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Carlsbad Field Office
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March 18, 2025

Mr. Bill McInroy
Deputy Division Leader
Los Alamos National Laboratories-Carlsbad Office
115 North Main Street
Carlsbad, NM 88220

Subject: Performance Assessment Inventory for Analysis of a 12-Panel Repository Configuration

References: 1) U.S. EPA letter dated January 16, 2025, from Ms. Lee Ann B. Veal to Mr. Mark Bollinger, Subject: Performance Assessment Calculations Needed for 2026 Waste Isolation Pilot Plant Compliance Recertification Application

2) Sandia National Laboratories letter dated September 23, 2024, from Steve Wagner to Anderson Ward, Subject: Sandia's WIPP Inventory Needs for Compliance Recertification Application 2026 Performance Assessment

Dear Mr. McInroy:

This letter provides guidance for determining the Land Withdrawal Act (LWA) volume of mixed transuranic (TRU) waste that can be emplaced in the approved number of panels at the Waste Isolation Pilot Plant (WIPP).

In the above reference one (1) letter, the U.S. Environmental Protection (EPA) clarified expectations specific to performance assessment (PA) calculations for the 2026 Compliance Recertification Application (CRA-2026). Briefly, the primary basis for the EPA's evaluation of CRA-2026 will be a PA that reflects the approved number of panels with a commensurate emplaced waste volume. In addition, a supplemental calculation that considers the LWA volume limit is needed to meet the requirements of 40 Code of Federal Regulations (CFR) 194.24(c)(1). Although it is recognized that LWA volume cannot be placed in the physical space provided by the approved panels, determining the final projected waste volume that would be emplaced in these panels is not straightforward.

The U.S. Department of Energy (DOE), Carlsbad Field Office (CBFO), recommends an LWA total inventory of 157,330 m^3, which comprises 156,247.12 m^3 of Contact-Handled (CH) waste and 1,584.80 m^3 of Remote-Handled (RH) waste. This recommendation honors the LWA TRU waste emplaced volumes reported for Panels 1 through 7, with 16,909.71 m^3 of CH waste and 244.61 m^3 of RH waste in each of Panels 8 through 12.

These volumes were derived from a statistical analysis of the Waste Data System (WDS) emplacement data for Panels 1 through 7. The CH LWA and RH LWA volumes were summed to generate a total LWA volume for each panel. These data were subjected to statistical analyses to determine the mean ($\bar{x}$), standard deviation (s_x), standard error ($s_{\bar{x}}$), the upper 95 percent confidence interval (CI), and the upper control limit (UCL). The recommended LWA volumes are based on the UCL, which is the maximum acceptable variation from $\bar{x}$ in a statistical process and is defined as $\bar{x} + 3s_x$. The complete analysis is presented in the enclosure.

Aside from the volume limits described above, all other guidelines provided in the above reference two (2) letter, describing Sandia's WIPP Inventory Data Needs for Compliance Recertification Application 2026 Performance Assessment should be honored. The data should be analyzed in accordance with a Quality Assurance program approved by CBFO.

If you have any questions, I can be reached at (575) 988-5414.

Sincerely,

ANDERSON WARD

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Dr. Anderson Ward
Compliance Certification Manager
Carlsbad Field Office

Enclosure

cc: w/enclosure

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ENCLOSURE

Estimating Inventory for CRA-2026

Background

The proposed repository configuration at closure comprises two replacement panels, Panels 11 and 12, and seven additional panels, Panels 13 through 19 (Figure 1). The DOE is seeking the EPA's approval for using two replacement panels in a Planned Change Request (PCR) submitted in 2024 (Bollinger, 2024). For the RPPCR, the repository was initially modeled with 19 panels (Brunell et al., 2024). During the review of the RPPCR, the Environmental Protection Agency (EPA) requested a supplemental analysis of repository performance with the existing panels and two replacement panels, i.e., only 12 panels (Ward, 2024). This analysis was subsequently performed and documented (Zeitler et al., 2025).

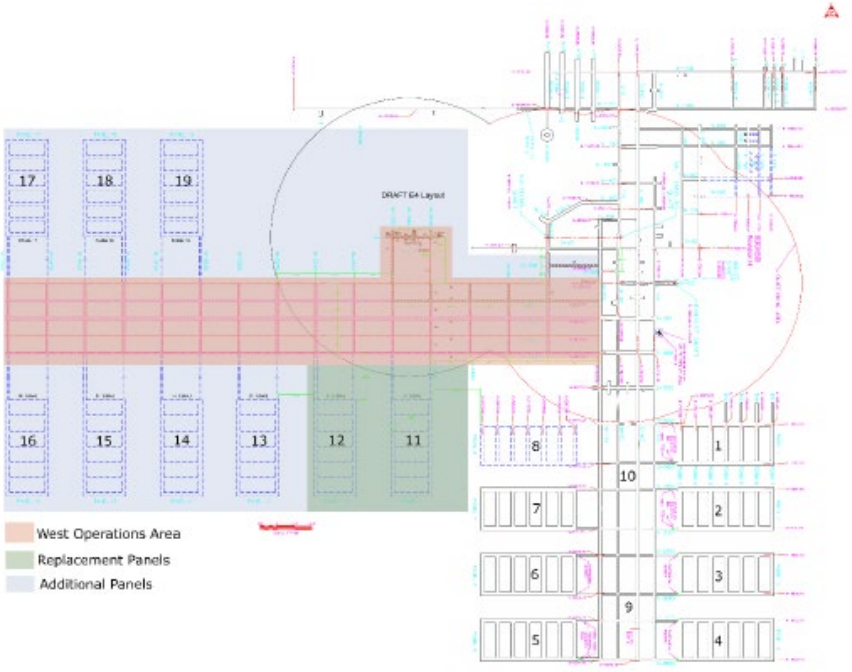


Figure 1. Conceptual Repository Configuration at Closure showing existing panels, two Replacement panels (Panels 11 and 12), and seven additional panels (Panels 13-19).

In a letter dated January 16, 2025, the EPA outlined its crucial expectations for CRA-2026 (Veal, 2025). The primary basis for the EPA's recertification decision will be a PA that reflects the number of panels that have been approved. To meet the requirements of 40 CFR 194.24(c)(1), the DOE must also provide a supplementary calculation that considers the total inventory authorized by the Land Withdrawal Act (LWA). These expectations are interpreted as a 12-panel configuration as the primary basis for the recertification decision and a 19-panel configuration for the supplemental analysis.

While the LWA defines the inventory to be disposed of in a full repository, the inventory that can fit 12 panels is not straightforward. Furthermore, the entire LWA inventory cannot be physically accommodated in 12 panels. This analysis aims to derive a defensible volume of waste that could be disposed of in 12 panels to inform the PA inventory report (PAIR) needed for the primary analysis in CRA-2026.

Materials and Methods

The approach is based on a statistical analysis of the Waste Data System (WDS) emplacement data, which are crucial for understanding the waste inventory. A query was run to generate an Emplacement Statistics Report for Panels 1 through 7, and the report output as a Comma-Separated Values (CSV) text file. This file comprised all the emplacement data by room for each panel. The contact-handled (CH) LWA volume and the remote-handled (RH) LWA volume were particularly significant to this analysis. These two columns were summed to generate a third variable, the total LWA volume for each panel.

The three waste volumes, CH, RH, and Total LWA, were then subjected to a basic statistical analysis to calculate the mean, median, mode, and standard deviation of the CH, RH, and total LWA volumes. The arithmetic mean $\bar{x}$, was calculated as:

$$\bar{x} = \frac{\sum_{i=1}^{i=N} x_i}{N} \quad (1)$$

where N is the sample size, and x_i is the i^{th} observation of the variable of interest, i.e., CH, RH, and total LWA volumes in this analysis.

To calculate the standard deviation, σ_x, one must consider that the seven panels represent a sample of the total population (19). Therefore, to calculate σ_x, N − 1 is used as the denominator to account for the population standard deviation being estimated from a sample. This is known as Bessel's correction and is used to correct the bias in estimating the population (N = 19) variance from a sample (N = 7), making the sample variance a more accurate estimator. Therefore, the standard deviation, σ_x, was calculated as:

$$\sigma_x = \sqrt{\frac{1}{N-1}\sum_{i=1}^{i=N}(x_i - \bar{x})^2} \quad (2)$$

The standard error, $\sigma_{\bar{x}}$, was then calculated as:

$$\sigma_{\bar{x}} = \frac{\sigma_x}{\sqrt{N}} \quad (3)$$

The confidence interval (CI) for the CH, RH, and total LWA volumes were calculated as follows:

$$CI = \bar{x} \pm t_\alpha \frac{\sigma_x}{\sqrt{N}} \quad (4)$$

In Eq. 4, t_α is the critical value for a two-tailed test in the Student's t-distribution at a significance level, α = 0.05 (95 percent) and *N-1* degrees of freedom. As evident from Eq. 4, an increase in *N* decreases $\sigma_{\bar{x}}$ and the error multiplier term ($t_\alpha \frac{\sigma_x}{\sqrt{N}}$), resulting in a tighter *CI*. For N = 7, N-1 = 6 and t_α = 2.447.

The control limit (CL) defines the acceptable variation from the process mean ($\bar{x}$) in statistical process control and is calculated as follows (Montgomery, 2020) :

$$UCL = \bar{x} \pm 3\sigma_x \quad (5)$$

The upper control limit (UCL) is the point beyond which the process may become out of control. It is calculated from Eq. (5) as $\bar{x} + 3\sigma_{\bar{x}}$.

The 95 percent confidence interval (Eq. 4) and the upper control limit (Eq. 5) are compared to estimate the inventory for the 12-panel configuration. This analysis assumes that waste is in all panels, including Panels 9 and 10. This approach maintains consistency with the replacement panel planned change request (RPPCR) performance assessment (Brunell et al., 2024) and the 12-panel supplemental analysis (Zeitler et al., 2024).

Results and Discussion

Appendix A presents the data obtained from the WDS Emplacement Statistics query and used in this analysis. Appendix B shows the summary statistics resulting from the analysis. Table 1 summarizes the calculated mean, the upper 95 percent confidence Interval, and the upper control limits for a 12-panel configuration.

Table 1 shows the Contact Handled (CH), Remote Handled (RH), and Total LWA Waste emplaced in Panels 1 Through 7. Panels 1 and 7 show the two lowest volumes attributed to underutilization of disposal capacity. The underutilized capacity in these panels is the primary driver for replacement panels 11 and 12. The largest emplaced volume occurred in Panel 2.

Table 1. Contact Handled (CH), Remote Handled (RH), and Total Waste Emplaced in Panels 1 Through 7.

Panel	LWA Volume (m^3)		
	CH	RH	‡Total
1	7,563.33	0	7,563.33
2	13,102.55	0	13,102.55
3	9,862.75	0	9,862.75
4	10,419.86	84.24	10,504.10
5	12,112.52	153.37	12,265.89
6	11,427.82	112.99	11,540.81
7	7,209.74	11.13	7,220.87
‡Total emplaced 72,060.30 m^3. The LWA limit is 175,564 m^3.			

Table 2 shows the descriptive statistics for CH, RH, and total LWA waste emplaced in Panels 1 Through 7. The volume of CH waste ranged from 7,209.74 to 13,102.55 $m^{3,}$ whereas RH waste ranged from 0 to 153.37 m^3. The total LWA volume emplaced ranged from 7,220.87 to 13,102.55 m^3. The descriptive statistics were used to calculate the upper 95 percent confidence interval and upper control limit according to Eq. (4) and Eq. (5).

Table 3 summarizes the CH, RH, and total LWA waste volumes emplaced in Panels 1 through 7. The estimated volumes that would be disposed of in Panels 8 through 12 are based on the upper 95 percent confidence interval (Eq. 4). A total of 12,378.20 m^3 would be placed in each of Panels 8 through 12. The total LWA volume of 133,951.29 m^3 comprises 133,188.50 m^3 CH waste and 917.50 m^3 RH waste.

Table 2. Summary Statistics for Contact Handled (CH), Remote Handled (RH), and Total Waste Emplaced in Panels 1 Through 7.

Statistic	LWA Volume (m^3)		
	CH	**RH**	**Total**
Mean	10,242.65	51.68	10,294.33
Standard Error	839.97	24.31	851.63
Median	10,419.86	11.13	10,504.10
Standard Deviation	2,222.35	64.31	2,253.21
Sample Variance	4,938,849.31	4,136.12	5,076,940.49
Kurtosis	-1.24	-1.41	-1.33
Skewness	-0.33	0.73	-0.36
Range	5,892.81	153.37	5,881.68
Minimum	7,209.74	0.00	7,220.87
Maximum	13,102.55	153.37	13,102.55
Sum	71,698.57	361.73	72,060.30
Count	7	7	7
Confidence Level (95.0%)	2,055.33	59.48	2,083.87
Upper Control Limit	6,667.06	192.94	6,759.62

Table 3. Contact Handled (CH), Remote Handled (RH), and Total Waste Volumes in Panels 1 through 7, including the Hypothetical Upper 95 Percent Confidence Limit to be Emplaced in Panels 8 Through 12.

Panel	LWA Volume (m^3)		
	CH	**RH**	**Total**
1	7,563.33	0	7,563.33
2	13,102.55	0	13,102.55
3	9,862.75	0	9,862.75
4	10,419.86	84.24	10,504.10
5	12,112.52	153.37	12,265.89
6	11,427.82	112.99	11,540.81
7	7,209.74	11.13	7,220.87
8	12,297.99	111.15	12,378.20
9	12,297.99	111.15	12,378.20
10	12,297.99	111.15	12,378.20
11	12,297.99	111.15	12,378.20
12	12,297.99	111.15	12,378.20
Total	**133,188.50**	**917.50**	**133,951.29**

There is only a 3 percent difference between this value and the initial estimate of 130,260 m^3, derived from the final LWA TRU mixed waste volume in Table 4.1.1 of the Hazardous Waste Facility Permit (NMED, 2024). This difference is not statistically significant (p = 0.05). However, the current approach is based on a rigorous statistical analysis of emplacement data and is consistent with PA calculations in which TRU mixed waste is emplaced in Panels 9 and 10. This approach also avoids any perceived linkage between operations and post-closure performance assessments.

Table 4 summarizes the CH, RH, and total LWA waste volumes emplaced in Panels 1 through 7. The estimated volumes that would be disposed of in Panels 8 through 12 are based on the upper control limit (Eq. 5). These estimated volumes for Panels 8 through 12 also assume waste is placed in Panels 9 and 10. The total LWA volume of 157,330.04 m^3 comprises 156,247.12 m^3 CH waste and 1,584.80 m^3 RH waste. A total of 17,053.95 m^3 would be emplaced in Panels 8 through 12. The total volume is 21 percent higher than the initial estimate derived from the final LWA TRU mixed waste volume in Hazardous Waste Facility Permit (NMED, 2024) and 17 percent higher than the upper 95 percent confidence interval.

Table 4. Contact Handled (CH), Remote Handled (RH), and Total Waste Volumes in Panels 1 through 7, including the Hypothetical Upper Control Limit to be Emplaced in Panels 8 Through 12.

Panel	LWA Volume (m^3)		
	CH	RH	Total
1	7,563.33	0	7,563.33
2	13,102.55	0	13,102.55
3	9,862.75	0	9,862.75
4	10,419.86	84.24	10,504.10
5	12,112.52	153.37	12,265.89
6	11,427.82	112.99	11,540.81
7	7,209.74	11.13	7,220.87
8	16,909.71	244.61	17,053.95
9	16,909.71	244.61	17,053.95
10	16,909.71	244.61	17,053.95
11	16,909.71	244.61	17,053.95
12	16,909.71	244.61	17,053.95
Total	**156,247.12**	**1,584.80**	**157,330.04**

Based on this analysis, the recommended values for the CH, RH, and total LWA waste volumes to be used in the PAIR for the 12-panel analysis uses the upper control limit (Table 4).

The UCL is a defensible choice for several reasons, including (Montgomery, 2020):

1. The ability to detect special cause variation- The UCL helps distinguish between common cause variation (random, inherent to the process) and special cause variation (unusual, due to external factors). Therefore, a data point exceeding the UCL is indicative that a process may be out of control, warranting investigation.

2. Indicator of process stability - The CL defines the boundaries of expected performance when the process is operating normally. Points within the CL suggest that the process is stable.
3. Its utility as a decision-making tool- Exceeding the UCL is a practical trigger for quality control and prompts action.
4. Its measure of statistical confidence- With $\pm 3\sigma_x$ limits, about 99.73% of observations in a normally distributed process should fall between the UCL and LCL when common cause variation is present. Therefore, crossing the UCL would be a rare event under normal conditions.

Conclusion

To support the EPA's CRA-2026 expectation of a PA that reflects the number of approved panels, the CBFO recommends that a PA be performed for a 12-panel configuration. The total LWA waste volume used to calculate the PA Inventory Report (PAIR) is based on the upper control limit derived from the WDS emplacement data.

The recommended LWA volume of 157,330.04 m^3 comprises 156,247.12 m^3 CH waste and 1,584.80 m^3 RH waste. The waste to be emplaced in Panels 8 through 12 includes 16,909.71 m^3 of CH waste and 244.61 m^3 of RH waste, for a total of 17,053.95 m^3.

References

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Appendix A. Waste Emplacement Statistics for Panels 1 Through 7.

Panel	Room	Waste Volume (m^3)		
		CH	RH	Total
1	7	1,811.19	0.00	1,811.19
1	6	269.94	0.00	269.94
1	5	283.67	0.00	283.67
1	4	237.28	0.00	237.28
1	3	1,292.87	0.00	1,292.87
1	2	2,318.42	0.00	2,318.42
1	1	1,349.95	0.00	1,349.95
2	7	2,212.84	0.00	2,212.84
2	6	2,041.50	0.00	2,041.50
2	5	2,063.58	0.00	2,063.58
2	4	1,869.45	0.00	1,869.45
2	3	2,272.29	0.00	2,272.29
2	2	1,962.25	0.00	1,962.25
2	1	680.63	0.00	680.63
3	7	1,260.11	0.00	1,260.11
3	6	1,512.26	0.00	1,512.26
3	5	1,355.97	0.00	1,355.97
3	4	1,550.87	0.00	1,550.87
3	3	1,505.69	0.00	1,505.69
3	2	1,555.00	0.00	1,555.00
3	1	1,122.86	0.00	1,122.86
4	7	1,671.63	0.00	1,671.63
4	6	1,601.74	3.30	1,605.04
4	5	1,700.03	11.14	1,711.17
4	4	1,493.14	20.33	1,513.47
4	3	1,416.54	18.57	1,435.11
4	2	1,578.21	19.22	1,597.43
4	1	958.56	11.68	970.24

Panel	Room	Waste Volume (m^3)		
		CH	RH	Total
5	7	1,742.70	11.10	1,753.80
5	6	1,876.37	22.32	1,898.69
5	5	1,885.46	22.29	1,907.75
5	4	1,617.58	21.66	1,639.24
5	3	1,747.11	25.53	1,772.64
5	2	1,952.79	28.45	1,981.24
5	1	1,290.50	22.02	1,312.52
6	7	2,012.27	14.07	2,026.34
6	6	1,844.42	7.42	1,851.84
6	5	1,706.61	10.72	1,717.33
6	4	1,610.97	12.70	1,623.67
6	3	1,750.04	14.25	1,764.29
6	2	1,442.96	25.42	1,468.38
6	1	1,060.56	28.41	1,088.97
7	7	257.15	5.33	262.48
7	6	263.27	0.63	263.90
7	5	1,532.20	0.00	1,532.20
7	4	718.1	1.98	720.08
7	3	1,743.39	1.98	1,745.37
7	2	1,659.70	1.21	1,660.91
7	1	1,035.95	0.00	1,035.95

Appendix B. Summary Statistics for Panels 1 through 7 Emplaced LWA Waste Volumes.

Statistic	LWA Volume (m^3)		
	CH	**RH**	**Total**
Max	2,272.29	28.45	2,272.29
Mean	1,626.44	10.02	1,636.46
Std. dev	344.66	10.15	344.11
N	35	35	35
N-1	34	34	34
Std. Err	58.26	1.72	58.17
CI (-)	1,508.06	6.53	1,518.27
CI (+)	1,744.83	13.50	1,754.66