DOE Oversight Bureau, New Mexico Environment Department

Direct Penetrating Radiation Monitoring Report at the Waste Isolation Pilot Plant

Conducted by the
New Mexico Environment Department DOE Oversight Bureau
for Calendar Year 2017 Q-1

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The purpose of this communication is to transmit direct penetrating radiation (DPR) dose levels collected at the Waste Isolation Pilot Plant during the first quarter of calendar year 2017. The data measurements were obtained using the E-PERM® electret ionization chamber system from Rad Elec Inc.

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Acronyms

CFR	Code of Federal Regulations
CY	Calendar Year
DOE	Department of Energy
DPR	Direct Penetrating Radiation
EDE	Effective Dose Equivalent
EPA	Environmental Protection Agency
mrad	Millirad
mrem	Millirem
NESHAP	National Emission Standards for Hazardous Air Pollutants
NMED	New Mexico Environment Department
OB	Oversight Bureau
Q-1	First Quarter
SD	Standard Deviation
WIPP	Waste Isolation Pilot Plant
WOS	WIPP Oversight Section

Introduction

The U.S. Department of Energy (DOE) has provided grant funding to the New Mexico Environment Department (NMED) DOE Oversight Bureau (DOE-OB or the Bureau) to conduct environmental surveillance and monitoring at the Waste Isolation Pilot Plant (WIPP) since 2005. Monitoring programs include ambient air sampling, exhaust air sampling, general environmental sampling and measuring direct penetrating radiation.

The purpose of the Direct Penetrating Radiation (DPR) Monitoring Program is to monitor gamma radiation (or direct penetrating radiation) at the WIPP facility, in the area immediately surrounding, and along the local WIPP transportation routes.

There are no Federal or State standards for gamma radiation in the environment. To verify that activities at the WIPP are protective of public health and the environment, the NMED WIPP Oversight Section (WOS) gamma radiation dosage results are compared to average naturally occurring background gamma radiation dosages and with historical NMED DPR data.

On average, Americans receive a radiation dose of about 620 mrem each year. Half of this dose (310 mrem) comes from natural background radiation: radon in the air, cosmic rays and the Earth itself. The other half comes from man-made sources of radiation: medical, commercial, and industrial sources (Doses in our Daily Lives, U.S. Nuclear Regulatory Commission website http://www.nrc.gov/about-nrc/radiation/around-us/doses-daily-lives.html, accessed August 4, 2017).

The environmental dose standard for the WIPP facility is established in Title 40 Code of Federal Regulations (CFR) Part 191, Subpart A, “Environmental Standards for Management and Storage.” The standard sets the regulatory limit for external radiation to a member of the public outside the exclusive use area boundary at 25 mrem per year to the whole body and 75 mrem to any critical organ.

In a 1995 memorandum of understanding between the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE), the DOE agreed that the WIPP facility would comply with 40 CFR Part 61, Subpart H, “National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities.” The NESHAP standard for radionuclides requires that the emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent (EDE) of 10 mrem per year. (US Environmental Protection Agency 1995)

The NMED WOS has measured and compiled DPR dose levels at NMED DOE-OB monitoring sites during the first quarter (Q-1) of the calendar year (CY) 2017. During CY2017, the DOE OB maintained a total of fourteen (14) monitoring sites located in the Exclusive Use Area at WIPP and ten (10) sites at off-site locations in the region surrounding WIPP. DPR dose data are collected quarterly. (See Table 1, Figure 1; Appendix 1).

Table 1. Location and operational details of Direct Penetrating Radiation monitoring stations located inside the WIPP Exclusive Use Area and in the WIPP vicinity.

DPR Number	Location Name	Operational History
DPR 01	Parking lot, WIPP Exclusive Use Area	CY2006 Q-3 to present
DPR 02	Railroad Entrance, WIPP Exclusive Use Area	CY2006 Q-3 to present
DPR 03	Southwest Fence Corner, WIPP Exclusive Use Area	CY2007 Q-1 to present
DPR 04	South Fence Center, WIPP Exclusive Use Area	CY2007 Q-1 to present
DPR 05	Near Southeast Fence Corner, WIPP Exclusive Use Area	CY2006 Q-3 to present
DPR 06	Far Southeast Fence Corner, WIPP Exclusive Use Area	CY2006 Q-3 to present
DPR 07	East Fence Middle, WIPP Exclusive Use Area	CY2007 Q-1 to present
DPR 08	Northeast Fence Corner, WIPP Exclusive Use Area	CY2007 Q-1 to present
DPR 09	North Northeast Fence Corner, WIPP Exclusive Use Area	CY2007 Q-1 to present
DPR 10	North Fence Salt Pile WIPP Exclusive Use Area	CY2007 Q-1 to present
DPR 11	Northwest Fence Corner, WIPP Exclusive Use Area	CY2006 Q-3 to present
DPR 12	Waste Handling Building Loading Dock West, WIPP Exclusive Use Area	CY2006 Q-3 to present
DPR 13	Waste Handling Building Loading Dock Center, WIPP Exclusive Use Area	CY2006 Q-3 to present
DPR 14	Waste Handling Building Loading Dock East, WIPP Exclusive Use Area	CY2006 Q-3 to present
DPR 15[1]	Carlsbad, NM - Canal St.(inactive)	CY2006 Q-3 to CY2012 Q-2
DPR 16	Loving Weigh Station	CY2007 Q-3, CY2009 Q-3 to present
DPR 17	Malaga Volunteer Fire Department	CY2008 Q-1 to present
DPR 17a[2]	Gnome Site	CY 2007 Q-3
DPR 18	Hobbs Highway / North Access Road Intersection	CY2009 Q-1 to present
DPR 19	Southeast Control Tower	CY2011 Q-4 to present
DPR 20	Carlsbad, NM – NMED Office. (interior)	CY2012 Q-3 to present
DPR 21	Carlsbad, NM – NMED Office (exterior)	CY2012 Q-3 to present
DPR 22	Seven Rivers Highway / Brantley (formerly “Artesia”)	CY2017 Q-2 to present
DPR 23	North Loop Road	CY2016 Q-3 to present
DPR 24	South Access Road / NM 128 Intersection	CY2016 Q-3 to present
DPR 25	Jal Highway MM49	CY2016 Q-3 to present

[1] Monitoring at DPR 15 was discontinued after CY2012 Q-2 when NMED moved their office from the Canal Street location to 406 N Guadalupe Street.
[2] Monitoring at DPR 17a was completed for Q-3 CY 2007 then discontinued.

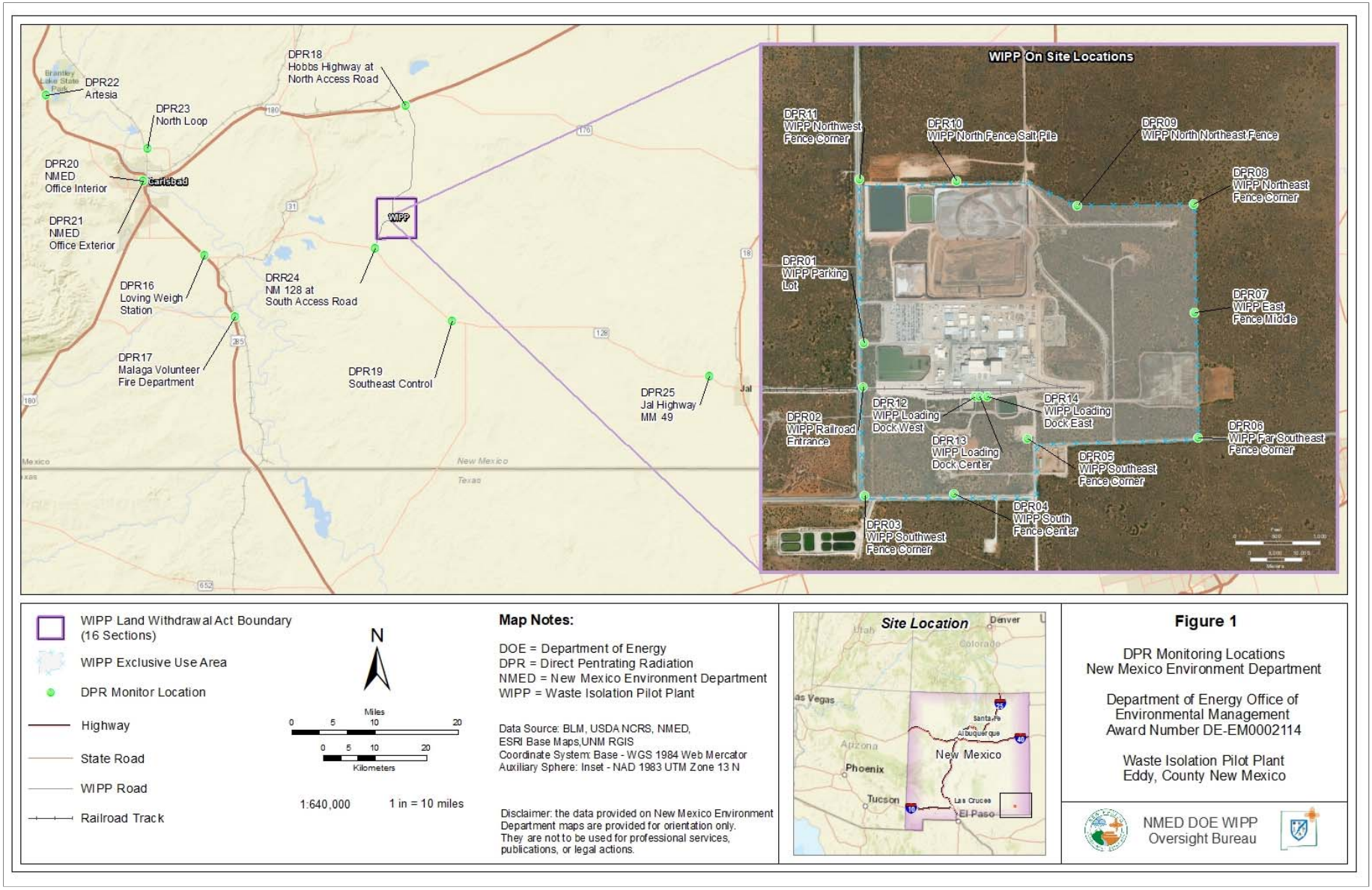

Figure 1. Location of NMED DOE-OB DPR monitors at WIPP and in the area surrounding WIPP

The data were obtained using the E-PERM® electret ionization chamber system from Rad Elec Inc. The electret passive ion chamber uses the principle of ion pair production resulting from gamma photons interacting with air molecules to reduce the voltage of a charged Teflon™ disk. (Rad Elec Inc. 2011) The chambers are housed in aluminum canisters designed to block gamma radiation from radon. Using a predetermined formula, the voltage drop indicates the amount of radiation passing through the chamber. (Rad Elec Inc. 2011) The WOS monitoring program reads electret passive ion chambers at the end of each quarter, readings are converted into quarterly dose values presented in units of millirads (mrad).

A rad is a unit of absorbed radiation dose, regardless of its source. The rem (Roentgen equivalent man) is a commonly used unit of ionizing radiation dose that uses a quality factor based on the source of radiation as it interacts with human body tissue. In the case of gamma radiation, the quality factor is one, and thus one rad is equal to one rem.

The quarterly dose rates have been normalized to reflect an actual quarter of 91.25 days. Normalized quarterly dose rates are summed for an estimated annual dose rate.

Results

The complete data set for Q-1 is presented in Appendix 1. The average quarterly dose measured at each station during Q-1 is provided in Table 2, Figures 2 and 3. The average quarterly dose of all DPR monitoring locations was 26.2 ± 5.9 standard deviation (SD).

DPR results at the WIPP site ranged from a minimum average quarterly dose of 20.6 mrad at the WIPP Northwest Fence Corner (DPR11), to a maximum average quarterly dose of 28.1 mrad at the WIPP Railroad Entrance (DPR02). The average of all measurements at the WIPP site during Q-1 was 24.4 mrad ± 2.2 SD.

DPR results off-site ranged from a minimum average quarterly dose of 24.2 mrad at the NMED Carlsbad Office Exterior (DPR 21), to a maximum average quarterly dose of 50.5 mrad at the Carlsbad Office Interior (DPR20). The average of all measurements off-site was 29.3 mrad ± 8.8 SD.

A review of the historical DPR data collected at WIPP and in the surrounding region identified several potential outliers in the dataset. In these instances, one of the three electrets at a location had a voltage drop that was significantly higher or lower than the other electrets. Potential outliers were compared to the quarterly average across all stations, and data that exceeded 2 and 3 SD from the mean are identified in Table 2. Potential outliers have not been excluded from the results reported or analyzed.

Table 2. NMED DOE-OB DPR Results for CY2017 Q-1, Average Quarterly Dose (mrad). No data is reported if the data were disqualified (DQ)[3]. One asterisk (*) indicates that one of the three electrets' calculated dose exceeds two SD of the mean quarterly average for all stations without a disqualifying event listed in the field notes. Two asterisks (**) indicates that one of three electrets' calculated dose exceeds three SD of the mean quarterly average for all stations without a disqualifying event in the field notes.

DPR Number	Location Name	2017 Q-1 Average Dose (mrad)
DPR 01	Parking lot, WIPP Exclusive Use Area	27.4
DPR 02	Railroad Entrance, WIPP Exclusive Use Area	28.1
DPR 03	Southwest Fence Corner, WIPP Exclusive Use Area	26.1
DPR 04	South Fence Center, WIPP Exclusive Use Area	24.2
DPR 05	Near Southeast Fence Corner, WIPP Exclusive Use Area	24.2
DPR 06	Far Southeast Fence Corner, WIPP Exclusive Use Area	20.8
DPR 07	East Fence Middle, WIPP Exclusive Use Area	23.5
DPR 08	Northeast Fence Corner, WIPP Exclusive Use Area	24.9
DPR 09	North Northeast Fence Corner, WIPP Exclusive Use Area	22.3
DPR 10	North Fence Salt Pile WIPP Exclusive Use Area	24.6
DPR 11	Northwest Fence Corner, WIPP Exclusive Use Area	20.6
DPR 12	Waste Handling Building Loading Dock West, WIPP Exclusive Use Area	25.7
DPR 13	Waste Handling Building Loading Dock Center, WIPP Exclusive Use Area	25.6
DPR 14	Waste Handling Building Loading Dock East, WIPP Exclusive Use Area	23.5
DPR 16	Loving Weigh Station	29.5
DPR 17	Malaga Volunteer Fire Department	DQ
DPR 18	Hobbs Highway / North Access Road Intersection	25.2
DPR 19	Southeast Control Tower	29.7
DPR 20	Carlsbad, NM – NMED Office. (interior)	50.5*
DPR 21	Carlsbad, NM – NMED Office (exterior)	24.2
DPR 22	Seven Rivers Highway / Brantley (formerly "Artesia")	DQ
DPR 23	North Loop Road	24.6
DPR 24	South Access Road / NM 128 Intersection	26.1
DPR 25	Jal Highway MM49	24.7

[3] Data is not reported if the canisters or electrets have been lost or no values were collected. Details of the conditions for disqualification or lack of reporting are provided in Appendix 1. Disqualified (DQ) data are not included in any further analysis.

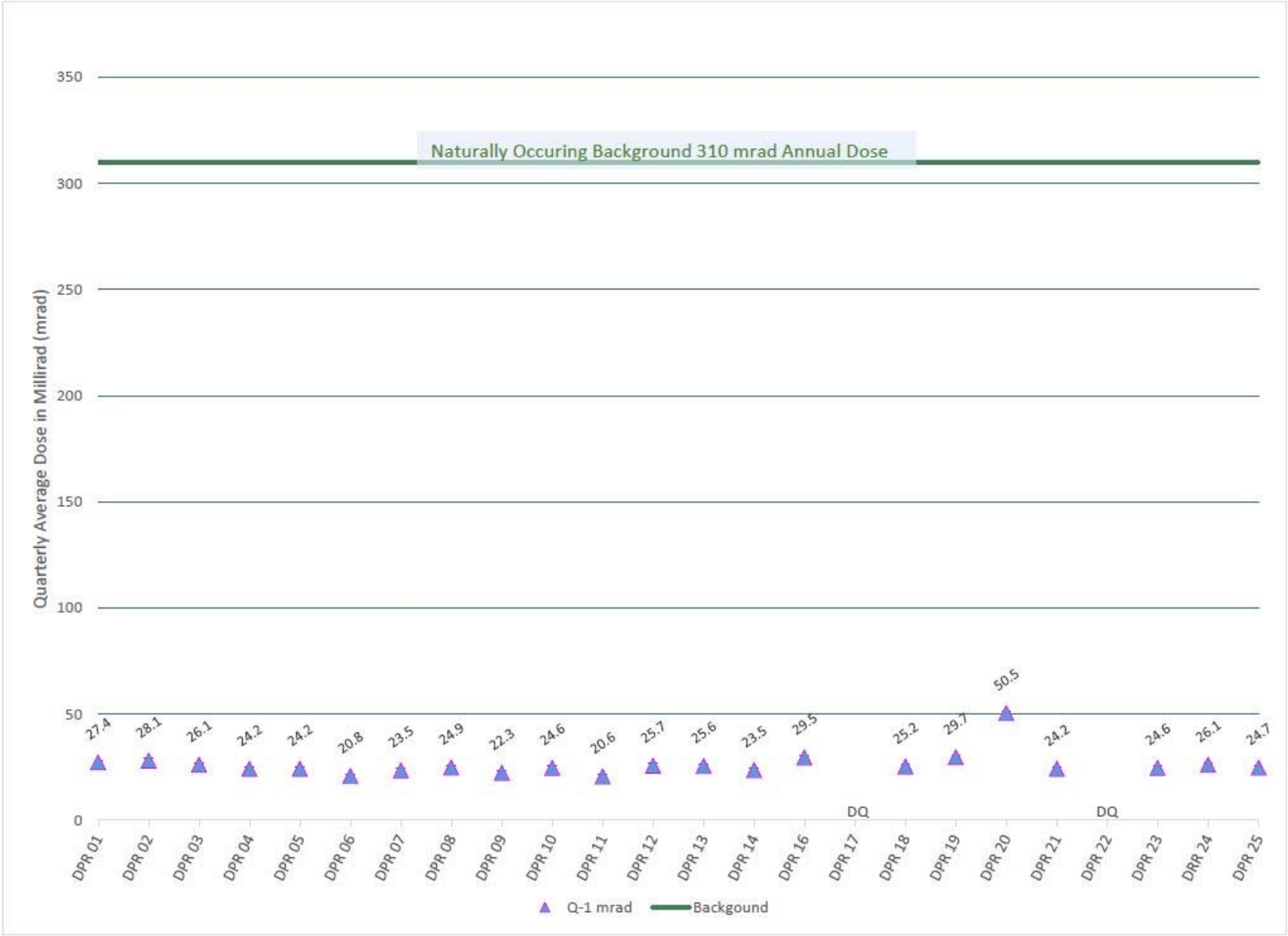

Figure 2. NMED DOE-OB DPR Results for CY2017 Q-1, Average Quarterly Dose (mrad)

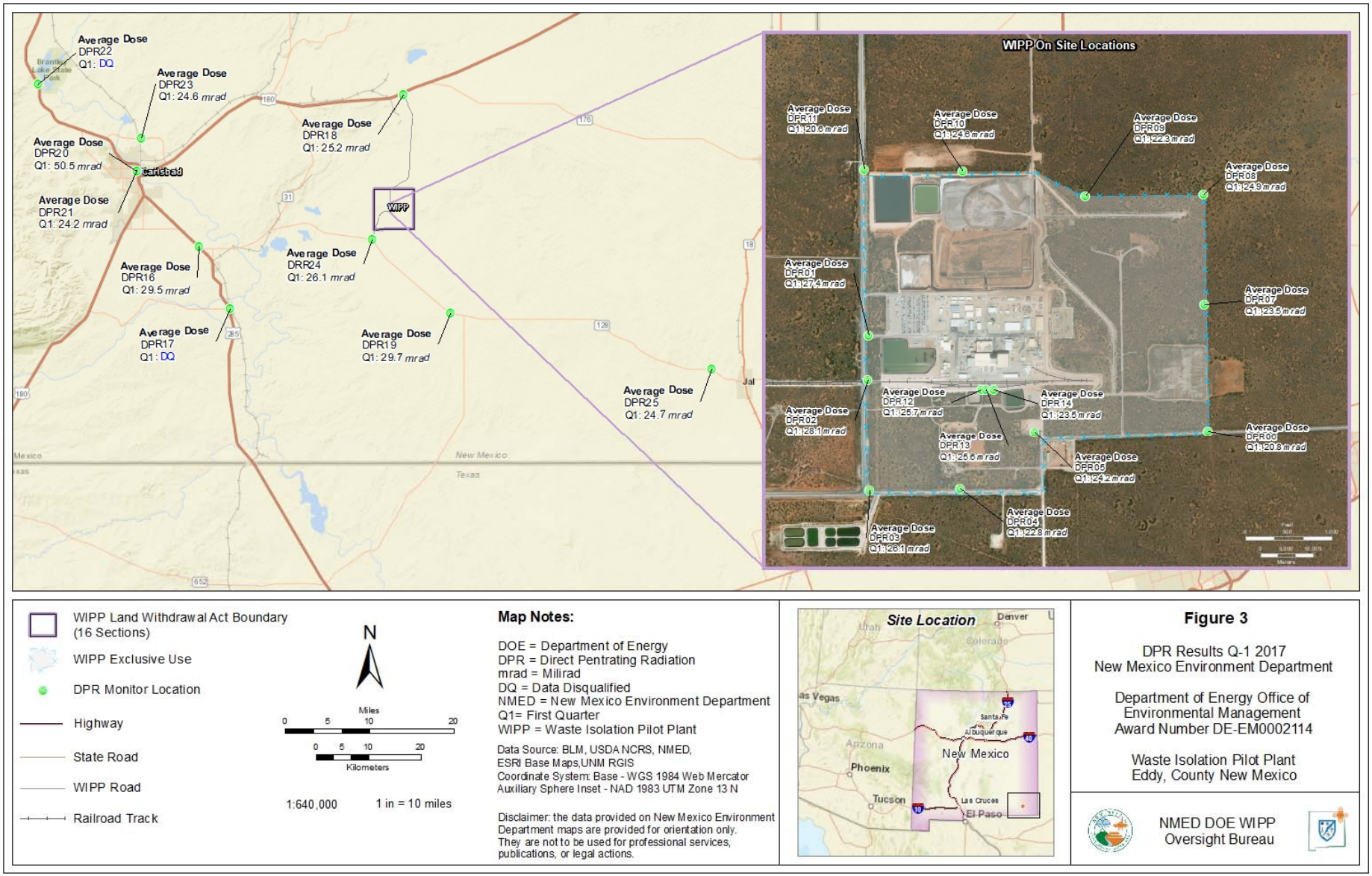

Figure 3. NMED DOE-OB DPR Results for CY2017 Q-1, Average Quarterly Dose (mrad) mapped by sampling location

Conclusions

The doses calculated from the NMED DOE-OB DPR sites located at WIPP and in the surrounding region during CY2017 Q-1 are comparable with historical results obtained by the Bureau since 2006. Overall the 2017 Q-1 data fall within the range of expected doses.

The average quarterly DPR dosages for Q-1 measured by the NMED DOE-OB at WIPP and in the region surrounding Carlsbad range from 20.6 to 50.5 mrad. If you extrapolate these quarterly doses for an entire year, the annual DPR dosages would range from 82.4 to 202.0 mrad. In the case of gamma radiation, the quality factor is one, and thus one rad is equal to one rem. These observed dose rates are less than the average U.S. natural background annual dose of 310 mrem which is the equivalent to 310 mrad.

References

Rad Elec Inc. 2011. "Environmental Gamma Radiation Measurements, Part II." *Rad Elect Manual E-Perm System Users Manual-2 321.* Rad Elec Inc.

United States Nuclear Regulatroy Commission. 2017. *USNRC Protecting People and the Environment.* July 6. Accessed August 14, 2017. https://www.nrc.gov/about-nrc/radiation/around-us/doses-daily-lives.html.

US Environmental Protection Agency. 1995. "Memorandum of Understanding Between the U.S. Environmental Protection Agency and the U.S. Department of Energy concering The Clean Air Act Emission Standards for Radionuclides 40 CFR part 61 Including Subparts H, I, Q and T." Departmental MOU.

Appendix 1

Direct Penetrating Radiation Quarterly Dose Rates for CY2017 Q-1. Data that have been disqualified are highlighted grey. A brief explanation for the disqualification is provided. One asterisk (*) next to a value, indicates that the calculated dose exceeds two standard deviations of the mean quarterly average for all stations without a disqualifying event listed in the field notes. Two asterisks (**) next to a value, indicates that the calculated dose exceeds three standard deviations of the mean quarterly average for all stations without a disqualifying event listed in the field notes.

Location	Electret ID	Start Date and Time	Stop Date and Time	Voltage Drop	Quarterly Dose Normalized (mrad)	Avg Quarterly Dose (mrad)
DPR01 WIPP Parking Lot	SHC 677	1/10/17 13:00	4/5/17 13:43	61	32.9	**27.4**
	SIR 643	1/10/17 13:00	4/5/17 13:43	46	26.2	
	SIR 699	1/10/17 13:00	4/5/17 13:43	44	23.0	
DPR02 WIPP Railroad Entrance	SHC 758	1/10/17 13:03	4/5/17 13:46	57	28.4	**28.1**
	SHV 170	1/10/17 13:03	4/5/17 13:46	55	27.4	
	SHC 749	1/10/17 13:03	4/5/17 13:46	57	28.4	
DPR03 WIPP SW Fence Corner	SIR 488	1/10/17 13:07	4/5/17 13:50	47	24.6	**26.1**
	SIR 684	1/10/17 13:07	4/5/17 13:50	45	26.0	
	SIR 538	1/10/17 13:07	4/5/17 13:50	48	27.8	
DPR04 WIPP SW Fence Center	SHV 216	1/10/17 13:10	4/5/17 13:55	50	24.9	**24.2**
	SHC 704	1/10/17 13:10	4/5/17 13:55	46	23.7	
	SHC 685	1/10/17 13:10	4/5/17 13:55	46	23.9	
DPR05 WIPP Near SE Fence Corner	SIR 449	1/10/17 13:13	4/5/17 13:58	52	25.2	**24.2**
	SHC 816	1/10/17 13:13	4/5/17 13:58	46	23.9	
	SHC 657	1/10/17 13:13	4/5/17 13:58	46	23.6	
DPR06 WIPP Far SE Fence Corner	SIR 590	1/10/17 13:15	4/5/17 14:01	35	18.7	**20.8**
	SHC 667	1/10/17 13:15	4/5/17 14:01	44	22.9	
	SIR 765	1/10/17 13:15	4/5/17 14:01	39	20.7	
DPR07 WIPP East Fence Mid	SHC 674	1/10/17 13:18	4/5/17 14:04	46	23.8	**23.5**
	SGJ 037	1/10/17 13:18	4/5/17 14:04	42	21.6	
	SIR 694	1/10/17 13:18	4/5/17 14:04	47	25.1	
DPR08 WIPP NE Fence Corner	SHC 763	1/10/17 13:20	4/5/17 14:08	49	24.4	**24.9**
	SHC 760	1/10/17 13:20	4/5/17 14:08	52	25.8	
	SHD 974	1/10/17 13:20	4/5/17 14:08	50	24.6	
DPR09 WIPP NNE Fence	SIR 470	1/10/17 13:30	4/5/17 14:12	44	23.1	**22.3**
	SHC 760	1/10/17 13:30	4/5/17 14:12	41	20.4	
	SHC 647	1/10/17 13:30	4/5/17 14:12	46	23.5	
DPR10 WIPP North Fence Salt Pile	SIR 517	1/10/17 13:33	4/5/17 14:15	48	23.2	**24.6**
	SIR659	1/10/17 13:33	4/5/17 14:15	48	25.6	
	SIR 535	1/10/17 13:33	4/5/17 14:15	52	25.1	

Location	Electret ID	Start Date and Time	Stop Date and Time	Voltage Drop	Quarterly Dose Normalized (mrad)	Avg Quarterly Dose (mrad)
DPR11 WIPP NW Fence Corner	SIR 499	1/10/17 13:36	4/5/17 14:21	41	21.7	**20.6**
	SIR 613	1/10/17 13:36	4/5/17 14:21	35	18.7	
	SIR 542	1/10/17 13:36	4/5/17 14:21	40	21.4	
DPR12 WIPP West Loading Dock	SHC 769	1/10/17 13:38	4/5/17 14:30	54	26.9	**25.7**
	SHC 722	1/10/17 13:38	4/5/17 14:30	44	22.2	
	SHC 705	1/10/17 13:38	4/5/17 14:30	55	28.0	
DPR13 WIPP Center Loading Dock	SHC 653	1/10/17 13:41	4/5/17 14:35	46	23.6	**25.6**
	SIR 647	1/10/17 13:41	4/5/17 14:35	53	28.3	
	SIR 478	1/10/17 13:41	4/5/17 14:35	51	24.8	
DPR14 WIPP East Loading Dock	SHC 842	1/10/17 13:45	4/5/17 14:40	44	22.7	**23.5**
	SHC 716	1/10/17 13:45	4/5/17 14:40	49	24.7	
	SHC 708	1/10/17 13:45	4/5/17 14:40	46	23.3	
DPR16 Loving Weigh Station	SHC 675	1/10/17 13:48	4/5/17 14:46	59	29.6	**29.5**
	SHC 696	1/10/17 13:48	4/5/17 14:46	55	27.4	
	SIR 489	1/10/17 13:48	4/5/17 14:46	66	31.6	
DPR17 Malaga VFD	Canister Lost					**DQ**
DPR18 North Access Road	SHC 839	1/10/17 13:55	4/5/17 14:50	48	24.3	**25.2**
	SHC 687	1/10/17 13:55	4/5/17 14:50	48	23.8	
	SHC 745	1/10/17 13:55	4/5/17 14:50	55	27.6	
DPR19 Southeast Control	SHD 971	1/10/17 13:58	4/5/17 14:52	58	29.4	**29.7**
	SHV 195	1/10/17 13:58	4/5/17 14:52	59	29.7	
	SIR 650	1/10/17 13:58	4/5/17 14:52	61	29.9	
DPR20 NMED Office Interior	SHC 751	1/10/17 14:01	4/5/17 14:55	106	53.9*	**50.5**
	SHD 902	1/10/17 14:01	4/5/17 14:55	84	43.2	
	SIR 549	1/10/17 14:01	4/5/17 14:55	104	54.2*	
DPR21 NMED Office Exterior	SIR 543	1/10/17 0:00	4/5/17 14:59	49	23.6	**24.2**
	SHC 692	1/10/17 0:00	4/5/17 14:59	47	23.3	
	SHD 979	1/10/17 0:00	4/5/17 14:59	51	25.6	
DPR22 Artesia (INACTIVE)	Canister not deployed					**DQ**
DPR23 Carlsbad Bypass	SIR 466	1/10/17 14:01	4/5/17 15:02	49	23.7	**24.6**
	SIR 501	1/10/17 14:01	4/5/17 15:02	55	26.5	
	SIR 656	1/10/17 14:01	4/5/17 15:02	49	23.6	
DPR24 South Access Rd	SIR 557	1/10/17 14:03	4/5/17 15:04	48	23.2	**26.1**
	SIR 454	1/10/17 14:03	4/5/17 15:04	53	26.0	
	SIR 752	1/10/17 14:03	4/5/17 15:04	60	29.2	

Location	Electret ID	Start Date and Time	Stop Date and Time	Voltage Drop	Quarterly Dose Normalized (mrad)	Avg Quarterly Dose (mrad)
DPR25 Jal Hwy	SIR 568	1/10/17 14:06	4/5/17 15:06	54	26.0	**24.7**
	SIR 738	1/10/17 14:06	4/5/17 15:06	49	23.7	
	SIR 525	1/10/17 14:06	4/5/17 15:06	51	24.5	