5.0 Air Pathway

This chapter describes the air-pathway monitoring program used to track and evaluate airborne emissions from the Fernald Preserve. It includes a discussion of radiological air particulates, radon, and direct radiation.

Results in Brief: 2007 Air Pathway

Radiological Air Particulates—Data collected from the site boundary air monitoring stations show that average concentrations for each radionuclide monitored were less than 1 percent of the corresponding DOE derived concentration guide.

Radon—There were no exceedances of the 10 CFR 834 proposed standard (0.5 pCi/L annual average above background) at the site boundary and off-property locations. The maximum annual average concentration at the Fernald Preserve boundary measured by continuous radon monitors was 0.4 pCi/L above background.

Direct Radiation—2007 direct radiation measurements at the site boundary were lower than those in 2006. This was attributed to the completion of soil remediation and construction activities in October 2006.

Air-pathway monitoring focuses on airborne pollutants carried from the site as particles or gas and how these pollutants are distributed in the environment. The physical form and chemical composition of pollutants influence their dispersal in the environment and the delivered radiation dose. For example, fine particles and gases remain suspended, while larger, heavier particles tend to settle and deposit on the ground. Chemical properties determine whether the pollutant will dissolve in water, be absorbed by plants and animals, or settle in sediment and soil.

The final year of soil remediation at the Fernald Preserve was 2006. By the end of October 2006, all major sources of airborne contamination were removed from the site or placed in the on-site disposal facility. In recognition of the removal of emission sources from the site, the number of air monitoring stations was decreased from 17 to 11 in April 2006 (DOE 2006d) and from 11 to 6 in November of 2006 (DOE 2006e). The six remaining monitors are placed at five boundary locations and one background location (Figure 5−1). They are used to demonstrate that wind erosion of the remediated soil poses no significant threat to the public or the environment.

The site's air monitoring approach (presented in the IEMP) provides an ongoing assessment of the particulate emissions originating from wind erosion of soil, as well as radon and direct radiation levels at the site boundary. Results of the 2007 assessment indicate that particulate, radon, and direct radiation are at their lowest levels, which reflects the absence of any significant contamination source on the Fernald Preserve.

5.1 Activities Affecting the Air Pathway

As the mission of the Fernald Preserve changed from production to remediation to wildlife preserve, work activities also changed. This change in work scope altered the characteristics of sources that emit pollutants in the environment via the air pathway. During the production years, the primary emission sources were point sources (i.e., stacks and vents) from process facilities. During remediation, the dominant emission sources were associated with construction activities in the form of fugitive emissions (i.e., excavation, hauling and processing of waste and contaminated soil, demolition of production facilities, and general activities supporting the remediation process) and the storage of radon-generating waste materials. In 2007, the only remaining emission source is soil that contains contaminants at levels near background values.

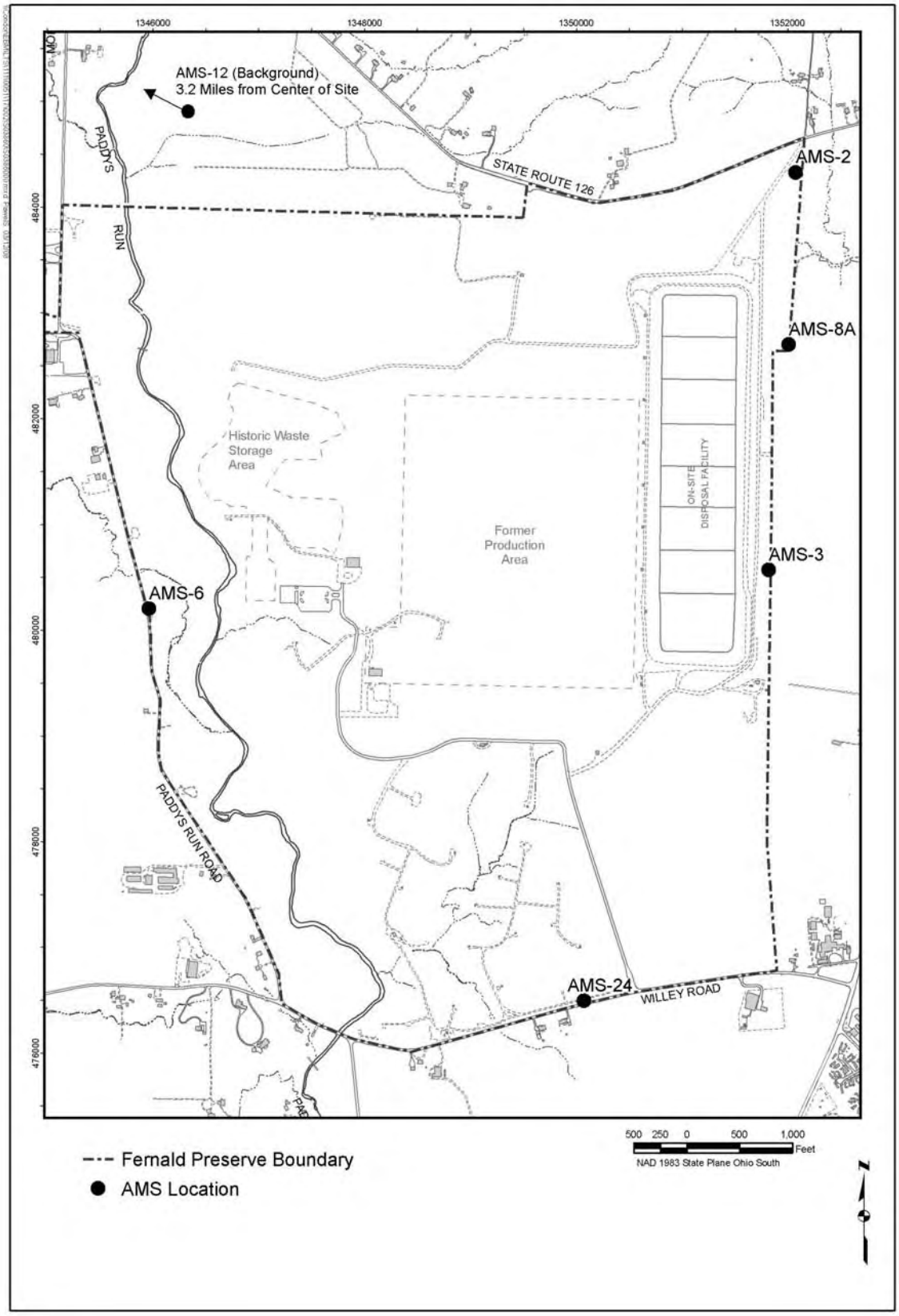

Figure 5–1. Radiological Air Monitoring Station (AMS) Locations

The only emission source active during 2007 was the site soil that has been certified as meeting the final remediation levels for all contaminants.

During 2007, minor construction activities were associated with the remodeling of the silo warehouse building into a visitor's center, ecological restoration activities, and ongoing maintenance activities associated with the on-site disposal facility and converted waste water treatment operations. In addition, a limited soil excavation in the swale adjacent to the former waste pit 3 was conducted as part of a maintenance activity implemented to address elevated uranium concentrations in surface water in the area.

5.2 Air Monitoring Program Summary for 2007

The site's air monitoring program, as defined in the IEMP, consists of three components:

- Radiological air particulate
- Radon
- Direct radiation

Each component of the air monitoring program is designed to address a unique aspect of air-pathway monitoring, and each has distinct sampling methodologies and analytical procedures. The key elements of the air monitoring program design are:

- **Sampling**—Sample locations, frequency, and the constituents were selected to address DOE and EPA requirements for assessing radiological emissions from the Fernald Preserve. Key considerations in the design of the sampling program included prevailing wind directions and the location of off-property receptors.
- **Data Evaluation**—The data evaluation process focuses on tracking and trending data against historical ranges and DOE, EPA, and OEPA standards. Sections 5.3 through 5.5 in this chapter present the air data and a comparison to applicable standards and guidelines.
- **Reporting**—All data are reported through the annual site environmental report.

5.3 Radiological Air Particulate Sampling Results

As described in the Legacy Management and Institutional Controls Plan, high-volume air particulate monitoring stations are used to measure the collective contributions from fugitive particulate emissions from the site. Many factors contribute to the amount of particulate captured at the stations; the most significant factors are the frequency of soil disturbance, amount of vegetation cover, moisture content of the soil, and average daily wind speeds. Figure 5−1 provides the locations of the IEMP air monitoring stations in operation during 2007.

The sampling and analysis program for the site boundary and background locations consists of monthly total uranium and total particulate analyses and a quarterly composite sample. The quarterly composite sample is analyzed for radium-226, thorium-228, thorium-230, thorium-232, uranium-234, uranium-235, and uranium-238 to evaluate compliance with the following:

- NESHAP Subpart H requirements that stipulate radionuclide emissions (excluding radon) to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive an effective dose equivalent of 10 mrem/year above

background levels. This dose is reported in the annual NESHAP Subpart H compliance report, which is attached as Appendix D.

- DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, guidelines for concentrations of radionuclides in air emissions. These guidelines, referred to as derived concentration guide values, are concentrations of radionuclides that, under conditions of continuous exposure for one year by one exposure mode (e.g., inhalation or ingestion), would result in a dose of 100 mrem to the public. These derived concentration guide values are not limits, but serve as reference values to assist in evaluating the radiological air particulate data.

Table 5−1 presents a summary of the minimum, maximum, and average concentrations for total uranium and total particulate in 2007 and 2006. Thorium-230 was not part of the monthly sampling in 2007, as Thorium-230 monitoring ceased in 2006 with the completion of all remedial construction activities.

Table 5–1. Summary of Total Uranium and Particulate Concentrations in Air

Location	2007 Total Uranium (pCi/m^3)	2006 Total Uranium (pCi/m^3)	2007 Total Particulate ($\mu g/m^3$)	2006 Total Particulate ($\mu g/m^3$)	2007 Thorium-230[a] (pCi/m^3)	2006 Thorium-230 (pCi/m^3)
Boundary Locations						
Minimum	6.0×10^{-6}	6.9×10^{-7}	1.2	0	NA	4.0×10^{-8}
Maximum	5.4×10^{-5}	2.6×10^{-4}	46	110	NA	3.0×10^{-5}
Average	1.5×10^{-5}	3.1×10^{-5}	23	31	NA	5.3×10^{-6}
Background Location						
Minimum	7.3×10^{-6}	7.8×10^{-7}	1.0	14	NA	0.0
Maximum	1.8×10^{-5}	2.3×10^{-5}	36	67	NA	6.8×10^{-6}
Average	1.3×10^{-5}	1.1×10^{-5}	23	25	NA	2.0×10^{-6}

[a]NA = not analyzed

For 2007, the average concentration of uranium and particulate are based on monthly samples, relative to biweekly samples in previous years. At the five boundary stations, uranium ranged from 6.0×10^{-6} to 5.4×10^{-5} picocuries per cubic meter (pCi/m^3), which is much less than 1 percent of the DOE derived concentration guide value of 0.1 pCi/m^3. The 2007 maximum value for uranium is nearly an order of magnitude lower than the 2006 maximum (2.6×10^{-4} pCi/m^3). Total particulate concentrations at the boundary ranged from 1.2 to 46 micrograms per cubic meter ($\mu g/m^3$), and the maximum value for 2007 was about one-half the 2006 value. There are no general or site-specific regulatory limits associated with total particulate measurements.

Figure 5−2 shows total uranium variation at the boundary and background locations. Monthly results are shown with the reported analytical uncertainty plotted as error bars. The uranium activity in the captured particulate is below 30 pCi/m^3, with the exception of the May samples collected from AMS-3 and AMS-8A. Higher activity in the two May samples correlates with higher particulate mass (Appendix C, Attachment C.1). Measurement uncertainty indicates that many of the monthly results for the boundary monitors exceed the uranium activity measured at the background location. However, as noted above, the results are much less than the DOE derived concentration guidance value (0.1 pCi/m^3). Additional statistical analysis and graphical displays of the 2007 data are provided in Appendix C, Attachment C.1.

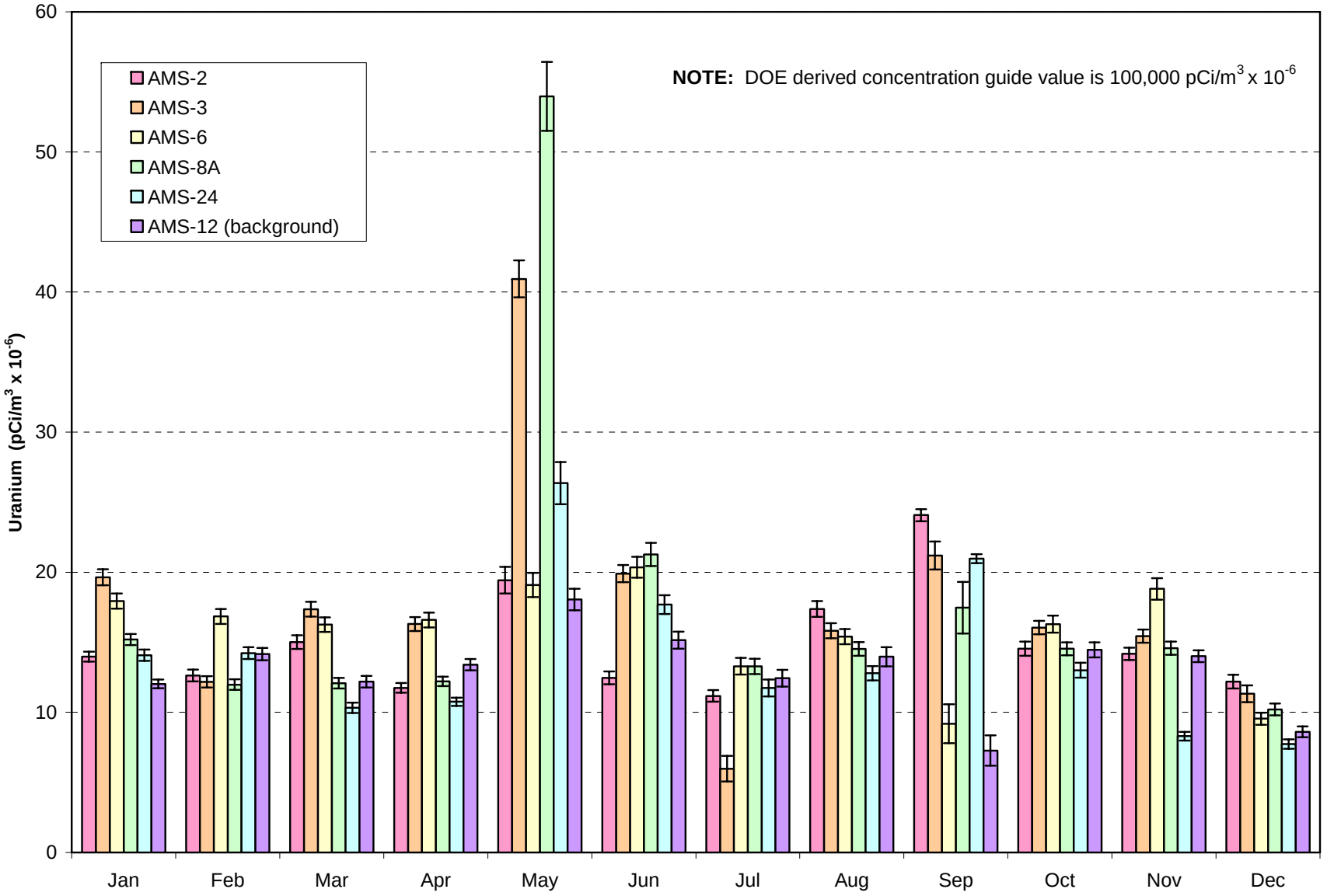

Figure 5–2. Monthly Results and Measurement Error for Uranium in Collected Air Particulate

In 2007, the quarterly composite samples were formed for each monitor from the monthly samples and analyzed for radium-226, thorium-228, thorium-230, thorium-232, uranium-234, uranium-235, and uranium-238. Figure 5−3 plots the annual activity and uncertainty for the quarterly results to show that boundary results are similar to background, with the exception of U-234 and U-238 at AMS-8A and Ra-226 at AMS-24. Appendix C, Attachment C.1 presents the complete annual summary for the data, and Appendix D shows that the results are in compliance with the NESHAP 10 mrem/year dose limit (the maximum dose for 2007 is 0.023 mrem/year at AMS-24).

5.4 Radon Monitoring

Radon-222 (referred to as radon) is a naturally occurring radioactive gas. It is produced by radioactive decay of radium-226, which can be found in varying concentrations in the earth's crust. Radon is chemically inert and tends to diffuse from the earth's crust to the atmosphere. The concentration of radon in the environment is dynamic and exhibits daily, seasonal, and annual variability.

Many factors influence the concentration of radon in the environment, including the distribution of radium-226 in the ground, porosity of the soil, and weather. For instance, radon diffusion from the ground is minimized by the presence of precipitation and snow cover. Alternatively, elevated temperatures and the absence of precipitation can produce cracks in the ground and changes in porosity that increase the rate of radon diffusion to the atmosphere.

Environmental radon concentrations are also influenced by atmospheric conditions. During periods of calm winds and temperature inversions (when the air near the earth's surface is cooler than the air above it), air is held near the earth's surface, minimizing the mixing of air. Consequently, radon's movement is limited vertically and concentrations tend to increase near the ground. Figures 1−7 through 1−10 in Chapter 1 and Appendix C, Attachment C.4 present a summary of meteorological data for 2007.

Waste material generated from uranium extraction processes performed decades ago contained radium-226, which produces radon. This waste material is no longer a source for radon at the site because the last of this material was shipped off site in 2006. Present radon sources at the Fernald Preserve are limited to residual radium-226 concentrations in the soil (near background levels) and waste material disposed of in the on-site disposal facility. Waste materials in the on-site disposal facility are covered with a polyethylene liner and several feet of stone and soil, which provides an effective radon barrier.

DOE Order 5400.5 and proposed 10 CFR 834 guidelines for radon limits at interim storage facilities state that radon must not exceed:

- 100 pCi/L at any given location and any given time.
- Annual average concentration of 30 pCi/L (above background) over the facility.
- Annual average concentration of 0.5 pCi/L (above background) at and beyond the Fernald Preserve boundary.

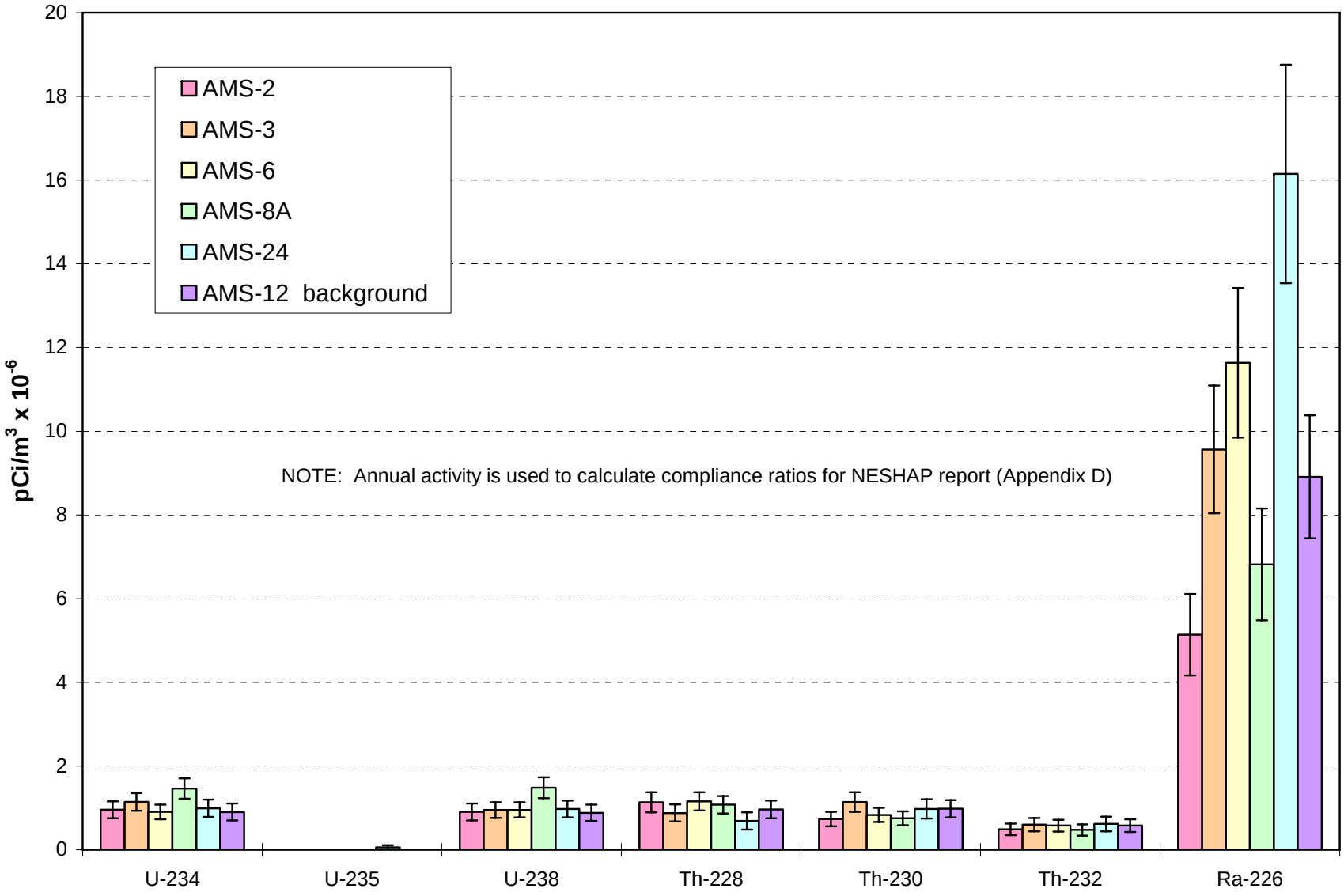

Figure 5–3. Annual Activity and Uncertainty for Isotopes Used in NESHAP Analysis

Figure 5−4 illustrates the continuous radon monitoring network used in 2007 to achieve compliance with DOE Order 5400.5 and proposed 10 CFR 834 requirements. Monitoring locations at the property boundary and a background location were selected using DOE guidance and EPA air monitor criteria.

The radon monitors at the Fernald Preserve use scintillation cells to evaluate radon activity on an hourly average. Radon gas in ambient air diffuses into the scintillation cell through a foam barrier without the aid of a pump (this technique is called passive sampling). Inside the cell, radon and its radioactive progeny decay by emission of alpha particles. Alpha particles interact with the scintillation material inside the cell, producing light pulses that are amplified and counted, and the number of light pulses counted is proportional to the radon activity inside the cell. The instrument records activity to the nearest 0.1 pCi/L, but without a reported uncertainty.

Table 5−2 provides the annual summary of the variation in monthly average radon activity at the site boundary. The maximum annual average for the site boundary locations (0.5 pCi/L at AMS-3) is 0.2 pCi/L above background (0.5 minus 0.3 for background), which is below the proposed 10 CFR 834 site boundary limit of 0.5 pCi/L above background. The annual average radon concentration at the background monitoring location was 0.3 pCi/L. Appendix C, Attachment C.2, provides graphical displays of the monthly average radon concentrations.

The 2007 results from the boundary monitoring locations indicate that radon levels are within the historical range (Figure 5−5). Note that there are no data for AMS-8A and AMS-24 in 1998, as theses monitors were not operational until 1999. Also, the radon results for the boundary locations are not corrected for background, yet the uncorrected results have never exceeded the 0.5 pCi/L above background line in the past 10 years.

5.5 Monitoring for Direct Radiation

Direct radiation originates from sources such as cosmic radiation, naturally occurring radionuclides in soil and food, and anthropogenic radioactive materials. Gamma rays and x-rays are the dominant types of radiation that create a public exposure concern because they penetrate into the deep tissues of the body. The largest historical source of direct radiation at the former Fernald Closure Project was waste material associated with the Silos Project. The last waste material associated with the Silos Project was removed from the site in 2006. Presently, there are no significant sources for direct radiation at the Fernald Preserve.

During 2007, direct radiation levels at the Fernald Preserve boundary were continuously measured at five locations and at one background location located 3.2 miles from the center of the Fernald Preserve (Figure 5−6) with thermoluminescent dosimeters (TLDs). TLDs absorb and store the energy of direct radiation within the thermoluminescent material. By heating the thermoluminescent material under controlled conditions in a laboratory, the stored energy is released as light, measured, and correlated to the amount of direct radiation.

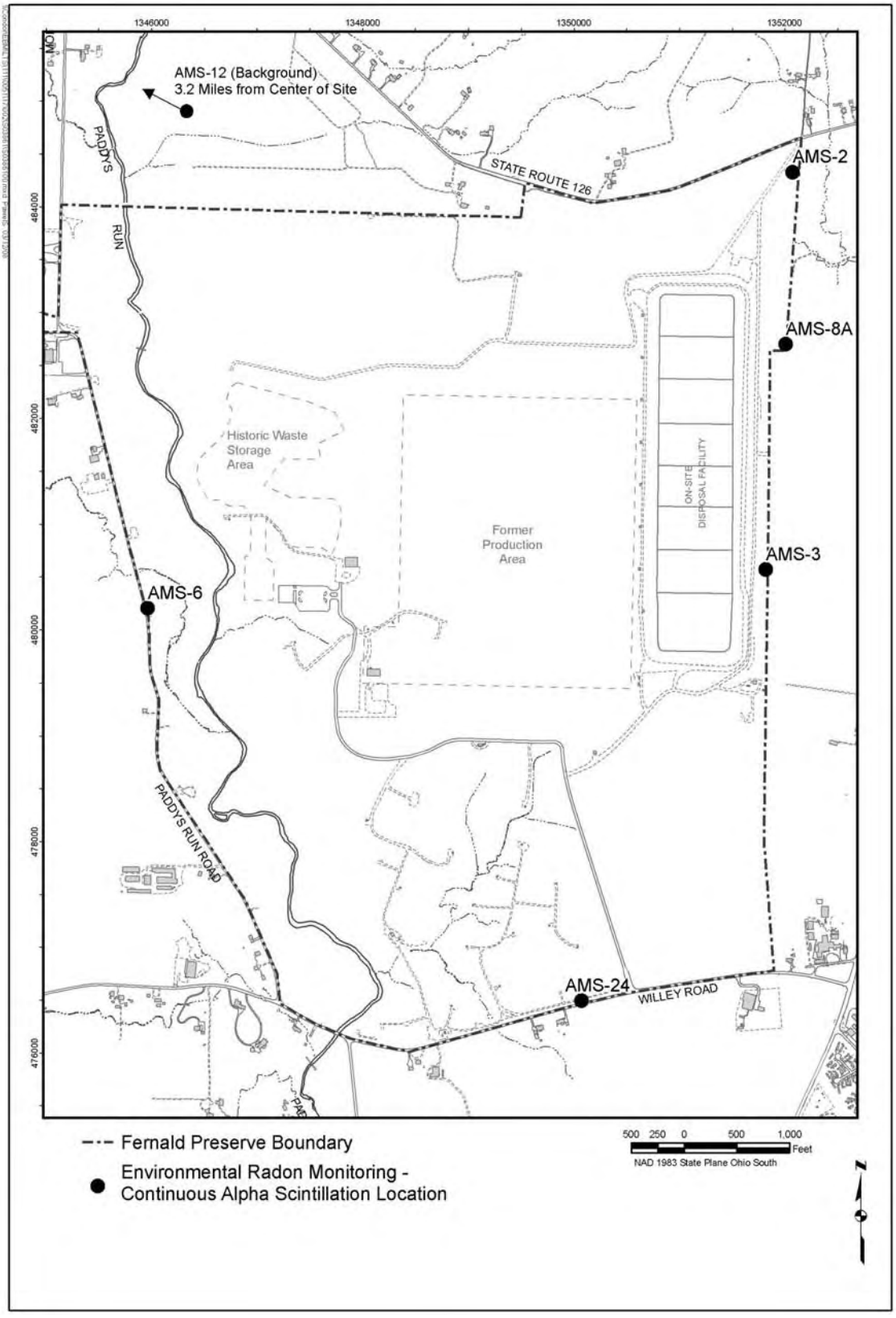

Figure 5–4. Radon Monitoring Locations

Table 5–2. Annual Summary for Monthly Average Radon Concentrations[a]

Location[b]	2007 Summary Results[c] (Instrument Background Corrected) (pCi/L)			2006 Summary Results[c] *(Instrument Background Corrected)* (pCi/L)		
	Min.	Max.	Avg.	Min.	Max.	Avg.
Boundary						
AMS-02	0.2	0.7	0.3	0.2	0.8	0.5
AMS-03	0.2	0.8	0.5	0.2	0.6	0.4
AMS-06	0.2	0.7	0.3	0.3	1.1	0.6
AMS-08A	0.2	0.7	0.3	0.2	0.7	0.4
AMS-24	0.3	0.8	0.4	0.2	0.9	0.6
Background						
AMS-12	0.2	0.5	0.3	0.1	0.5	0.3

[a]Monthly average radon concentrations are calculated from the daily average concentrations.
[b]Refer to Figure 5-4 for radon monitoring locations.
[c]Instrument background changes as monitors are replaced.

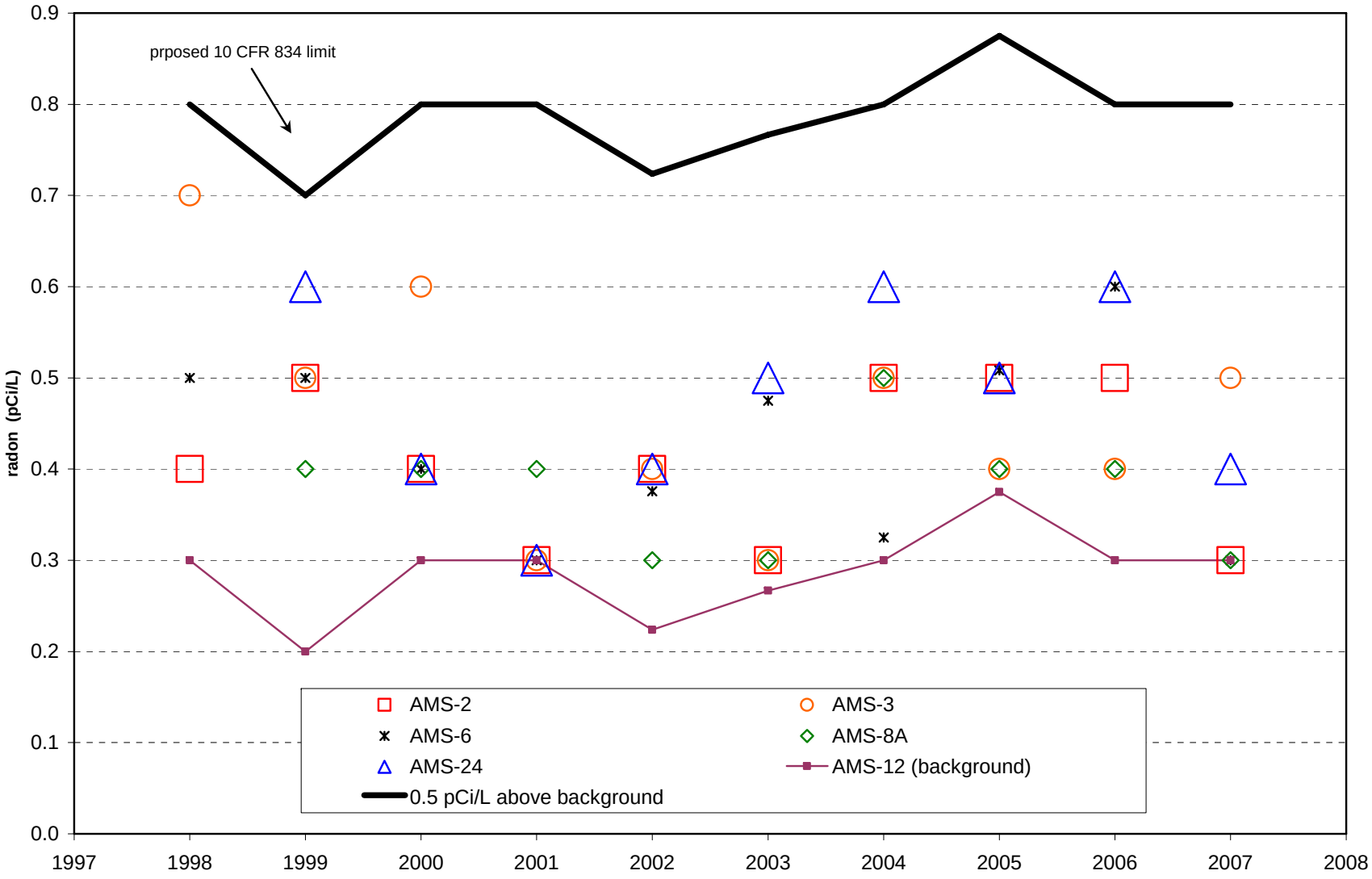

Figure 5–5. 2007 Average Radon Results Compared to Historical Levels (no background correction)

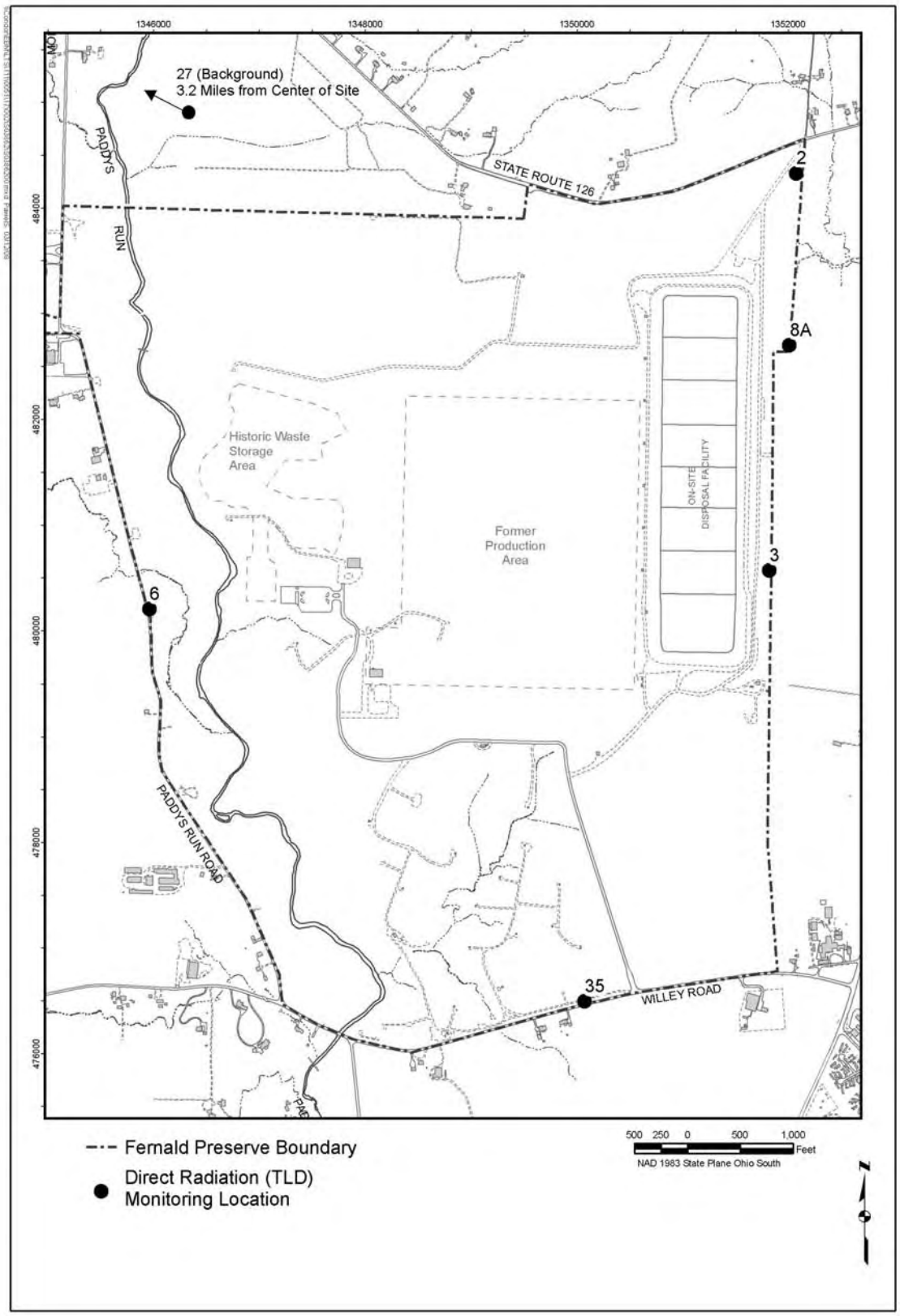

Figure 5–6. Direct Radiation (TLD) Monitoring Locations

Table 5−3 provides the annual range of direct radiation measurements for 2007 and 2006, and Figure 5−7 illustrates the quarterly results and counting errors for 2007. In general, the quarterly measurement increased through the 3rd quarter and then leveled out. On the basis of plotted measurement error bars, measurements recorded for boundary locations 2 and 8A exceed the background measurement every quarter. Locations 3 and 6 exceed background only for the third quarter. However, as noted in Attachment C.3, the boundary measurements are similar to background when statistical variability is evaluated, which is in agreement with removal of the last direct radiation sources in 2006. This observation carries over to the dose assessment presented in Chapter 6 and Appendix D, which shows there is no significant dose associated with direct radiation.

Table 5–3. Direct Radiation (Thermoluminescent Dosimeter) Measurement Summary

	Direct Radiation (mrem)	
TLD Location	**Sum of 2007 Quarterly Results**	**Sum of 2006 Quarterly Results[a]**
Boundary		
Minimum	47	77
Maximum	53	84
Background		
Minimum	48	79
Maximum	48	79

[a]The minimum and maximum results presented for 2006 are based on those TLDs that remained in service through all four quarters of the year.

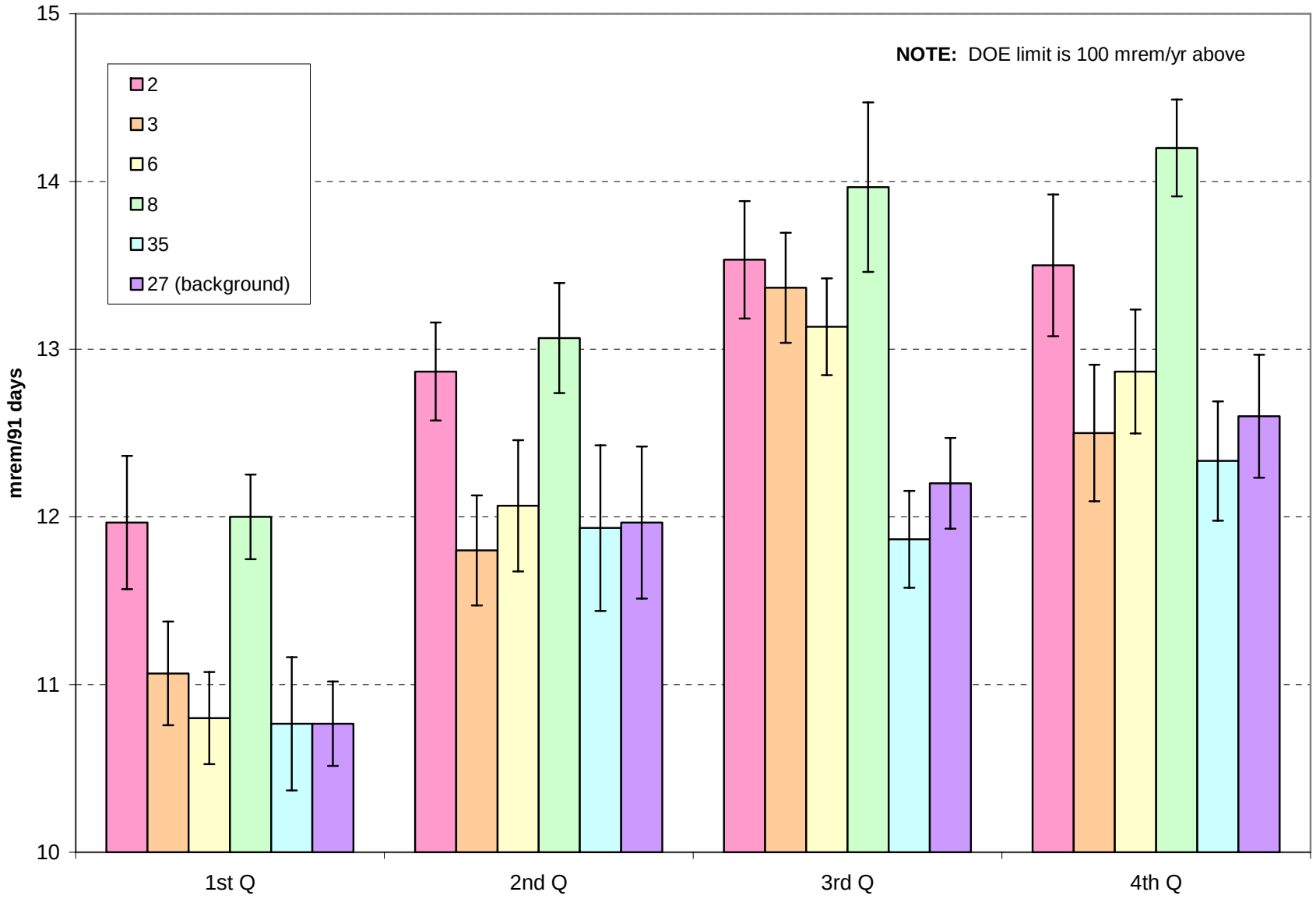

Figure 5–7. Quarterly Results and Measurement Error Recorded by TLD Monitoring Location