8.13 External Radiation Monitoring

E. J. Antonio and C. J. Perkins

External radiation at Hanford is monitored (1) onsite in relative close proximity to known, suspected, or potential radiation sources; (2) onsite at locations away from facilities and operations (site-wide); and (3) offsite in local communities, at locations distant from the site, and on or near the site perimeter. External radiation is defined as radiation originating from a source external to the body. Sources of external radiation at Hanford include waste materials associated with the historical production of plutonium for defense; residual nuclear inventories in former production and processing facilities; radioactive-waste handling, storage, and disposal activities; waste cleanup and remediation actions; atmospheric fallout from historical nuclear weapons testing; and natural sources such as cosmic radiation. During the year, external radiation levels can vary from 15% to 25% at any location because of changes in soil moisture and snow cover (National Council on Radiation Protection and Measurements 1975).

The Harshaw thermoluminescent dosimeter system is used to measure external radiation at the Hanford Site. This system includes the Harshaw 8800-series dosimeter and the Harshaw 8800 reader. The Harshaw 8800-series environmental dosimeter consists of two TLD-700 chips and two TLD-200 chips and provides both shallow and deep dose measurement capabilities using filters within the dosimeter. The two TLD-700 chips were used to determine the average total environmental dose at each location. The average daily dose rate was determined by dividing the average total environmental dose by the number of days the dosimeter was exposed. Daily dose equivalent rates (millirem per day) at each location were converted to annual dose equivalent rates (millirem per year) by averaging the daily dose rates and multiplying by 365 days per year. The two TLD-200 chips were included only to determine doses in the event of a radiological emergency and were not used during 2004. Thermoluminescent dosimeters were positioned approximately 1 meter (3.3 feet) above the ground and were collected and read quarterly.

Radiation surveys with portable instruments are conducted to monitor and detect contamination and to provide a coarse screening for external radiation fields. The types of areas surveyed in 2004 included underground radioactive materials areas, contamination areas, soil contamination areas, high contamination areas, roads, fence lines, and selected Columbia River shoreline locations.

Gamma radiation levels were monitored with pressurized ionization chambers at four offsite community-operated air-monitoring stations. A pressurized ionization chamber is a stainless steel spherical 8-liter (2.1-gallon) chamber, about the size of a basketball, that is filled to a pressure of 25 atmospheres with ultra-high purity argon gas. Radiation penetrating the chamber wall is captured and converted by instruments to an electric current that can be related directly to an exposure rate. Results from locations near and downwind of the site are compared to results from a distant location and to thermoluminescent dosimeter measurements obtained at each chamber location.

In the following sections, all 2004 external radiation measurements are compared to results from previous years, and 2004 onsite measurements are compared to measurements obtained at perimeter and distant locations in 2004. For further information about the monitoring and surveillance programs that support these efforts, see Section 8.0 or DOE/RL-91-50.

8.13.1 External Radiation Monitoring Onsite Near Facilities and Operations

C. J. Perkins

During 2004, external radiation fields were monitored with thermoluminescent dosimeters at 135 locations near onsite facilities and operations. Thermoluminescent dosimeter results were used individually or averaged to determine dose rates in a given area for a particular sampling period. A comparison of 2004 and 2003 results for thermoluminescent dosimeters located near waste handling facilities on the Hanford Site as well as historical comparative results from offsite locations for 1999 through 2004 can be found in Table 8.13.1. Individual thermoluminescent dosimeter results and detailed monitoring-location maps are provided in PNNL-15222, APP. 2.

8.13.1.1 External Radiation Measurements Onsite Near Facilities and Operations

100-B/C Area. At the former 116-B-11 and 116-C-1 liquid waste disposal facilities (located in the 100-B/C Area), dose rate levels in 2004 were, as in past years, approximately 85 mrem/yr.

100-K Area. Cleanup activities at the 100-K Area basins and adjacent retired reactor buildings continued in 2004, and average dose rates measured in 2004 increased by approximately 41% relative to 2003 values. As with a similar increase observed during 2003, the 2004 increase

Table 8.13.1. Thermoluminescent Dosimeter Results (mrem/yr)[a] Near Hanford Site Operations in 2003 and 2004 and Comparative Offsite Location Results for 1999 through 2004

Hanford Site Locations	No. of Dosimeters, 2004	2003 Maximum[b]	2003 Mean[c]	2004 Maximum[b]	2004 Mean[c]	% Change[d]
100-B/C Area	4	88 ± 6	85 ± 5	88 ± 7	86 ± 5	<1
100-K Area	11	523 ± 1,060	162 ± 304	1,352 ± 3,329	229 ± 748	41
100-KR-1	5	103 ± 11	95 ± 15	104 ± 10	97 ± 15	2
100-N Area	14	993 ± 71	261 ± 485	475 ± 76	210 ± 257	-19
200-East Area	42	482 ± 225	118 ± 138	4,000 ± 12,000	200 ± 1,202	69
200-West Area	24	189 ± 21	106 ± 52	3,000 ± 10,000	225 ± 1,196	112
200-North Area[b]	1	3,400 ± 131	3,000 ± 570	3,000 ± 472	3,000 ± 295	-4
300 Area	8	112 ± 2	92 ± 24	112 ± 12	92 ± 25	<1
300 TEDF	6	90 ± 12	85 ± 5	87 ± 5	85 ± 4	<1
300-FF-2	6	NA; new for 2004		91 ± 40	87 ± 5	NA
400 Area	7	85 ± 7	81 ± 5	85 ± 6	83 ± 2	3
CVDF	4	82 ± 4	80 ± 6	258 ± 445	177 ± 175	122
ERDF	3	99 ± 11	94 ± 11	100 ± 22	95 ± 8	1

Offsite Locations[e]	No. of Dosimeters, 2004	1999-2003 Maximum[b]	1999-2003 Mean[f]	2004 Maximum[b]	2004 Mean[f]
Perimeter	11	106 ± 7	91 ± 2	97 ± 5	89 ± 3
Community	7	89 ± 3	79 ± 2	87 ± 8	79 ± 3
Distant	2	75 ± 8	72 ± 1	71 ± 4	71 ± 1

(a) To convert to international metric system units, multiply mrem/yr by 0.01 to obtain mSv/yr.
(b) Maximum values are ± analytical uncertainty.
(c) ±2 standard deviation.
(d) Numbers indicate a decrease (-) or increase from the 2003 mean.
(e) Section 8.13.2.
(f) ±2 times the standard error of the mean.
CVDF = Cold Vacuum Drying Facility.
ERDF = Environmental Restoration Disposal Facility.
NA = Not applicable.
TEDF = 300 Area Treated Effluent Disposal Facility.

was primarily due to elevated dose rates at two monitoring locations situated near radioactive materials transfer and storage areas. One location was near the 105-K East spent nuclear fuel storage basin load-out station and the other was near the 105-K West spent nuclear fuel storage basin. Dose rates at the 105-K East location, which were elevated during the first half of the year as spent nuclear fuel was removed from the storage basin, decreased by the year's end to a level slightly higher than typical site background levels. Dose rates at the 105-K West location, which had declined during the first quarter of the year from levels measured at the end of 2003, steadily decreased during the next two quarters of 2004 and then increased significantly during the fourth quarter when radioactive materials destined for disposal were temporarily stored in outdoor staging areas.

Dosimeter monitoring sites around the 100-K Area's Cold Vacuum Drying Facility showed a significant annual dose rate increase of 122% in 2004 compared to 2003. Dose rates at all four monitoring locations began increasing noticeably at mid-year when radioactive materials associated with cleanup activities in the K Basins began to be stored on the east side of the facility. As more of these materials were added, dose rates at two monitoring locations situated on the east side of the facility continued to increase significantly during the last half of the year. The dose rates observed at two locations on the west side of the facility showed a more moderate, though continual, increase during the third and fourth quarters of the year.

Dose rate levels measured at the 100-KR-1 (100-K Area) remedial action site in 2004, as in 2003, were approximately 95 mrem/yr.

100-N Area. The average dose rate measured in the 100-N Area in 2004 was approximately 19% lower than that measured in 2003. Direct radiation levels were, again, highest near facilities that contained or received liquid effluent from the N Reactor. These facilities primarily included the retired 116-N-1 (also known as 1301-N) and 116-N-3 (also known as 1325-N) liquid waste disposal trenches. Annual average dose rates at five monitoring locations near the 116-N-1 trench showed an increase of approximately 13% compared to levels measured at the same locations in 2003. The 2004 annual average dose rate levels at the three monitoring locations near the 116-N-3 facility showed a decrease of approximately 35% from 2003 levels. This reduction in dose rates was directly attributable to the removal of contaminated materials from the facility during 2003. Also significantly reduced were the dose rates near the retired 1304-N Emergency Dump Tank, which was decontaminated and demolished during 2004. Average dose rates at two monitoring locations near the tank were approximately 50% lower in 2004 than they were in 2003. Annual average thermoluminescent dosimeter results for the entire 100-N Area from 1994 through 2004 are presented in Figure 8.13.1.

100-N Area Shoreline (N Springs). Dose rates were measured along the Columbia River shoreline in the 100-N Area (N Springs) to determine potential external radiation doses to onsite workers and to members of the public using the river. Cleanup activities at the retired 116-N-1 and 116-N-3 trenches (located near the Columbia River) have reduced the skyshine effect (i.e., radiation reflected by the atmosphere back to the earth's surface) at the shoreline and the dose rates there have decreased notably over the past few years (Figure 8.13.1). The 2004 dose rates were similar to the 2003 dose rates.

200-East and 200-West Areas. The highest dose rates in the 200 Areas were measured near waste handling facilities. One such location in the 200-East Area and another in the 200-West Area exhibited noticeably elevated dose rates during the second quarter of 2004. The 200-East Area location was at the A Tank Farm (a group of underground waste-storage tanks) and the 200-West Area location was at the S Tank Farm. These elevated dose rate levels appeared to be directly correlated with waste retrieval activities in both tank farms during 2004. By the end of the year, dose rates at both locations returned to typical site background levels. The overall effect, primarily from these two elevated-dose rate locations, was that average dose rates measured in the 200-East and 200-West Areas in 2004 were 69% and 112% higher, respectively, than the 2003 average dose rates (Figure 8.13.1.)

Average dose rates measured in 2004 at the Environmental Restoration Disposal Facility (located near the 200-West Area) were similar to 2003 levels, with only a slight increase of approximately 1%.

200-North Area. One thermoluminescent dosimeter monitoring site, located in the 200-North Area at the contaminated 212-R Railroad Car Disposition Area,

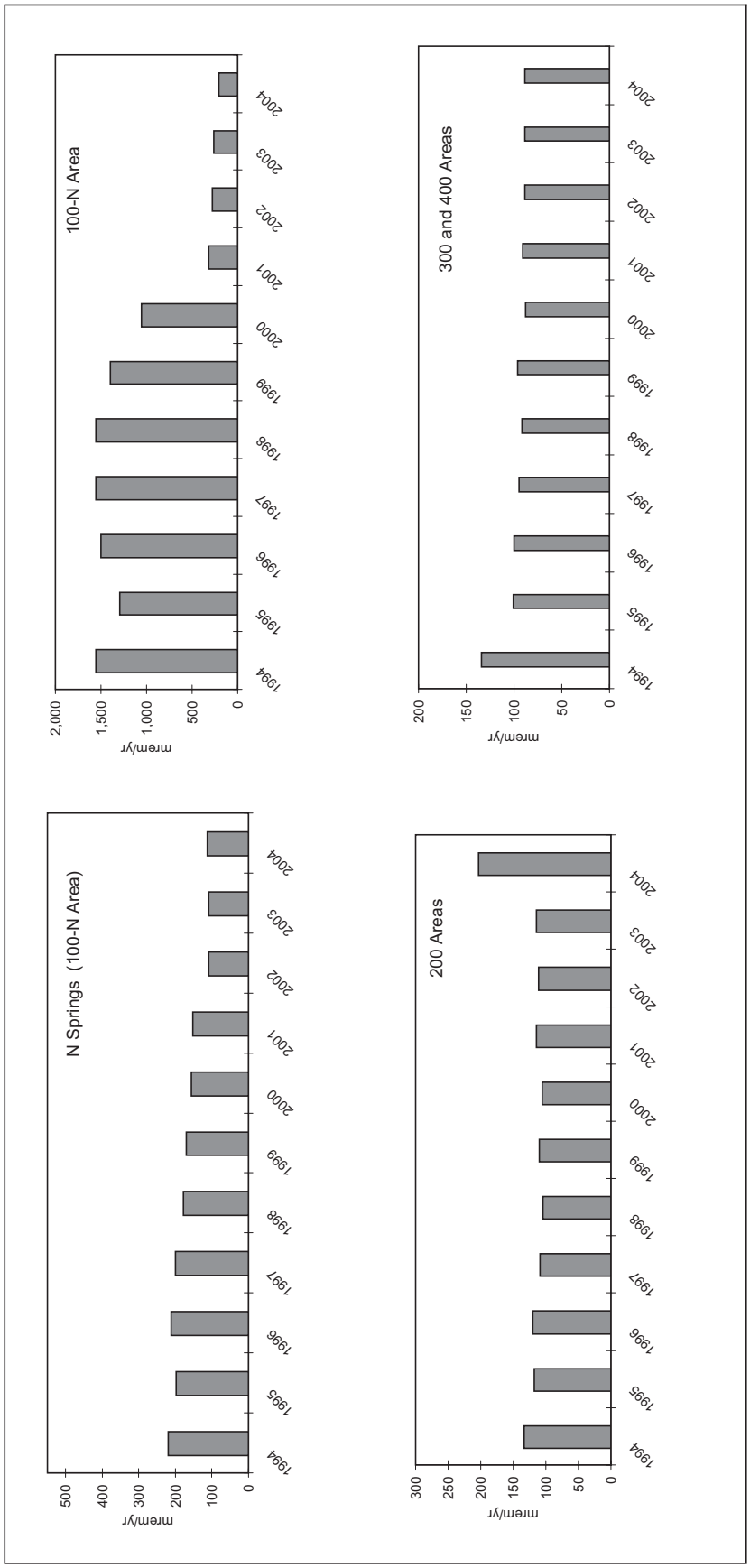

Figure 8.13.1. Annual Average Dose Rates in Selected Areas Near Facilities and Operations on the Hanford Site

showed a decrease in the annual average dose rate of 4% in 2004 compared to 2003. This thermoluminescent dosimeter location was established in 2000 to monitor expected high radiation levels emitted from contaminated railroad cars staged in the immediate vicinity.

300 and 400 Areas. The average dose rates in the 300 Area and at the 300 Area Treated Effluent Disposal Facility in 2004 were virtually unchanged from their 2003 levels, and dose rate levels observed in the 400 Area were only 3% higher than dose rates measured in 2003 (Figure 8.13.1).

Thermoluminescent dosimeters were installed during the second quarter of 2004 to monitor activities at the 300-FF-2 remedial action site in the 300 Area. Dose rate levels measured at these six locations were comparable to typical levels observed in the older established locations in the 300 and 400 Areas (i.e., approximately 85 mrem/yr).

8.13.1.2 Radiological Surveys at Active and Inactive Waste Disposal Sites

S. M. McKinney and R. M. Mitchell

During 2004, 524 environmental radiological surveys were conducted at active and inactive waste disposal sites and the terrain surrounding them to detect and characterize radioactive surface contamination. Vehicles equipped with radiation detection devices and global positioning systems were used to accurately measure the extent of the contamination. Area measurements were entered into the Hanford Geographical Information System, a computer database maintained by Fluor Hanford, Inc. Routine radiological survey locations included former waste disposal cribs and trenches, retention basin perimeters, ditch banks, solid waste disposal sites (e.g., burial grounds), unplanned release sites, tank farm perimeters, stabilized waste disposal sites, roads, and firebreaks in and around the site operational areas. These sites were posted as underground radioactive materials areas, contamination areas, and soil contamination areas. It was estimated that the external dose rate at 80% of the outdoor contaminated areas was less than 1 mrem/hr (0.01 mSv/hr), though direct dose rate readings from isolated radioactive specks could have been higher.

Underground radioactive materials areas are areas where radioactive materials occur below the soil surface. These areas are typically stabilized cribs, burial grounds, covered ponds, trenches, and ditches. Barriers over the contamination sources are used to inhibit radionuclide transport to the surface. These areas are surveyed at least annually to assess the effectiveness of the barriers.

Contamination areas and soil contamination areas may or may not be associated with an underground structure containing radioactive material. A breach in the surface barrier of a contaminated underground area may result in the growth of contaminated vegetation. Insects or animals may burrow into the soil and bring contamination to the surface. Vent pipes or risers from an underground structure may be a source of speck contamination (particles with a diameter less than 0.6 centimeter [0.25 inch]). Areas of contamination not related to subsurface structures can include sites contaminated with fallout from effluent stacks or with materials from unplanned releases (e.g., contaminated tumbleweeds, and animal feces).

All contaminated areas may be susceptible to contamination migration and are surveyed at least annually to assess their current radiological status (locations of posted contamination areas are illustrated in PNNL-15222, APP. 2). In addition, onsite roadways are surveyed annually and the intersections along the Environmental Restoration Disposal Facility haul routes are surveyed quarterly.

During 2004, the Hanford Site had approximately 3,628 hectares (8,965 acres) of outdoor contaminated areas of all types and approximately 637 hectares (1,575 acres) that contained underground radioactive materials not including active facilities. A listing of the contaminated areas, underground radioactive materials areas, their status, and their general locations is provided in Table 8.13.2. No new areas of significant size were discovered during 2004, and approximately 33 hectares (82 acres) of previously posted contamination and/or underground radioactive materials areas were remediated and released from posting during the year. Table 8.13.3 summarizes the change in status of outdoor contamination areas during 2004.

Table 8.13.2. Status of Outdoor Contamination Areas at Hanford, 2004

Area	Contamination Areas,[a] ha	(acres)	Underground Radioactive Materials Areas,[b] ha	(acres)	Closed Out, ha	(acres)
100-B/C	8	(20)	39	(96)	0	(0)
100-D/DR	0	(0)	29	(72)	0	(0)
100-F	1	(2)	31	(77)	3	(7)
100-H	0	(0)	10	(25)	4	(10)
100-K	8	(20)	53	(131)	9	(22)
100-N	25	(62)	12	(30)	4	(10)
200-East[c]	72	(178)	141	(348)	0	(0)
200-West[c]	27	(67)	225	(556)	0	(0)
300	9	(22)	42	(104)	13	(32)
400	0	(0)	0	(0)	0	(0)
600[d]	3,478	(8,594)	55	(136)	0	(0)
Totals	**3,628**	**(8,965)**	**637**	**(1,575)**	**33**	**(82)**

(a) Includes areas posted as contamination/soil contamination or as radiologically controlled and areas that had both underground radioactive material and contamination/soil contamination.
(b) Includes areas with only underground contamination.
(c) Includes tank farms.
(d) Includes BC crib controlled area, Environmental Restoration Disposal Facility, and waste disposal facilities outside the 200-East and 200-West Areas boundaries.

Table 8.13.3. Change in Status of Outdoor Contamination Areas at Hanford, 2004

Areas	Changes	Area, ha	(acres)
100	CA/URM to None[a]	20	(50)
200-East	None to report	0	(0)
200-West	None to report	0	(0)
300	CA/URM to None[a]	13	(32)
400	None to report	0	(0)
600	None to report	0	(0)

(a) Changes due to remediation activities.
CA = Contamination/soil contamination area.
URM = Underground radioactive material area.

8.13.2 External Radiation Monitoring at Site-Wide and Offsite Locations

E. J. Antonio

During 2004, external radiation levels were measured at 33 site-wide locations on the Hanford Site (Figure 8.13.2), 11 locations around the perimeter of the site, 9 locations in surrounding communities including 2 at distant locations (Figure 8.13.3), and 28 locations along the Columbia River shoreline from the Vernita Bridge to downstream of Bateman Island at the mouth of the Yakima River (Figure 8.13.4). Measurements were made using thermoluminescent dosimeters and pressurized ionization chambers. Annual results for 2004 are compared to results obtained during the previous 5 years in Tables 8.13.4 through 8.13.6. External radiation and surface contamination surveys at specified locations were performed with portable radiation survey instruments.

All community and most of the onsite and perimeter thermoluminescent dosimeter locations were collocated with air-monitoring stations. The onsite and perimeter locations were selected based on determinations of the high potential for public exposure to radiation resulting from remediation activities (i.e., access areas and downwind population centers) and from past and current Hanford Site operations. The two background stations in Yakima and Toppenish were chosen because they are generally upwind and distant from the site.

Ground contamination surveys were conducted quarterly at 13 shoreline locations. One new shoreline location, Coyote Rapids (location 7 in Figure 8.13.4), was added in 2004 because shoreline survey results at that location indicated possible elevated radiation levels. These surveys were conducted using Geiger-Mueller meters (also called Geiger or GM counters) and Bicron® Microrem meters. Readings were in counts per minute and microrem per hour, respectively. Geiger counter measurements were made within 2.54 centimeters (1 inch) of the ground and covered a 1-square-meter (10-square-foot) area. The Bicron® measurements were taken 1 meter (3.3 feet) above the ground surface and at least 10 meters (33 feet) away from devices or structures, which may have contributed to the ambient radiation levels.

Pressurized ionization chambers were situated at four community-operated monitoring stations (Section 8.13.2.5). These instruments measured ambient exposure rates near and downwind of the site and at locations distant and upwind of the site. Continuous

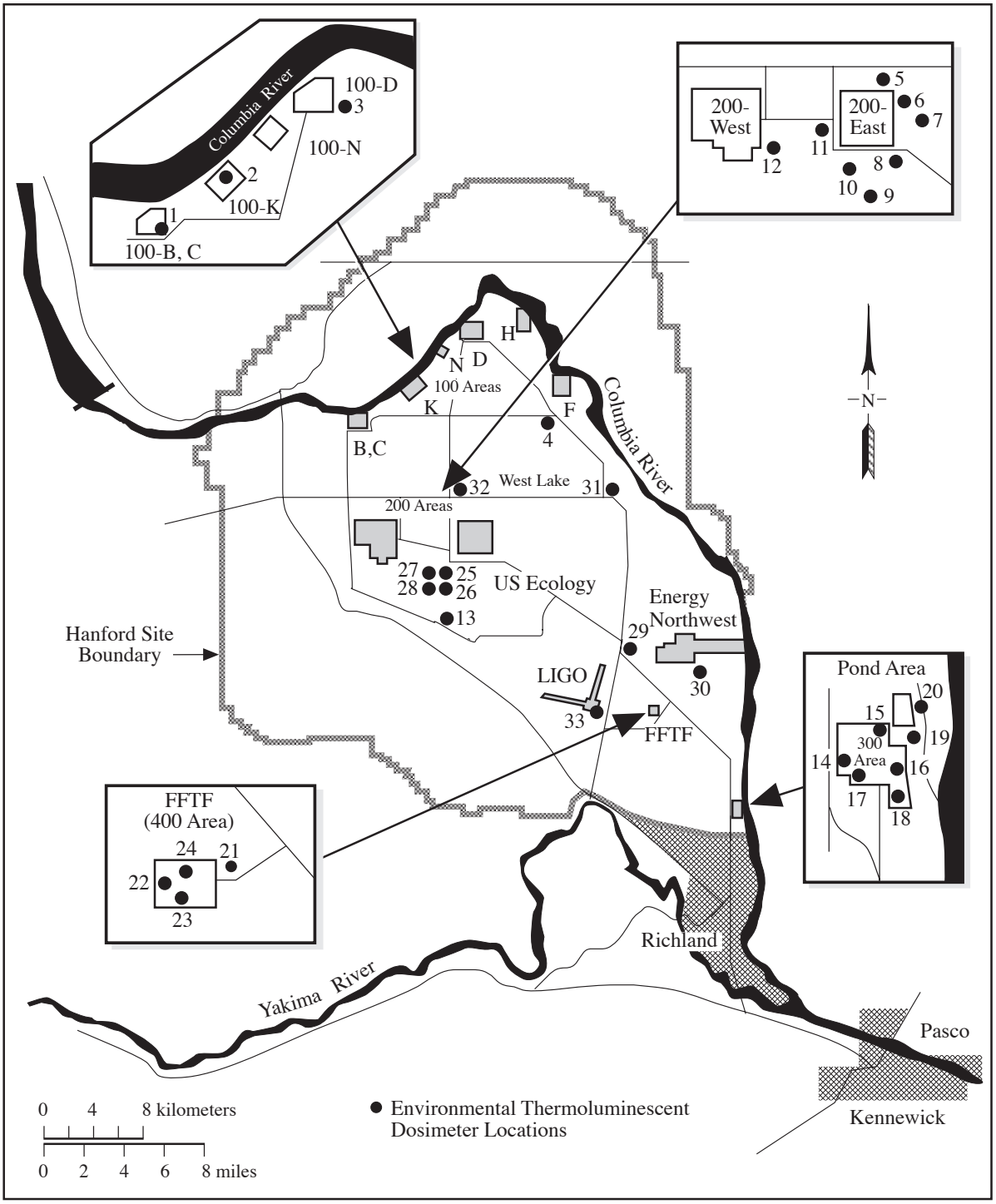

Figure 8.13.2. Surface Environmental Surveillance Project Thermoluminescent Dosimeter Locations (and Station Numbers) on the Hanford Site, 2004 (see Appendix C, Table C.10 for station names)

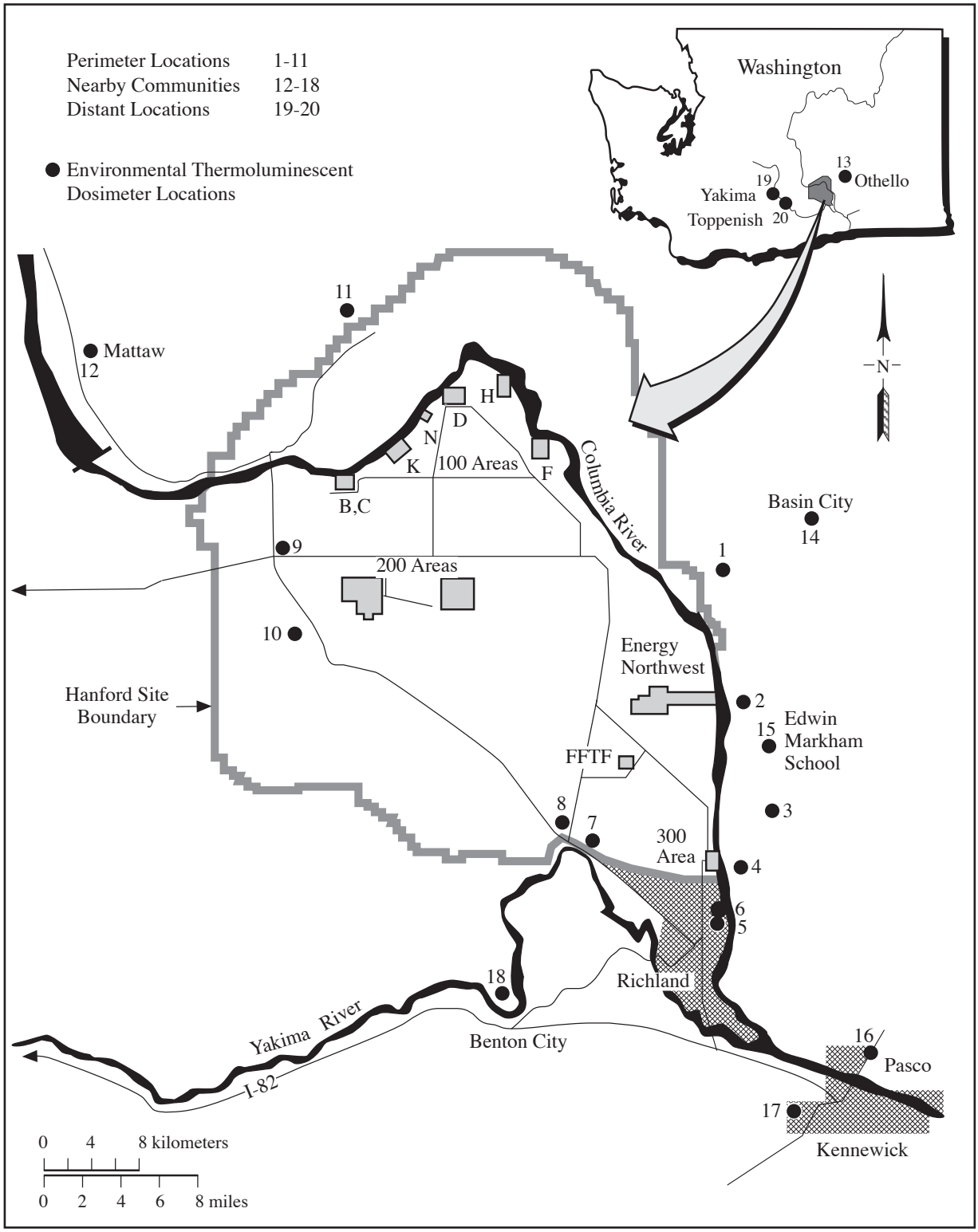

Figure 8.13.3. Community, Distant, and Perimeter Thermoluminescent Dosimeter Locations (and Station Numbers) Around the Hanford Site, 2004 (see Appendix C, Table C.10 for station names)

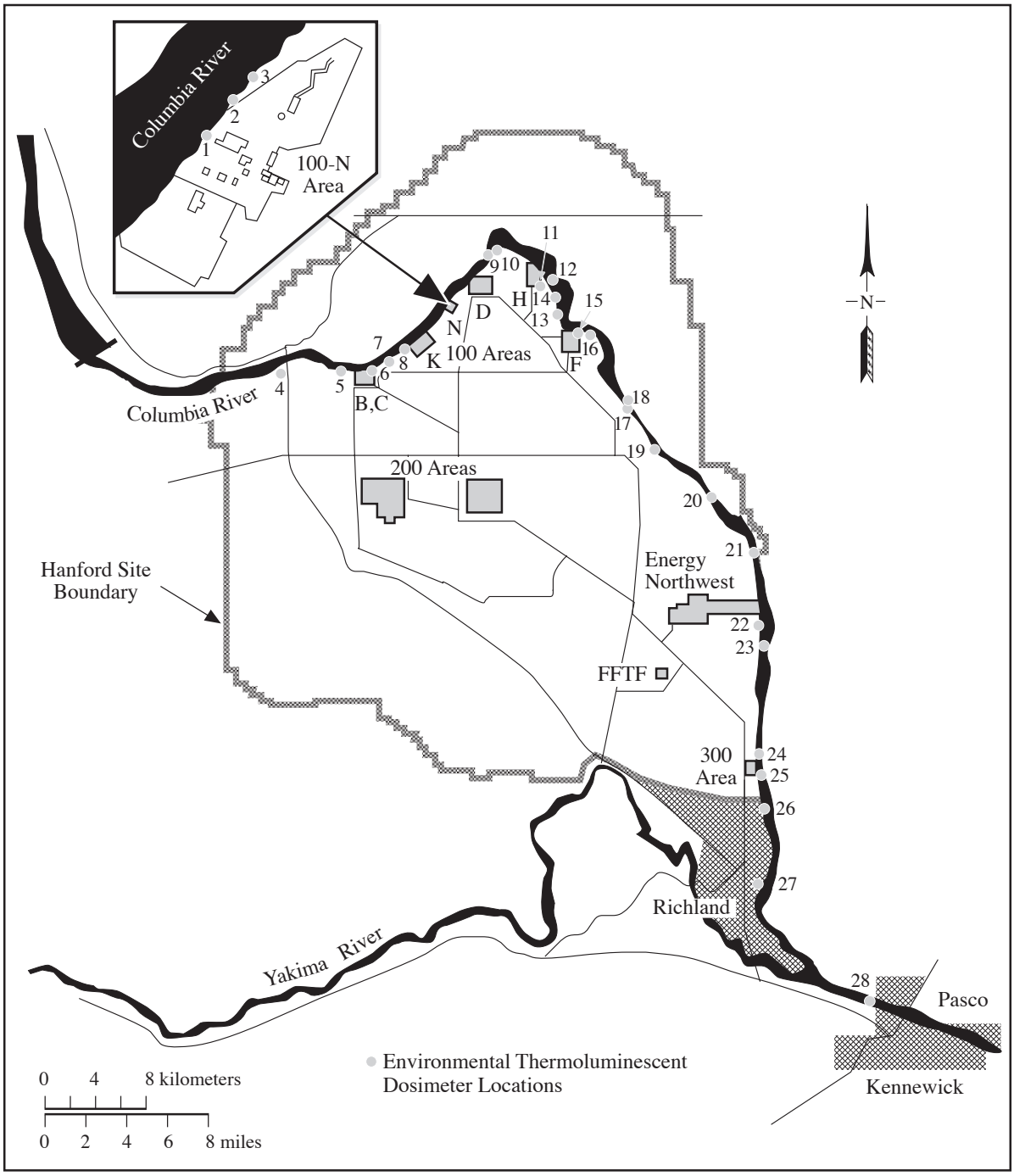

Figure 8.13.4. Hanford Site Surface Environmental Surveillance Project Thermoluminescent Dosimeter Locations (and Station Numbers) Along the Columbia River, 2004 (see Appendix C, Table C.10 for station names)

Table 8.13.4. Dose Rates (mrem/yr[a]) Measured by Thermoluminescent Dosimeters at Site-Wide Locations on the Hanford Site, 2004 Compared to Previous 5 Years

		2004		1999-2003		
Location	Map Location[b]	Maximum[c]	Mean[d]	No. of Samples	Maximum[c]	Mean[d]
100 Areas	1 - 4	88 ± 6	82 ± 5	17	88 ± 4	82 ± 3
200 Areas	5 - 13	95 ± 9	87 ± 3	44	98 ± 6	88 ± 1
300 Area	14 - 20	91 ± 7	84 ± 3	32	107 ± 6	84 ± 2
400 Area	21 - 24	84 ± 7	83 ± 1	20	89 ± 7	83 ± 1
600 Area	25 - 33	96 ± 9	86 ± 3	40	128 ± 22	88 ± 3
Combined site-wide	1 - 33	96 ± 9	85 ± 2	153	128 ± 22	86 ± 1

(a) Multiply by 10 to convert to μSv/yr.
(b) All station locations are shown on Figure 8.13.2 and are described in Appendix C, Table C.10.
(c) Maximum annual average dose rate for all locations within a given distance classification (±2 standard deviations).
(d) Means computed by averaging annual means for each location within a given distance classification (±2 standard error of the mean).

Table 8.13.5. Dose Rates (mrem/yr[a]) Measured by Thermoluminescent Dosimeters at Perimeter and Offsite Locations Around the Hanford Site, 2004 Compared to Previous 5 Years

		2004		1999-2003		
Location	Map Location[b]	Maximum[c]	Mean[d]	No. of Samples	Maximum[c]	Mean[d]
Perimeter	1 - 11	97 ± 5	89 ± 3	55	106 ± 7	91 ± 2
Community	12 - 18	87 ± 8	79 ± 3	39	89 ± 3	79 ± 2
Distant	19 - 20	71 ± 4	71 ± 1	10	75 ± 8	72 ± 1

(a) Multiply by 10 to convert to μSv/yr.
(b) All station locations are shown on Figure 8.13.3 and are described in Appendix C, Table C.10.
(c) Maximum annual average dose rate for all locations within a given distance classification (±2 standard deviations).
(d) Means computed by averaging annual means for each location within a given distance classification (±2 standard error of the mean).

exposure-rate data were displayed at each station to provide information to the public and to serve as an educational tool for the teachers who manage the stations.

8.13.2.1 External Radiation Measurements at Site-Wide Locations

The average dose rates near all operational areas (Table 8.13.4) were higher than average dose rates measured at distant locations (Table 8.13.5). The highest annual average dose rate measured at site-wide locations during 2004 (96 ± 9 mrem [0.96 ± 0.09 mSv]) was detected at the southwest corner of the US Ecology waste burial site (location 28 in Figure 8.13.2). The 5-year maximum annual average site-wide dose rate (128 ± 22 mrem [1.28 ± 0.22 mSv]) was measured during 1999 at the same location.

8.13.2.2 External Radiation Measurements at Perimeter and Offsite Locations

The average perimeter dose rate was 89 ± 3 mrem (0.89 ± 0.03 mSv) in 2004; the maximum was 97 ± 5 mrem (0.97 ± 0.05 mSv) (Table 8.13.1). The 5-year (1999 through 2003)

Table 8.13.6. Dose Rates (mrem/yr[a]) Measured by Thermoluminescent Dosimeters Along the Shoreline of the Hanford Reach of the Columbia River, 2004 Compared to Previous 5 Years

		2004		1999-2003		
Location	Map Location[b]	Maximum[c]	Mean[d]	No. of Samples	Maximum[c]	Mean[d]
100-N Area shoreline	1 - 3	103 ± 7	92 ± 9	15	143 ± 9	112 ± 9
Typical shoreline	4 - 27	100 ± 15	86 ± 3	112	101 ± 16	87 ± 1
All shoreline	1 - 27	103 ± 7	86 ± 3	127	143 ± 9	90 ± 2

(a) Multiply by 10 to convert to µSv/yr.
(b) All station locations are shown on Figure 8.13.4 and are described in Appendix C, Table C.10.
(c) Maximum annual average dose rate for all locations within a given distance classification (±2 standard deviations).
(d) Means computed by averaging annual means for each location within a given distance classification (±2 standard error of the mean).

perimeter annual average dose rate was 91 ± 2 mrem (0.90 ± 0.02 mSv) and the 5-year maximum annual average dose rate was 106 ± 7 mrem (1.06 ± 0.07 mSv). The location of the 2004 maximum perimeter dose was Byers Landing (location number 4 on Figure 8.13.3). The variation in dose rates may be partially attributed to changes in natural background radiation that can occur as a result of changes in annual cosmic radiation (up to 10%) and terrestrial radiation (15% to 25%) (National Council on Radiation Protection and Measurements 1987). Other factors possibly affecting the annual dose rates reported here have been described in PNL-7124, *The Determination of the Penetrating Radiation Dose at Hanford.*

The average background dose rate (measured in distant communities) in 2004 was 71 ± 1 mrem (0.71 ± 0.01 mSv) per year, which was almost equal to the average for 2003 (PNNL-14687) and the 5-year annual average of 72 ± 1 mrem (0.72 ± 0.01 mSv) (Table 8.13.1). Site-wide and perimeter average dose rates in 2004 were 13 mrem (0.13 mSv) and 18 mrem (0.18 mSv) per year higher, respectively, than average dose rates measured at distant locations (Figure 8.13.5).

8.13.2.3 External Radiation Measurements at Columbia River Shoreline Locations

During 2004, average dose rates along the Columbia River shoreline near the 100-N Area were approximately 6 mrem (0.06 mSv) per year higher than the average of all other shoreline dose rates (Table 8.13.6). Higher dose rates historically measured along the 100-N Area shoreline were attributed to waste management practices in that area (PNL-3127). The shoreline location of the highest average thermoluminescent dosimeter reading was along the 100-N Area shoreline. The 2004 maximum annual 100-N Area shoreline dose rate of 103 ± 7 mrem (1.03 ± 0.07 mSv) is about the same as the maximum annual dose rate of 99 ± 7 mrem (0.99 ± 0.07 mSv) measured at that location in 2003 (PNNL-14687), but is significantly different (i.e., the 95% confidence intervals

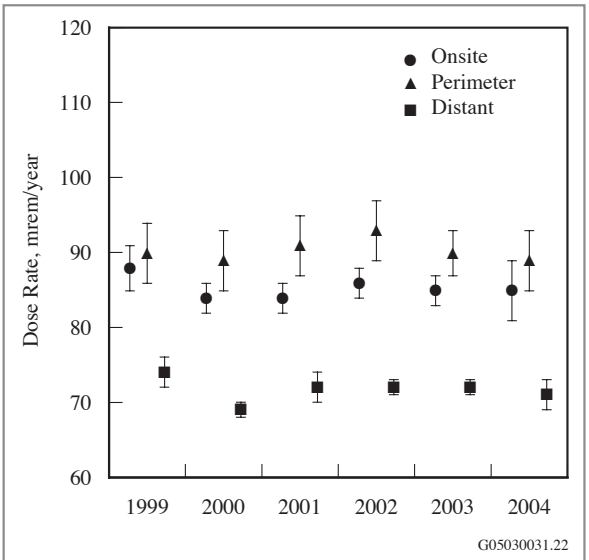

Figure 8.13.5. Annual Average Dose Rates (±2 standard error of the mean) at Site-Wide, Perimeter, and Distant Locations of the Hanford Site, 1999 through 2004

associated with the two measurements do not overlap) than the 5-year maximum annual average of 143 ± 9 mrem (1.43 ± 0.9 mSv) measured during 1999. Over the past 5 years, the maximum dose rates along the 100-N Area shoreline have decreased as a result of cleanup efforts in the 100-N Area (Figure 8.13.6). The general public is not permitted access to the 100-N Area shore above the high water line but does have boat access to the Columbia River. The dose implications associated with using the Columbia River near the 100-N Area are discussed in Section 8.14 and in DOH 320-032, *2003 External Radiation Survey Along the Columbia River Shoreline of the Hanford Site's 100 Area*.

8.13.2.4 Columbia River Shoreline Radiological Survey Results

During 2004, Bicron® Microrem meters and Geiger counters were used to perform radiological surveys at selected Columbia River shoreline locations. These surveys provided a coarse screening for external radiation fields. The highest dose rate measured with the Bicron® Microrem meter (9 µrem [0.09 µSv] per hour, approximately 78 mrem per year) was measured along the 100-N Area shoreline; the lowest dose rate measured with the Bicron® Microrem meter was 4 µrem (0.04 µSv) per hour and was recorded at various locations along the Hanford Reach shoreline. The highest reported count rate measured with the Geiger counter in ground level surveys (100 counts per minute) was measured at various locations and in multiple yearly quarters. The lowest ground level count rate (50 counts per minute) was recorded at several locations throughout the year.

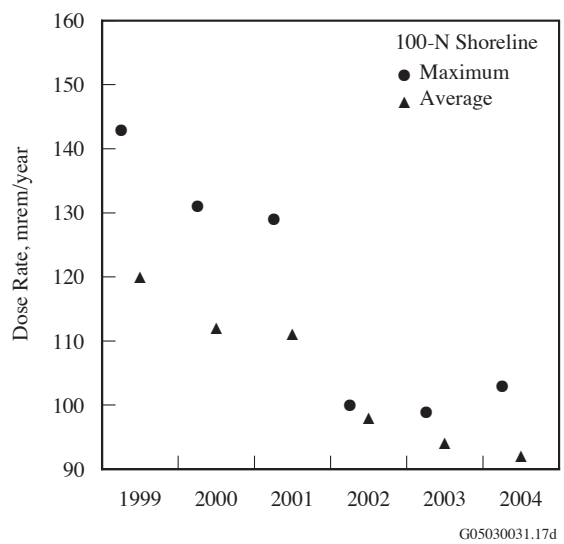

Figure 8.13.6. Maximum and Average External Dose Rates Measured Along the Columbia River at 100-N Area Shoreline Locations on the Hanford Site, 1999 through 2004

8.13.2.5 Pressurized Ionization Chamber Results at Four Offsite Locations

Gamma radiation levels were monitored with pressurized ionization chambers at four community-operated air-monitoring stations during 2004 (Section 8.17). These stations were located in Leslie Groves Park in Richland, at Edwin Markham Elementary School in north Franklin County, at Basin City Elementary School in Basin City, and at Heritage University near Toppenish (locations 36, 40, 35, and 44, respectively, on Figure 8.2.2). Measurements were collected to determine ambient gamma radiation levels near and downwind of the site and upwind and distant from the site, to display near-continuous exposure rate information to the public living near the stations, and for educational information for the teachers who manage the stations.

Data collection systems consisted of computers, data loggers, and radiotelemetry instruments. Data from all stations were transmitted by radiotelemetry to a computer at the Hanford Meteorology Station near the 200-West Area. These data were summarized and posted on the Internet (http://hms.pnl.gov) at 15-minute intervals.

Readings at the Leslie Groves Park and Heritage University stations were collected every 5 seconds with a Reuter-Stokes Model RSS-121 pressurized ionization chamber and an average reading was recorded every hour. Data at Basin City and Edwin Markham Elementary Schools were collected every second with a Reuter-Stokes Model RSS-131 pressurized ionization chamber and averaged every 15 minutes. The 15-minute averages were then used to generate a 60-minute average.

Average maximum hourly exposure rates ranged from 16.1 microRoentgen (µR) per hour at Edwin Markham Elementary School during January to 7.9 µR per hour at Heritage University in July (Table 8.13.7). Monthly mean

Table 8.13.7. Exposure Rates[a] Measured by Pressurized Ionization Chambers at Four Locations Around the Hanford Site,[b] 2004

Month		Exposure Rate, µR/h (number of hourly averages)							
		Leslie Groves Park[c]		Basin City[d]		Edwin Markham[d]		Toppenish[c]	
January	Mean	8.2	(740)	7.4	(630)	7.0	(165)	7.5	(740)
	Maximum	12.6		14.1		16.1		13.2	
	Minimum	4.9		6.8		7.0		7.0	
February	Mean	8.8	(696)	7.8	(562)	ND		7.9	(695)
	Maximum	9.8		8.9		ND		10.3	
	Minimum	5.9		7.4		ND		7.3	
March	Mean	8.6	(744)	7.8	(730)	7.5	(541)	7.7	(744)
	Maximum	9.3		8.6		8.5		9.1	
	Minimum	6.4		7.5		6.8		7.2	
April	Mean	8.7	(719)	7.7	(279)	7.5	(586)	7.8	(727)
	Maximum	9.6		14.5		8.9		9.0	
	Minimum	4.9		7.4		6.6		7.4	
May	Mean	8.5	(744)	7.7	(734)	7.5	(736)	7.8	(747)
	Maximum	9.9		8.8		9.6		10.5	
	Minimum	3.8		7.5		6.4		7.5	
June	Mean	8.5	(720)	7.8	(448)	7.5	(444)	7.7	(60)
	Maximum	10.3		8.2		8.6		8.0	
	Minimum	6.0		7.5		6.4		7.5	
July	Mean	8.5	(744)	7.9	(584)	7.5	(571)	7.6	(281)
	Maximum	9.0		8.9		9.8		7.9	
	Minimum	7.8		7.5		7.0		7.4	
August	Mean	8.5	(744)	7.9	(640)	7.5	(645)	7.8	(742)
	Maximum	9.2		9.0		9.5		9.9	
	Minimum	3.7		7.5		6.9		7.3	
September	Mean	8.7	(697)	7.8	(579)	7.5	(523)	8.1	(710)
	Maximum	9.4		8.6		8.5		9.5	
	Minimum	8.2		7.3		6.5		7.6	
October	Mean	8.8	(597)	7.9	(512)	7.6	(533)	8.9	(229)
	Maximum	9.6		9.2		8.9		10.6	
	Minimum	8.4		7.3		7.1		8.1	
November	Mean	9.0	(715)	8.0	(717)	7.7	(707)	8.9	(654)
	Maximum	10.0		8.8		8.4		10.0	
	Minimum	8.4		7.5		7.1		8.0	
December	Mean	9.1	(736)	8.3	(713)	7.7	(662)	8.7	(546)
	Maximum	12.8		15.3		13.3		11.8	
	Minimum	8.5		6.9		2.0		7.7	

(a) Maximum and minimum values are hourly averages. Means are monthly means.
(b) Measurement locations are illustrated in Figure 8.2.2.
(c) Readings are stored every 60 minutes. Each 60-minute reading is an average of measurements collected at 5-second intervals.
(d) Readings were collected every second and averaged every 15 minutes. Fifteen-minute averages were used to compute 60-minute averages (as many as 3,600 individual measurements per hour).
ND = No data collected.

readings were consistently between 7.0 and 9.1 μR per hour at the stations near Hanford and ranged between 7.5 and 8.9 μR per hour at the distant station (Heritage University). These average exposure rates were similar to exposure rates measured at these locations in past years and by thermoluminescent dosimeters located at or near these locations in 2004 (Table 8.13.8). One μR per hour is approximately equal to 1 microrem per hour.

Table 8.13.8. Quarterly Average Exposure Rates (μR/h[a]) Measured by Thermoluminescent Dosimeters at Four Locations Around the Hanford Site,[b] 2004

Quarter Ending	Leslie Groves Park[c]	Basin City	Edwin Markham	Toppenish
March	8.29 ± 0.46	8.58 ± 0.08	8.08 ± 0.50	7.54 ± 0.08
June	9.04 ± 0.08	[d]	8.88 ± 0.08	8.54 ± 0.21
September	8.75 ± 0.63	[d]	8.25 ± 0.00	8.33 ± 0.13
December	9.50 ± 0.00	8.92 ± 0.13	8.79 ± 0.00	8.13 ± 0.08

(a) ± counting error.
(b) Sampling locations shown on Figure 8.2.2.
(c) Thermoluminescent dosimeter located ~1 kilometer (0.6 mile) north of Leslie Groves Park at map location 26, Figure 8.13.4.
(d) Dosimeter missing.