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Pilot Test Report Evaluating Type 4 Vapor-Sampling Systems at Material Disposal Area G

Prepared by the Environmental Programs Directorate

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1.0 INTRODUCTION

This report summarizes the results of implementing the approved pilot test work plan for evaluating Type 4 vapor monitoring systems at Technical Area 54 (TA-54) (LANL 2008, 101375). The New Mexico Environment Department (NMED) requested the evaluation in its March 14, 2008, letter providing comments on the 2007 "Review of Periodic Monitoring Report for Vapor-Sampling Activities at Material Disposal Area G, Technical Area 54, for Fiscal Year 2007" (NMED 2008, 100606) to determine the potential for short-circuiting between sampling port depths. The test was performed in accordance with the scope defined in the approved work plan for evaluating potential for short-circuiting between ports in Type 4 boreholes at TA-54.

2.0 BACKGROUND

Type 4 vapor-monitoring systems were constructed for Material Disposal Area (MDA) G to monitor soil vapor during the 1980s. Eight Type 4 monitoring systems were constructed between 1986 and 1989, six Type 4 systems (locations 54-02025, 54-02026, 54-02027, 54-02028, 54-02029, and 54-02030) are located in the Zone 4 area east of MDA L, and two Type 4 systems are located east and west of the active disposal region of Area G (locations 54-02032 and 54-02033, respectively). Two of the Type 4 systems, locations 54-02032 and 54-02033, are currently included in the approved "Interim Subsurface Vapor-Monitoring Plan for Material Disposal Area G at Technical Area 54" (LANL 2007, 098608, Appendix D) and were proposed to be evaluated in the approved Type 4 work plan (Figure 2.0-1). Five of the Zone 4 Type 4 monitoring systems are included in the MDA L periodic monitoring program (54-02025, 54-02026, 54-02027, 54-02028, and 54-02029) and were recommended for abandonment in fiscal year 2008. In 2007, 54-02030 was abandoned.

Type 4 monitoring systems consist of sampling ports connected to the surface by rigid stainless-steel tubing with the borehole backfilled with sand. Because there is no bentonite layer above and below the sampling ports (Figure 2.0-2), the vertical extent of influence of purging above and below each port depth is uncertain. As a result, the true depth interval of a subsurface vapor sample is unknown.

3.0 SCOPE OF ACTIVITIES

The two Type 4 monitoring systems currently included in the annual monitoring network (locations 54-02032 and 54-02033) were evaluated during the annual vapor monitoring at MDA G in July 2008. The pilot test was conducted to evaluate the potential for short-circuiting between sampling port depths in these monitoring systems.

A Gast Manufacturing, oil-free model DOA-P104-AA pump with a typical purge rate of approximately 14 L/min was used to purge the sampling ports. Two handheld Dwyer Series 475 Mark III (Range 0–40 in. W.C., 0–9.96 kPa) manometers were used to read the differential pressure before, during, and after purging. Background manometer readings were collected before purging by connecting the positive side of the digital manometer to each sample port and recording differential pressure readings each minute for 10 min to develop a background data set for each port in the borehole. After the background readings were collected, purging of the annular space and sample tubing was initiated on the sample port with the positive sides of the digital manometers connected to sample tubing of the adjacent sample port(s). By placing the positive side of the manometer on the adjacent sampling port(s), impacts of purging on differential pressure are indicated by a negative change in differential pressure at that port. Purging

proceeded for 10 min with manometer readings recorded at 1-min intervals. The purging time interval is the approximate time required to purge annular space and sample tubing before collection of a soil vapor sample. After 10 min of purging, the pump was shut off for a 5-min recovery period with manometer readings recorded every minute. Upon completion of each port, purging proceeded to the next sampling port and was repeated until each port in a borehole was tested. Results of the test were recorded along with purge times, borehole location IDs, and sample port depths.

4.0 RESULTS

Differential pressure data are presented in Table 4.0-1 (location 54-02032) and Table 4.0-2 (location 54-02033) and are shown graphically in Figure 4.0-1 and Figure 4.0-2, respectively. The tables provide the minimum, maximum, range, and mean of the background differential pressure readings as a reference for evaluating potential changes due to purging. A mean value for the purge period and the difference between the background and purge period means are also provided.

The differences in the means of background and purge measurements were compared to determine if a significant change in differential pressure readings in adjacent ports occurred as a result of purging. If the purge measurement mean was less than the background mean for a particular port, an independent t-test was performed to assess the statistical significance between the two means at the 95% confidence level. In an independent t-test, a difference in means is significant at the 95% confidence level if the p-value is below 0.05 (less than a 5% probability that the means are equivalent). Short-circuiting between ports was determined to be definitive if purging each port resulted in more negative manometer readings on the other port (i.e., negative differential pressure change from both upper-port purge to lower-port readings and lower-port purge to upper-port readings) and if the t-test confirmed that the background and purge measurements were different.

The differential pressure data from location 54-02032 indicated no change in differential pressures between ports as a result of purging. All differential pressure readings remained constant or trended in the positive direction.

The differential pressure data from location 54-02033 indicated definitive short-circuiting between the ports at 200 ft and 220 ft, definitive short-circuiting between 260 ft and 277 ft, and potential short-circuiting between ports at 60 ft and 100 ft, 100 ft and 160 ft, and 160 ft and 200 ft. Results of t-tests performed are presented in Table 4.0-3.

For the 200-ft port purge event, the 220-ft port background differential pressure values ranged from –0.23 to –0.24 kPa (a range of 0.01 kPa), with a mean background value of –0.232 kPa. While purging from the 200-ft port, differential pressure readings at 220 ft ranged from –0.24 to –0.26 kPa, with a mean value of –0.255 kPa. The difference between the background mean and the purge mean was –0.023 kPa. The independent t-test indicated a significant difference between the background and purge measurements at the 95% confidence level. During the recovery period, differential pressure readings returned to background at the end of the 5-min period. A potential short-circuiting trend was confirmed during the 220-ft purge event by a greater response difference between background and purge period means of –0.047 kPa; this difference in means was statistically significant at the 95% confidence level. In addition, during the recovery period, differential pressure readings trended toward background values but were slightly higher than background at the end of the recovery period.

For the 260–ft port purge event, the 277-ft port background differential pressure values ranged from –0.09 to -0.12 kPa, with a mean background value of –0.103 kPa. While purging from the 260 ft port, the 277-ft port differential pressure readings ranged from –0.36 to –0.44 kPa, with a mean value of –0.407 kPa; a difference between the background mean and the purge mean of –0.305 kPa. The independent t-test indicated a significant difference between the background and purge measurements at the 95% confidence level. During the recovery period, differential pressure readings returned to background. The potential short-circuiting trend was confirmed during the 277-ft purge event, which showed a greater response difference between background and purge period means of –0.365 kPa. The independent t-test indicated a significant difference between the background and purge measurements at the 95% confidence level. During the recovery period, differential pressure readings returned to background.

Three other purge events resulted in weak negative trends at one of the neighboring ports: (1) the 60-ft port purge and 100-ft port response, (2) the 100-ft purge and 160-ft port response, and (3) the 200-ft purge and 160-ft port response. Two of the responses were approximately 0.005 kPa greater than background and one response was 0.002 kPa less than background. However, while the independent t-tests indicated a significant difference in background and purge measurement means for these tests, none of these trends were confirmed in the opposite direction (i.e., negative differential pressure change from both upper-port purge to lower-port readings and lower-port purge to upper-port readings); therefore, no conclusion can be made regarding the potential for short-circuiting at these ports.

5.0 CONCLUSIONS

The pilot test indicated a potential for short-circuiting between ports that are 17 ft and 20 ft apart during sampling at location 54-02033. No discernible short-circuiting was found between ports greater than 20 ft apart. However, because the next closest sampling port distance was 40 ft in this borehole, it is difficult to determine the maximum distance between ports where the effects of purging occur. No changes were observed in differential pressures between ports during the test as a result of purging at location 54-02032 where the sampling port distances ranged from 26 to 60 ft. However, while no response was documented for 54-02032, the data from 54-02033 indicate the potential for short-circuiting at distances up to 20 ft above and below each port and therefore create uncertainty as to the actual depth of collected samples.

6.0 RECOMMENDATIONS

Based on the results of the pilot test, it is recommended that boreholes 54-02032 and 54-02033 be removed from the MDA G annual monitoring network and abandoned because the data being collected from each port may not be representative of the depth of the port. The pilot test demonstrated that the sand-filled borehole at location 54-02033 is more permeable than the geological units and may result in subsurface vapor being collected from distances as far away 20 ft above and below a given sample port.

Los Alamos National Laboratory (the Laboratory) recommends that 54-02033 be replaced by a new monitoring borehole, constructed with stainless-steel tubing connecting the sampling ports to the surface, similar to the monitoring ports constructed recently in 54-24378. The Laboratory also recommends that the borehole at location 54-02032 be replaced with a new stainless-steel monitoring system at nearby location 54-24385. Location 54-24385 is an existing open borehole in the eastern portion of MDA G (Figure 6.0-1).

7.0 REFERENCES

The following list includes all documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ER ID number. This information is also included in text citations. ER ID numbers are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau; DOE–Los Alamos Site Office; EPA, Region 6; and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

LANL (Los Alamos National Laboratory), October 2007. "Corrective Measures Evaluation Plan for Material Disposal Area G at Technical Area 54, Revision 2," Los Alamos National Laboratory document LA-UR-07-6882, Los Alamos, New Mexico. (LANL 2007, 098608)

LANL (Los Alamos National Laboratory), April 18, 2008. "Response to the Review of Periodic Monitoring Report for Vapor Sampling Activities at Material Disposal Area G, Technical Area 54, for Fiscal Year 2007 and Submittal of Pilot Test Work Plan for Evaluating Type 4 Vapor-Sampling Systems at Material Disposal Area G," Los Alamos National Laboratory letter (EP2008-0194) to J.P. Bearzi (NMED-HWB) from S. Stiger (LANL) and D. Gregory (DOE-LASO), Los Alamos, New Mexico. (LANL 2008, 101375)

NMED (New Mexico Environment Department), March 14, 2008. "Review of Periodic Monitoring Report for Vapor-Sampling Activities at Material Disposal Area G, Technical Area 54, for Fiscal Year 2007," New Mexico Environment Department letter to D. Gregory (DOE-LASO) and D. McInroy (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2008, 100606)

Figure 2.0-1 Type 4 monitoring system boreholes evaluated at MDA G

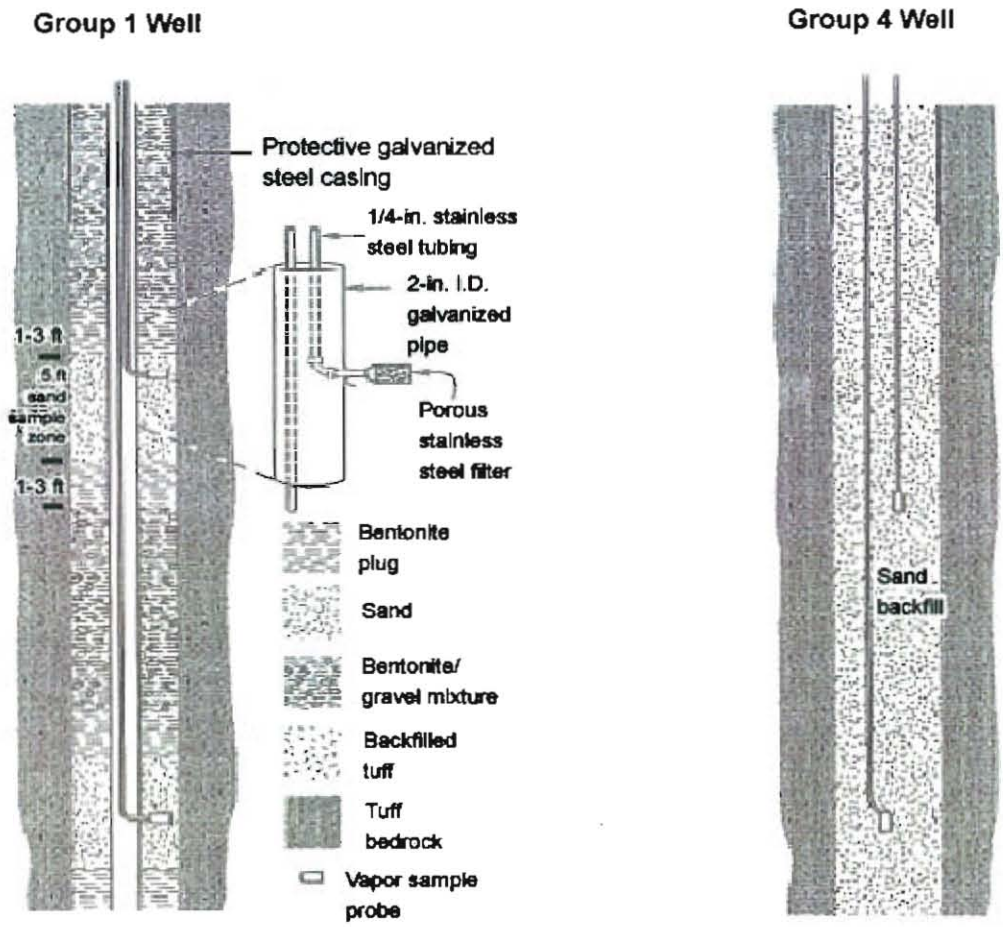

Figure 2.0-2 Construction details of instrumented boreholes for subsurface vapor sampling

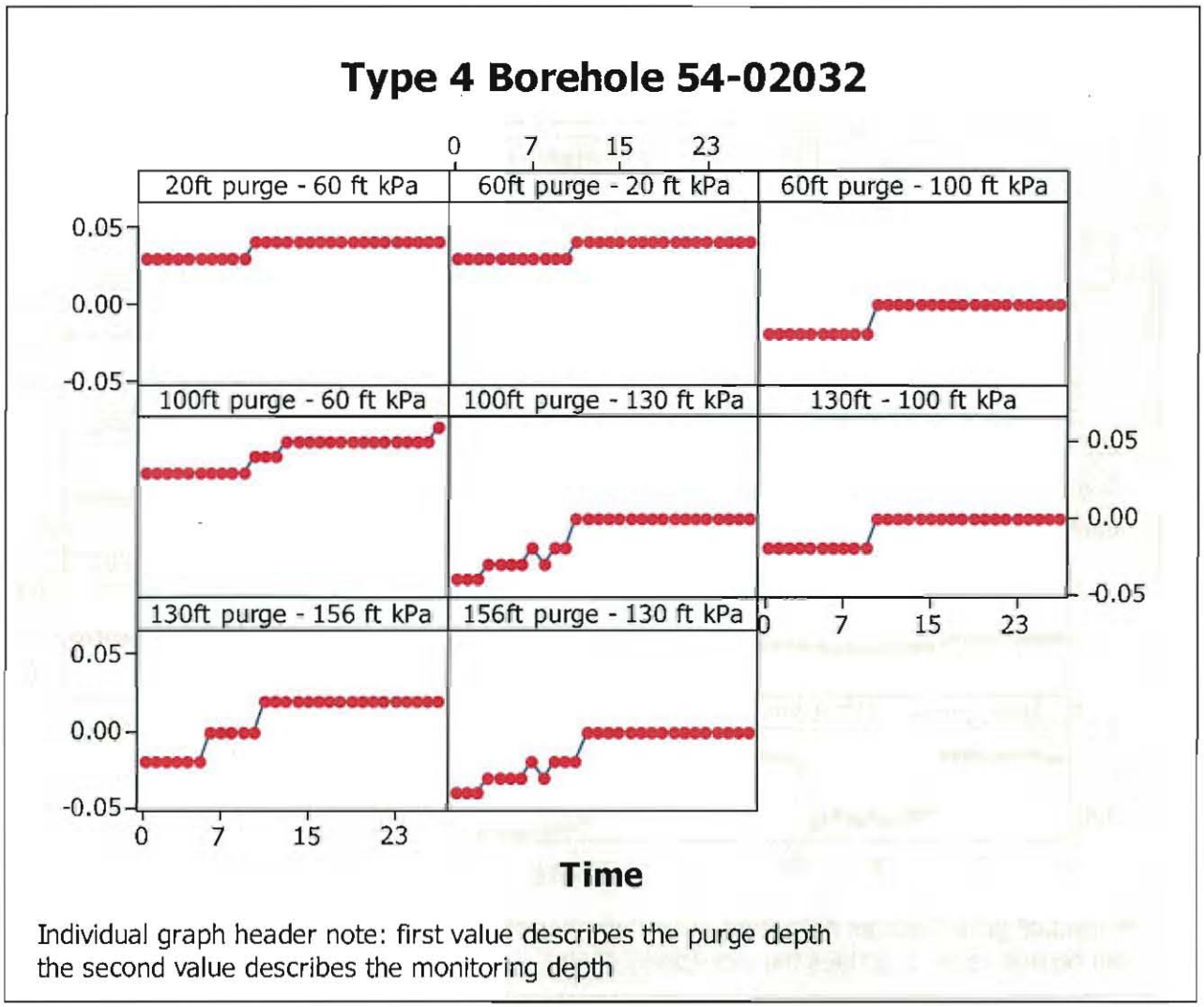

Figure 4.0-1 Differential pressure data from the borehole 54-02032 purge test

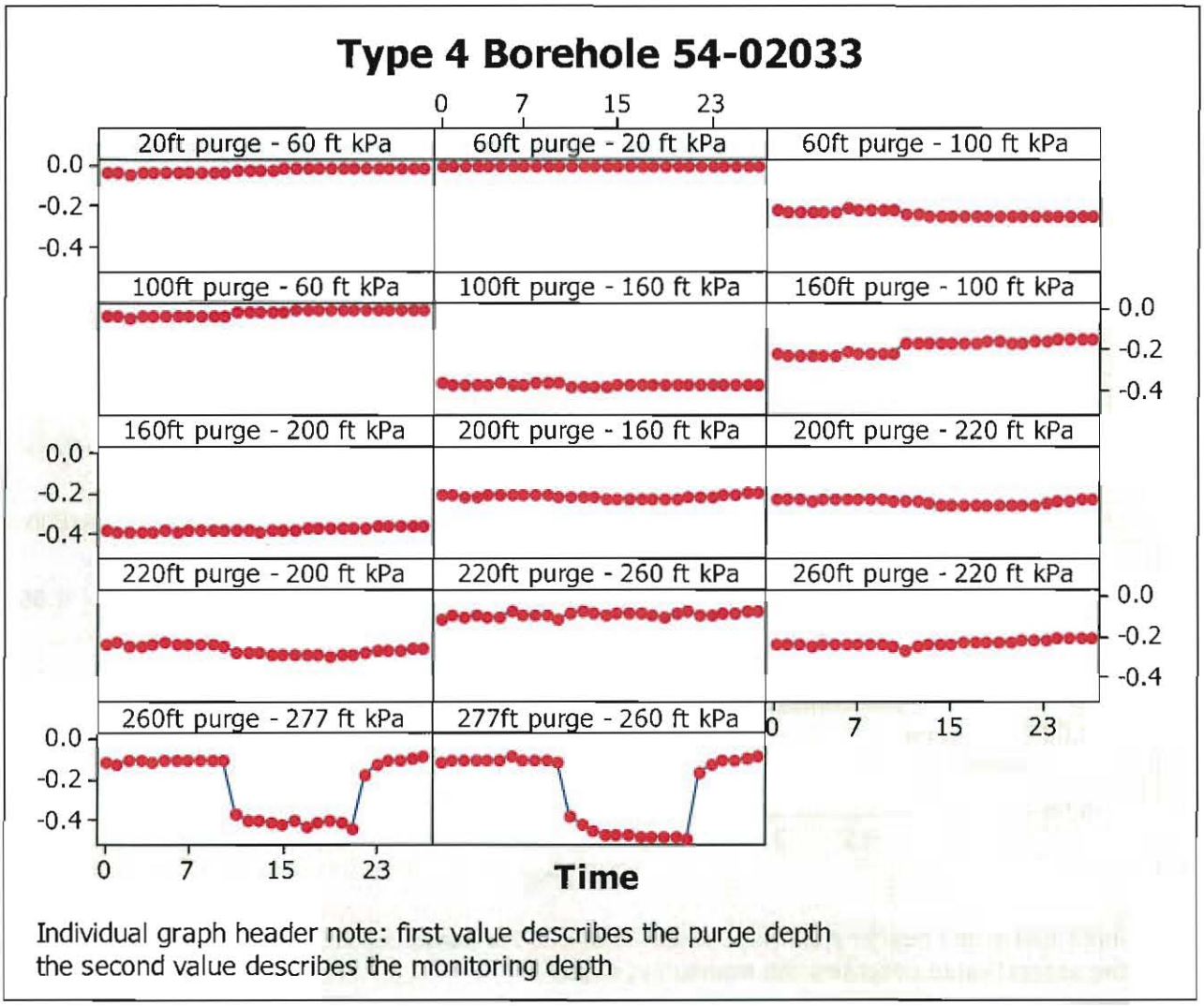

Figure 4.0-2 Differential pressure data from the borehole 54-02033 purge test

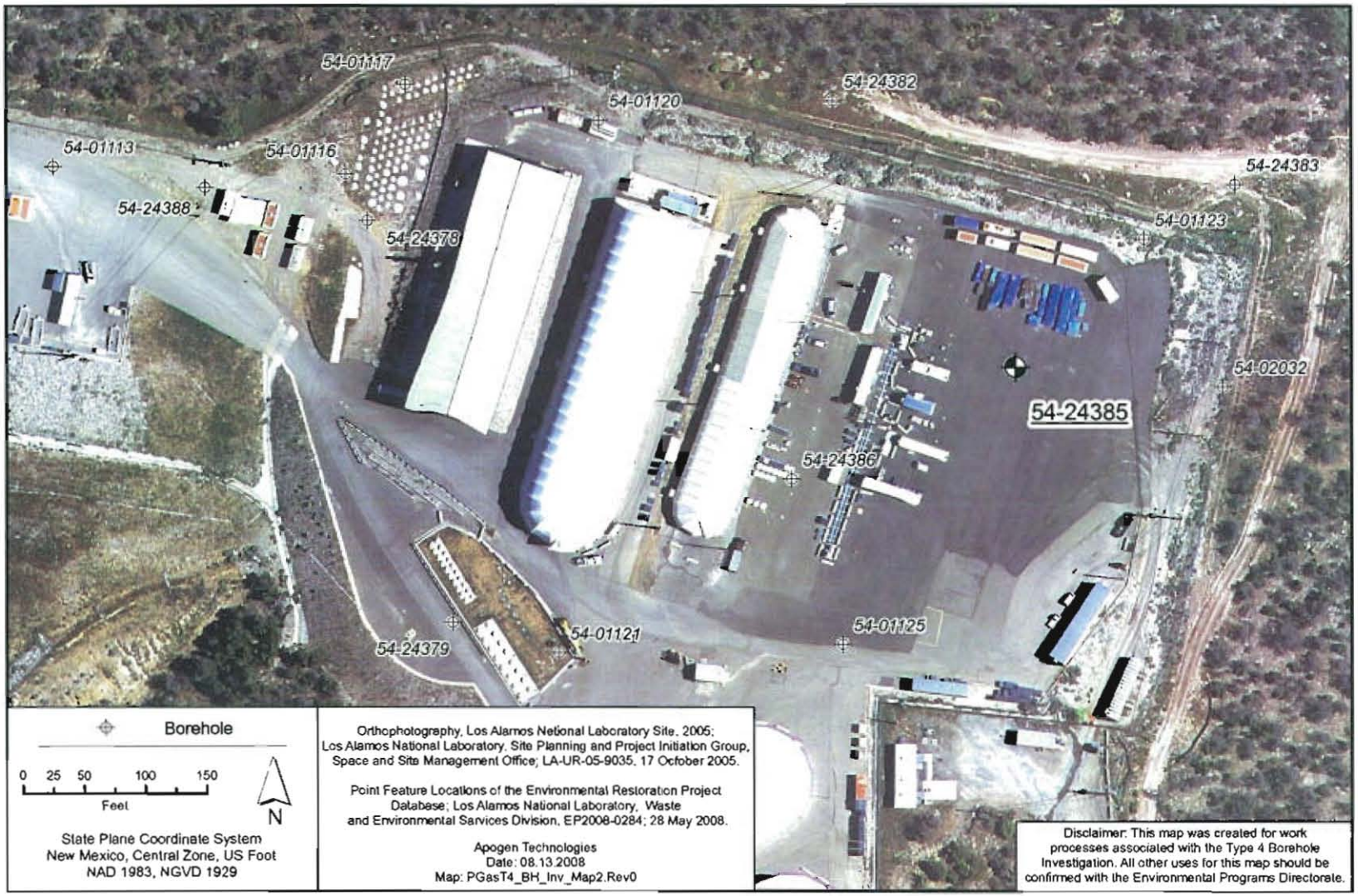

Figure 6.0-1 Eastern portion of MDA G showing borehole 54-24385

Table 4.0-1
54-02032 Type 4 Purge Short-Circuit Manometer Readings (kPa)

Purge Port Depth		20 ft	60 ft		100 ft		130 ft		156 ft	
	time	60 ft	20 ft	100 ft	60 ft	130 ft	100 ft	156 ft	130 ft	
Background	0	0.03	0.03	-0.02	0.03	-0.04	-0.02	-0.02	-0.04	
	1	0.03	0.03	-0.02	0.03	-0.04	-0.02	-0.02	-0.04	
	2	0.03	0.03	-0.02	0.03	-0.04	-0.02	-0.02	-0.04	
	3	0.03	0.03	-0.02	0.03	-0.03	-0.02	-0.02	-0.03	
	4	0.03	0.03	-0.02	0.03	-0.03	-0.02	-0.02	-0.03	
	5	0.03	0.03	-0.02	0.03	-0.03	-0.02	-0.02	-0.03	
	6	0.03	0.03	-0.02	0.03	-0.03	-0.02	0	-0.03	
	7	0.03	0.03	-0.02	0.03	-0.02	-0.02	0	-0.02	
	8	0.03	0.03	-0.02	0.03	-0.03	-0.02	0	-0.03	
	9	0.03	0.03	-0.02	0.03	-0.02	-0.02	0	-0.02	
	10	0.04	0.03	0	0.04	-0.02	0	0	-0.02	
Start purge	11	0.04	0.04	0	0.04	0	0	0.02	-0.02	
	12	0.04	0.04	0	0.04	0	0	0.02	0	
	13	0.04	0.04	0	0.05	0	0	0.02	0	
	14	0.04	0.04	0	0.05	0	0	0.02	0	
	15	0.04	0.04	0	0.05	0	0	0.02	0	
	16	0.04	0.04	0	0.05	0	0	0.02	0	
	17	0.04	0.04	0	0.05	0	0	0.02	0	
	18	0.04	0.04	0	0.05	0	0	0.02	0	
	19	0.04	0.04	0	0.05	0	0	0.02	0	
	20	0.04	0.04	0	0.05	0	0	0.02	0	
	21	0.04	0.04	0	0.05	0	0	0.02	0	
Recovery period	22	0.04	0.04	0	0.05	0	0	0.02	0	
	23	0.04	0.04	0	0.05	0	0	0.02	0	
	24	0.04	0.04	0	0.05	0	0	0.02	0	
	25	0.04	0.04	0	0.05	0	0	0.02	0	
	26	0.04	0.04	0	0.05	0	0	0.02	0	
	27	0.04	0.04	0	0.06	0	0	0.02	0	
Background Min		0.03	0.03	-0.02	0.03	-0.04	-0.02	-0.02	-0.04	
Background Max		0.04	0.03	0	0.04	-0.02	0	0	-0.02	
Background Range		0.010	0.000	0.020	0.010	0.020	0.020	0.020	0.020	
Background Mean		0.031	0.0	-0.018	0.031	-0.030	-0.018	-0.011	-0.030	
Purge Mean		0.040	0.0	0.000	0.048	0.000	0.000	0.020	-0.002	
Difference		0.009	0.010	0.018	0.017	0.030	0.018	0.031	0.028	

Table 4.0-2
54-02033 Type 4 Purge Short-Circuit Manometer Readings (kPa)

Purge Port Depth		20 ft	60 ft		100 ft		160 ft		200 ft		220 ft		260 ft		277 ft
	min	60 ft	20 ft	100 ft	60 ft	160 ft	100 ft	200 ft	160 ft	220 ft	200 ft	260 ft	220 ft	277 ft	260 ft
Background	0	-0.03	0	-0.22	-0.03	-0.36	-0.22	-0.38	-0.21	-0.23	-0.23	-0.11	-0.23	-0.11	-0.11
	1	-0.03	0	-0.23	-0.03	-0.37	-0.23	-0.39	-0.21	-0.23	-0.22	-0.09	-0.23	-0.12	-0.09
	2	-0.04	0	-0.23	-0.04	-0.37	-0.23	-0.39	-0.22	-0.23	-0.24	-0.1	-0.23	-0.09	-0.1
	3	-0.03	0	-0.23	-0.03	-0.37	-0.23	-0.39	-0.22	-0.24	-0.24	-0.09	-0.24	-0.1	-0.09
	4	-0.03	0	-0.23	-0.03	-0.37	-0.23	-0.39	-0.21	-0.23	-0.23	-0.1	-0.23	-0.11	-0.1
	5	-0.03	0	-0.23	-0.03	-0.36	-0.23	-0.38	-0.21	-0.23	-0.22	-0.1	-0.23	-0.1	-0.1
	6	-0.03	0	-0.21	-0.03	-0.37	-0.21	-0.39	-0.21	-0.23	-0.23	-0.07	-0.23	-0.1	-0.07
	7	-0.03	0	-0.22	-0.03	-0.37	-0.22	-0.38	-0.21	-0.23	-0.23	-0.09	-0.23	-0.1	-0.09
	8	-0.03	0	-0.22	-0.03	-0.36	-0.22	-0.38	-0.21	-0.23	-0.23	-0.09	-0.23	-0.1	-0.09
	9	-0.03	0	-0.22	-0.03	-0.36	-0.22	-0.38	-0.21	-0.23	-0.23	-0.09	-0.23	-0.1	-0.09
	10	-0.03	0	-0.22	-0.03	-0.36	-0.22	-0.38	-0.22	-0.24	-0.24	-0.11	-0.24	-0.1	-0.11
Start purge	11	-0.02	0	-0.24	-0.01	-0.38	-0.17	-0.38	-0.22	-0.24	-0.27	-0.08	-0.26	-0.36	-0.37
	12	-0.02	0	-0.24	-0.01	-0.38	-0.17	-0.38	-0.22	-0.24	-0.27	-0.07	-0.24	-0.4	-0.42
	13	-0.02	0	-0.25	-0.01	-0.38	-0.17	-0.39	-0.22	-0.25	-0.27	-0.08	-0.23	-0.4	-0.45
	14	-0.02	0	-0.25	-0.01	-0.38	-0.17	-0.38	-0.23	-0.26	-0.28	-0.09	-0.23	-0.41	-0.47
	15	-0.01	0	-0.25	-0.01	-0.37	-0.17	-0.38	-0.23	-0.26	-0.28	-0.08	-0.23	-0.42	-0.47
	16	-0.01	0	-0.25	0	-0.37	-0.17	-0.38	-0.23	-0.26	-0.28	-0.08	-0.22	-0.4	-0.47
	17	-0.01	0	-0.25	0	-0.37	-0.17	-0.37	-0.23	-0.26	-0.28	-0.08	-0.22	-0.43	-0.48
	18	-0.01	0	-0.25	0	-0.37	-0.16	-0.37	-0.23	-0.26	-0.28	-0.09	-0.22	-0.41	-0.48
	19	-0.01	0	-0.25	0	-0.37	-0.16	-0.37	-0.23	-0.26	-0.29	-0.1	-0.22	-0.4	-0.48
	20	-0.01	0	-0.25	0	-0.37	-0.17	-0.37	-0.23	-0.26	-0.28	-0.08	-0.22	-0.41	-0.48
	21	-0.01	0	-0.25	0	-0.37	-0.17	-0.37	-0.22	-0.26	-0.28	-0.07	-0.21	-0.44	-0.49
Recovery period	22	-0.01	0	-0.25	0	-0.37	-0.16	-0.37	-0.22	-0.26	-0.27	-0.09	-0.21	-0.17	-0.16
	23	-0.01	0	-0.25	0	-0.37	-0.16	-0.36	-0.22	-0.25	-0.26	-0.09	-0.21	-0.12	-0.12
	24	-0.01	0	-0.25	0	-0.37	-0.15	-0.36	-0.21	-0.24	-0.26	-0.08	-0.2	-0.1	-0.1
	25	-0.01	0	-0.25	0	-0.37	-0.15	-0.36	-0.21	-0.24	-0.26	-0.08	-0.2	-0.09	-0.09
	26	-0.01	0	-0.25	0	-0.37	-0.15	-0.36	-0.2	-0.23	-0.25	-0.07	-0.2	-0.08	-0.08
	27	-0.01	0	-0.25	0	-0.37	-0.15	-0.36	-0.2	-0.23	-0.25	-0.07	-0.2	-0.07	-0.07
Background Min		-0.04	0	-0.23	-0.04	-0.37	-0.23	-0.39	-0.22	-0.24	-0.24	-0.11	-0.24	-0.12	-0.11
Background Max		-0.03	0	-0.21	-0.03	-0.36	-0.21	-0.38	-0.21	-0.23	-0.22	-0.07	-0.23	-0.09	-0.07
Background Range		0.010	0.000	0.020	0.010	0.010	0.020	0.010	0.010	0.010	0.020	0.040	0.010	0.030	0.040
Background Mean		-0.031	0.0	-0.224	-0.031	-0.365	-0.224	-0.385	-0.213	-0.232	-0.231	-0.095	-0.232	-0.103	-0.095
Purge Mean		-0.014	0.0	-0.248	-0.005	-0.374	-0.168	-0.376	-0.226	-0.255	-0.278	-0.082	-0.227	-0.407	-0.460
Difference		0.017	0.000	**-0.025**	0.026	**-0.008**	0.055	0.008	**-0.014**	**-0.024**	**-0.047**	0.013	0.005	**-0.305**	**-0.365**

Note: Bold negative values indicate differential pressure changes due to purging at an adjacent port.

Table 4.0-3
Independent t-Test Results for 54-02033

Inpedendent-Test for 60 ft Purge - Manometer Readings at 100 ft Port

Groups	n	Mean	SD	SE
60ft purge-100 ft Back	11	-0.224	0.007	0.0020
60ft purge-100 ft Purge	11	-0.248	0.004	0.0012
n	22			
Difference between means	0.025			
95% CI	0.020 to 0.029			
t statistic	10.35			
DF	20.0			
2-tailed p	<0.0001			

Inpedendent-Test for 220 ft Purge - Manometer Readings at 200 ft Port

Groups	n	Mean	SD	SE
220ft purge-200 ft Back	11	-0.231	0.007	0.0021
220ft purge-200 ft Purge	11	-0.278	0.006	0.0018
n	22			
Difference between means	0.047			
95% CI	0.041 to 0.053			
t statistic	16.96			
DF	20.0			
2-tailed p	<0.0001			

Inpedendent-Test for 100 ft Purge - Manometer Readings at 160 ft Port

Groups	n	Mean	SD	SE
100ft purge-160 ft Back	11	-0.365	0.005	0.0016
100ft purge-160 ft Purge	11	-0.374	0.005	0.0015
n	22			
Difference between means	0.008			
95% CI	0.004 to 0.013			
t statistic	3.74			
DF	20.0			
2-tailed p	0.0013			

Inpedendent-Test for 260 ft Purge - Manometer Readings at 277 ft Port

Groups	n	Mean	SD	SE
260ft purge-277 ft Back	11	-0.103	0.008	0.0024
260ft purge-277 ft Purge	11	-0.407	0.021	0.0062
n	22			
Difference between means	0.305			
95% CI	0.291 to 0.318			
t statistic	45.93			
DF	20.0			
2-tailed p	<0.0001			

Inpedendent-Test for 100 ft Purge - Manometer Readings at 160 ft Port

Groups	n	Mean	SD	SE
200ft purge-160 ft Back	11	-0.213	0.005	0.0014
200ft purge-160 ft Purge	11	-0.226	0.005	0.0015
n	22			
Difference between means	0.014			
95% CI	0.009 to 0.018			
t statistic	6.58			
DF	20.0			
2-tailed p	<0.0001			

Inpedendent-Test for 277 ft Purge - Manometer Readings at 260 ft Port

Groups	n	Mean	SD	SE
277ft purge-260 ft Back	11	-0.095	0.011	0.0034
277ft purge-260 ft Purge	11	-0.460	0.035	0.0107
n	22			
Difference between means	0.365			
95% CI	0.342 to 0.389			
t statistic	32.54			
DF	20.0			
2-tailed p	<0.0001			

Inpedendent-Test for 200 ft Purge - Manometer Readings at 220 ft Port

Groups	n	Mean	SD	SE
200ft purge-220 ft Back	11	-0.232	0.004	0.0012
200ft purge-220 ft Purge	11	-0.255	0.008	0.0025
n	22			
Difference between means	0.024			
95% CI	0.018 to 0.029			
t statistic	8.57			
DF	20.0			
2-tailed p	<0.0001			