modeled as separate point sources.

The combined point source emissions were modeled at an average release height using a conservative stack diameter (based on actual stack data) and an exit velocity characteristic of obstructed flow (such as would occur at a release point with a nonvertical stack or rain cap).

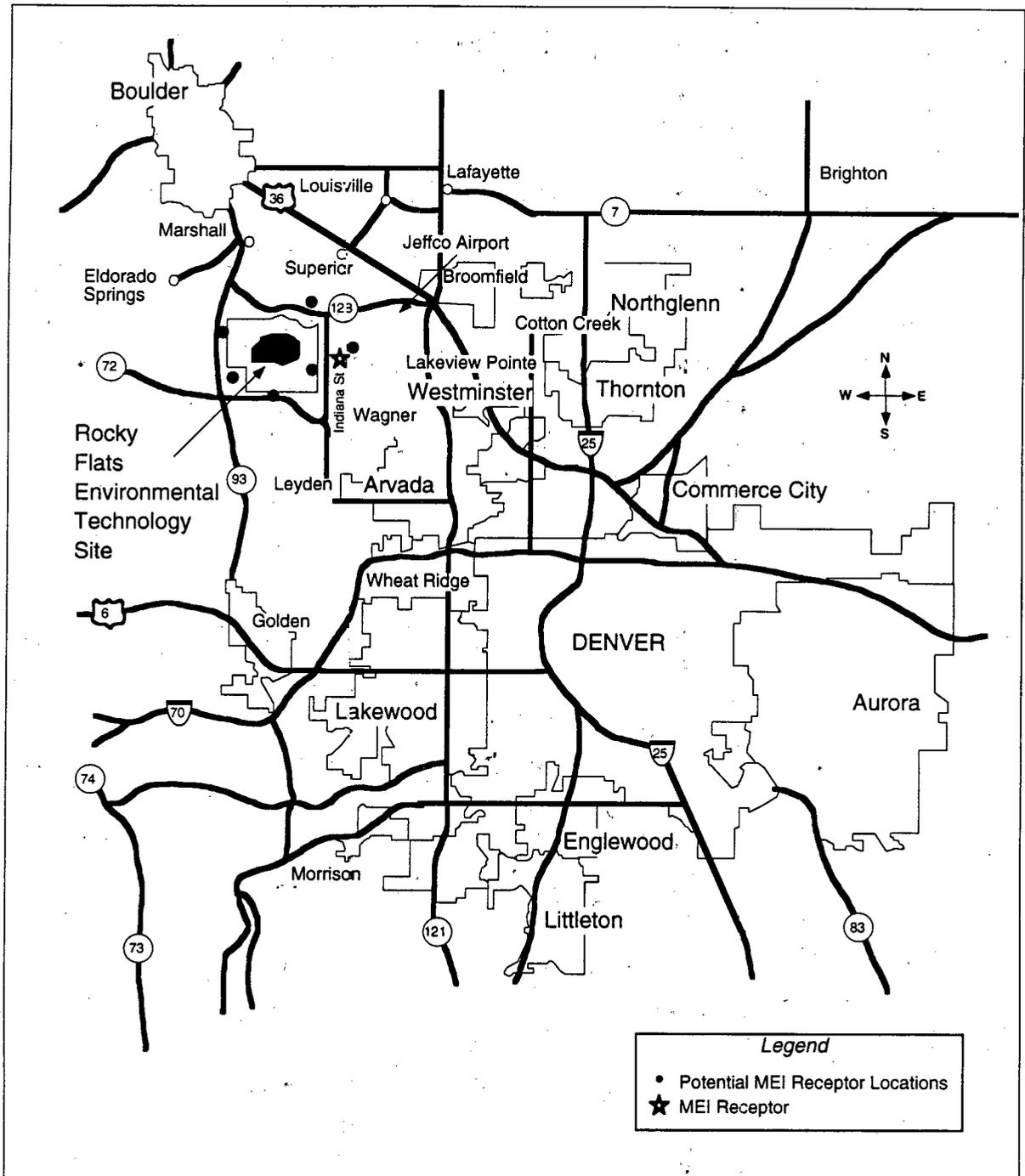


Figure 4-1. Receptor Locations for 1997 Dose Analysis

Several sets of stack parameters were screened and the set that would result in the highest point source EDE to the public was used in the modeling analysis. The Tent 5 emissions, the Mound TDU, and the calculated tritium emissions were modeled separately, using stack data specific to the release points.

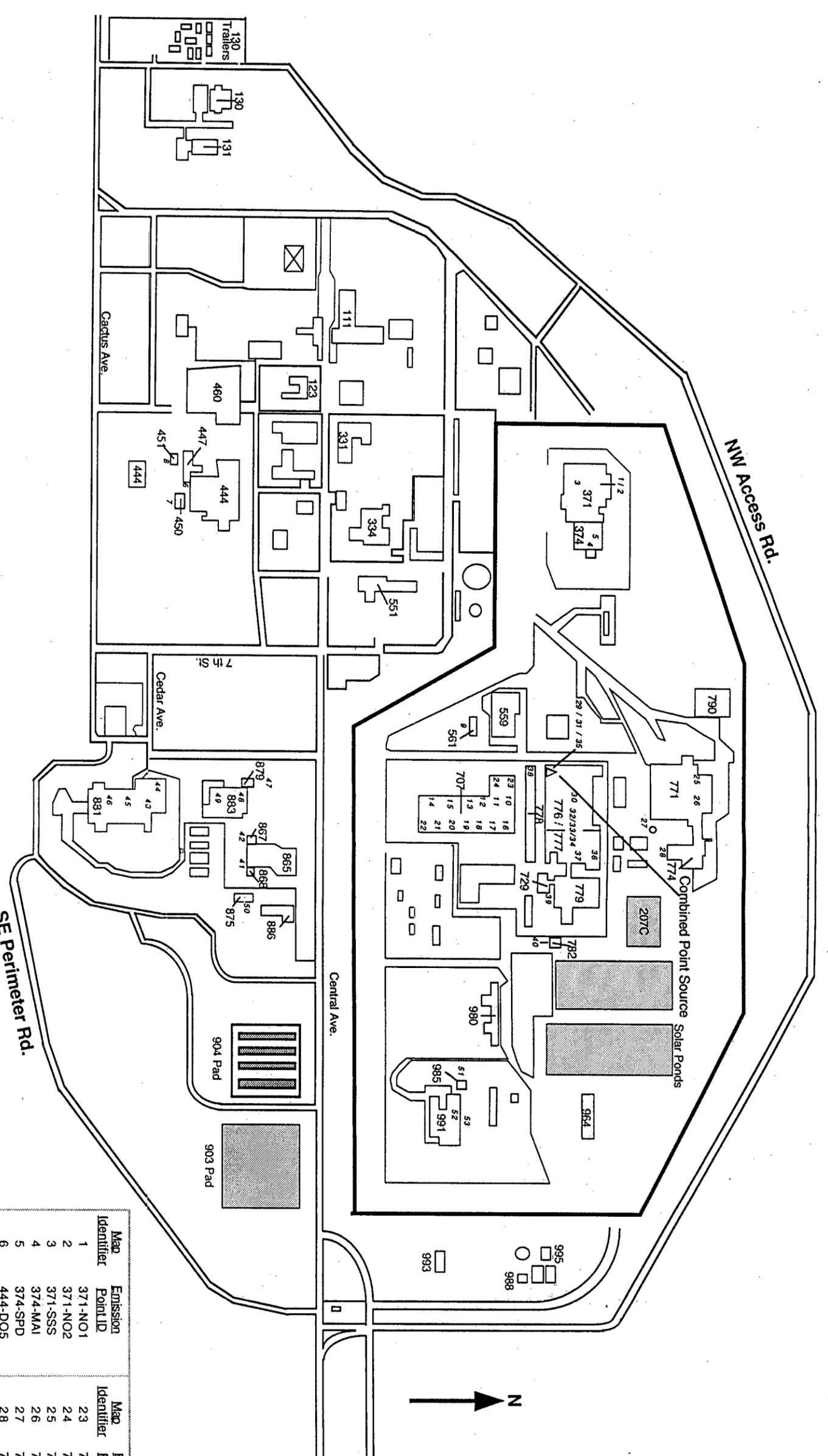
Figure 4-2 shows the location of individual emission sources that were combined for modeling purposes, as well as the location from which the combined emissions were modeled. Figure 4-2 also shows the three building locations from which the calculated tritium emissions occurred: Buildings 123, 790, and 881. Figure 4-3 shows the location of projects whose point-source emissions were not combined for the dose modeling: the Tent 5 stack and the Mound TDU. Table 4-1 shows the release characteristics for the combined emissions source, the calculated tritium emissions, the Tent 5 source, and the Mound TDU. Detailed information regarding the characteristics of individual release points is given in Appendix C.

4.2.3 Nonpoint Source Input Data

As described in Section 3.1, emissions from wind resuspension of contaminated soil were estimated based on surface soil radionuclide concentration isopleths for the Site that have been developed based on a Site-specific soil sampling database, combined with geographic information system (GIS) software. The GIS was used to compute the area of each isopleth, the centroid of each isopleth (representing the center of mass of the radionuclide contamination), and the distances from each centroid to each receptor. The area of each isopleth and the distance and direction to the MEI receptor are shown in Tables 4-2 through 4-6 for each of the isotopes modeled.

CAP88-PC simulates each nonpoint source as a point source at the centroid of the source area. The location of the individual nonpoint (area) sources that were modeled representing the Buildings 549/559 steam line excavation and backfill emissions, the T-3/T-4 "hot spot" excavation emissions, and the Sewage Treatment Plant backfill emissions are shown in Figure 4-3 (source input data for these sources are listed in Table 4-7). The soil resuspension isopleth centroid locations are shown in Figures 4-4 through 4-8. Nonpoint source emissions were simulated as ground level releases (height = 0.0 m) with no momentum plume rise (exit velocity = 0.0 meters per second [m/s]).

not to scale
Revision 2, June 1998



Map Identifier	Emission Point ID	Map Identifier	Emission Point ID	Map Identifier	Emission Point ID
1	371-NO1	23	707-R45A/B	45	881-MA3
2	371-NO2	24	707-R46A/B	46	881-MA4
3	371-SSS	25	771-CMA	47	883-AAA
4	374-MAI	26	771-CRM8	48	883-BBB
5	374-SPD	27	771-MAI	49	883-CCC
6	444-DOS	28	774-202	50	886-875
7	444-MAI	29	776-201/203	51	991-985
8	447-MAI	30	776-202	52	991-MA1
9	559-561	31	776-204	53	Drum Crushing
10	707-101/103	32	776-205		
11	707-102/104	33	776-206		
12	707-105	34	776-207		
13	707-106	35	776-250		
14	707-107	36	776-251		
15	707-108	37	776-252		
16	707-R21A/B	38	778-LDY		
17	707-R22A/B	39	779-729		
18	707-R23A/B	40	779-782		
19	707-R24A/B	41	865-EEE		
20	707-R25A/B	42	865-WWW		
21	707-R26A/B	43	881-MA1		
22	707-R27A/B	44	881-MA2		

Note:
Unmonitored tritium emissions occurred from Buildings 123, 790, and 881.

Figure 4-2. Industrial Area Point Source Locations

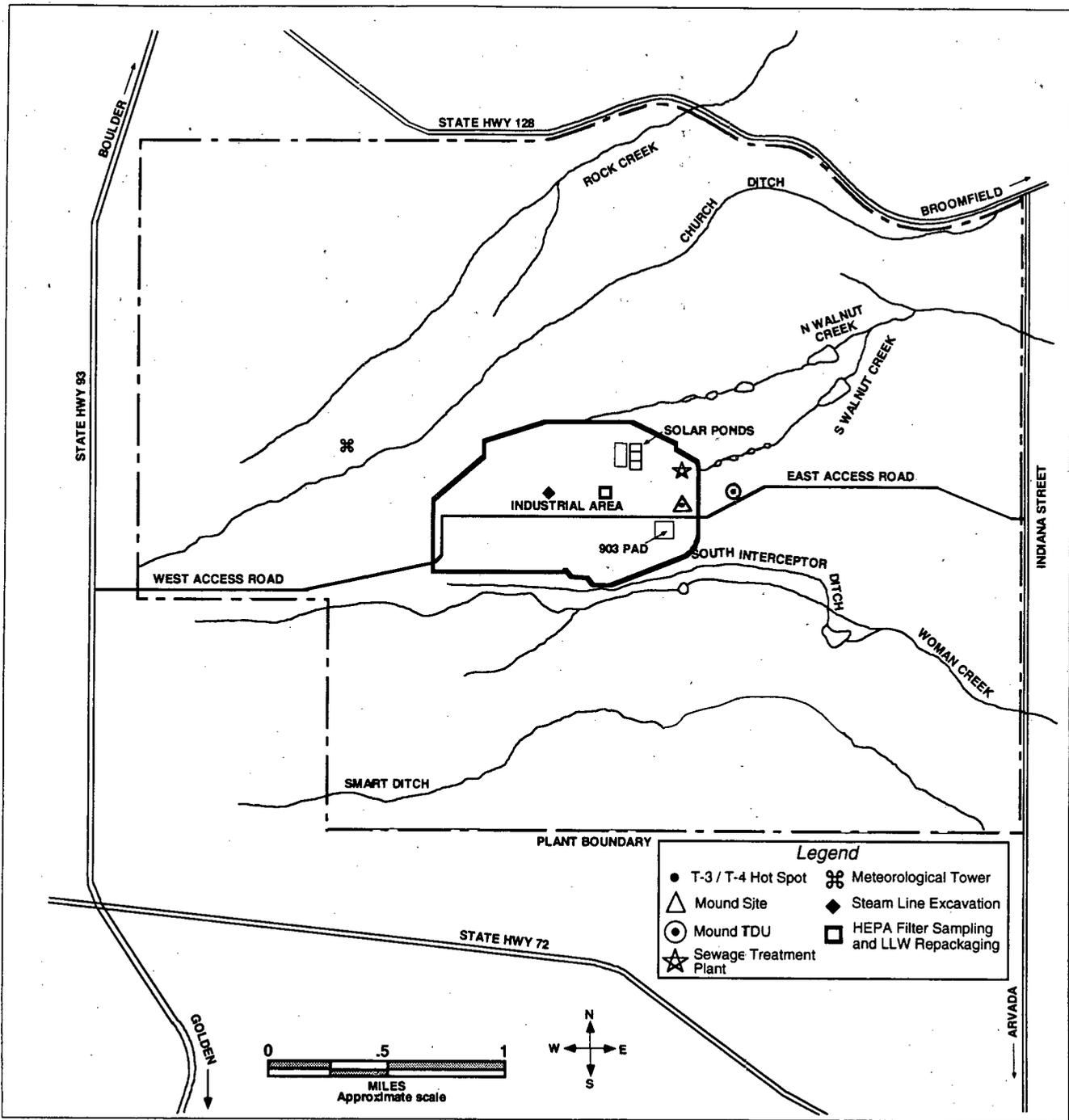


Figure 4-3. Project Emission and Meteorological Data Collection Locations

Table 4-1.

Source Data for Model Input—Point Sources

Parameter	Combined Point Sources ^a	Calculated Tritium Emissions	Mound Site TDU	HEPA Filter Sampling	Low-Level Waste Repackaging
Height (m)	9.1	10.0	4.6	5.0	5.0
Diameter (m)	0.4	1.1	0.5	0.2	0.2
Exit Velocity (m/s)	0.1	8.3	18.4	0.5	0.5
Distance to MEI (m)	4,143	4,143	3,372	4,172	4,172
Direction to MEI	ESE	ESE	ESE	NE	NE

^a Includes drum crushing operation and measured point source emissions.

Notes:

- ESE = East-southeast
- m = Meters
- m/s = Meters per second
- MEI = Maximally exposed individual
- NE = Northeast
- TDU = Thermal desorption unit
- HEPA = High efficiency particulate air

Table 4-2.

Americium-241 Nonpoint Source Model Input Data^a

Isopleth No.	Area (m ²)	Distance to MEI (m) ^b	Direction to MEI ^b
Isopleth 1	8,435,258	2,620	ESE
Isopleth 2	95,570	2,371	SE
Isopleth 3	2,978,028	2,286	ESE
Isopleth 4	116,806	3,786	ESE
Isopleth 5	4,354	3,672	ESE
Isopleth 6	42,732	1,386	E
Isopleth 7	1,901,048	2,415	ESE
Isopleth 8	87,078	3,758	ESE
Isopleth 9	4,477	3,915	ESE
Isopleth 10	5,414	3,786	ESE
Isopleth 11	305,065	3,143	ESE
Isopleth 12	27,106	2,472	ESE
Isopleth 13	217,109	3,157	ESE
Isopleth 14	12,556	3,200	ESE
Isopleth 15	104,835	3,258	ESE
Isopleth 16	64,360	1,064	SE
Isopleth 17	34,105	2,523	SE
Isopleth 18	7,504	3,315	ESE

^a All nonpoint sources were modeled with heights of 0.0 m and no momentum plume rise (0.0 m/s exit velocity). Emissions are shown in Table 3-3.

^b From isopleth centroids.

Notes:

- E = East
- ESE = East-southeast
- m = Meters
- m² = Square meters
- m/s = Meters per second
- MEI = Maximally exposed individual
- SE = Southeast

Table 4-3.

Plutonium-239/240 Nonpoint Source Model Input Data^a

Isopleth No.	Area (m²)	Distance to MEI (m)^b	Direction to MEI^b
Isopleth 1	20,706,106	4,143	ESE
Isopleth 2	188,186	2,297	SE
Isopleth 3	6,475,068	2,185	SE
Isopleth 4	267,835	2,406	SE
Isopleth 5	4,966,529	2,172	ESE
Isopleth 6	131,338	2,967	SE
Isopleth 7	222,993	2,996	SE
Isopleth 8	2,187,390	2,343	ESE
Isopleth 9	18,185	1,372	E
Isopleth 10	1,124,776	2,614	ESE
Isopleth 11	107,203	1,686	SE
Isopleth 12	11,518	2,658	ESE
Isopleth 13	64,337	2,172	SE
Isopleth 14	379,920	3,057	ESE
Isopleth 15	24,270	2,500	ESE
Isopleth 16	285,832	1,063	SE
Isopleth 17	191,315	2,379	ESE
Isopleth 18	83,574	2,824	E
Isopleth 19	41,276	2,563	SE
Isopleth 20	11,221	2,465	SSE

^a All nonpoint sources were modeled with heights of 0.0 m and no momentum plume rise (0.0 m/s exit velocity). Emissions are shown in Table 3-3.

^b From isopleth centroids.

Notes:

- E = East
- ESE = East-southeast
- m = Meters
- m² = Square meters
- m/s = Meters per second
- MEI = Maximally exposed individual
- SE = Southeast
- SSE = South-southeast

Table 4-4.

Uranium-233/234 Nonpoint Source Model Input Data^a

Isopleth No.	Area (m ²)	Distance to MEI (m) ^b	Direction to MEI ^b
Isopleth 1	3,444	2,634	S
Isopleth 2	34,942	2,633	S
Isopleth 3	3,475	2,632	S
Isopleth 4	22,714	2,632	S
Isopleth 5	23,320	2,747	S
Isopleth 6	2,356	2,726	S
Isopleth 7	16,505	2,702	S
Isopleth 8	12,384	2,691	S
Isopleth 9	905	2,681	S
Isopleth 10	12,012	2,570	SSE
Isopleth 11	7,257	2,557	SSE
Isopleth 12	262	2,562	SSE
Isopleth 13	3,032	4,701	ESE

^a All nonpoint sources were modeled with heights of 0.0 m and no momentum plume rise (0.0 m/s exit velocity). Emissions are shown in Table 3-3.

^b From isopleth centroids.

Notes:

- ESE = East-southeast
- m = Meters
- m² = Square meters
- m/s = Meters per second
- MEI = Maximally exposed individual
- S = South
- SSE = South-southeast

Table 4-5.

Uranium-235 Nonpoint Source Model Input Data^a

Isopleth No.	Area (m²)	Distance to MEI (m)^b	Direction to MEI^b
Isopleth 1	13,336	2,704	S
Isopleth 2	1,008	2,692	S
Isopleth 3	8,033	2,680	S
Isopleth 4	270	2,632	S
Isopleth 5	2,513	2,631	S

^a All nonpoint sources were modeled with heights of 0.0 m and no momentum plume rise (0.0 m/s exit velocity).

Emissions are shown in Table 3-3.

^b From isopleth centroids.

Notes:

- m = Meters
- m² = Square meters
- m/s = Meters per second
- MEI = Maximally exposed individual
- S = South

Table 4-6.

Uranium-238 Nonpoint Source Model Input Data^a

Isopleth No.	Area (m ²)	Distance to MEI (m) ^b	Direction to MEI ^b
Isopleth 1	53	3,929	ESE
Isopleth 2	1,171	3,715	ESE
Isopleth 3	8,299	3,343	ESE
Isopleth 4	7,254	3,500	ESE
Isopleth 5	2,969	2,610	S
Isopleth 6	314	2,611	S
Isopleth 7	795	2,639	SSE

^a All nonpoint sources were modeled with heights of 0.0 m and no momentum plume rise (0.0 m/s exit velocity). Emissions are shown in Table 3-3.

^b From isopleth centroids.

Notes:

ESE = East-southeast
 m = Meters
 m² = Square meters
 m/s = Meters per second
 MEI = Maximally exposed individual
 S = South
 SSE = South-southeast

Table 4-7.

Source Data for Model Input—Nonpoint Sources

Parameter	T-3/T-4 Hot Spot	Sewage Treatment Plant Backfill	549/559 Steam Line Excavation/Backfill	Mound Site Excavation/Backfill
Height (m)	0	0	0	0
Diameter (m)	2	37	9.3	100
Exit Velocity (m/s)	0	0	0	0
Distance to MEI (m)	3,372	4,143	4,143	3,372
Direction to MEI	ESE	ESE	ESE	ESE

Notes:

- ESE = East-southeast
- m = Meters
- m/s = Meters per second
- MEI = Maximally exposed individual

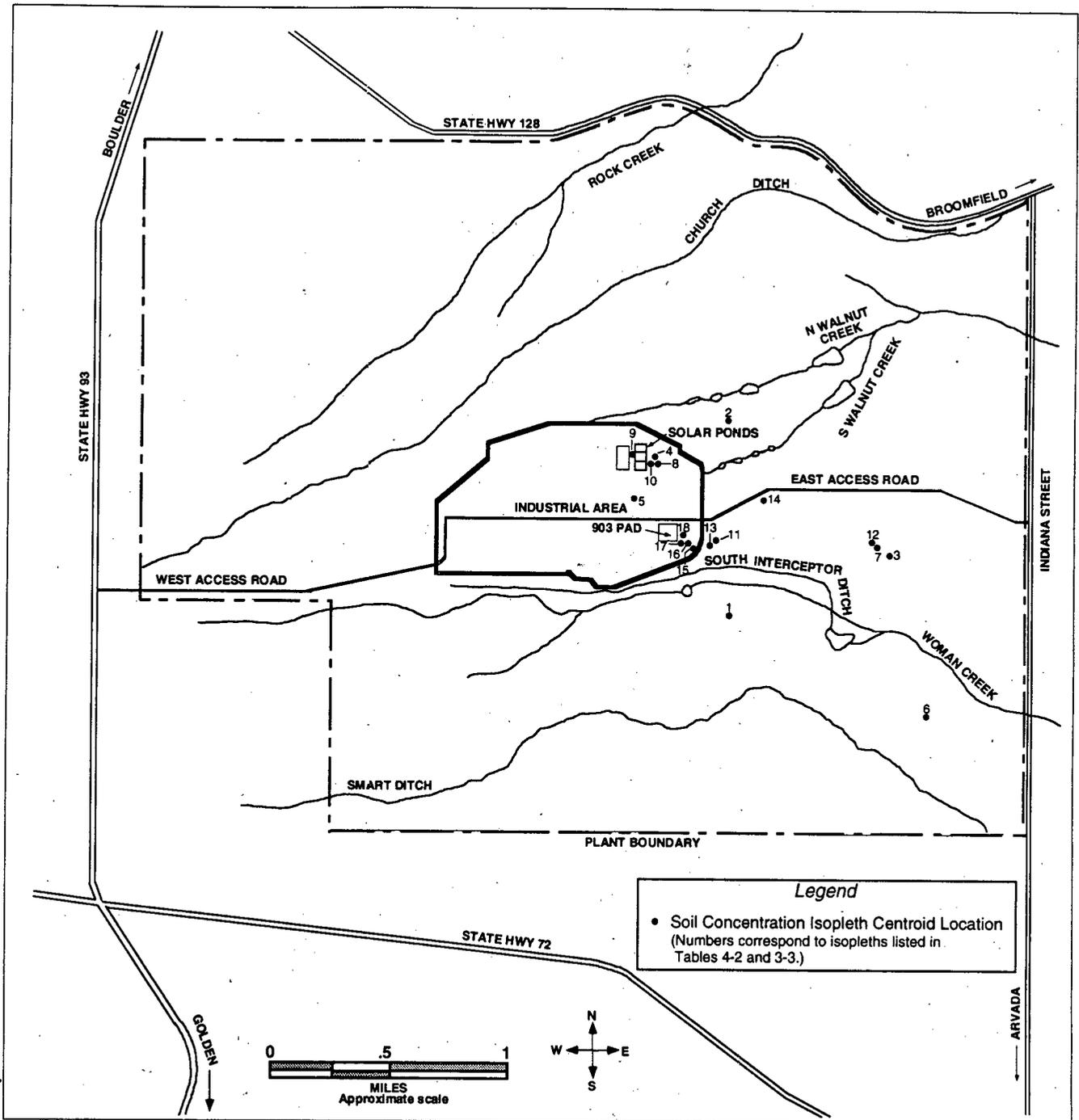


Figure 4-4. Soil Concentration Isopleth Centroid Locations for Americium-241

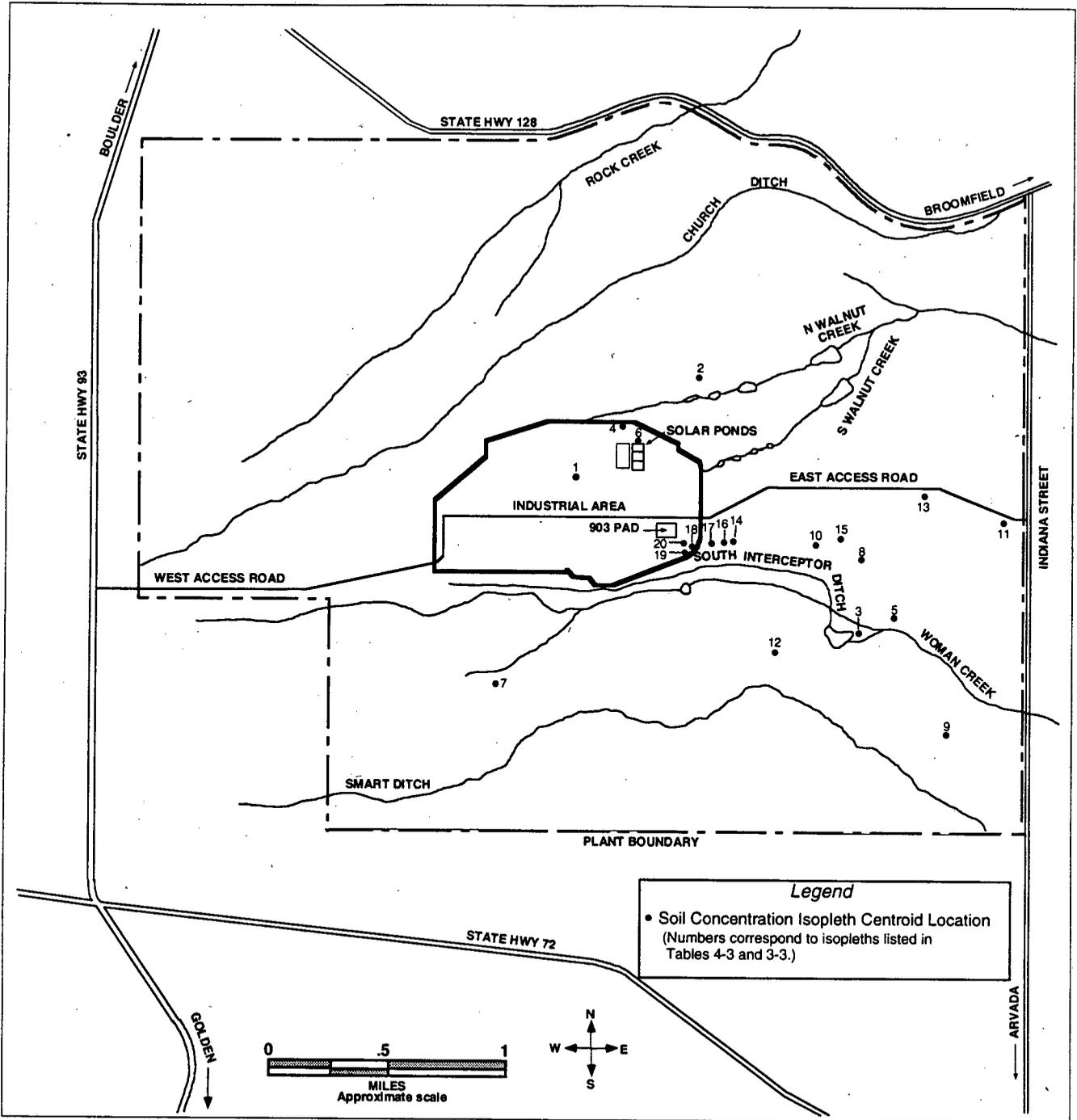


Figure 4-5. Soil Concentration Isoleth Centroid Locations for Plutonium-239 and Plutonium-240

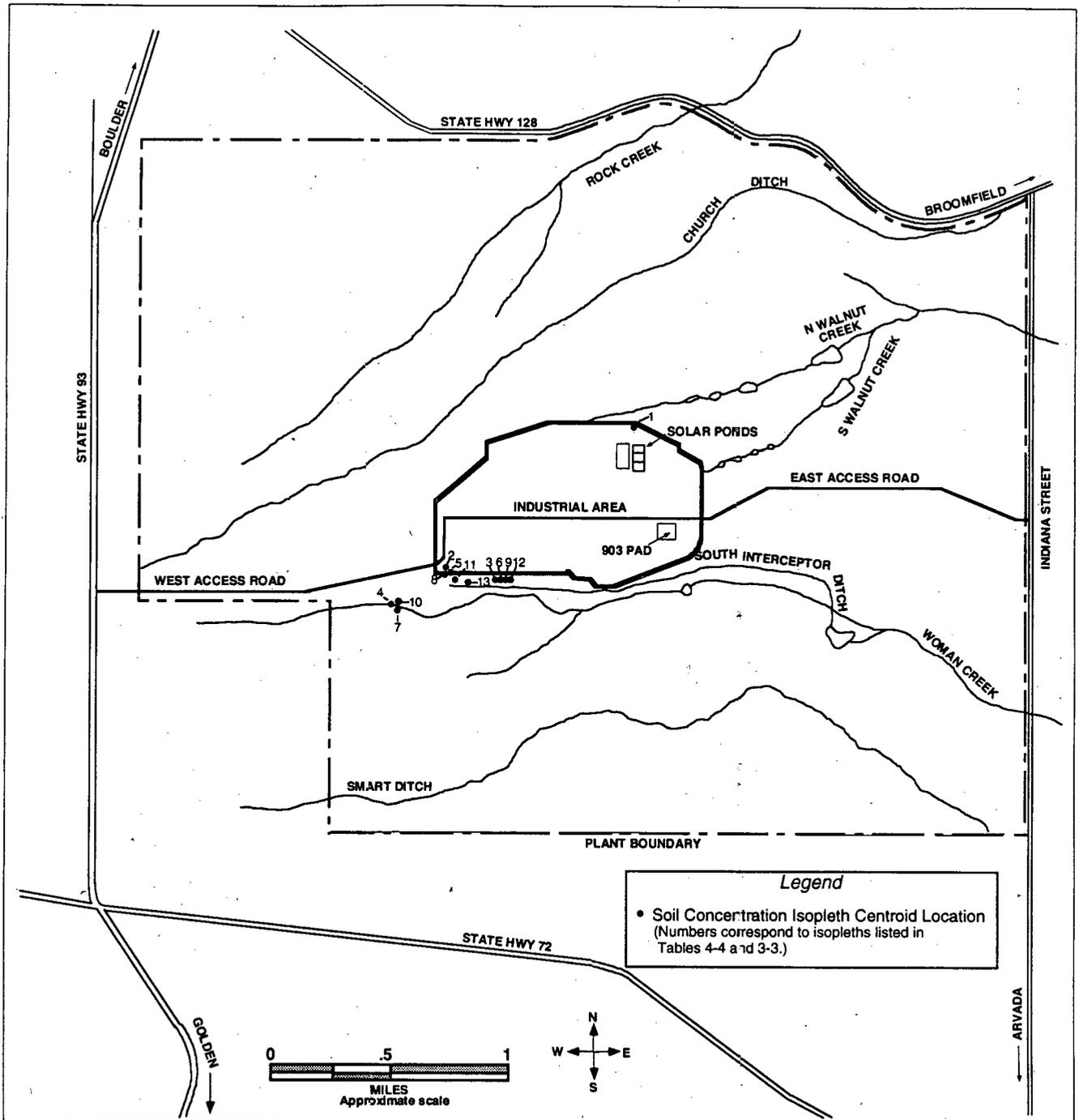


Figure 4-6. Soil Concentration Isopleth Centroid Locations for Uranium-233 and Uranium-234

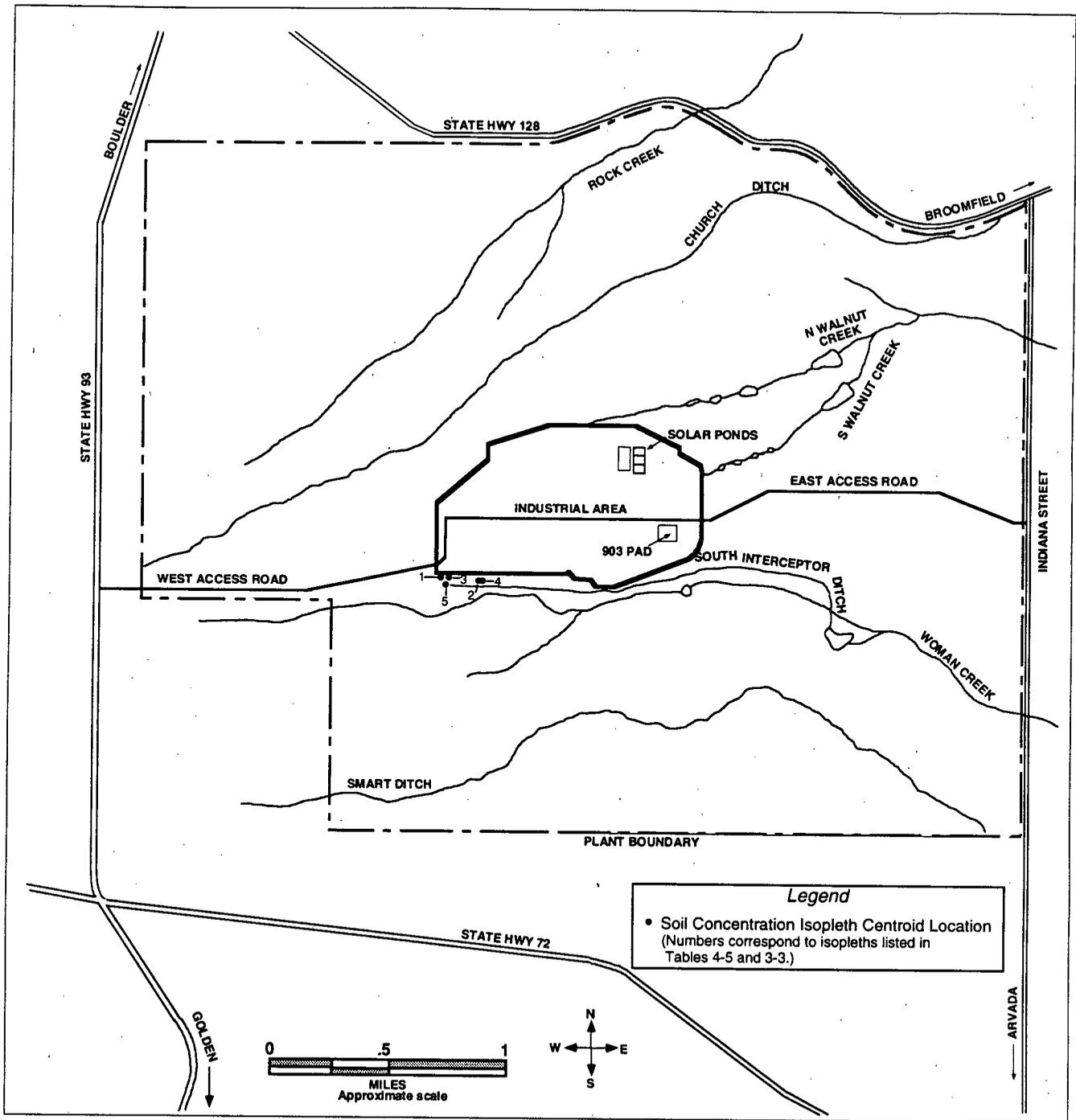


Figure 4-7. Soil Concentration Isopleth Centroid Locations for Uranium-235

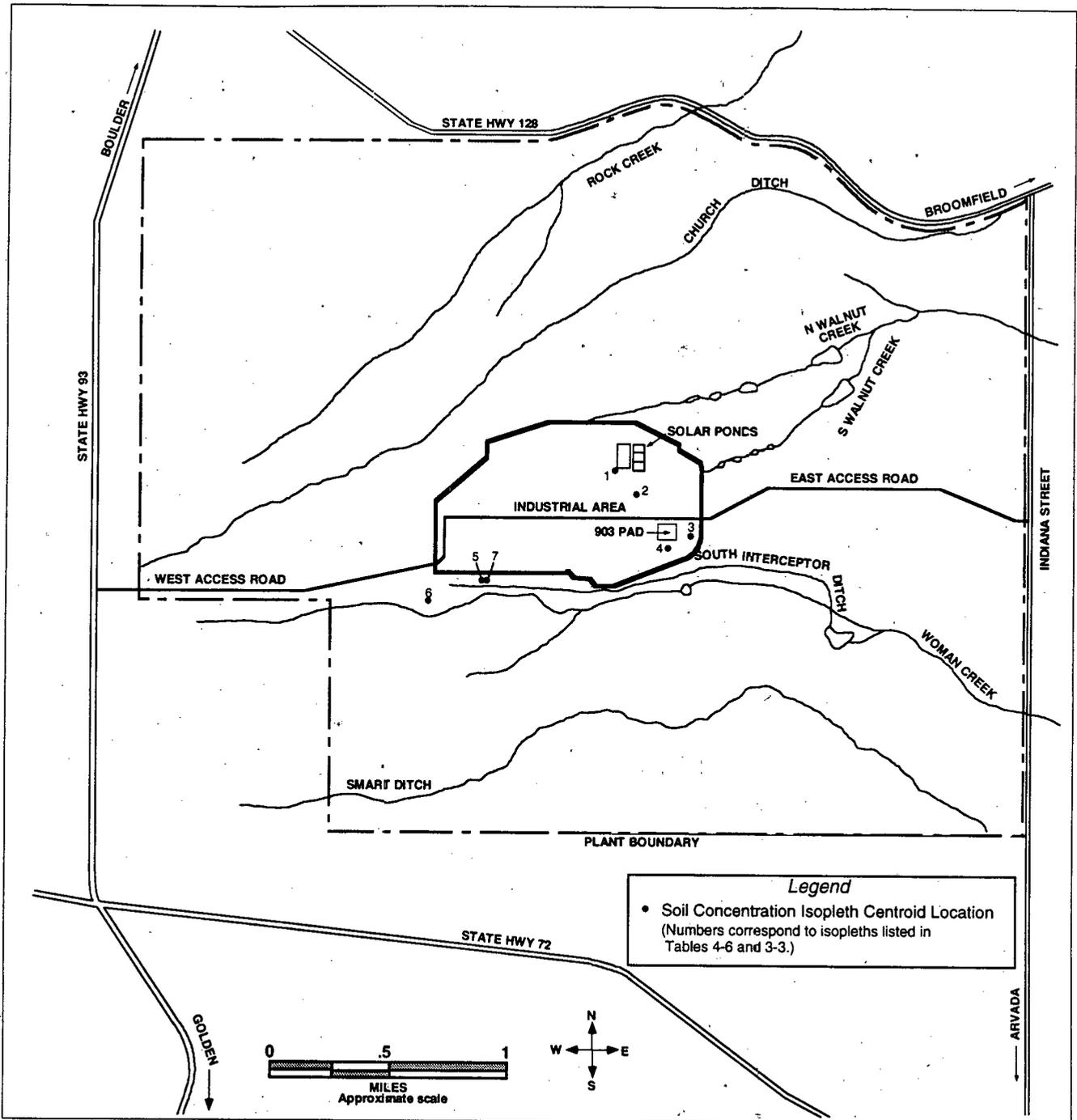


Figure 4-8. Soil Concentration Isopleth Centroid Locations for Uranium-238

4.2.4 Meteorological Data

Meteorological data for calendar year 1997 were collected from a tower located in the western portion of the Site (the tower location is shown in Figure 4-3). 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 Figure 4-9. Appendix D gives a detailed list of the joint frequency meteorological data for calendar year 1997.

Annual precipitation and temperature data collected on Site for calendar year 1997 are summarized in Table 4-8. An average mixing height for the Denver, Colorado, area of 1,405 m was used in the model (EPA, 1972).

4.2.5 Other Input Data

The CAP88-PC model also requires other input data. Model default values were used for the median aerodynamic diameter (1.0 μm) and solubility class. Urban agricultural data were used in the model and are shown in Table 4-9. Default values were also used for the origin of food products, as shown in Table 4-10.

The shortest distance between a Site radionuclide release point and farmland producing agricultural products is 720 m for beef cattle, 5,228 m for dairy cattle, and 1,063 m for cropland.

Appendix E summarizes the model input data used for this assessment.

4.3 Compliance Assessment

The EDEs calculated for each modeled emission source were summed for each receptor and the MEI determined. The maximum off-Site calendar year 1997 EDE from all Site emissions was 0.004 mrem (0.00004 mSv), less than one percent of the 10 mrem (0.1 mSv) standard. The MEI was located east of Mower Reservoir, approximately 4,143 m east-southeast of the center of the Site's industrial area.

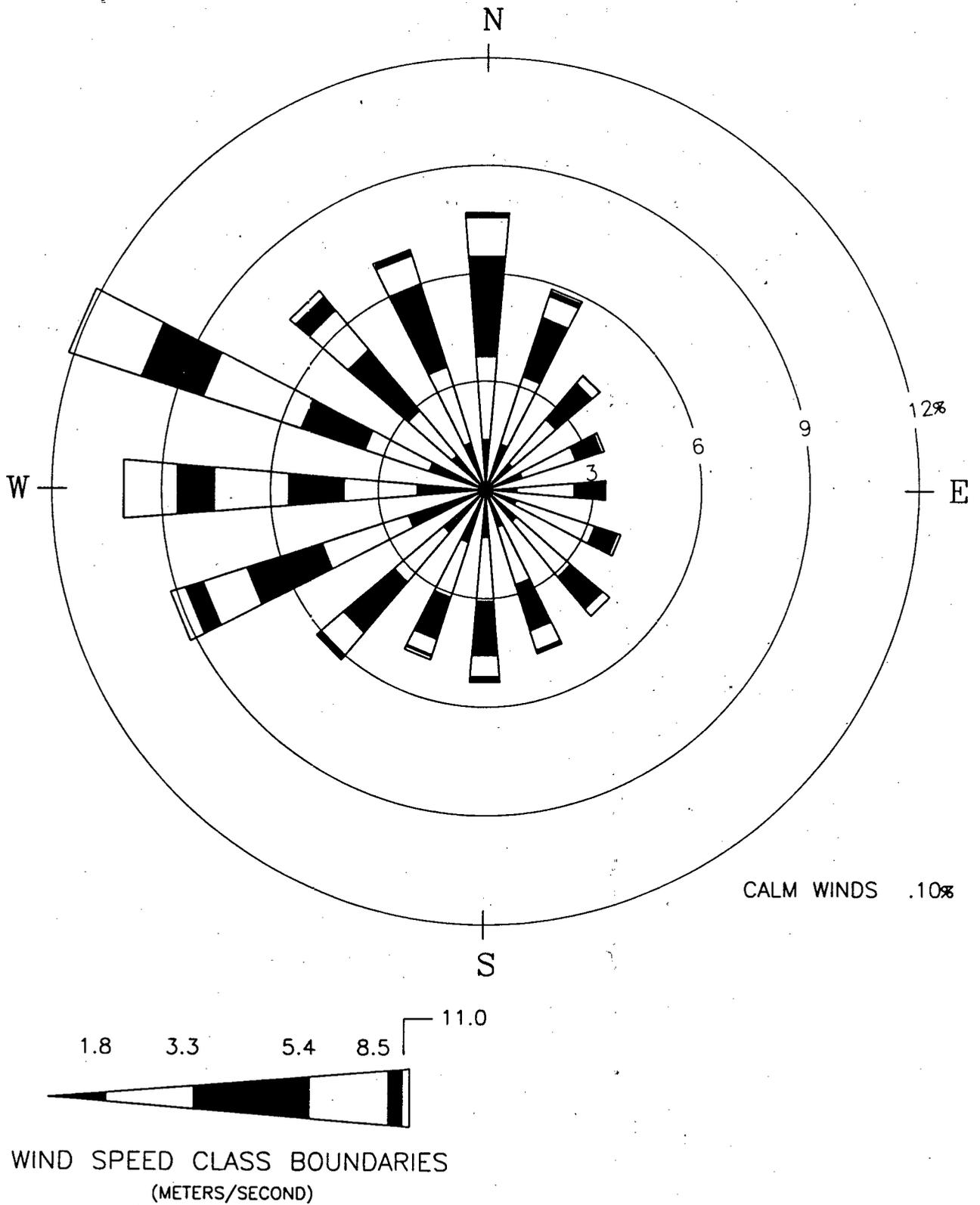


Figure 4-9. Wind Frequency Distribution for 1997

Table 4-8.

Additional Meteorological Data for Model Input

Input	Value Used
Wind Data	From on-Site tower at 10 m height
Annual Precipitation ^a	34.95 cm
Annual Average Temperature ^b	8.6°C
Mixing Height ^c	1,405 m

^a Total precipitation equivalent for 1997 (rainfall and snowfall).

^b Average of monthly average temperatures.

^c Average of annual morning and afternoon mixing heights for Denver from *Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States* (EPA, 1972).

Notes:

cm = Centimeter
m = Meter
°C = Degrees Celsius
EPA = U.S. Environmental Protection Agency

Table 4-9.

Agricultural Data for Model Input

Input	Value Used
Source	Urban
Beef Cattle Density ^a	1.13 E-01 cattle/km ²
Milk Cattle Density ^a	3.50 E-03 cattle/km ²
Land Fraction Cultivated for Vegetable Crops ^a	1.39 E-02

^a Model default values.

Note:

km² = Square kilometers
E# = x 10[#]

Table 4-10.

Origin of Food Products

Origin	Food Product		
	Vegetable	Milk	Beef
Fraction Home Produced ^a	0.076	0.0	0.008
Fraction From Assessment Area ^a	0.924	1.0	0.992
Fraction Imported ^a	0.0	0.0	0.0

^a Model default values.

The total dose to the public in 1997 was well within the standard and represents a 100-fold decrease from 1996, when a dose of 0.3 mrem was reported (see addendum to this report).

Both the isotopic mix and the location of maximum impact also changed from 1996. The contributions of various emission source types to the maximum annual off-Site EDE for 1997 are shown in Figure 4-10. The major contributor to dose came from wind-blown soil contamination and other processes that disturbed contaminated soils. Wind-blown soil contamination contributed approximately 73% of the MEI dose, while other projects that disturbed soils, primarily the Sewage Treatment Plant soil backfill operation, contributed approximately 27 percent. The combined emissions of all other Site point sources contributed less than one percent to the 1997 MEI dose.

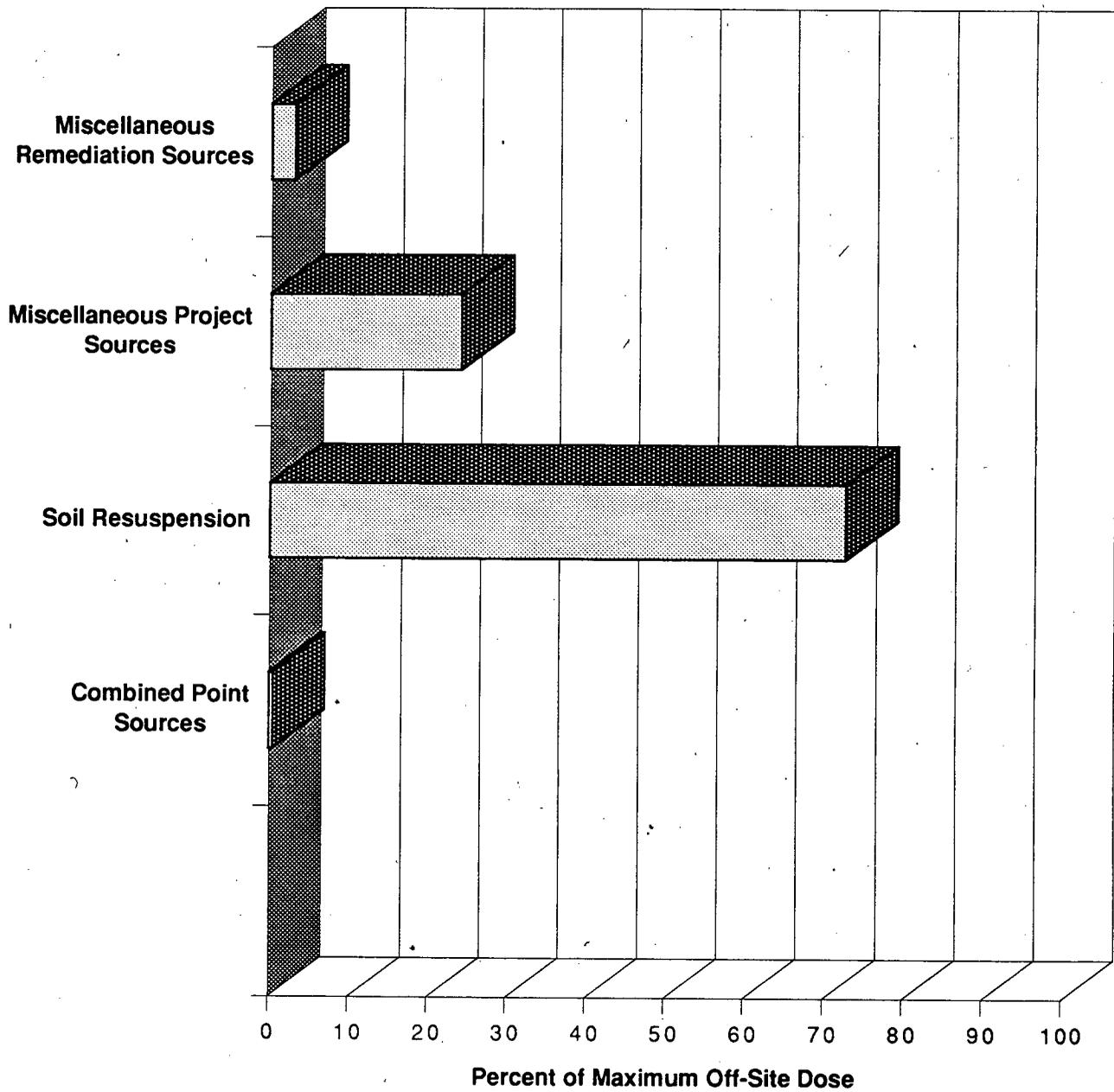
The 1997 results are consistent with patterns seen in previous years. In 1996, over 97% of the MEI dose was the result of cleanup activities that disturbed contaminated soil and sludge. In 1995, wind-blown soil contamination dominated the dose.

As cleanup of the Site continues, the Site air emission and dose profile will be increasingly dominated by projects that disturb contaminated soil or debris. In many cases, these cleanup activities will involve much smaller amounts of radionuclides than are stored or handled inside Site buildings. However, the nature of remediation activities is such that emissions cannot be reduced to the same extent as emissions from activities taking place under controlled conditions inside structures.

A graph portraying the contribution from each isotope to the EDE at the MEI location is shown in Figure 4-11. The contribution of various isotopes to the total 1997 dose differs from the contributions in 1996. In 1996, the dose showed significant contributions by the uranium isotopes associated with the T-3/T-4 remediation. In contrast, the 1997 dose is dominated by Pu-239 and, to a lesser extent, Am-241, which are present as surface soil contamination near the 903 Pad and in soils associated with the Sewage Treatment Plant backfill operation. Such results are characteristic of reporting periods prior to calendar year 1996.

The MEI location has also changed from previous years. In 1997, the MEI was located to the east-southeast of the Site, near Mower Reservoir. This is slightly north and east of the "historical" MEI location at 96th Avenue and Indiana Street, which represented the MEI

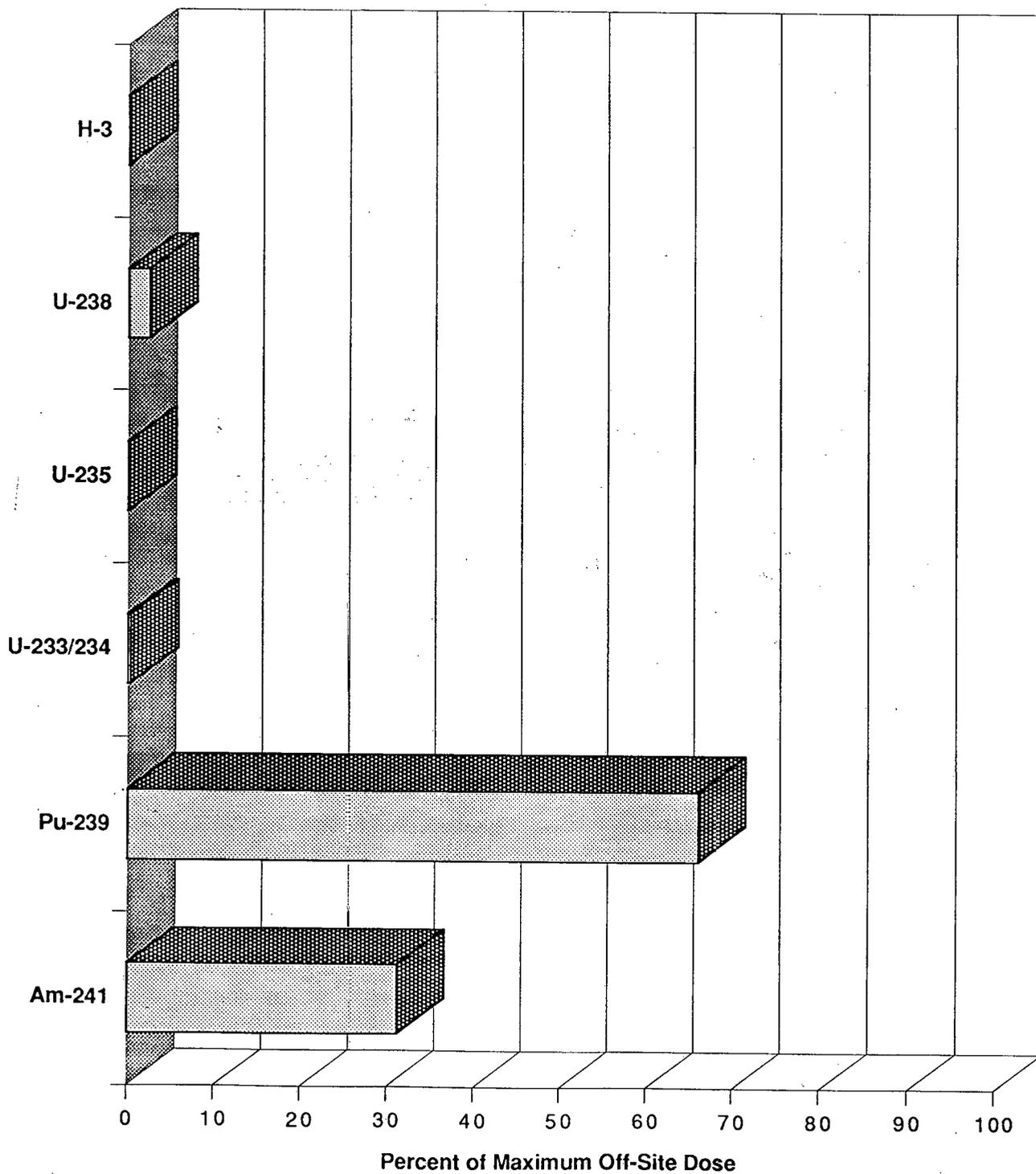
Figure 4-10.
Contribution to 1997 Maximum Off-Site EDE by Source Type



Notes:

EDE = Effective dose equivalent

Figure 4-11.
 Contribution to 1997 Maximum Off-Site EDE by Isotope



Notes:

Am	=	Americium	Pu	=	Plutonium	H-3	=	Tritium
EDE	=	Effective dose equivalent	U	=	Uranium			

prior to 1996, and corresponds to the direction of prevailing wind flow across the center of the Site. The Mower Reservoir receptor did not exist prior to 1996. In 1996, the MEI occurred to the northeast of the Site along McCaslin Boulevard. The 1996 maximum impact location was heavily influenced by the wind patterns that occurred over the shorter timeframes representing the peak T-3/T-4 and Building 774 tank draining activities.

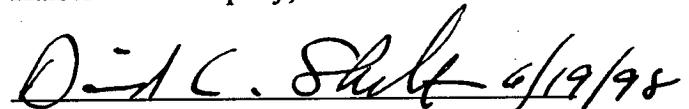
4.4 Certification

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 Environmental Compliance
Department of Energy


Signature *ACT 1001 REY* Date *6/23/98*
JOYR LA GARRE

David C. Shelton
Vice-President, Environmental Management &
Compliance
Kaiser-Hill Company, L.L.C.


Signature Date *6/19/98*

5.0 SUPPLEMENTAL INFORMATION

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

- **Calendar year 1997 dose at non-MEI locations:** The maximum EDE to the public for calendar year 1997 was 0.004 mrem (0.00004 mSv) for a receptor located near Mower Reservoir, 4,143 m to the east-southeast of the center of the Site. Annual EDE estimates for the closest receptor locations in other directions from the center of the Site are shown in Table 5-1 for comparison.
- **Calendar year 1997 collective dose:** The collective dose to the surrounding population was calculated with CAP88-PC using population figures that were adjusted from 1994 data based on regional growth information. The collective dose represents the total dose to the surrounding population within 52 miles (83.7 km) of the Site. The collective dose for calendar year 1997 was 0.27 person-rem (0.0027 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 1997.
- **Sitewide modeling/environmental measurement data comparison for calendar year 1997:** As discussed below, the Site has proposed an alternative compliance demonstration method for 40 CFR 61, Subpart H. Under the alternative compliance demonstration method, compliance with the 10 mrem (0.1 mSv) annual standard will be assessed by comparing concentrations of individual isotopes measured at the Site boundary to allowable concentrations for each isotope listed in Table 2 of Appendix E of 40 CFR 61

Table 5-1.

**Calendar Year 1997 Dose at
Receptor Locations Surrounding the Site**

Location	1997 EDE (mrem)	Distance to Receptor^a (m)	Direction to Receptor^a
Mower Reservoir (MEI)	0.004	4,143	ESE
McCaslin Boulevard	0.002	4,425	NE
East of Great Western Reservoir	0.002	5,695	E
96th and Indiana	0.002	4,064	SE
Sawmill, east of Highway 93	0.001	2,994	WNW
South, at Highway 72	0.002	3,419	S
Rocky Flats Lake	0.001	3,625	SW

^a From center of Site industrial area.

Notes:

E	=	East
EDE	=	Effective dose equivalent
ESE	=	East-southeast
m	=	Meters
MEI	=	Maximally exposed individual
mrem	=	Millirem
NE	=	Northeast
S	=	South
SE	=	Southeast
SW	=	Southwest
WNW	=	West-northwest

and by summing fractional values of allowable concentrations for each isotope. Compliance will be demonstrated if the measured concentration for each individual isotope is less than the concentration value listed in Table 2 of Appendix E and if the sum of the fractional values is less than 1.0.

For 1997, several comparisons have been made. Measured concentrations of various individual isotopes and the summed fractional values of all isotopes are compared in Table 5-2 with the corresponding modeled estimates at the nearest receptor locations. Table 5-2 also shows the measured concentrations and fractional sum at the perimeter sampler with the largest fractional sum in 1997 (i.e., the "critical receptor") and compares these values with the concentrations estimated through modeling for the MEI. Figure 5-1 shows the locations of the perimeter samplers and receptors.

In general, modeled and measured concentrations of Pu-239 and Am-241 are very similar, within an order of magnitude at all locations. It should be noted that the uncertainty associated with the measured values for these two isotopes is sufficiently large that the modeled concentrations would be within the measured value, plus or minus the calculated uncertainty, in nearly every case.

Uranium isotopes show a somewhat different pattern. The measured values for all uranium isotopes are consistently higher than modeled values. This is particularly true of U-233/234 and U-235. U-238 values are closer but still consistently higher in the measured data.

This pattern is not surprising since the soils surrounding Rocky Flats are rich in naturally occurring uranium. In general, natural uranium has approximately equal activities for U-233/234 and U-238, while the uranium emissions estimated and modeled for Site activities reflect the depleted uranium (rich in U-238) that was present in the soil/debris disturbed during 1997.

If measured concentrations are converted to dose units using the assumption that the allowable concentrations given in Table 2 of Appendix E of 40 CFR 61 represent the concentrations of individual isotopes that would correspond to a 10 mrem dose, the maximum dose measured at the perimeter of the Site was

Table 5-2.

**Calendar Year 1997 Measured and
Modeled Concentrations**

Paired Locations^a	Isotope	Modeled Concentration (Ci/m³)	Measured Concentration (Ci/m³)	Allowable Concentration^b (Ci/m³)
East of Great Western Reservoir (Modeled) S-137 (Measured)	Pu-239	3.07 E-19	8.53 E-19	2.0 E-15
	U-233/234	7.00 E-21	1.94 E-17	7.1/7.7 E-15
	U-235	7.91 E-22	5.94 E-19	7.1 E-15
	U-238	5.42 E-20	1.75 E-17	8.3 E-15
	Am-241	1.56 E-19	3.39 E-19	1.9 E-15
	Fractional Sum	--	0.0055	1.0
Mower Reservoir (Modeled) S-138 (Measured)	Pu-239	8.76 E-19	2.08 E-18	2.0 E-15
	U-233/234	1.31 E-20	1.56 E-17	7.1/7.7 E-15
	U-235	1.42 E-21	1.01 E-18	7.1 E-15
	U-238	1.14 E-19	1.69 E-17	8.3 E-15
	Am-241	2.92 E-19	6.56 E-19	1.9 E-15
	Fractional Sum	--	0.0058	1.0
96th and Indiana (Modeled) S-207 (Measured)	Pu-239	4.56 E-19	9.70 E-19	2.0 E-15
	U-233/234	1.12 E-20	2.13 E-17	7.1/7.7 E-15
	U-235	1.26 E-21	5.36 E-19	7.1 E-15
	U-238	8.60 E-20	2.06 E-17	8.3 E-15
	Am-241	1.99 E-19	2.48 E-19	1.9 E-15
	Fractional Sum	--	0.0062	1.0
South, at Highway 72 (Modeled) S-141 (Measured)	Pu-239	2.47 E-19	7.23 E-19	2.0 E-15
	U-233/234	1.17 E-20	1.66 E-17	7.1/7.7 E-15
	U-235	1.31 E-21	8.20 E-19	7.1 E-15
	U-238	5.79 E-20	1.57 E-17	8.3 E-15
	Am-241	1.74 E-19	2.00 E-19	1.9 E-15
	Fractional Sum	--	0.0048	1.0
South, at Highway 72 (Modeled) S-142 (Measured)	Pu-239	2.47 E-19	5.05 E-19	2.0 E-15
	U-233/234	1.17 E-20	1.63 E-17	7.1/7.7 E-15
	U-235	1.31 E-21	6.78 E-19	7.1 E-15
	U-238	5.79 E-20	1.58 E-17	8.3 E-15
	Am-241	1.74 E-19	2.82 E-19	1.9 E-15
	Fractional Sum	--	0.0047	1.0
Rocky Flats Lake (Modeled) S-209 (Measured)	Pu-239	1.03 E-19	4.35 E-19	2.0 E-15
	U-233/234	5.55 E-21	1.94 E-17	7.1/7.7 E-15
	U-235	6.36 E-22	7.38 E-19	7.1 E-15
	U-238	2.33 E-20	1.79 E-17	8.3 E-15
	Am-241	7.84 E-20	4.59 E-19	1.9 E-15
	Fractional Sum	--	0.0055	1.0

Table 5-2.
(Continued)

Paired Location^a	Isotope	Modeled Concentration (Ci/m³)	Measured Concentration (Ci/m³)	Allowable Concentration^b (Ci/m³)
Sawmill, east of Highway 93 (Modeled) S-132 (Measured)	Pu-239	1.11 E-19	7.29 E-19	2.0 E-15
	U-233/234	6.78 E-21	3.81 E-17	7.1/7.7 E-15
	U-235	8.14 E-22	1.81 E-18	7.1 E-15
	U-238	2.63 E-20	3.76 E-17	8.3 E-15
	Am-241	1.01 E-19	4.54 E-19	1.9 E-15
	Fractional Sum	--	0.0107	1.0
McCaslin Boulevard (Modeled) S-134 (Measured)	Pu-239	2.63 E-19	9.49 E-19	2.0 E-15
	U-233/234	8.19 E-21	1.24 E-17	7.1/7.7 E-15
	U-235	8.96 E-22	4.10 E-19	7.1 E-15
	U-238	7.38 E-20	1.20 E-17	8.3 E-15
	Am-241	1.69 E-19	7.47 E-19	1.9 E-15
	Fractional Sum	--	0.0041	1.0
McCaslin Boulevard (Modeled) S-136 (Measured)	Pu-239	2.63 E-19	4.84 E-19	2.0 E-15
	U-233/234	8.19 E-21	1.39 E-17	7.1/7.7 E-15
	U-235	8.96 E-22	7.03 E-19	7.1 E-15
	U-238	7.38 E-20	1.27 E-17	8.3 E-15
	Am-241	1.69 E-19	4.22 E-19	1.9 E-15
	Fractional Sum	--	0.0041	1.0
MEI: Mower Reservoir (Modeled) Critical Receptor: S-140 (Measured)	Pu-239	8.76 E-19	8.97 E-19	2.0 E-15
	U-233/234	1.31 E-20	4.47 E-17	7.1/7.7 E-15
	U-235	1.42 E-21	2.06 E-18	7.1 E-15
	U-238	1.14 E-19	4.57 E-17	8.3 E-15
	Am-241	2.92 E-19	4.49 E-19	1.9 E-15
	Fractional Sum	--	0.0128	1.0

^a Locations of receptors and samplers are shown in Figure 5-1.

^b Allowable concentrations are the standards given in Table 2, Appendix E, 40 CFR 61.

Notes:

- Am = Americium
- Pu = Plutonium
- CFR = Code of Federal Regulations
- Ci/m³ = Curies per cubic meter
- E# = x 10[#]
- MEI = Maximally exposed individual
- U = Uranium
- = Not applicable

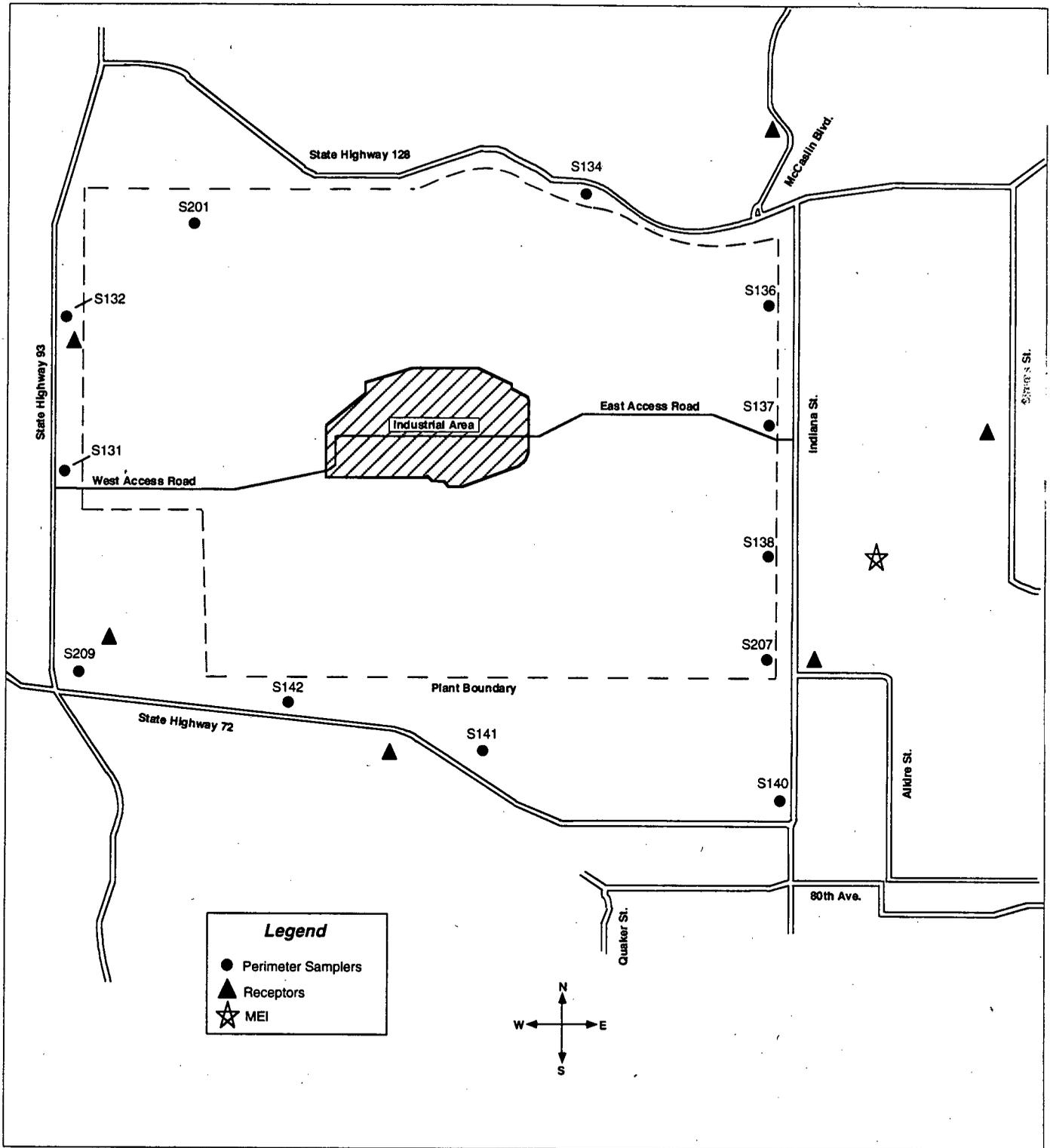


Figure 5-1. Receptor Locations and Nearby Samplers

approximately 0.128 mrem in 1997. In contrast, the modeled MEI dose was 0.004 mrem. Uranium isotopes contributed approximately 0.12 mrem to the measured dose and 0.0001 mrem to the modeled dose. Inspection of the U-233/234 to U-238 ratios in the measured data indicate that most of the uranium measured was naturally occurring. The measured dose due to plutonium and americium isotopes is approximately 0.008 mrem, compared to the total modeled contributions for those isotopes of 0.0039 mrem.

• **Basis of alternative method for compliance demonstration:**

Currently, the Site demonstrates compliance with the annual 10 mrem public dose standard in 40 CFR 61, Subpart H, through measurement and dispersion modeling of the effluent (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. The Site has historically demonstrated Subpart H compliance using this approach.

As the Site continues to work toward cleanup and closure, buildings that contain significant quantities of radionuclide materials will be deactivated. Following limited contaminant removal, the ventilation systems may be sealed and then tuned off. In other cases, equipment removal and structural demolition will be carried out, with the existing ventilation systems disrupted or dismantled at some point in the process. In some cases, the deactivated buildings may contain enough potentially dispersible contamination to exceed the annual monitoring threshold of 0.1 mrem (0.001 mSv) based on potential uncontrolled emissions. However, a lack of directed flow from the contaminated areas will preclude normal effluent emission collection and measurement in these buildings. Such buildings will become nonpoint (diffuse) sources of airborne radionuclides.

Environmental restoration projects present a similar dilemma. Radionuclide emissions will occur from disturbance of contaminated soils and debris, as well as from waste treatment, handling, and packaging activities. As with building deactivation and decommissioning, normal effluent emission collection and measurement will not be possible for most such activities.

As buildings are closed and become diffuse sources, and as the number of environmental restoration projects increases, the number of effluent source locations where emissions are directly collected and measured will decrease and the number of sources at the Site where emissions must be estimated will increase. In such cases where diffuse sources are primary contributors to dose, as has been the case at the Site since 1995, an alternative environmental measurement approach becomes particularly appropriate for demonstrating compliance with the public dose standard of 40 CFR 61, Subpart H (EPA, 1991).

In recognition of this fact, DOE submitted a proposal to EPA and CDPHE in July 1997 describing an alternative compliance demonstration approach, as allowed by 40 CFR 61.93(b)(5), based on the existing 12 perimeter Radioactive Ambient Air Monitoring Program (RAAMP) samplers, plus one additional sampler to be located at the northeast Site boundary. The ambient samplers collect both fine and coarse particulate fractions continuously on filters and removable impactor surfaces that can be exchanged and analyzed on a monthly schedule. The samples are analyzed for the plutonium, uranium, and americium 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. The resulting monthly concentration data at each of the environmental sampling locations are compared with allowable concentration levels in Table 2 of Appendix E of 40 CFR 61 and time-weighted averages for each location are reported annually to EPA and CDPHE.

Under the alternative compliance demonstration method, effluent collection and measurement will be discontinued for insignificant release points on Site and the ambient network will be 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 effluent samplers.

Annual compliance data will be reported from all ambient sampling locations at the Site perimeter. The location with the highest annual radioisotope concentrations will be considered the "critical receptor" used to demonstrate compliance with the standard. However, for a two-year transition period

following approval of the alternative method, emissions from the Site will be modeled, including estimated diffuse source emissions, and the resulting EDE will also be reported to allow comparison with environmental measurements.

- **Representative Effluent Samplers (RES):** On November 22, 1994, the EPA approved the Alternate Reference Methodology (ARM) for sampling radionuclide aerosol particles from stacks and ducts at DOE facilities. The ARM approach uses single-point shrouded probe sampling methodology to measure radionuclide emissions. In November 1994, DOE, RFFO agreed to install shrouded probes at radionuclide release points at the Site that are subject to the continuous emission sampling or monitoring requirements of 40 CFR 61.93(b) by December 31, 1997. This agreement is documented in a letter from D. A. Brockman of DOE, RFFO to P. D. Hull of the EPA, dated February 27, 1995 (Brockman, 1995).

Sampling Locations Upgraded to Shrouded Probe Systems

Table 5-3 lists the 18 sampling locations that were upgraded to the single-point shrouded probe sampling systems. All single-point shrouded probe sampling systems in Buildings 371, 374, 561, 707, 771, 774, and 776/777 became operational prior to January 1, 1998, except the sampling system for plenums 205, 206, and 207 in Building 776, which became operational on January 15, 1998. Because high winds damaged a crane needed to complete the sampling system installation, EPA and CDPHE agreed to the revised schedule for completing 776-205, -206, and -207 that was proposed by DOE (McCallister, 1997). Figure 5-2 shows the sampling locations that were upgraded to shrouded probes.

The Site discontinued using the old multipoint effluent air samplers in Buildings 374, 561, 707, 771, 774, and 776/777 in February 1998. As of June 1998, Building 371 continues to be sampled using both the new single-point shrouded probe and old multipoint effluent air sampling systems, as discussed below.

On November 18, 1997, EPA approved a request from DOE, RFFO to delay the commencement of certified shrouded probe sampling in Building 371 until

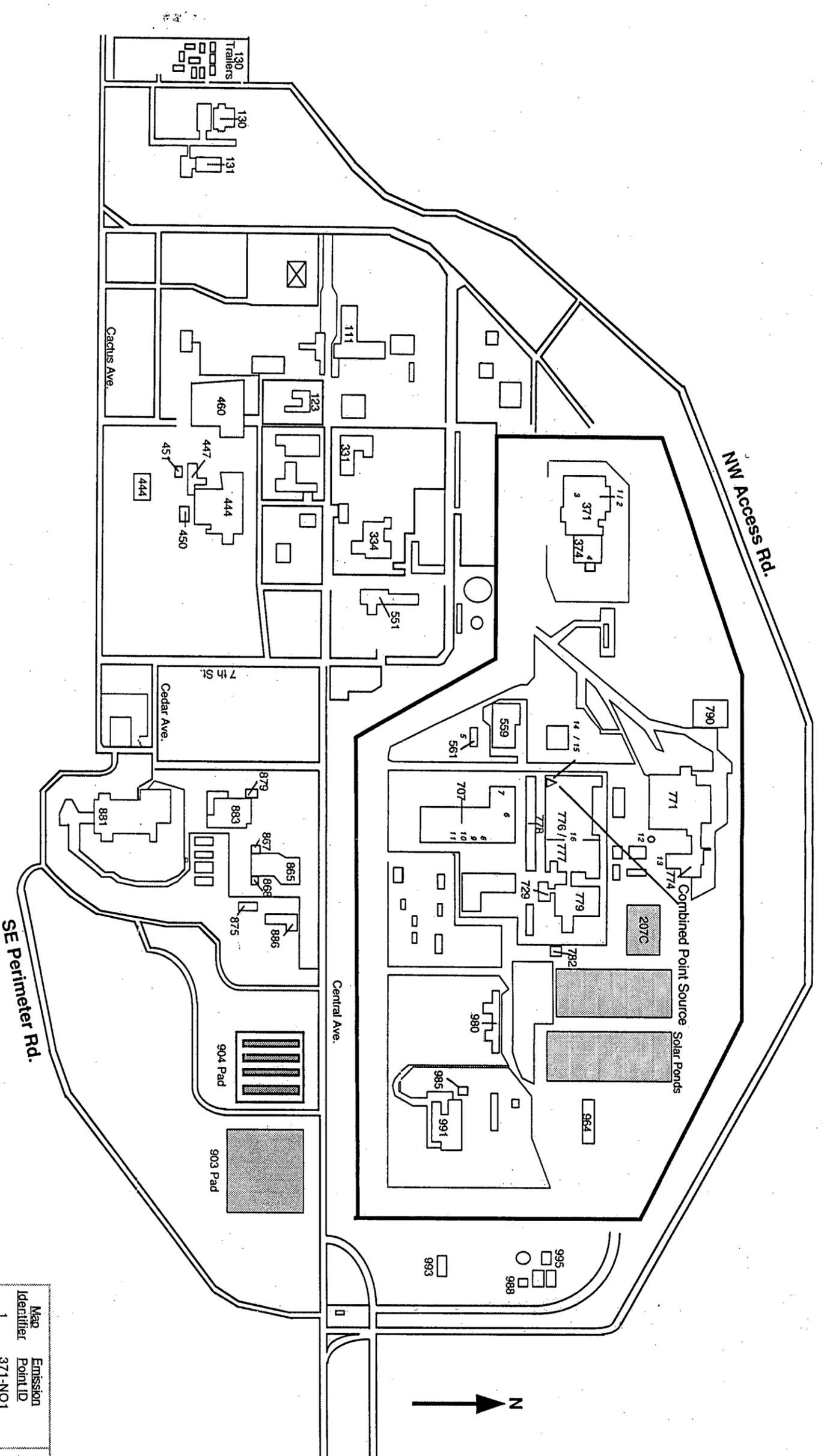
Table 5-3.

Sampling Locations Upgraded to Shrouded Probes

Map Identifier	Release Point Identifier (Building/Location)
1	371-NO1 ^a
2	371-NO2 ^a
3	371-SSS
4	374-MAI
5	559-561
6	707-101/103
7	707-102/104
8	707-105
9	707-106
10	707-107
11	707-108
12	771-MAI
13	774-202
14	776-201/203
15	776-204
16	776-205 ^b
16	776-206 ^b
16	776-207 ^b

- ^a Release points 371-NO1 and 371-NO2 are two individual stacks that are continuously sampled for particulate radionuclide emissions with a shrouded probe in each stack. These two release points are identified separately in Figure 5-2.
- ^b Release points 776-205, -206, and -207 are combined through a mixing plenum and are continuously sampled with one shrouded probe. These three release points are identified as a single point source in Figure 5-2.

not to scale
Revision 2, June 1998



Map Identifier	Emission Point ID	Map Identifier	Emission Point ID
1	371-NO1	10	707-107
2	371-NO2	11	707-108
3	371-SSS	12	771-MAI
4	374-MAI	13	774-202
5	559-561	14	776-201/203
6	707-101/103	15	776-204
7	707-102/104	16	776-205
8	707-105	16	776-206
9	707-106	16	776-207

Figure 5-2. Sampling Locations Upgraded to Shrouded Probe

April 30, 1997, if enhanced mixing of the effluent air was needed (Hestmark, 1997). The schedule revision was necessary to allow reinforcement of the ducts to accommodate the mixing systems. Subsequent performance testing of the Building 371 south and north effluent stacks indicated that effluent mixing will be required at both sampling locations to comply with the single-point shrouded probe sampling specification. Until the appropriate mixing systems have been installed, emissions will continue to be sampled with parallel systems.

Locations Dropped From Upgrade Project

The existing radionuclide air effluent sampling systems in Buildings 776/777 at plenums 202 and 250 were originally scheduled for upgrade during the RES project. Based on an assessment of dispersible radionuclide sources associated with plenum systems 202 and 250 in Buildings 776/777 that was performed in 1997, it was determined that continuous effluent air sampling is not required at these locations. The potential dispersible radionuclide sources associated with plenums 202 and 250 yield dose estimates below the 0.1 mrem monitoring threshold defined in 40 CFR 61, Subpart H. Periodic confirmatory measurements will continue to be performed at plenums 202 and 250 using the existing multipoint sampling systems to verify low emissions. To demonstrate compliance with 40 CFR 61, Subpart H, the source term associated with plenum systems 202 and 250 in Buildings 776/777 will continue to be reevaluated annually to determine any changes with respect to the 0.1 mrem threshold.

The existing radionuclide air effluent sampling systems in Buildings 729 and 782 (plenum buildings for Building 779) were also originally scheduled for upgrade during the RES project. However, Building 779 is scheduled for demolition and activities are not expected to resume in Building 779 that would exceed the 0.1 mrem monitoring threshold. EPA and CDPHE approved the Site's request to remove Building 779 from the RES upgrade project in June 1997 (Lammering and Hestmark, 1997; Fox, 1997). Continuous effluent air sampling will continue at Building 779, using the existing multipoint sampling systems in Buildings 729 and 782, until the source term is reduced below the 0.1 mrem threshold defined in 40 CFR 61.93(b)(4).

Sampling Methodology

The ARM, which is found in a proposed American National Standards Institute (ANSI) revision (EPA, 1994), is a performance-based methodology that requires testing the flow at the sampling location to ensure that both the fluid momentum and the contaminant concentration are well mixed. Details of the testing procedure are presented by McFarland (1996) in a guide for demonstrating compliance with an impending update to ANSI N13.1, 1969, titled *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities* (ANSI, 1969), where the proposed revisions to the ANSI standard encompass the single-point shrouded probe sampling approach given in the ARM.

To ensure that a representative air effluent sample is obtained, mixing systems were installed on nine stacks of Buildings 561, 707, 774, and 776/777. The mixing systems are attached to the stack above the roof and are designed to handle both high and low flow rates. The characteristics of the mixing system are illustrated in Figure 5-3 and consist of a mixing plenum, exit duct, and elbow. Flow from the stack or duct enters the mixing plenum, where it is diverted around the internal extension of the exit duct and then directed to the flow element, which reduces the swirl and pressure loss. The flow then enters the exit duct and is sampled with a shrouded probe at a distance of approximately 2.5 duct diameters from the end of the mixing plenum.

The single-point shrouded probe continuously withdraws a sample from the effluent and passes it through vertical tubing and a 4.7 centimeter (cm) glass microfiber filter. A flow control valve on the Health Physics Vacuum Line is used to adjust the sample flow rate to 2 actual cubic feet per minute. The sample flow rate is verified and adjusted quarterly using a calibrated thermal anemometer or air flow meter.

Mixing systems were not required in four stacks and ducts in Buildings 374, 771, and 776/777, where the existing flow systems provided good mixing of both fluid momentum and contaminant concentration. Figure 5-4 provides a general schematic of the shrouded probe sampling system without a mixing plenum.

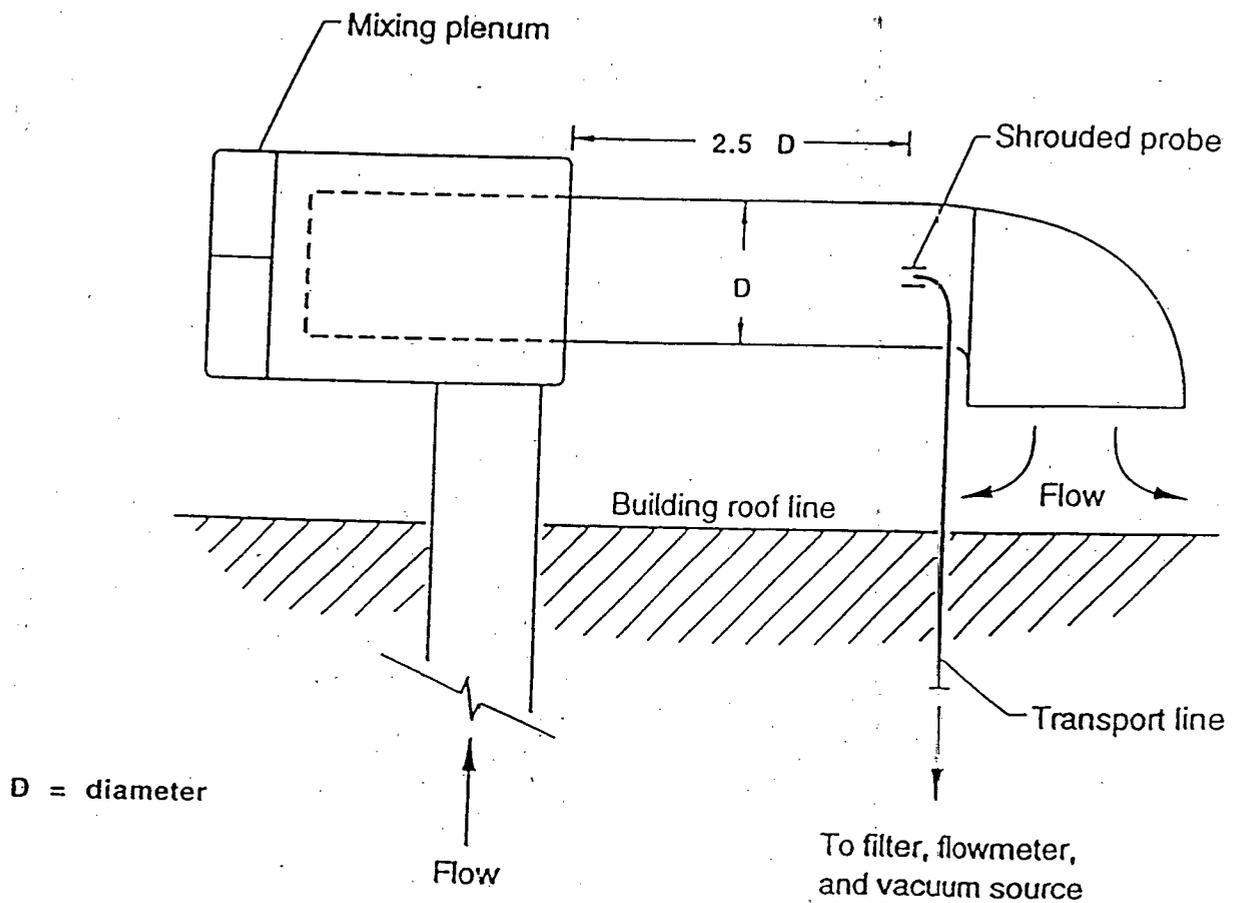


Figure 5-3. Schematic of Shrouded Probe Mechanism with Mixing Plenum

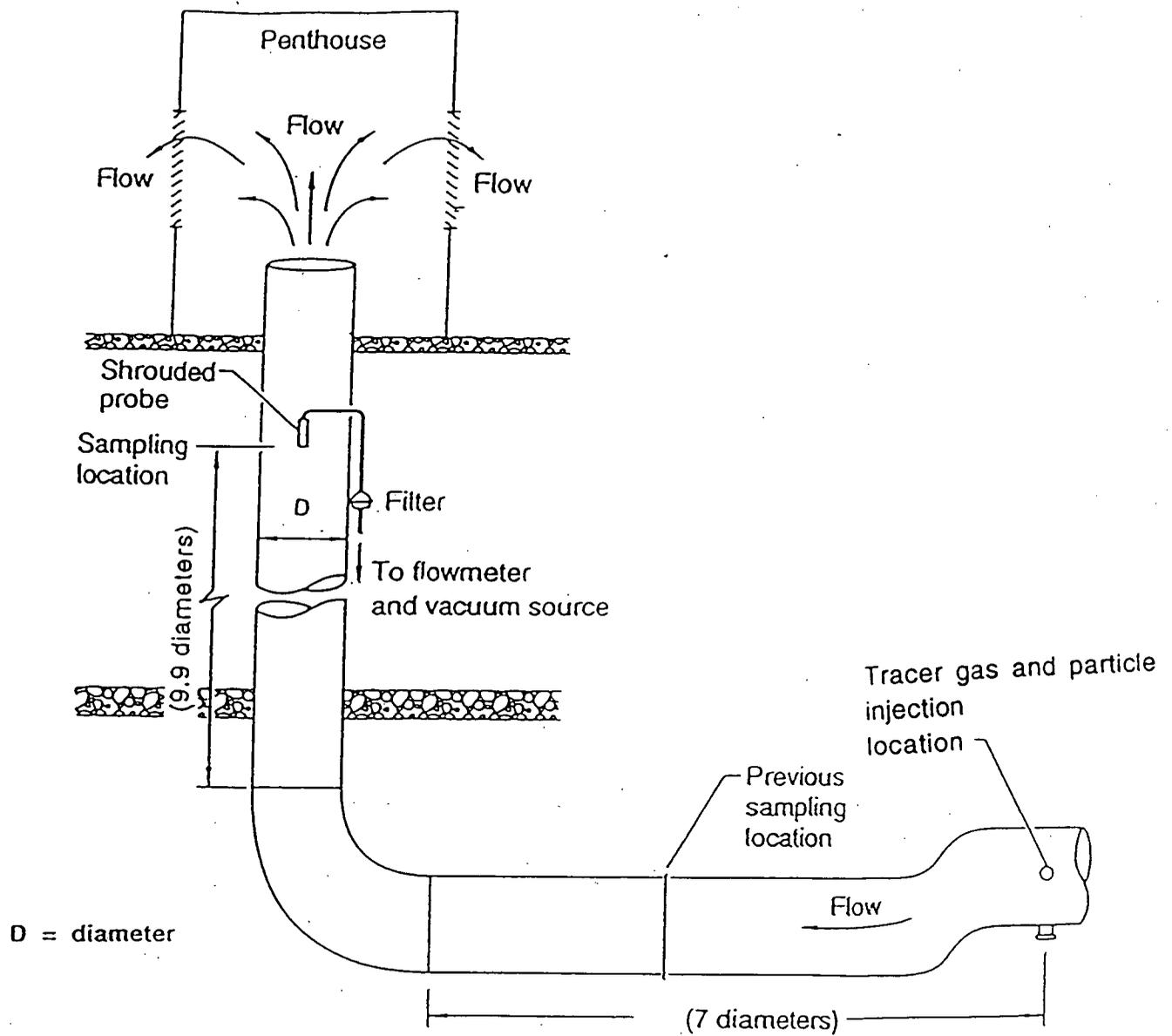


Figure 5-4. Schematic of Shrouded Probe Mechanism without Mixing Plenum

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APPENDIX A

RADIOACTIVE MATERIALS ASSOCIATED WITH ROCKY FLATS

ROCKY FLATS HEALTH PHYSICS REPORT
RADIOACTIVE MATERIALS
ASSOCIATED WITH
ROCKY FLATS

October 31, 1995

B. Britton
Source Registry Program Administrator
303/966-8452

Reviewed for Classification/UCNI

By: _____

Date: _____

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 REGISTERED AND/OR MISCELLANEOUS SOURCES

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

Sealed solids >10 μ Ci
Plated solids >1 μ Ci
Liquids > 10⁻³ μ Ci

Americium	(Am-241)	Iridium	(Ir-192)
Antimony	(Sb-124)	Iron	(Fe-55)
Barium	(Ba-133)	Nickel	(Ni-63)
Cadmium	(Cd-109)	Plutonium	(Pu-238,-239,-240,-244)
Californium	(Cf-252)	Promethium	(Pm-147)
Cesium	(Cs-137)	Radium	(Ra-226)
Cobalt	(Co-57,60)	Selenium	(Se-75)
Europium	(Eu-152)	Sodium	(Na-22)
Hydrogen (Tritium)	(H-3)	Strontium	(Sr-90)
		Thorium	(Th-228)
		Uranium	(U-234,-235,-238)

APPENDIX B

EFFLUENT INFORMATION SYSTEM (EIS) DATA

Summary Table For The EIS/ODIS Report^a

1997-Release (Ci)

97_ODIS Location	ODIS Location Code	N	Effluent Volume (m ³)	Plutonium	Americium	Uranium	Uranium	Uranium	Tritium
				239	241	233/234	235	238	
707-101	AFGHB707005	12	9.742E+06	3.435E-10	8.752E-11	-1.263E-10	2.160E-11	-2.490E-10	
707-102	AFGHB707006	12	2.370E+07	3.561E-10	-1.420E-10	-1.379E-09	-4.033E-11	-4.175E-10	
707-105	AFGHB707003	12	7.244E+07	2.315E-10	-7.559E-11	-2.530E-10	-4.300E-13	-5.151E-11	
707-106	AFGHB707001	12	2.182E+07	1.785E-10	8.516E-11	-4.360E-10	3.122E-11	-6.553E-10	
707-107	AFGHB707004	12	1.771E+08	1.988E-10	-4.149E-11	-2.545E-10	2.836E-10	-6.663E-10	
707-108	AFGHB707002	12	8.990E+07	6.464E-10	8.883E-11	-4.687E-10	-1.976E-11	-6.773E-10	
707-R21	AFGHI707001	1	4.453E+08	-9.298E-11	-2.790E-10	2.236E-09	6.340E-11	7.270E-10	
707-R22	AFGHI707002	1	4.453E+08	3.302E-10	-3.895E-10	7.959E-10	-2.540E-11	2.409E-09	
707-R23	AFGHI707003	1	4.453E+08	-4.230E-12	2.113E-11	1.141E-09	-1.479E-10	1.428E-09	
707-R24	AFGHI707004	1	4.453E+08	6.333E-11	-4.855E-10	5.742E-10	-3.377E-11	1.828E-09	
707-R25	AFGHI707005	1	4.453E+08	-1.100E-10	-1.396E-10	4.780E-10	-6.345E-11	5.161E-10	
707-R26	AFGHI707006	1	4.453E+08	5.495E-11	-4.903E-10	1.293E-09	-8.877E-11	1.179E-09	
707-R27	AFGHI707007	1	4.453E+08	5.292E-10	-3.810E-10	6.773E-10	-3.217E-10	1.367E-09	
707-R45	AFGHI707008	8	4.453E+08	8.399E-10	3.314E-10	-2.848E-09	-3.690E-12	-1.667E-10	
707-R46	AFGHI707009	1	4.453E+08	1.563E-10	-2.535E-10	2.248E-09	-2.577E-10	2.467E-09	
779-782	AFGHF779002	12	6.049E+08	5.668E-09	-9.506E-10	-4.484E-09	5.727E-10	1.389E-09	1.270E-03
779-729	AFGHF779001	12	1.722E+08	7.155E-10	-3.357E-10	-1.148E-09	-1.767E-10	-5.422E-10	
776-201	AFGHE776003	12	7.580E+06	5.459E-10	4.626E-11	1.536E-10	3.235E-11	9.076E-11	
776-202	AFGHE776008	12	7.229E+07	3.310E-09	4.013E-09	-5.670E-10	5.949E-11	-4.882E-10	
776-204	AFGHE776005	12	1.587E+08	3.013E-09	3.709E-11	-5.693E-10	3.886E-10	2.488E-11	
776-205	AFGHE776004	12	1.072E+08	1.178E-09	5.119E-10	-5.781E-10	-1.272E-10	-7.795E-10	1.400E-04
776-206	AFGHE776002	12	7.709E+07	3.394E-09	1.274E-09	-9.200E-10	-1.153E-10	8.475E-10	8.800E-04
776-207	AFGHE776009	12	6.613E+07	1.539E-09	1.105E-10	-6.300E-10	3.315E-10	-8.273E-10	
776-250	AFGHE776001	8	3.782E+08	2.056E-08	-2.979E-09	4.230E-08	1.689E-09	5.118E-08	1.000E-03
776-251	AFGHE776006	1	3.282E+08	3.281E-10	4.141E-10	-3.790E-10	-3.190E-12	2.637E-09	4.100E-04
776-252	AFGHE776007	1	8.708E+07	1.137E-10	8.454E-12	-1.644E-10	-4.790E-11	7.421E-11	
559-561 ^b	AFGHA559001	12	6.486E+08	4.417E-09	7.062E-11	8.821E-09	6.147E-10	8.513E-09	
778-LDY	AFGHH778001	1	1.000E+02	6.100E-14	2.500E-14	2.200E-14	1.000E-15	1.340E-13	
771-MAI ^c	AFGHC771001	12	2.205E+09	1.037E-07	6.902E-09	-1.839E-07	-6.438E-09	-1.923E-07	
771-CMA	AFGHC771002	1	6.997E+07	1.305E-10	4.294E-11	1.844E-10	-2.442E-11	5.532E-10	
771-CRM	AFGHC771005	1	8.510E+07	1.276E-09	2.184E-10	4.194E-10	-2.374E-11	7.802E-10	
774-202 ^c	AFGHD774001	12	7.617E+07	1.277E-09	2.212E-10	-1.874E-10	8.497E-11	2.146E-10	
444-MAI	AFGHN444004	1	1.353E+09	7.516E-10	3.695E-09	1.810E-09	3.176E-11	1.874E-09	
444-D05	AFGHN444003	1	1.580E+08	1.194E-11	-1.582E-10	-2.537E-10	1.821E-10	8.416E-10	
447-MAI	AFGHO447001	1	7.597E+08	3.264E-10	-4.984E-10	-2.884E-09	-3.661E-10	-3.709E-09	
865-EEE	AFGHP865001	1	4.103E+08	6.001E-10	-2.945E-10	-1.394E-09	4.324E-10	-1.174E-09	
865-WWW	AFGHP865002	1	6.799E+08	3.985E-10	1.328E-10	-2.940E-09	1.364E-09	-7.728E-10	
886-875	AFGHS886001	12	1.168E+08	5.454E-10	1.000E-10	-7.479E-10	3.819E-10	-1.228E-09	
881-ANX	AFGHQ881002	0							
881-MAI	AFGHQ881001	4	3.923E+09	3.086E-09	-1.833E-08	-7.053E-08	-4.156E-09	-7.070E-08	

(Continued)

97_ODIS Location	ODIS Location Code	N	Effluent Volume (m ³)	Plutonium 239	Americium 241	Uranium 233/234	Uranium 235	Uranium 238	Tritium
883-AAA	AFGHR883001	1	7.810E+08	1.137E-10	-1.806E-10	-5.620E-10	1.204E-10	-2.944E-10	
883-BBB	AFGHR883002	1	1.089E+09	1.338E-10	-7.026E-10	2.295E-09	5.286E-10	4.530E-09	
883-CCC	AFGHR883003	1	2.361E+08	5.942E-10	-3.489E-10	-3.189E-09	-2.562E-10	-3.843E-09	
889-MAI	AFGHT889001	0							
991-985	AFGHU991001	1	1.256E+08	2.323E-09	-4.241E-10	-1.818E-09	3.029E-10	5.635E-09	
374-MAI ^b	AFGHJ374001	12	3.666E+08	2.034E-08	2.185E-09	-3.327E-09	1.419E-09	8.053E-10	
991-MAI	AFGHU991002	1	9.940E+07	1.464E-08	1.160E-10	1.137E-09	-9.980E-10	1.383E-08	
371-NNN	AFGHC371001	24	6.284E+08	4.359E-09	1.068E-09	-5.953E-09	1.493E-09	-2.711E-09	
371-SSS	AFGHC371002	12	2.879E+08	7.547E-10	-8.670E-12	4.640E-10	8.458E-11	1.079E-09	
374-SPD	AFGHD374002	1	9.577E+07	1.296E-09	6.964E-10	8.118E-10	3.133E-11	8.189E-10	
RFETS		308	2.066E+10	2.101E-07	-5.412E-09	-2.250E-07	-3.191E-09	-1.746E-07	3.700E-03

^a Did not analyze for Pu-238 in 1997.

^b Shrouded probe data used for this location in November and December.

^c Shrouded probe data used for this location in December.

Note:

EIS = Effluent Information System

ODIS = Off-Site Discharge Information System

Ci = Curies

N = Number of filters analyzed

m³ = Cubic meters

RFETS = Rocky Flats Environmental Technology Site

APPENDIX C

STACK DATA FOR POINT SOURCES

Stack Data for Point Sources

Building/ Location	Height ^a (m)	Diameter (m)	Width (m)	Length (m)	Exit Velocity (m/s)	Stack Type	Vent No.
123-001 through 004	6 .00	0 .61	--	--	f	Grouped	f
371-SSS	16 .00	--	1 .54	5 .76	3 .44	Penthouse	2
371-NO1/NO2 ^a	16 .00	--	1 .54	5 .76	8 .72	Penthouse	1
374-MAI	23 .77	--	1 .83	1 .37	14 .25	Penthouse	7, 8, 9
374-SPD	9 .14	0 .42	--	--	21 .35	90°	3
444-D05	3 .56	--	0 .76	0 .61	10 .78	90°	122
444-MAI	5 .90	--	2 .74	2 .44	6 .41	90°	200
447-MAI	4 .00	--	1 .83	1 .52	8 .64	90°	201
559-561	7 .00	--	1 .50	2 .28	14 .55	Gooseneck	36
707-101/103 ^b	11 .33	--	0 .30	0 .46	3 .48	Gooseneck	36
707-102/104 ^c	11 .33	--	0 .61	0 .91	2 .91	Gooseneck	9, 10
707-105	11 .33	--	0 .91	1 .37	3 .15	Gooseneck	28
707-106	11 .33	--	0 .61	0 .91	2 .57	Gooseneck	55
707-107	11 .33	--	1 .06	1 .60	6 .63	Gooseneck	65
707-108	11 .33	--	0 .91	1 .37	6 .26	Gooseneck	75
707-R21A	13 .70	1 .10	--	--	11 .74	Open	38
707-R21B	13 .70	1 .10	--	--	11 .74	Open	39
707-R22A	13 .70	1 .10	--	--	11 .74	Open	40
707-R22B	13 .70	1 .10	--	--	11 .74	Open	41
707-R23A	13 .70	1 .10	--	--	11 .74	Open	42
707-R23B	13 .70	1 .10	--	--	11 .74	Open	43
707-R24A	13 .70	1 .10	--	--	11 .74	Open	44
707-R24B	13 .70	1 .10	--	--	11 .74	Open	45
707-R25A	13 .70	1 .10	--	--	11 .74	Open	76
707-R25B	13 .70	1 .10	--	--	11 .74	Open	77
707-R26A	13 .70	1 .10	--	--	11 .74	Open	78
707-R26B	13 .70	1 .10	--	--	11 .74	Open	79
707-R27A	13 .70	1 .10	--	--	11 .74	Open	80
707-R27B	13 .70	1 .10	--	--	11 .74	Open	81

(Continued)

Building/ Location	Height ^a (m)	Diameter (m)	Width (m)	Length (m)	Exit Velocity (m/s)	Stack Type	Vent No.
707-R45A	13.00	0.84	--	--	11.74	Open	1
707-R45B	12.86	0.84	--	--	11.74	Open	2
707-R46A	12.86	0.81	--	--	11.74	Open	3
707-R46B	12.86	0.81	--	--	11.74	Open	4
771-CMA	7.67	0.61	--	--	7.60	Gooseneck	9
771-CRM8	7.82	0.45	--	--	11.54	90°	1
771-CRM10	7.25	--	0.61	0.51	2.48	90°	8
771-MAI	50.14	3.12	--	--	9.70	Open	86
774-202	7.11	--	0.61	0.91	10.98	Gooseneck	4
776-201/204/250 ^d	12.00	--	0.74	6.17	2.41	Penthouse	24
776-202	16.10	0.52	--	--	5.86	Rain Cap	17
776-205/206/207 ^e	12.00	--	1.06	1.60	4.86	Penthouse	32
776-251	13.00	--	0.81	1.52	8.32	Wall penetration	45
776-252	13.20	--	0.91	0.56	8.42	90° Wall penetration	44
778-LDY	8.00	1.22	--	--	5.75	Open	50
779-729	26.82	0.96	--	--	7.49	Open	12
779-782	6.70	--	0.91	1.45	14.67	Gooseneck	1
790	f	f	f	f	f	f	f
865-EEE	5.66	--	1.12	1.52	7.64	90°	63,64
865-WWW	5.30	--	1.42	1.42	10.65	90°	58,59
881-MA1	12.40	2.44	--	--	5.66	Open	8
881-MA2	12.40	2.44	--	--	11.13	Open	7
881-MA3	12.40	2.44	--	--	5.28	Open	5
881-MA4	12.40	2.44	--	--	4.62	Open	6
883-AAA	7.41	--	1.32	2.50	7.53	90°	44
883-BBB	7.07	--	1.32	2.50	10.50	90°	45
883-CCC	21.34	1.22	--	--	6.40	Open	34
886-875	5.95	--	1.22	0.61	9.97	Gooseneck	15

(Continued)

Building/ Location	Height ^a (m)	Diameter (m)	Width (m)	Length (m)	Exit Velocity (m/s)	Stack Type	Vent No.
991-985	6.25	--	1.22	0.51	11.90	Gooseneck	2
991-MAI	7.21	--	1.37	1.52	1.50	Gooseneck	41

^a 371-N01/N02 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.

^f Data not available.

Notes:

-- = Not applicable
m = Meters
m/s = Meters per second

APPENDIX D

METEOROLOGICAL DATA SET

**Meteorological Data Set
Wind Speed and Stability Class, 1997**

Wind Direction ^a	Stability Class	Wind Speed Frequency (%)					
		1.0 to 1.8 (m/s)	1.8 to 3.3 (m/s)	3.3 to 5.4 (m/s)	5.4 to 8.5 (m/s)	8.5 to 11.0 (m/s)	>11.0 (m/s)
N	A	0.003	0.005	0.000	0.000	0.000	0.000
NNE	A	0.004	0.006	0.000	0.000	0.000	0.000
NE	A	0.004	0.007	0.000	0.000	0.000	0.000
ENE	A	0.005	0.007	0.000	0.000	0.000	0.000
E	A	0.004	0.008	0.000	0.000	0.000	0.000
ESE	A	0.004	0.012	0.000	0.000	0.000	0.000
SE	A	0.003	0.007	0.000	0.000	0.000	0.000
SSE	A	0.002	0.003	0.000	0.000	0.000	0.000
S	A	0.002	0.002	0.000	0.000	0.000	0.000
SSW	A	0.002	0.002	0.000	0.000	0.000	0.000
SW	A	0.001	0.001	0.000	0.000	0.000	0.000
WSW	A	0.002	0.001	0.000	0.000	0.000	0.000
W	A	0.002	0.001	0.000	0.000	0.000	0.000
WNW	A	0.002	0.001	0.000	0.000	0.000	0.000
NW	A	0.001	0.002	0.000	0.000	0.000	0.000
NNW	A	0.002	0.002	0.000	0.000	0.000	0.000
N	B	0.001	0.003	0.004	0.000	0.000	0.000
NNE	B	0.001	0.002	0.003	0.000	0.000	0.000
NE	B	0.000	0.002	0.005	0.000	0.000	0.000
ENE	B	0.001	0.002	0.002	0.000	0.000	0.000
E	B	0.001	0.002	0.004	0.000	0.000	0.000
ESE	B	0.001	0.004	0.003	0.000	0.000	0.000
SE	B	0.001	0.005	0.003	0.000	0.000	0.000
SSE	B	0.001	0.002	0.002	0.000	0.000	0.000
S	B	0.001	0.001	0.001	0.000	0.000	0.000
SSW	B	0.001	0.001	0.001	0.000	0.000	0.000
SW	B	0.000	0.000	0.001	0.000	0.000	0.000
WSW	B	0.001	0.001	0.001	0.000	0.000	0.000
W	B	0.000	0.000	0.001	0.000	0.000	0.000
WNW	B	0.000	0.000	0.001	0.000	0.000	0.000
NW	B	0.000	0.001	0.001	0.000	0.000	0.000
NNW	B	0.001	0.002	0.002	0.000	0.000	0.000
N	C	0.001	0.005	0.009	0.003	0.000	0.000
NNE	C	0.001	0.002	0.004	0.001	0.000	0.000
NE	C	0.000	0.001	0.003	0.000	0.000	0.000
ENE	C	0.001	0.002	0.001	0.000	0.000	0.000
E	C	0.000	0.001	0.002	0.000	0.000	0.000
ESE	C	0.001	0.002	0.002	0.000	0.000	0.000
SE	C	0.001	0.002	0.005	0.001	0.000	0.000
SSE	C	0.001	0.002	0.003	0.001	0.000	0.000
S	C	0.001	0.001	0.002	0.001	0.000	0.000
SSW	C	0.001	0.001	0.000	0.001	0.000	0.000

(Continued)

Wind Direction ^a	Stability Class	Wind Speed Frequency (%)					
		1.0 to 1.8 (m/s)	1.8 to 3.3 (m/s)	3.3 to 5.4 (m/s)	5.4 to 8.5 (m/s)	8.5 to 11.0 (m/s)	>11.0 (m/s)
SW	C	0.001	0.001	0.001	0.001	0.000	0.000
WSW	C	0.000	0.000	0.001	0.001	0.000	0.000
W	C	0.000	0.000	0.001	0.002	0.000	0.000
WNW	C	0.000	0.000	0.002	0.003	0.000	0.000
NW	C	0.001	0.001	0.003	0.001	0.000	0.000
NNW	C	0.001	0.002	0.004	0.001	0.000	0.000
N	D	0.004	0.006	0.014	0.008	0.001	0.000
NNE	D	0.004	0.005	0.008	0.005	0.001	0.001
NE	D	0.003	0.004	0.005	0.002	0.000	0.000
ENE	D	0.002	0.003	0.002	0.000	0.000	0.000
E	D	0.001	0.002	0.002	0.000	0.000	0.000
ESE	D	0.002	0.002	0.001	0.001	0.000	0.000
SE	D	0.003	0.003	0.003	0.001	0.000	0.000
SSE	D	0.003	0.004	0.006	0.005	0.001	0.000
S	D	0.004	0.006	0.010	0.005	0.001	0.000
SSW	D	0.005	0.006	0.006	0.003	0.000	0.001
SW	D	0.006	0.006	0.011	0.007	0.001	0.000
WSW	D	0.009	0.009	0.014	0.011	0.005	0.004
W	D	0.008	0.010	0.012	0.018	0.010	0.015
WNW	D	0.006	0.008	0.011	0.024	0.018	0.021
NW	D	0.005	0.006	0.012	0.013	0.005	0.002
NNW	D	0.005	0.007	0.014	0.007	0.002	0.000
N	E	0.001	0.002	0.001	0.000	0.000	0.000
NNE	E	0.000	0.002	0.002	0.000	0.000	0.000
NE	E	0.000	0.002	0.001	0.000	0.000	0.000
ENE	E	0.000	0.001	0.002	0.000	0.000	0.000
E	E	0.000	0.001	0.000	0.000	0.000	0.000
ESE	E	0.000	0.001	0.000	0.000	0.000	0.000
SE	E	0.000	0.001	0.001	0.000	0.000	0.000
SSE	E	0.000	0.001	0.002	0.000	0.000	0.000
S	E	0.000	0.004	0.003	0.000	0.000	0.000
SSW	E	0.000	0.003	0.005	0.001	0.000	0.000
SW	E	0.002	0.006	0.006	0.001	0.000	0.000
WSW	E	0.002	0.009	0.006	0.000	0.000	0.000
W	E	0.002	0.004	0.002	0.000	0.000	0.000
WNW	E	0.001	0.003	0.005	0.001	0.000	0.000
NW	E	0.000	0.003	0.006	0.000	0.000	0.000
NNW	E	0.000	0.003	0.004	0.001	0.000	0.000
N	F	0.004	0.003	0.000	0.000	0.000	0.000
NNE	F	0.004	0.002	0.000	0.000	0.000	0.000
NE	F	0.001	0.001	0.000	0.000	0.000	0.000
ENE	F	0.002	0.002	0.000	0.000	0.000	0.000

(Continued)

Wind Direction ^a	Stability Class	Wind Speed Frequency (%)					
		1.0 to 1.8 (m/s)	1.8 to 3.3 (m/s)	3.3 to 5.4 (m/s)	5.4 to 8.5 (m/s)	8.5 to 11.0 (m/s)	>11.0 (m/s)
E	F	0.003	0.002	0.000	0.000	0.000	0.000
ESE	F	0.002	0.002	0.000	0.000	0.000	0.000
SE	F	0.003	0.003	0.000	0.000	0.000	0.000
SSE	F	0.004	0.004	0.000	0.000	0.000	0.000
S	F	0.005	0.004	0.000	0.000	0.000	0.000
SSW	F	0.006	0.003	0.000	0.000	0.000	0.000
SW	F	0.005	0.004	0.000	0.000	0.000	0.000
WSW	F	0.008	0.005	0.000	0.000	0.000	0.000
W	F	0.007	0.005	0.000	0.000	0.000	0.000
WNW	F	0.008	0.006	0.000	0.000	0.000	0.000
NW	F	0.005	0.005	0.000	0.000	0.000	0.000
NNW	F	0.005	0.006	0.000	0.000	0.000	0.000

^a Direction represents origin of winds relative to the Site.

Notes:

- E = East
- ENE = East-northeast
- ESE = East-southeast
- m/s = Meters per second
- N = North
- NE = Northeast
- NNE = North-northeast
- NNW = North-northwest
- NW = Northwest
- S = South
- SE = Southeast
- SSE = South-southeast
- SSW = South-southwest
- SW = Southwest
- W = West
- WNW = West-northwest
- WSW = West-southwest

APPENDIX E

MODEL INPUT SUMMARY

MODEL INPUT SUMMARY

Input Parameters for CAP88-PC for the Radionuclide Air Emission Annual Report for Calendar Year 1997

FACILITY INFORMATION

Dataset date: Model supplies date and time of dataset generation from its internal clock.

Facility: Rocky Flats Environmental Technology Site

City: Golden

State: Colorado

Zip Code: 80402-0464

Emission Year: 1997

Source Category: Former Nuclear Weapons Facility

Comments: Radionuclide air emissions for the 1997 Annual Air Emission Report required under 40 CFR 61, Subpart H

RUN INFORMATION

Run Type: Individual (Model is run to calculate dose to maximally exposed individual [MEI], not to a population.)

Distances: Varies (Each specific distance from the source to the receptor is entered; see Tables 4-1 through 4-7.)

Generate genetic effects? YES

Create Dose & Risk Factor file? YES

Create Concentration Table file? YES

Create Chi/Q Table file? YES

METEOROLOGICAL DATA

Wind file to use: Varies (Use RFP97, wind file generated from on-site meteorological data for calendar year 1997.)

Annual Precipitation: Varies (See Table 4-8.)

Annual Ambient Temperature: Varies (See Table 4-8.)

Height of Lid: 1,405 m (Value is an annual average of mixing heights formerly measured at Stapleton International Airport. Stapleton is the closest location that has historically measured mixing height.)

(Continued)

SOURCE DATA

Source Type: Area or Stack
Number of Sources: 1
Height: Varies (0 for area source, specific stack height is entered for stack sources; see Table 4-1.)
Diameter (Stack sources only): Varies (Specific stack diameter is entered here; see Table 4-1.)
Area (Area sources only): Varies (Specific area of source is entered here; see Tables 4-2 through 4-7.)
Plume Rise: Momentum
Exit Velocity: Varies (0 for area source, specific exit velocity is entered for stack sources; see Table 4-1.)

AGRICULTURAL DATA

Source: Urban (The rest of the values used on this screen are defaults.)

RADIONUCLIDE LIST

Nuclide: Varies (Radionuclide used corresponds to the source and isotope being modeled.)
Ci/y: Varies (Release rate corresponds to the source being modeled; see Tables 3-1 through 3-3.)

SIZE & CLASS DATA

Nuclide: Varies (Radionuclide used corresponds to the source and isotope being modeled.)
Size: Default
Class: Default

ADDENDUM TO
RADIONUCLIDE AIR EMISSIONS ANNUAL REPORT
CALENDAR YEAR 1996

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ABBREVIATIONS AND ACRONYMS

Am	Americium
Aug	August
CAP88-PC	Clean Air Act Assessment Package-1988 (Version 1.0)
CAQCC	Colorado Air Quality Control Commission
CFR	Code Of Federal Regulations
cm	Centimeter
EDE	Effective dose equivalent
DOE	U.S. Department Of Energy
HEPA	High efficiency particulate air (filter)
H-3	Tritium
m	Meter
MEI	Maximally exposed individual
mrem	Millirem
m/s	Meters per second
mSv	MilliSievert
NE	Northeast
Pu	Plutonium
RAAMP	Radiological Ambient Air Monitoring Program
STP	Sewage Treatment Plant
Site	Rocky Flats Environmental Technology Site
T-2	Trench 2
T-3	Trench 3
T-4	Trench 4
TDU	Thermal desorption unit
U	Uranium
USC	United States Code
UST	Underground storage tanks
°C	Degrees Celsius

ADDENDUM TO RADIONUCLIDE AIR EMISSIONS ANNUAL REPORT

CALENDAR YEAR 1996

BACKGROUND

One of the projects conducted at the Rocky Flats Environmental Technology Site (Site) during calendar year 1996 was the decontamination of underground storage tanks (USTs) near Building 774. The project was described in Section 2.2.2 of the annual report prepared to demonstrate compliance with the public dose standard of Title 40 of the Code of Federal Regulations (CFR), Part 61, Subpart H (incorporated by reference as Colorado Air Quality Control Commission [CAQCC] Regulation No. 8, Part A, Subpart H). As reported in the calendar year 1996 annual report (Department of Energy [DOE], 1997), the maximum off-Site impact from the project was estimated to be 2.7×10^{-4} millirem (mrem) (2.7×10^{-6} milliSieverts [mSv]).

In October 1997, it was discovered that two Radiological Control Technicians at the Site had received radiation doses from exposure to plutonium (Pu). Analyses of prior exposure records and job histories identified the 1996 tank remediation project as the most likely activity to have caused this occurrence. Subsequent analysis of the project itself and of archived filters from the Site's Radioactive Ambient Air Monitoring Program (RAAMP) samplers showed that the public dose resulting from this project was higher than estimated and reported in the 1996 calendar year report (DOE, 1997).

PROJECT DESCRIPTION

Three underground concrete tanks, located in the Protected Area near Building 774, were decontaminated in 1996. The tank cleaning operations were part of an accelerated removal action supporting stabilization of potential contaminants in USTs that had been identified as actual or potential "leakers" to the environment.

The scope of the project activities included: 1) sampling any residual liquid and sludge remaining in the tanks; 2) removing any liquid and/or sludge remaining in the tanks; 3) multirinsing the tanks; 4) sampling each rinsate to determine the rinse effectiveness and to document the extent of

contamination remaining in the tanks; and 5) filling the tanks with an inert foam to stabilize the tank contents until final closure is authorized. A soft-sided containment structure was used to prevent the release of radioactive contaminants to the environment, and exhaust from the containment structure was filtered through a two-stage high efficiency particulate air (HEPA) filter. Field activities commenced in February 1996 and were completed in September 1996.

The liquid and sludge that remained in the tanks from previous process activities contained low levels of radionuclides. The decontamination process, as originally proposed, involved rinsing the inside of the tanks with high pressure water. In practice, air sparging was also used to mobilize the sludge, which resulted in higher radionuclide emissions than were initially estimated from the project. In addition, the radioactivity of the tank contents was higher than the initial characterization data indicated. Based on a review of project activities that may have led to the apparent plutonium exposure incident described above, most emissions from the project occurred between August 8 and August 12, 1996. The revised emission and dose analysis is described below.

REVISED DOSE CALCULATIONS FROM THE 774 TANK DRAINING PROJECT

The Site routinely measures radionuclide concentrations in ambient air at several locations on and around the Site. Radioactive particulates are collected on filters, which are changed monthly. Filters from key locations are subjected to isotopic analysis, while the remainder of the filters are stored for later analysis if necessary.

Upon notification of the apparent release from the tank draining project, the August 1996 samples from the six RAAMP samplers located around Building 774 (samplers S-101, S-102, S-103, S-104, S-116, and S-121) were analyzed for isotopes of plutonium, americium (Am), and uranium (U). The locations of the samplers and the project location are shown in Figure 1. Samples from two locations to the east of Building 774 (S-104 and S-121) showed elevated plutonium levels, while plutonium results from the other four locations fell within typical levels. No other analytes could be compared to historical results because prior to fiscal year 1997, ambient samples were only analyzed for plutonium (historically, the Site dose through the air pathway to off-Site receptors has been dominated by plutonium releases from building stacks and vents).

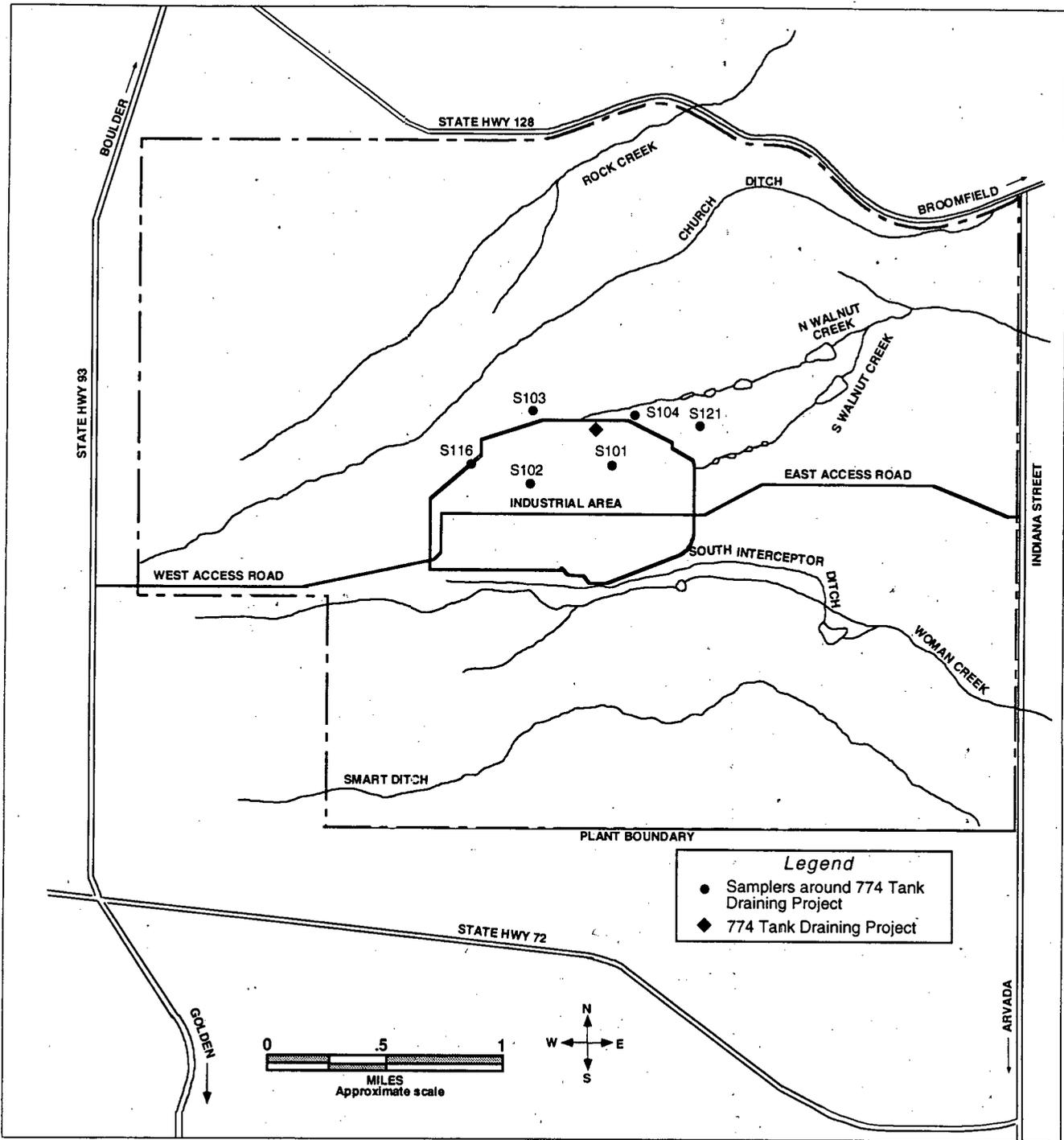


Figure 1. Building 774 Tank Draining Project and Sampler Locations

Americium concentrations at these six samplers tracked the trend in the plutonium results very closely. Because of the good agreement in the data for the two isotopes, and the fact that the Building 774 tank draining project was the only known source of significant quantities of americium released to the air in August 1996, americium results from samplers S-104 and S-121 were used to estimate the americium release magnitude (plutonium and uranium concentrations measured at the RAAMP samplers during August 1996 would, in contrast, have reflected the contribution of multiple on-Site sources). Preproject data regarding the distribution of radioisotopes in the material released were used in conjunction with the americium source estimates to calculate the amount of other radionuclides released.

Methodology

The Clean Air Act Assessment Package -1988 (CAP88-PC) model was used to back-calculate the source term from the ambient data, as well as to project maximum effective dose equivalent (EDE) values for off-Site receptors. The model requires two types of input: meteorological data and source information. The meteorological data were generated using on-Site measurements taken between August 8 and August 12, 1996, at the tower located in the west Buffer Zone. A "wind rose" for that time period is shown in Figure 2. Precipitation and temperature data are shown in Table 1.

The source information used in the modeling analysis is also shown in Table 1. Input data for mixing height, median aerodynamic diameter, solubility class, origin of food products, agricultural data, and distance to agricultural products were the same as those used in other CAP88-PC modeling for the calendar year 1996 annual report (DOE, 1997).

Measured americium concentrations at the ambient samplers were compared to model results, based on a hypothetical source and the previously described meteorological data, to generate scaling factors. The scaling factors were used to estimate the amount of radionuclide released during the project, as well as the projected impact at off-Site locations.

Results

Table 2 shows the source term estimated from the modeling analysis using the scaling factors generated from S-104 and S-121, and preproject radionuclide distribution data. It is important to note the relative consistency of the two estimates, suggesting that one source was primarily

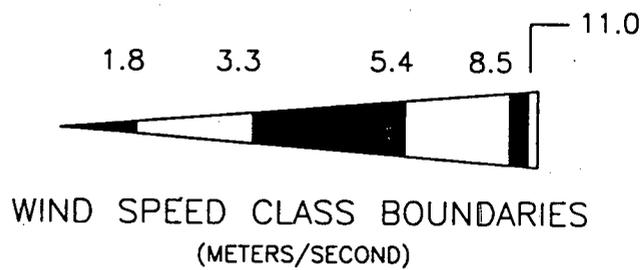
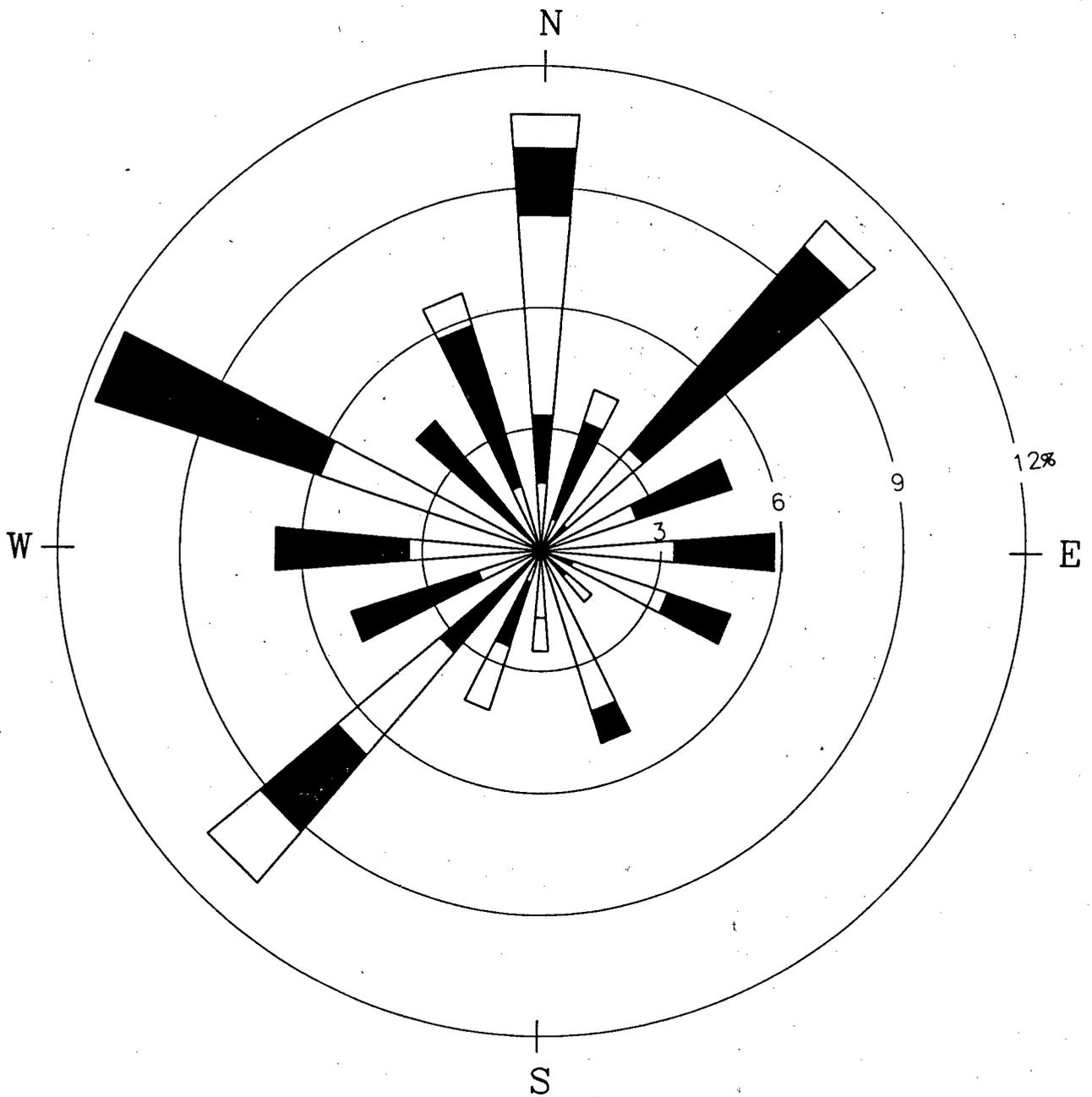


Figure 2. Wind Frequency Distribution - Building 774 Tank Draining Project

Table 1.

Source Data For Model—Input Building 774 Tank Draining Project

Input Parameter	Building 774 Tank Draining Project
Wind Data	Aug 8 - Aug 12, 1996
Total Precipitation (cm)	0.0
Average Temperature (°C)	21.21
Mixing Height (m)	1,405
Release Height (m)	0.3
Diameter (m)	0.2
Exit Velocity (m/s)	0.0
Distance to MEI (m)	4,425
Direction to MEI	NE

Notes:

- Aug = August
- cm = Centimeter
- m = Meter
- m/s = Meters per second
- MEI = Maximally exposed individual
- °C = Degrees Celsius

Table 2.

Source Term Estimates For Building 774 Tank Draining Project

Isotope	Source Term Using S-104 Sampling Results (Curies)	Source Term Using S-121 Sampling Results (Curies)
Pu-239	2.10 E-03	2.80 E-03
Am-241	7.60 E-04	1.00 E-03
U-233/234	3.20 E-08	4.30 E-08
U-235	1.20 E-08	1.60 E-08
U-238	1.50 E-08	2.00 E-08
H-3	2.50 E-05	3.40 E-05

Notes:

Am = Americium
Pu = Plutonium
U = Uranium
H-3 = Tritium
E# = x 10[#]

responsible for the ambient impacts that were measured. Table 3 shows the estimated maximum EDE to off-Site receptors based on S-104 and S-121 scaling factors and preproject radionuclide distribution data. The results show that the maximally exposed individual (MEI) resided on McCaslin Boulevard, north and east of the Site. The project MEI is the same as the MEI determined previously for calendar year 1996 emissions.

COMPLIANCE ASSESSMENT

The higher EDE at each receptor shown in Table 3 was added to the dose estimates from other calendar year 1996 emissions (as reported in the calendar year 1996 annual report) to yield a revised total EDE for each receptor. The MEI dose, as well as the total Site dose through the air pathway at other receptors, is shown in Table 4.

The maximum off-Site calendar year 1996 EDE from all Site emissions was 0.3 mrem (0.003 mSv), approximately 3% of the 10 mrem (0.1 mSv) standard (the dose was originally reported as 0.182 mrem, based on the assessment performed before the Building 774 tank draining release became apparent). The MEI was located along McCaslin Boulevard, 4,425 meters (m) to the northeast of the center of the Site's industrial area.

The contributions of various emission source types to the maximum annual off-Site EDE for 1996 are shown in Figure 3. The Trench 3/ Trench 4 (T-3/T-4) remediation project contributed over 57% of the MEI dose in 1996, while the Building 774 tank draining project contributed approximately 40% of the dose. Two additional projects that handled radionuclide-contaminated soil, the Sewage Treatment Plant Phase III Upgrade and thermal treatment of contaminated soils from Trench 2 (T-2), each contributed more to the MEI dose than either wind-blown soil contamination or the combined emissions of all other Site point sources.

The isotopic breakdown of the 1996 maximum annual off-Site EDE is shown in Figure 4. The graph shows that Pu-239 contributed over 37% of the EDE, while Am-241, U-233/234, and U-238 also contributed significantly to the total dose. Prior to calendar year 1996, Pu-239 dominated the maximum off-Site dose. The increased contribution of uranium and americium isotopes in 1996 was due to their presence in the soils, debris, and sludge handled during the T-3/T-4 cleanup, Building 774 tank draining, and Sewage Treatment Plant Phase III Upgrade projects.

Table 3.

Effective Dose Equivalents From Building 774 Tank Draining Project

Receptor	EDE Using S-104 Sampling Results (mrem)	EDE Using S-121 Sampling Results (mrem)
McCaslin Boulevard (MEI)	0.087	0.120
96th and Indiana	0.020	0.027
East of Great Western Reservoir	0.028	0.037
Sawmill, east of Highway 93	0.034	0.045
South, at Highway 72	0.009	0.011
Rocky Flats Lake	0.040	0.054
Mower Reservoir	0.061	0.082

Notes:

- EDE = Effective dose equivalent
- MEI = Maximally exposed individual
- mrem = Millirem

Table 4.

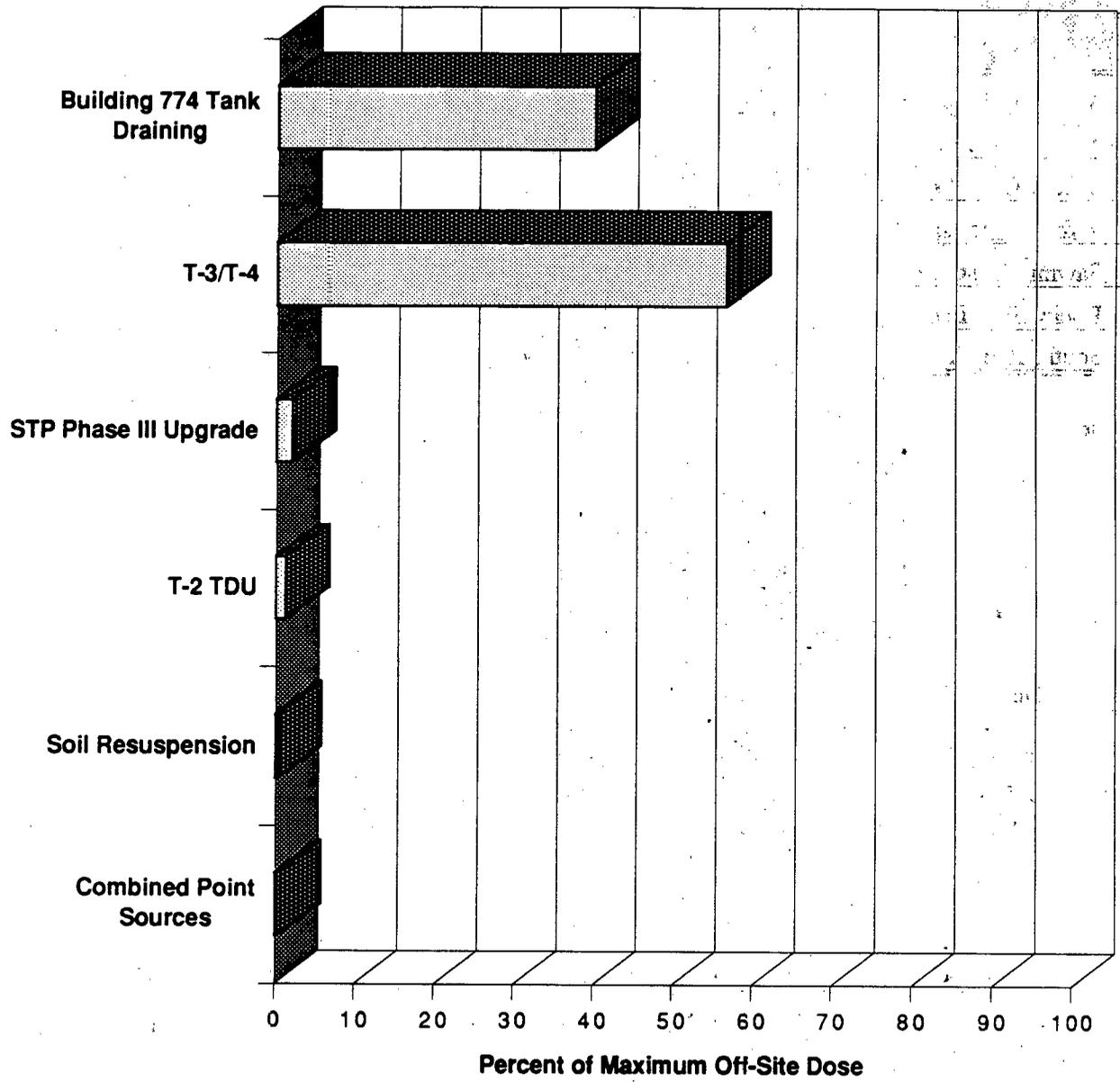
Revised Calendar Year 1996 Dose At Receptor Locations
Surrounding The Site

Location	1996 EDE (mrem)	Distance to Receptor (m)	Direction to Receptor
McCaslin Boulevard (MEI)	0.30	4,425	NE
Mower Reservoir	0.24	4,143	ESE
East of Great Western Reservoir	0.17	5,695	E
96th and Indiana	0.16	4,064	SE
Sawmill, east of Highway 93	0.15	2,994	WNW
Rocky Flats Lake	0.14	3,625	SW
South, at Highway 72	0.10	3,419	S

Notes:

- E = East
- EDE = Effective dose equivalent
- ESE = East-southeast
- m = Meters
- MEI = Maximally exposed individual
- mrem = Millirem
- NE = Northeast
- S = South
- SE = Southeast
- SW = Southwest
- WNW = West-northwest

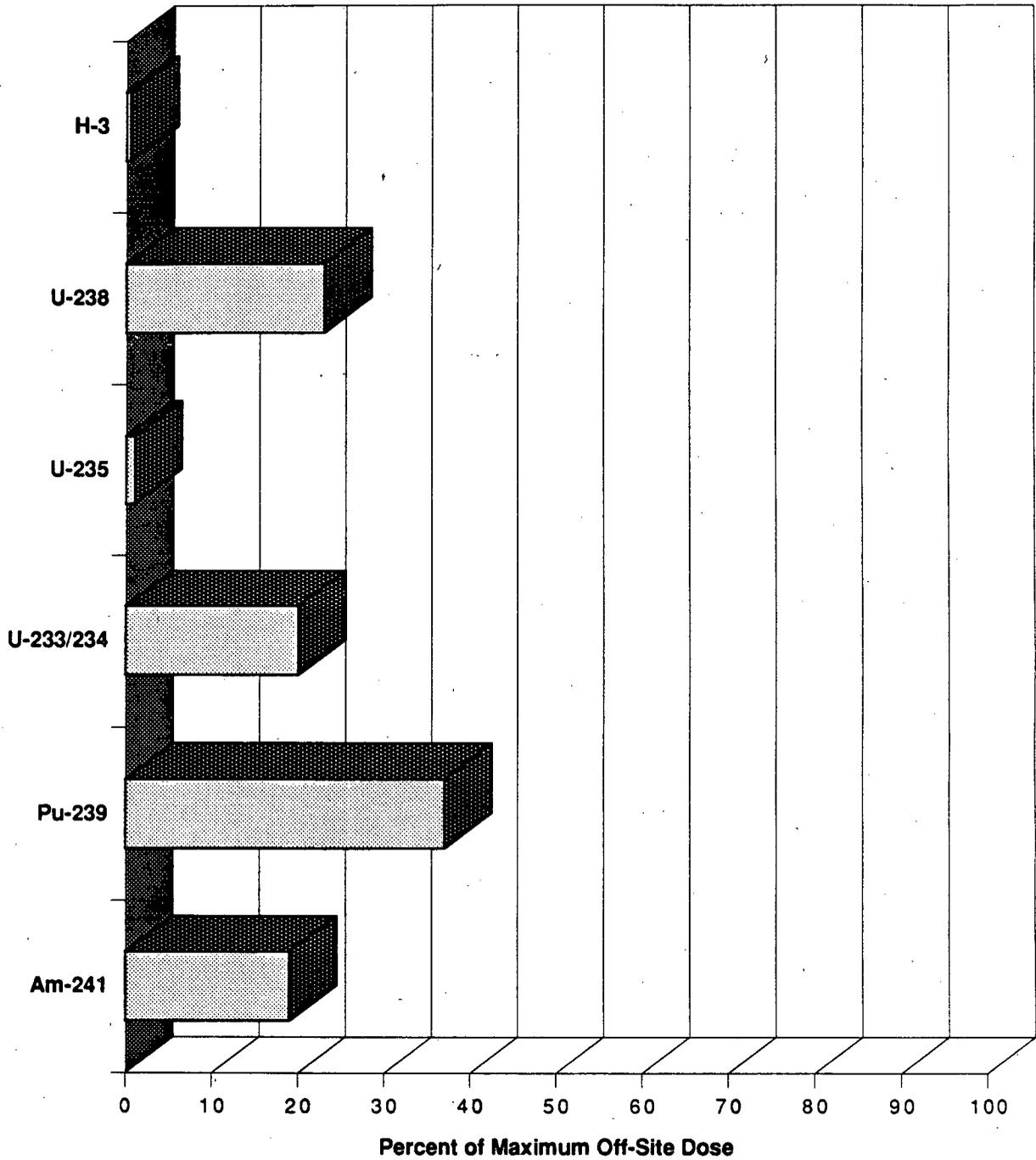
**Figure 3.
Contribution to 1996 Maximum Off-Site EDE by Source Type**



Notes:

- | | | | | | |
|-----|---|---------------------------|---------|---|-------------------|
| EDE | = | Effective dose equivalent | T-2 | = | Trench 2 |
| STP | = | Sewage Treatment Plant | T-3/T-4 | = | Trench 3/Trench 4 |
| TDU | = | Thermal desorption unit | | | |

Figure 4.
Contribution to 1996 Maximum Off-Site EDE by Isotope



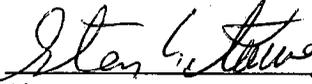
Notes:

Am	=	Americium	H-3	=	Tritium	U	=	Uranium
EDE	=	Effective dose equivalent	Pu	=	Plutonium			

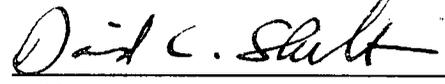
CERTIFICATION

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 Environmental Compliance
Department of Energy


Signature *ACTING FOR*
JOE LEGARE Date *6/23/98*

David C. Shelton
Vice President, Environmental Management &
Compliance
Kaiser-Hill Company, L.L.C.


Signature Date *6/19/98*

REFERENCES CITED

U.S. Department of Energy. *Radionuclide Air Emissions Annual Report for Calendar Year 1996*. June 1997.