Dunmore Gas Site
Dunmore Borough
Lackawanna County

Final Project Report
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EXECUTIVE SUMMARY

The gas monitoring program during the Centralia Mine Fire Assessment[1] has provided basic information on various parameters that would be considered "normal" for anthracite mine air. This report cites the Ash (1948) reference where ambient and "normal" anthracite mine air would not be significantly different. The comparison (Referenced Report; Table 3) shows slightly lower than ambient oxygen (20.72%) and slightly elevated carbon dioxide (0.12%). The anticipated normal methane (0.02%) and carbon dioxide would indicate significant displacement of oxygen should not occur under the referenced "normal" conditions. The Dunmore Gas Site Investigation considered the logic that the decomposition in the abandoned mines could possibly show deviations from the Centralia Mine Fire background. However, the continuous monitoring and the laboratory analysis conducted during the Dunmore Gas Site Investigation has shown oxygen concentrations which are significantly lower than ambient levels, and at one location have approached zero per-cent. The carbon dioxide and carbon monoxide concentrations have also been observed at the Dunmore Gas Site at significantly higher levels than originally anticipated.

This report is organized into five sections. The Executive Summary is Section 1 that provides the basic interpretations and recommendations. The brief description of historical studies and the HSCP funded study is provided as Section 2. The interpretations of the borehole data are provided as Section 3. The interpretation of the residential data is provided in Section 4. The documented toxicity of carbon dioxide from various sources is provided as Section 5. The objective of the carbon dioxide toxicity section is not to attempt to compare the scenarios with the Dunmore study area, but to demonstrate that carbon dioxide can be a significant health threat in confined and unconfined spaces.

The review of the carbon monoxide data showed very high concentrations during the initial stage of the monitoring program. Although the same magnitude of concentrations were not observed during the winter/spring 2000 period, there was strong evidence of a period where carbon monoxide was rising at the tail-end of the monitoring program. This was particularly noticeable in the borings in the northern part of the study area. The carbon monoxide interpretations were also supported by the temperature data from the upper and lower zones of each borehole. The spatial data would indicate that elevated carbon monoxide would be anticipated in the northern section of the study area.

The temperature data provided significant information on heat gradient patterns in each boring. The data also showed some significant differences within a particular area with respect to slightly elevated temperatures. Although none of the data was high with respect to anticipated temperatures at a mine fire, the summarized period averages, and the weekly data reviews did indicate deviations at specific boreholes.

The review of carbon dioxide and oxygen data did indicate that significant displacement of oxygen could be anticipated at shallow depths below ground surface, and within the deep zones. The displacement of oxygen predominantly by carbon dioxide appears to be supported by the continuous monitoring, and the packer tests. There is also evidence that nitrogen may be displaced to some degree. However, there appears to be evidence that other undefined gases may also be a factor in the displaced oxygen to some degree. This interpretation is also supported by the documented high carbon dioxide and low oxygen at Home C and Home D defined by historical monitoring.

The volatile organic compounds analyzed during the four rounds of packer testing showed higher than anticipated concentrations of BTEX and common solvent compound types. In particular, toluene was found in concentrations exceeding 1.0 parts per million at several locations, and was detected in the majority of the samples during all four rounds. The comparison of volatile concentrations against USEPA Risk Based Concentrations (RBCs) indicated that volatiles might also present a possible health threat if a pathway from the subsurface to human receptors is completed. The limited residential data collected during the fourth round of packer tests does indicate that some detected volatiles may be associated with the subsurface and also exceed RBCs.

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[1] Office of Surface Mining, Centralia Mine Fire Assessment Drilling and Diagnostic Monitoring – Final Report; May 1993.

The open voids and fractures have been demonstrated during the historical monitoring, and during this investigation to provide relatively rapid pathways for air contaminants. The study area also has a major thrust fault from the northern through the southern part of the study area. The previous information provided by Robert Gadinski, and the Surfer contour maps for his report entitled; Modified Packer Pump for Site Characterization; Abstract Number: 471 (September 2000) illustrate the controls of this major fault, and the barrier pillar which is located beneath Jessup Street.

The interpretations of the continuous monitoring and the packer tests have indicated that the unlined portion of Keystone Sanitary Landfill is a likely source of carbon monoxide, volatile organic compounds, and carbon dioxide. The temperature and oxygen data from the continuous monitoring program also tends to support this source area. Although the geologic pathways exist for movement of air along the major fault, and through the voids, from the unlined landfill through southern Dunmore, it is possible that an additional source(s) may be contributing to the problem.

The Tetra Tech EM Inc. (Tetratech) Final Site Investigation Report (June 8, 2000) has been distributed to representatives of the Environmental Cleanup Program, Emergency Response Program, Bureau of Abandoned Mines, and the Department of Health for any additional comments and recommendations on possible remedial action. This report provides the interpretations of data by the Regional Project Officer for the Dunmore CO HSCA Site.

The Bureau of Mining and Reclamation may have appropriate and relevant (ARAR) policies with respect to the potential and documented health threat at this site. The Technical Guidance titled *"Prompt Closure of Abandoned Underground Mine Openings"* would be applicable to underground mine openings sealed after the effective date of June 30, 1997. However, the basic objective of this policy is provided in the following statement:

"The purpose of this document is to describe the procedures for ensuring immediate securing and prompt sealing of all abandoned underground mine openings in order to protect public health and safety.[2] "

Although this guidance may not reflect existing regulatory requirements, it would provide some framework for a potential ARAR.

The Bureau of Deep Mine Safety also has possible applicable, relevant, and/or appropriate Technical Guidance titled, *"Guidelines to Approve Ventilation Plans for Abandoned and Unused Mine Areas".* This guidance policy is applicable to all Deep Mine Safety Stall and underground coalmine operators and personnel. The basic objective is stated as follows:

" The purpose of this technical guidance is to provide consistency of enforcement through guidelines thus insuring adequate ventilation of abandoned and unused areas.[3] *"*

The above documents may provide at least some Department guidance, if not the regulatory framework, for any continued investigations or remedial actions.

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[2] PA Department of Environmental Protection, Bureau of Mining and Reclamation; Prompt Closure of Abandoned Underground Mine Openings; Document Number: 562-2112-315; Effective Date: June 30, 1997.

[3] PA Department of Environmental Protection, Bureau of Deep Mine Safety; Guidelines to Approve Ventilation Plans for Abandoned and Unused Mine Areas; Document Number: 580-2219-002; Effective Date: April 1, 2000.

SECTION TWO

HISTORICAL INVESTIGATIONS

U.S. Environmental Protection Agency's (USEPA) Site Assessment Technical Assistance (SATA) team performed the initial assessment of carbon monoxide in the subsurface. Roy F. Weston, Inc. was the SATA contractor that was mobilized for the monitoring and assessment during March 1997. The Final Subsurface Report[4] has documented relatively high carbon monoxide and carbon dioxide in the subsurface and provided recommendations for continued investigations in the Dunmore area. The range of concentrations from the borehole field screening (Appendix 4) is provided in Table 1. The range of concentrations during the packer testing performed during June and July 1997 are summarized in Table 2.

Table 1
Weston Site Assessment Technical Assistance Team
Range of Field Data

BOREHOLE	OXYGEN (%)		CARBON DIOXIDE (PPM)		CARBON MONOXIDE (PPM)		LEL (%)	
	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
SATA-1	17.7	22.8	0	710,000	0	11	0	7
SATA-2	7.6	21.4	150	72,000	0	84	0	8
SATA-3	22.9	15.0	50	27,000	0	153	0	14
SATA-4	17.6	22.9	50	710,000	0	8	0	10
SATA-5	18.4	22.5	0	21,000	0	65	0	13
SATA-6	0.1	22.6	0	89,000	0	160	0	17
SATA-7	11.5	21.7	1,700	58,000	0	1	0	12

Table 2
Weston Site Assessment Technical Assistance Team
Range of Packer Test Data

BOREHOLE	O2 (%) FIELD		CO2 (PPM) FIELD		CO2 (PPM) LAB		CO (PPM) FIELD		CO (PPM) LAB	
	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
SATA-1	12.0	20.7	>10,000	>10,000	14,000	57,000	1.0	2.0	3.4	3.6
SATA-2	20.0	20.3	4,550	>10,000	4,000	61,900	1.0	7.0	3.2	5.4
SATA-3	14.6	20.3	1,000	32,000	3,700	44,000	1.0	42.0	2.5	6.0
SATA-4	14.8	21.7	>10,000	100,000	1,600	83,600	0.0	90.0	2.6	8.8
SATA-5	9.6	17.8	>10,000	>10,000	380	73,000	1.0	9.0	2.1	3.7
SATA-6	20.0	20.0	>10,000	>10,000	14,000	74,900	3.0	5.0	2.1	2.7
SATA-7	NA	NA	NA	NA	25,400	51,000	NA	NA	2.7	4.2

[4] Roy F. Weston Inc., Subsurface Investigation Report, December 19, 1997.

The above tables from the SATA Final Report illustrate the high detection of carbon monoxide and carbon dioxide, and relatively low concentrations of oxygen. The summarized data in these tables does not present the basic statistical averages of the field monitoring, or the specifics of the borehole intervals. The summary Tables are presented for illustrating the significant concentrations detected during this initial investigation. The interpretations on the potential intervals within each borehole would require examination of the referenced SATA appendix. The SATA report had also utilized the Office of Surface Mines borings (OSM) and several additional boreholes to construct basic geologic cross sections and identify the specific coal zones. These figures have been scanned and are provided as Attachment 1 to this report.

The Department's Hazardous Sites Cleanup Program contracted Tetra Tech EM, Inc. (formerly PRC Environmental Services) to continue the initial weekly residential air monitoring program, and assisted the USEPA SATA contractor with the borehole monitoring. The Final Specification of Services was dated November 26, 1997. Tetra Tech EM, Inc. (Tetratech) performed the monitoring and additional requested services from October 1997 thru March 1998. The specifics of the residential monitoring program are discussed in the Residential Monitoring Section. The Final Air Quality Investigation Report[5] was submitted to PADEP with the analytical summaries reports. The Final Report supplemented the weekly evaluations, and provided recommendations for continued monitoring activities.

HAZARDOUS SITES CLEANUP PROGRAM CONTINUED INVESTIGATION

Tetratech's recommendation for the drilling subcontractor was approved during January 1999. Additional borings were installed to supplement the six (SATA-1 was covered over during the Penn DOT road construction) existing USEPA borings. The selected drilling subcontractor, Eichelbergers, Inc., mobilized on February 3, 1999 and completed the installation of the additional ECP borings on February 18, 1999. The completed drilling subtask deviated slightly from the original Scope of Work due to site conditions. The two shallow borings adjacent to the HUD Apartment 56 area was not performed due to the potential for subsidence created by the drilling rig. The two shallow borings (ECP-6-S1 and ECP-6-S2), located in Sherwood Park and south of Shirley Lane, were completed as open borings instead of PVC cased holes. The summarized well completion details are provided in the following Table.

Table 3
BORING CONSTRUCTION STATISTICS

BORING	*BOTTOM OF CASING (FEET)*	*CASING COMPLETION*	*DEPTH (FEET)*	*DRILLING COMPLETION*	*FINAL COMPLETION*
ECP-1	***20.0***	***2-03-99***	***225***	***2-10-99***	***2-17-99***
ECP-2	***20.0***	***2-03-99***	***230***	***2-07-99***	***2-17-99***

[5] Tetra Tech Environmental Management, Inc., Final Air Quality Investigation Report, Dunmore CO Site, Lackawanna County, Pennsylvania, Contract No. ME-93830, Work Requisition No. 22-023, June 29, 1998.

ECP-3	***20.0***	***2-03-99***	***225***	***2-09-99***	***2-17-99***
ECP-4	***30.0***	***2-03-99***	***190***	***2-12-99***	***2-17-99***
ECP-5	***17.5***	***2-03-99***	***170***	***2/17-99***	***2-17-99***
ECP-6	***31.0***	***2-08-99***	***225***	***2-10-99***	***2-17-99***
ECP-6-1S	***18.0***	***2-11-99***	***50***	***2-15-99***	***2-17-99***
ECP-6-2S	***19.0***	***2-11-99***	***28***	***2-15-99***	***2-17-99***
ECP-7	***21.5***	***2-11-99***	***105***	***2-18-99***	***2-18-99***
ECP-8	***19.0***	***2-15-99***	***210***	***2-16-99***	***2-17-99***

Tetratech's recommendation for the downhole video and geophysical logs was approved during January 1999. Tetratech subcontracted Earth Data Incorporated to perform this subtask. The video logging was performed on February 22-23, 1999. The geophysical logging required several addition hours on February 24, 1999 for completion. The downhole videotapes and geophysical logs were received on March 10, 1999. The specific zones within each borehole to be sampled using the packers were selected based on recommendations by Tetratech, Robert Gadinski, and the PADEP Regional Project Officer.

construction of ECP-6-S1

geophysics at SATA-5

The four rounds of packer tests were performed during the anticipated seasonal weather periods with consideration for scheduling of personnel and equipment. Tetratech subcontracted Earth Data Incorporated to set the packers at the selected zones within each borehole and assist in the collection of laboratory samples with Tetratech personnel. The collection of samples and the review of the analytical results during these four periods warranted several changes in the initial protocol based on site-specific conditions and data evaluation. The first round of samples was collected from each interval as field parameters (oxygen, carbon monoxide, LEL, and H2S) measured by the MSA Passport stabilized. The field oxygen concentrations ranged from 7.4 % to 20.7 %, which were found to within the expected range, in retrospect of the data collected during the four rounds, and during the continuous monitoring for oxygen and carbon monoxide. However, the laboratory analysis for the ASTM D-1946 parameters indicated anomalous high oxygen (ranging from 23.39 % to 32.66 %, with the highest concentrations noted in a test blank and field blank), and relatively high detection levels for carbon dioxide, carbon monoxide, and methane. Tetratech discussed these discrepancies with Severn Trent laboratories, and technical discussions were also continued with PADEP and USEPA personnel experienced with the initial investigation and air monitoring techniques. These discussions indicated that the field measurements for oxygen, carbon dioxide, carbon monoxide and methane would be accurate and superior to the ASTM D-1946 methodology for this type of investigation. The subsequent field monitoring equipment and the equipment used during the packer tests is provided in Attachment 2 and Attachment 3 to this report.

Continuous data was collected from the ECP and SATA series borings from February 1999 through April 2000. Temperature data was collected using Onset Optic StowAway temperature probes set at recording measurements at five minute intervals. The temperature was collected at near surface (approximately 20-feet) and at deep intervals (approximately 150-feet). The exception to this procedure was at the two shallow borings (ECP-6S1 and ECP-6S2), and at ECP-2 due to a blockage at approximately 80 feet. The continuous data for carbon monoxide and oxygen was collected utilizing GasTech GT Series monitors. These monitors were positioned slightly below the surface elevation of the borehole.

The temperature data was downloaded on a weekly basis utilizing a portable IBM Thinkpad computer and inverter connected to the Onset Optic Shuttle. The carbon monoxide and oxygen data was downloaded directly from Gastech GT monitors to the computer. The carbon monoxide, oxygen, and temperature data was reviewed during weekly reports that provided attached graphs. The equipment utilized for this task is provided as Attachment 4 and Attachment 5 to this report.

Tetratech completed the Final Site Investigation Report (June 8, 2000) incorporated the complete data in a format for each boring which would allow comparison over time. The report provides details of the field work and any modification to the Scope of Work and Specification of Services (December 1998). The interpretations and data presentation have been submitted in an excellent technical manner. The Department is considering the recommendations and conclusions of the Tetratech report for any future decisions.

SECTION THREE

Methane and Lower Explosive Limit

There were few detections for methane or the lower explosive limit (LEL) during the monitoring program. The field measurements are provided in Attachment 6 for the periods when this was available. The highest LEL (6.0 per-cent) noted during the two rounds of field data was observed at ECP-4 at the140 to 160 foot interval. The LEL was noted above 1.0 per-cent at ECP-4, SATA-3, SATA-4, and SATA-5 during the third round of packer testing. The LEL was noted above 1.0 per-cent at ECP-2, ECP-3, ECP-6S1, and SATA-5 during the fourth round of packer testing. The LEL was observed at more than one interval at ECP-3 (Round 3), ECP-4 (Round 4), ECP-7 (Round 3), ECP-8 (Rounds 3 and 4), SATA-2 (Round 3), SATA-3 (Round 3), SATA-4 (Round 3), and SATA-5 (Rounds 3 and 4).

The highest methane observations were at ECP-8 at the 148 to 168 foot interval (5.0 per-cent) and the 14 to 34 foot interval (3.0 per-cent). Trace methane was observed during Round 2 at ECP-4 (two intervals), SATA-2, SATA-4 (one interval), and SATA-6 (three intervals). No field methane was detected during the fourth round of packer testing. Laboratory samples of fixed gases during the third and fourth packer tests showed all methane analysis less than 0.5 per-cent with the exception of a qualified detection at ECP-4B (0.25(J)).

Oxygen and Carbon Dioxide

The limitations of the ASTM-1946 method for oxygen and carbon dioxide were observed during the review of the analytical results from the first round of sampling. A significant proportion of oxygen concentrations were reported above the ambient concentration of 20.8. Tetratech discussed the concentrations with the laboratory, and continued technical discussions with PADEP and USEPA technical staff. The conclusion of these discussions was that field observations of oxygen would be more appropriate for this type of investigation. The other fixed gases could still be done using the ASTM procedure with appropriate detection limits. The summary of oxygen and carbon dioxide for the second, third, and fourth round of packer testing are provided in Attachment 6. The objective of this attachment is to present a comparison of each parameter with time. The summary of field parameters for each round is provided in Attachment 7. This attachment allows comparison of several parameters for a specific round.

The review of the oxygen for a specific interval with time indicates that the oxygen concentration could show significant changes during the packer tests. This is particularly notable for SATA-6 with both intervals showing a concentration of 4.3 per-cent during the first round; and concentrations ranging from 19.6 to 20.8 during the third and fourth rounds. Although the low concentrations might be suspect in contrast to the subsequent data, the continuous monitoring of oxygen at SATA-6 showed very high rises and falls in concentrations over a short time period (with concentrations approaching zero per-cent). The temperature data also indicates relatively fast air-flow at this location.

The number of observations within a specific concentration range for the three rounds of packer tests is provided on the following table. This table illustrates that a significant proportion of these discrete intervals had concentrations which would be significantly lower than anticipated in a typical mine void environment. This table also illustrates that the gases, which are displacing the oxygen, may be in significant concentrations with respect to human health levels.

OBSERVATIONS IN OXYGEN RANGE (%)

ROUND	TOTAL	>20.0	>15.0 to <20.0	>10.0 to <15.0	>5.0 to < 10.0	<5%
2	45	14	23	6	0	2
3	45	5	31	6	3	0
4	45	10	26	7	1	1

The field observations for carbon dioxide during the three packer test rounds are also provided in Attachment 7. This allows comparison of the carbon dioxide/oxygen values within a specific interval. This Attachment also illustrates that the sum of the observed oxygen and carbon dioxide within an interval would be close to the ambient oxygen concentration at many of the intervals. This supports the historical information that carbon dioxide is the major gas that displaces the oxygen. However, note that at some intervals (see Attachment 7) the sum would indicate that a significant percentage of other unidentified gases would be present at some locations. The basic statistics were calculated for the second and fourth round comparing carbon dioxide and oxygen. The following table demonstrates that the basic statistics would also support the strong correlation of these parameters. The third round of data utilized the Telaire 1320 meter for carbon dioxide measurements. This meter would continue to read above the full scale during high concentrations, and continue to read digitally from the zero point at intervals anticipated to have higher concentrations. Therefore, the carbon dioxide observations that were within the meter range appeared to be comparable to the other two rounds. However, the intervals with anticipated high carbon dioxide concentrations showed lower and inaccurate readings due to the limitations of this meter.

BASIC STATISTICS

	ROUND 3 (%)	ROUND 4 (%)
AVERAGE O2+CO2	20.7	20.4
MEDIAN O2+CO2	20.9	20.8
STAN. DEV O2+CO2	2.1	1.5
CORRELATION COEFFICIENT O2 AND CO2	-0.88	-0.90

The carbon dioxide ranged from less than 0.1 to 9.2 per-cent during the second round, and less than 0.1 to 10.2 per-cent during the fourth round. The carbon dioxide was measured by the Telaire meter during the third round ranged from 492 (0.04 per-cent) to greater than 10,000 (1 per-cent) parts per million during the third round. The following table illustrates the number of carbon dioxide observations were equal to or above the respective daily average and individual reading human health levels of 5,000 parts per million (0.5 per-cent), and the 50,000 parts per million (5.0 per-cent). The observations observed at greater than 10,000 parts per million with the Telaire meter are included in the 0.5 to 5.0 per-cent range.

CARBON DIOXIDE RANGE (Number of Observations)

	ROUND 2	ROUND 3	ROUND 4
TOTAL	45	42	45
<0.5	5	32	9
0.5 to 5.0 %	26	10	25
>5.0%	14	unknown	11

The continuous oxygen recordings have been summarized for each well in Tetratech's Final Report[6]. The data represents 922,426 individual data points for all the borings from April 1999 to May 2000. The data represents a composite sample of the voids/fractures that are intercepted by each borehole. However, this data is collected at just below the surface elevation and would be representative of a potential human health threat if a pathway from the subsurface to a residence exists presently, or in the future. The weekly statistics on these excel spreadsheets have been compared to the OSHA defined "oxygen deficient" concentration of 19.5 per-cent. The rationale of using this concentration as a reference point in this comparison is due to the unknown possibility of oxygen displacement within a building foundation, and the documented oxygen deficiencies at Home C and Home D. The following table summarizes the individual Tetratech spreadsheets for each boring. This table provides information on the number of monitoring periods (approximately one week per period), total oxygen measurements per boring for the entire program, and the number of observations (period minimum and period average) that were less than the referenced 19.5 per-cent.

[6] Tetratech EMI;

OXYGEN COMPARISON
(NUMBER OF OBSERVATIONS)

BORING	Total Periods	O2min<19.5	O2avg<19.5	Average	Total measurements
ECP-1	47	26	2	20.5	53,608
ECP-2	50	36	15	19.8	61,720
ECP-3	48	35	5	20.4	60,789
ECP-4	50	37	17	20.2	60,817
ECP-5	49	34	7	20.4	60,800
ECP-6	50	27	3	20.4	61,406
ECP-6S1	49	32	3	20.4	61,984
ECP-6S2	50	27	1	20.6	64,610
ECP-7	49	24	8	19.8	60,855
ECP-8	49	36	23	19.4	60,745
SATA-2	46	45	12	19.8	43,774
SATA-3	44	38	0	20.4	44,747
SATA-4	49	47	14	19.7	56,928
SATA-5	43	33	18	19.4	56,628
SATA-6	49	47	24	19.3	59,141
SATA-7	49	43	23	19.0	53,874

OXYGEN COMPARISON
(NUMBER OF OBSERVATIONS)

BORING	Total Periods	O2min<15.5	O2min=0
ECP-1	47	1	1
ECP-2	50	1	0
ECP-3	48	16	1
ECP-4	50	20	0
ECP-5	49	2	0
ECP-6	50	5	0
ECP-6S1	49	3	0
ECP-6S2	50	1	0
ECP-7	49	7	0
ECP-8	49	33	0
SATA-2	46	37	2
SATA-3	44	18	2
SATA-4	49	19	1
SATA-5	43	20	0
SATA-6	49	40	10
SATA-7	49	31	0

This simple comparison does indicate that there were a significant amount of periods where the oxygen minimum concentration was less than 19.5 per-cent. However, the number of periods where the period average (typically about seven days) was below 19.5 per-cent was also noted at least once with the exception of SATA-3. In particular, note the "Average" column, where the average of the period averages fell below this concentration. The low total averages were found at ECP-8, SATA-5, SATA-6, and SATA-7.

An additional comparison of the Tetratech spreadsheets was performed comparing the period minimum oxygen concentrations with an oxygen value of 15.5 per-cent. This concentration was selected for comparison considering that the oxygen/carbon dioxide correlation was high, and the maximum individual carbon dioxide reading greater than 5.0 per-cent would be above the PADOH[7] inhabitability criteria. Considering that an elevated carbon dioxide concentration of 5.0 per-cent would be expected to decrease the normal oxygen to approximately 15.8 per-cent, this selected value would be conservative. The above table provides this comparison. This comparison would indicate that high (with respect to health levels) sporadic carbon dioxide concentrations are possible at all of the borings. However, the most probable borings would be ECP-8, SATA-2, SATA-6, and SATA-7. Also note that the minimum oxygen was observed at zero (or negative) concentrations during some periods. This would indicate that oxygen has been detected (at least once) at less than the meter detection limit for a referenced period. This was particularly notable at SATA-6, which was noted during the reviews of the graphs included with Tetratech's weekly reports.

The above comparisons would also be on the conservative side if based on the assumption that **carbon dioxide and other gases are displacing only oxygen**. The review of Tetratech's Final Report (Tables 6, 12, and 16) show nitrogen averages for all borings per round. The nitrogen averages for Rounds 1, 3, and 4 are respectively 75.9, 73.6, and 69.3 per-cent. These averages are close to the ambient atmospheric concentration of approximately 70 per-cent. The summary of the laboratory QA/QC samples and field/trip blanks are summarized for the nitrogen concentrations. Note that the QA blanks provide per-cent recovery, and the matrix spikes provide relative difference in the parenthesis. Tetratech notes that the sum of oxygen and nitrogen exceeds 100 per-cent occasionally for various intervals. This would indicate that the degree of accuracy would be questionable. However, large deviations from the anticipated 70 per-cent would not be anticipated **if** nitrogen was not also being displaced. This rationale is also provided in the review of the QA/QC samples, which do show concentrations above 70 percent, but indicate accuracy within an acceptable range.

ROUND	SAMPLE	NITROGEN (%)
1	FB-1 (3/24/99)	74.93
1	TB (3/29/99)	75.34
1	ABLKD6	75.48 (96.6%)
1	ABLKE1	75.54 (96.7%)
1	MATRIX SPIKE	76.98 (0.2%)
1	TB (3/31/99)	75.49
1	TB (4/7/99)	75.59
1	ABLK4	75.67 (96.9%)
1	ABLKE7	76.29 (97.7%)
1	MATRIX SPIKE	77.23 (0.1%)
1	MATRIX SPIKE	75.87 (0.5%)
1	MATRIX SPIKE	78.78 (2.2%)
1	TB (4/8/99)	75.44
1	MATRIX SPIKE	76.54 (0.0%)
3	FB1099036-1	84
3	FB109036-1 DUP	83
4	FB0100062-12	78.9
4	FB0100062-12 DUP	77.4
4	FB0100076-16	66.7
4	FB0200020-5	66.4

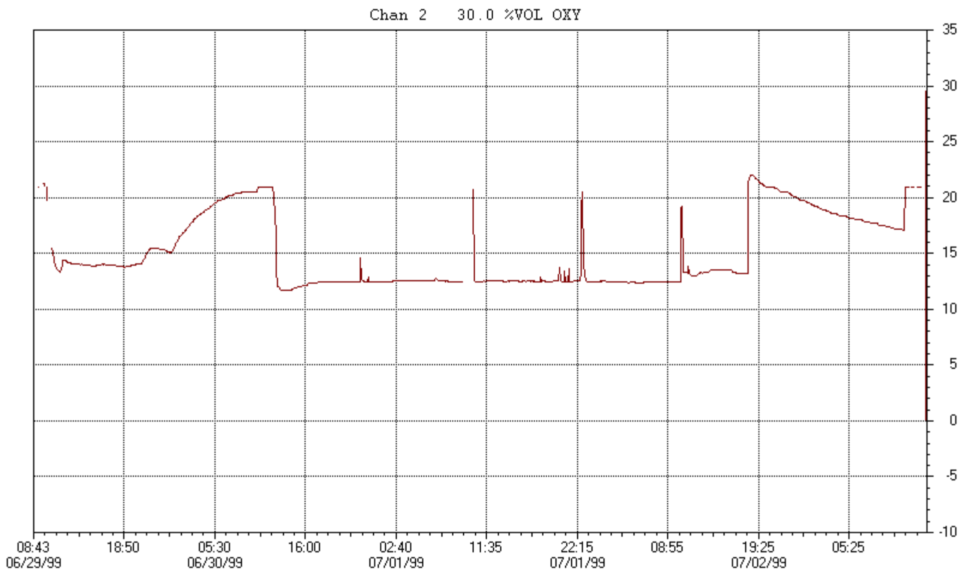
The Tetratech provides a summary (Table 74) of nitrogen concentrations in each packer interval for Rounds 1, 3 and 4. Concentrations which were below 70 per-cent during Round 1 occurred at ECP-1B, ECP-1C, ECP-2C, ECP-3D, ECP-4C, ECP-4D, ECP-5B, ECP-5C, ECP-7A, ECP-8A-DUPE, ECP-8C, ECP-8D, ECP-8E, SATA-2A, SATA-3A, SATA-3B, SATA-3C, SATA-3D, SATA-4C, SATA-4D, SATA-5C, SATA-6A DUPE, SATA-6B, SATA-7A, AND SATA-7B. Note that the low concentrations of 10.7 and 17.0 per-cent were observed at ECP-1B and ECP-1C DUPE respectively. Nitrogen concentrations, which were below 70 per-cent during Round 3, occurred at ECP-2A DUPE, ECP-3A, ECP-3B, ECP-3C, ECP-3D, ECP-6A, ECP-6B DUPE, ECP-6C, ECP-6S1A, ECP-6S1B, ECP-6S2, SATA-3C, and SATA-5A. The

[7] PA Department of Health; correspondence to Paul Nardozzi, Dunmore Borough from Joel Hersh, M.Ed.; February 14, 1997.

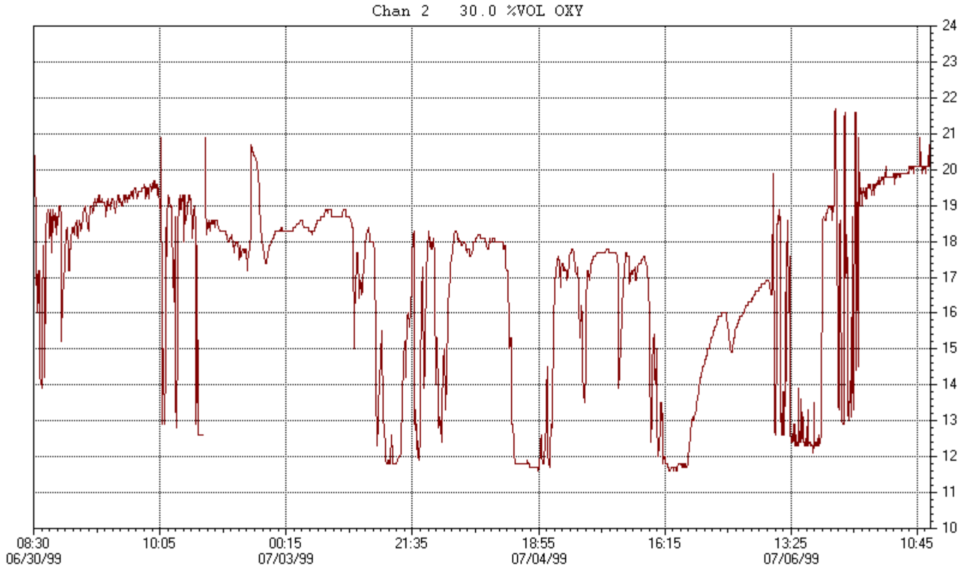
lowest concentration was 50.0 per-cent at ECP-3B during Round 3. Nitrogen concentrations which were below 70 per-cent during Round 4 occurred at ECP-1C, ECP-3A, ECP-4B, ECP-4C, ECP-4D, ECP-5B, ECP-6C, ECP-6S1B, ECP-7A, ECP-7B, ECP-8C, SATA-2A, SATA-2B, SATA-3A, SATA-3B, SATA-3C, SATA-3D, SATA-4A, SATA-4B, SATA-4C, SATA-4D, SATA-5A, SATA-5B, SATA-6A, SATA-6B, SATA-6C, and SATA-7A. The lowest nitrogen concentration was 6.7 per-cent at SATA-2B. The objective of this comparison of nitrogen concentrations would strongly suggest the possibility that other gases are displacing nitrogen as well as oxygen.

The comparison of weekly oxygen graphs from the ECP-8 and SATA-7 borings, and the concentrations of carbon dioxide in Homes C and D are addressed in the next section of this report. However, it was noted that the low oxygen at these borings was consistent with the high carbon dioxide periods at these residences. Both of these borings did show seasonal low oxygen periods, but the weekly periods did indicate that fluctuations could occur within a relatively short time span. The following representative graphs for these boring show these fluctuations for specific and representative summer periods.

ECP-8 Week 11 Oxygen

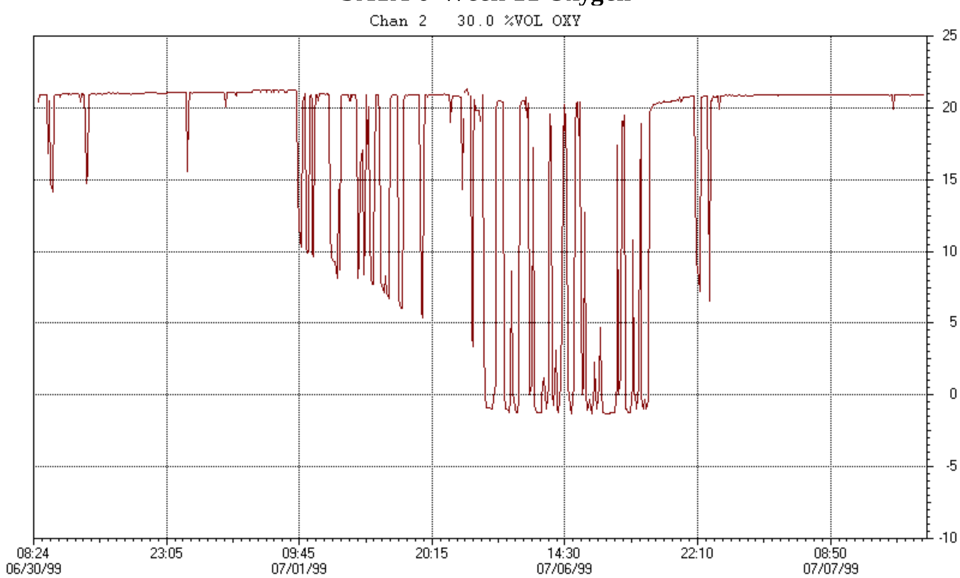


SATA-7 Week 11 Oxygen

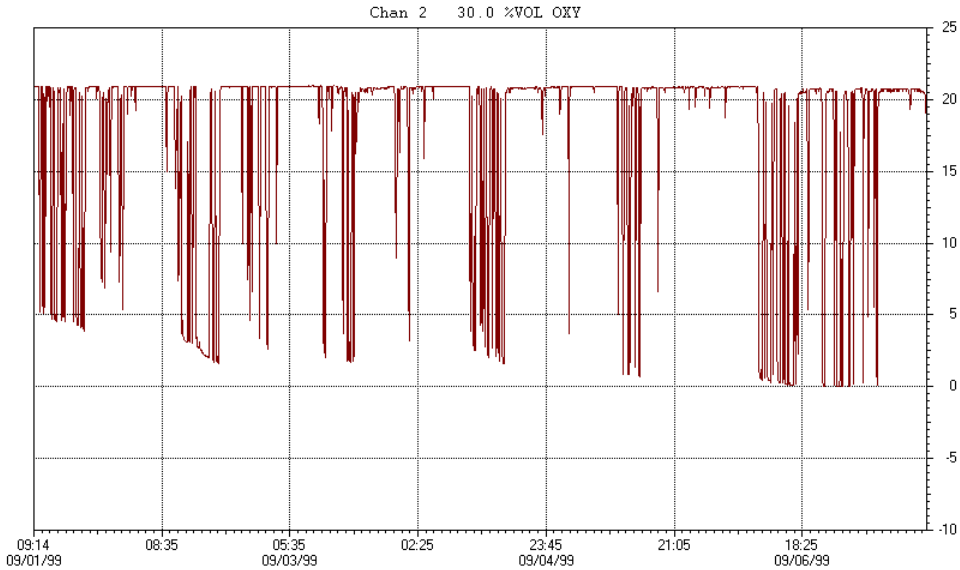


The low levels discussed for ECP-8 and SATA-7 are in areas of former complaints, which have been confirmed with historical monitoring, and during the latest PADEP study. However, the lowest oxygen readings noted have been at SATA-6 as discussed in the preceding paragraph. The following representative graphs provide an illustration of the severe fluctuations at this boring.

SATA-6 Week 11 Oxygen



SATA-6 Week 20 Oxygen



The objective of these graphs is to illustrate the sharp drops in oxygen within a relatively short time span. In general, the frequency and duration of the oxygen drops increased during warmer weather at ECP-8 and SATA-7 as anticipated. SATA-6 appears to be less predictable but the summary of weekly data would indicate that warmer weather would also increase the frequency of the drops, although oxygen could show very low minimums throughout the seasons.

Volatile Organics

The four rounds of packer tests included the volatile organic compounds utilizing the TO-14 analytical technique. The summary of the analysis for these four rounds is provided as Attachment 8. The compounds listed on these excel spreadsheets have been highlighted and **bolded** where detected, and not qualified (B) as the "compound detected in method blank". The review of this data has shown various volatile organic compounds to be commonly found at the various intervals in the borings. The volatiles have been detected in deep as well as shallow borehole intervals. The relationship between the volatiles detected during the residential sampling (Round 4) and the volatiles in adjacent borings is discussed in the next section. The detected volatiles commonly found the BTEX compounds, but also detected the common solvent compounds such as 1,1,1-trichloroethane, trichloroethene, and tetrachloroethene during all of the four monitoring events. Styrene was a compound found in low concentrations at several locations. The detection of styrene was observed to be located at the borings in the northern section of the Dunmore study area, with the exception of SATA-7. The locations where styrene was detected are listed below:

	STYRENE DETECTIONS
ROUND 1	ECP-3D, SATA-5A, SATA-5A (DUPE), SATA-7A
ROUND 2	ECP-3D, ECP-3D (DUPE), ECP-4C, ECP-6B (DUPE), SATA-2B, SATA-6B, SATA-6C
ROUND 3	ECP-6A, ECP-7A
ROUND 4	ECP-1A

The analytical results for all four rounds indicated that toluene was the most common compound, and was detected in the highest concentrations. The other common BTEX compounds were present at various locations. However, the frequency of detection of toluene and the relative concentration relative to the other compounds indicates that this compound was significant to the study area. The toluene concentrations for the four packer tests are provided in Attachment 9.

The toluene concentrations for Round 1show that the highest concentration was 376.42 ppb observed at SATA-5A (Duplicate). No concentrations exceeded the 1.0 part per million (1,000 ppb) concentration.

The toluene concentrations for Round 2 show that the highest concentration was 13,612.24(E) at SATA-6C. Toluene concentrations were observed exceeding 1.0 parts per million at ECP-1B, ECP-3A, ECP-3B, ECP-3C, SATA-2B, SATA-3B, SATA-3C, SATA-3D, SATA-4A, SATA-6B, AND SATA-6C. Toluene concentrations also exceeded 5.0 parts per million was observed at SATA-2B, SATA-6B, and SATA-6C.

The toluene concentrations for Round 3 show the highest concentration was 2,779.78 parts per billion at SATA-2B (Duplicate). Toluene concentrations were observed exceeding 1.0 parts per million at ECP-1A, ECP-6A, ECP-6C, ECP-7B, SATA-2B, SATA-3C, SATA-3D, and SATA-6C.

The toluene concentrations for Round 4 show the highest concentration was 5,488.16 at SATA-3D (Duplicate). Toluene concentrations exceeding were observed exceeding 1.0 parts per million at ECP-7A, SATA-3C, SATA-3D, SATA-4A, SATA-6B, SATA-6C, and SATA-7A. Toluene also exceed 5.0 parts per million at SATA-3D.

The toluene concentrations were observed at deep as well as shallow intervals in the borings. This would appear to indicate that surface and shallow fuel releases would not likely be the source for these organics. The other BTEX compounds and solvents also showed similar patterns. Tetratech's Final Report[8] also provides the total volatile organic compounds (VOCs) for each interval in Tables 4A, 7A, 12A, and 14 (Rounds 1 thru 4 respectively). The total VOCs also confirm that these contaminants are present in all zones.

Methylene Chloride was frequently detected in low part per billion concentrations during Rounds 3 and 4. However, several relatively high concentrations during Round 2 are of specific interest. SATA-4(A) had a concentration of 507.72(D). SATA-6B and SATA-6C had concentrations of 9,471.39(D) and 21,280.49(D) respectively. Note that these intervals also had toluene concentrations exceeding 1.0 part per million during Round 2.

The Department's Mobile Analytical Unit (MAU) was utilized for several days during the second round of packer tests. The MAU was reassigned to another project on July 7, 1999, which limited the on-site data to some degree. The volatile analysis for the borings sampled on July 6, 1999 and July 7, 1999 are provided in the following table. The MAU also provided analysis for semi-volatile compounds. However, the semi-volatile analysis was qualitative and detected compounds were indicated as detected but with no quantitative concentration. The summarized results of both of these analysis are provided on the following tables. Representative digital pictures of the MAU and the sampling equipment are provided as Attachment 10.

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[8] Tetra Tech EM Inc., Final Site Investigation Report, Dunmore CO Site, Lackawanna County, Pennsylvania, June 8, 2000.

DEP MAU Volatile Summary

BORING	SAMPLE ID	INTERVAL (FEET)	DATE	BENZENE	TOLUENE	XYLENE	TCA	TCE
ECP-1	**C**	42-62	7/7/99	<2	22.7	<3	4.5	<54
ECP-1	**B**	146-166	7/7/99	5.1	280.7*	7.9	<1	<54
ECP-1	**A**	180-BOTTOM	7/7/99	<2	26.4	<3	<1	<54
ECP-2	**A**	60-BOTTOM	7/7/99	<2	14.2	<3	<1	<54
ECP-5	**C**	72-92	7/8/99	<1	3.7	<2	2.8	<27
ECP-5	**B**	114-134	7/8/99	<1	4.3	<2	4	<27
ECP-5	**A**	134-BOTTOM	7/8/99	<1	3.9	<2	5	<27
ECP-6	**C**	70-90	7/6/99	<2	5.3	<1	<2	<17
ECP-6	**B**	164-184	7/6/99	<2	20.1	<1	8.7	<17
ECP-6	**A**	185-215	7/6/99	<2	9.3	<1	8.7	<17
ECP-6-S1	**B**	16-36	7/7/99	<2	97.9*	5.7	<1	<54
ECP-6-S1	**A**	36-50	7/7/99	<2	46.4*	<3	2.6	<54
ECP-6-S2	**A**	18-BOTTOM	7/7/99	<2	38.7*	<3	<1	<54
ECP-7	**B**	21-41	7/8/99	<1	60.6*	6.1	2.6	<27
ECP-7	**A**	45-BOTTOM	7/8/99	<1	41.8*	3.8	4.2	<27
SATA-5	**A**	154-BOTTOM	7/8/99	<1	37.9*	<2	3.6	<27
LEGEND								
Bureau of Laboratories Report dated 7/22/99								
**** concentration is above upper detection limit.***								
< concentration is below the detection limit.								

DEP MAU Semi Volatile Summary

BORING	SAMPLE ID	INTERVAL (FEET)	DATE	TOLUENE	DIMETHYL ACETAMIDE	HEPTANE	3-METHYL HEXANE	DIMETHYL BENZENE	METHYL CYCLOHEXANE
ECP-1	**C**	42-62	7/7/99	detected					
ECP-1	**B**	146-166	7/7/99	detected					
ECP-1	**A**	80-BOTTO	7/7/99	detected					
ECP-2	**A**	60-BOTTOM	7/7/99	detected					
ECP-5	**C**	72-92	7/8/99						
ECP-5	**B**	114-134	7/8/99						
ECP-5	**A**	34-BOTTO	7/8/99						
ECP-6	**C**	70-90	7/6/99	detected					
ECP-6	**B**	164-184	7/6/99	detected					
ECP-6	**A**	185-215	7/6/99	detected					
ECP-6-S1	**B**	16-36	7/7/99	detected					
ECP-6-S1	**A**	36-50	7/7/99	detected					
ECP-6-S2	**A**	18-BOTTOM	7/7/99	detected					
ECP-7	**B**	21-41	7/8/99	detected	detected	detected	detected	detected	detected
ECP-7	**A**	45-BOTTOM	7/8/99	detected					
SATA-5	**A**	54-BOTTO	7/8/99	detected					
LEGEND									
Bureau of Laboratories Report dated 7/22/99									
blank entries note no detection									

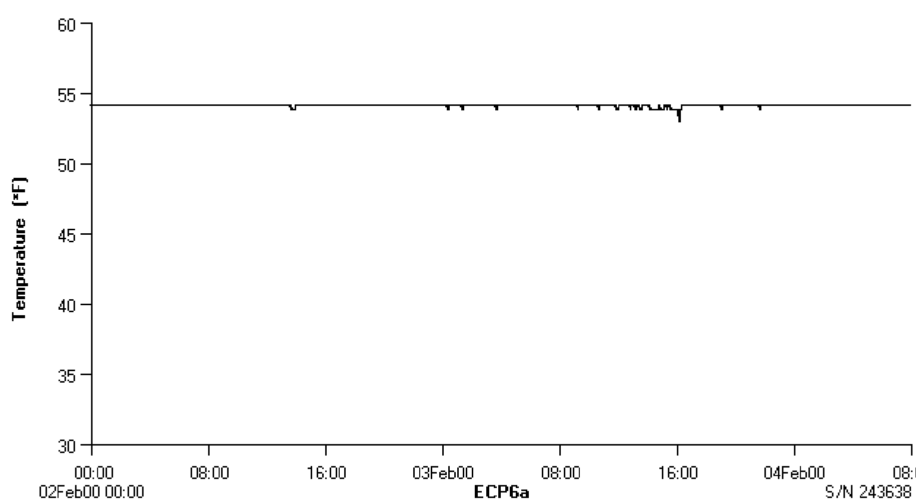
The significance of the volatile organic concentrations could be estimated by considering the available risk based concentrations. Although the inhalation pathway would only be available if the detected volatile organic compounds vented from the voids into residences, the comparison would be valuable with respect to a benchmark for significant concentrations for a specific compound. The inhalation pathway has been demonstrated to be a valid pathway both by documented data, and historical PADEP complaints. The U.S. EPA Region III Risk Based Concentration (RBC) Table (revised April 13, 2000) is provided in Attachment 11. This excel spreadsheet was highlighted in the Ambient air (ug/m^3) column, and the rows where compounds were detected. The detected compounds (rows) and the ambient air RBC column have been copied from this spreadsheet, and an additional column added for this report. The additional column provides the calculation from the micrograms per cubic meter to parts per billion. These calculations allow direct comparison of the RBCs to the four rounds of analytical results. This spreadsheet is provided as Attachment 12. The comparison of the RBC concentrations (converted into parts per billion units) indicates that concentrations in the borehole samples have exceeded the RBCs. This was particularly noted with toluene (110.64 ppb RBC) when compared against the summarized concentrations in Attachment 9.

Temperature

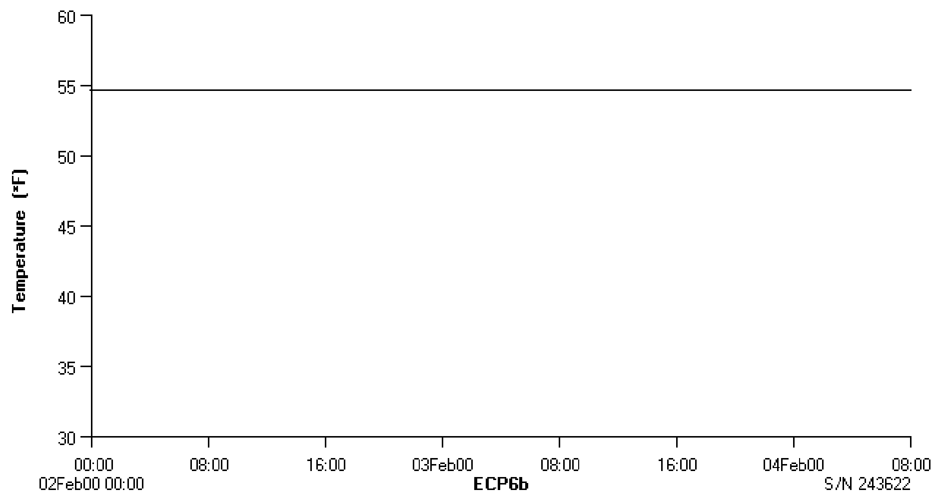
The objective of the temperature monitoring was to determine the direction of vertical air movement in the mined and fractured zones. The upper and lower Onset temperature data loggers were placed at respective depths of 25 (Zone A) and 150 feet (Zone B) below ground surface. The Tetratech Final Report has provided the basic statistics of each monitoring period in the summary tables for each boring. The basic monitoring period consists of approximately seven days of five-minute temperature recordings for each of the two intervals per boring. Therefore, the average temperature per period reflects on the large number (typically greater than 2000 individual data points per data logger per average period) of individual data points. The Tetratech Report provides temperature graphs in the Appendices. This report also provides graphics of the period averages with respect to time.

The upper and lower temperature averages for each boring are provided in Attachment 13. The objective of these graphs is to provide interpretation of the change in the vertical heat gradient for each boring. The graphs indicated that the lower zone appeared to show a relatively constant temperature throughout the year of approximately 55.0 degrees (F) in most cases. The upper zone typically showed increasing temperatures that continued through the summer, and continued through the colder months before the curve started to show a decreasing trend. The area of each graph where the upper temperature was less than the lower temperature should indicate a decrease in the heat gradient upward, and a possible movement of air from the mines to the surface.

In the preceding section, the volatiles noted in Home A and Home B appear to compare with the volatiles detected in the adjacent borings. Therefore, an increasing heat gradient vertically upward would support this interpretation. The volatile samples at these residences collected during the fourth round of packer testing during February 2-3, 2000. The graph for boring ECP-6 does show that the average upper temperature was less than the lower temperature during this time period. Therefore, the heat gradient would be upward, and mine air would be anticipated to move upward considering just the gradient. The weekly graphs for these specific dates (zoom on February 2-4, 2000) have been are also provided for each zone for comparison. The adjacent boring ECP-6 also shows that the graph of the individual data recordings within this specific period show an increasing (although small) upward heat gradient.

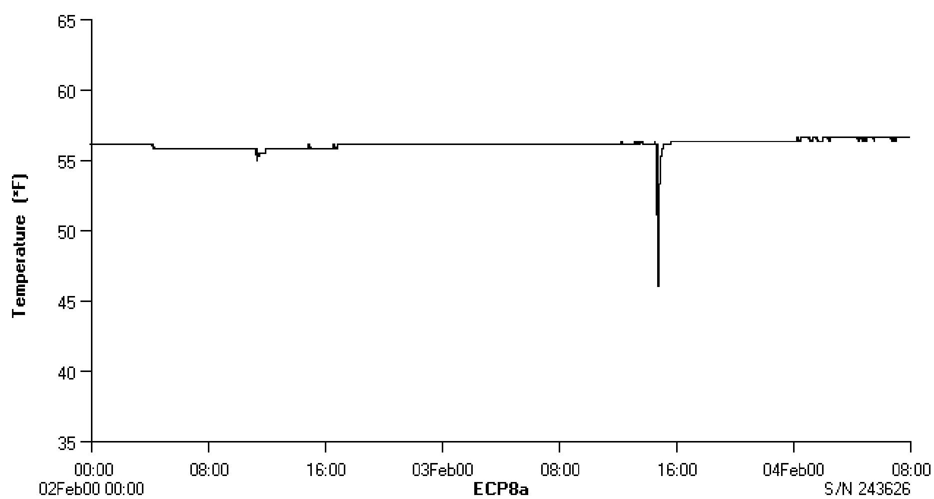


zoom on Onset data for week 41 in upper zone of ECP-6

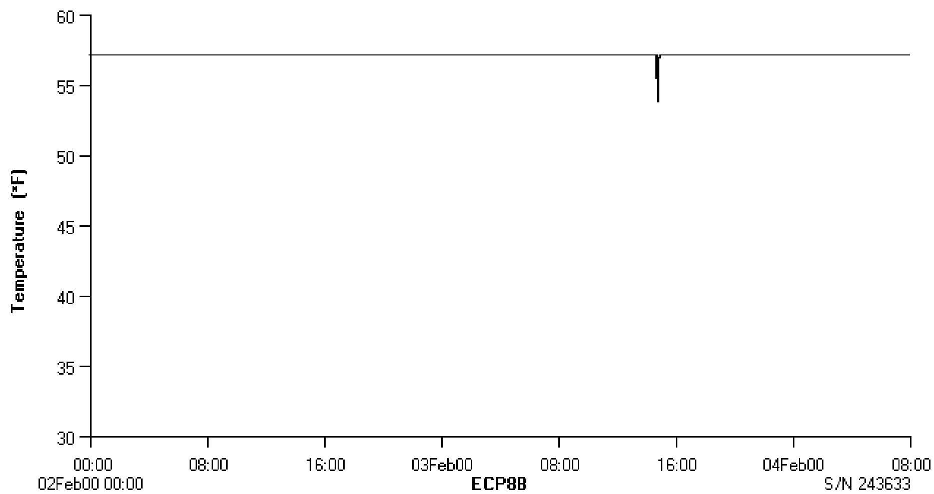


zoom on Onset data for week 41 in lower zone of ECP-6

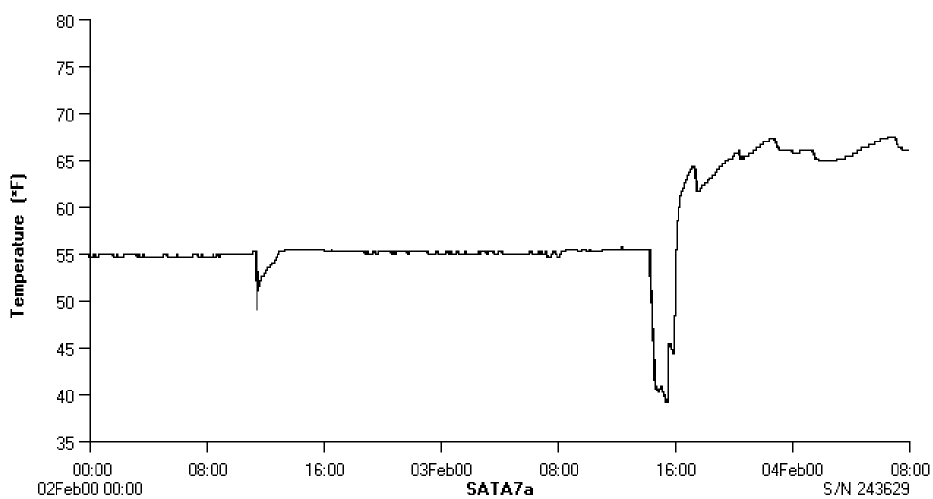
The volatile analysis at Home C and Home D showed only trace volatiles, which would be consistent with the documented air movement upward during the warmer months. The volatile samples were collected on February 3, 2000 at these residences, and continuous residential monitoring (detailed in the next Section of this report) showed normal CO2 and oxygen during this period as anticipated. The graph for adjacent borings SATA-7 (Home C) and ECP-8 (Home D) show that the upper zone average temperature are less than the lower zone temperature at ECP-8 and SATA-7. However, note that the averages of the upper zone have shown reverse gradient at about this period. . The weekly graphs which covers this sampling event (zoom on February 2-4, 2000) have been are also provided for each zone for comparison for these borings.



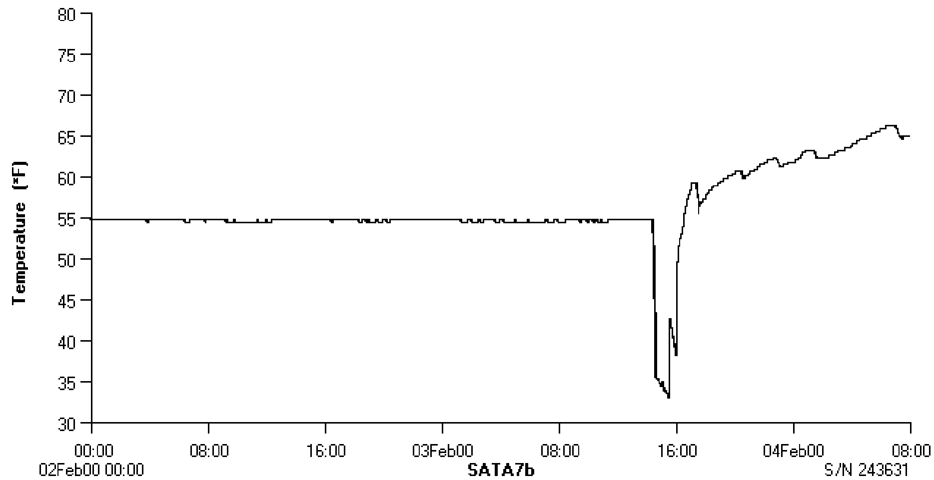
zoom on Onset data for week 41 in upper zone of ECP-8



zoom on Onset data for week 41 in lower zone of ECP-8



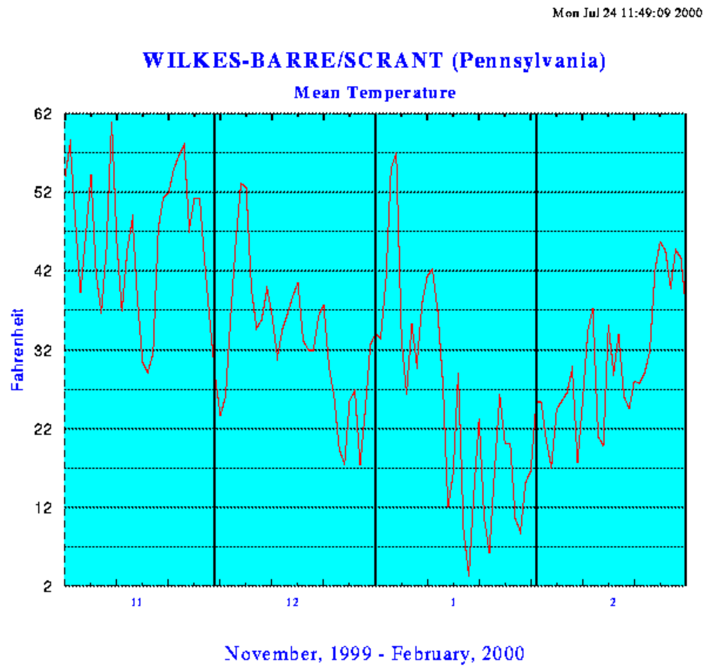
zoom on Onset data for week 41 in upper zone of SATA-7



zoom on Onset data for week 41 in lower zone of SATA-7

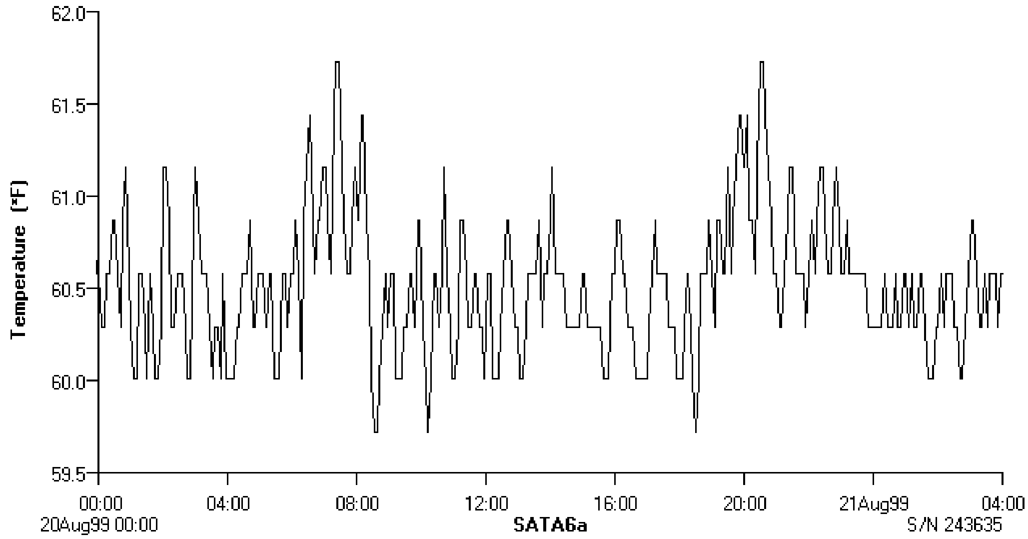
The graphs of the individual points for these borings indicate that heat gradients were almost identical and could be anticipated to reverse during this time period. Note that the temperature peak for all of the borings typically was during the later part of the year. The graph comparing the upper and lower zones indicates that both of these wells have consistent lower temperatures throughout the year (ECP-8=57.0, SATA-7=55.0) with variations typically less than 1.0 degree. The average upper temperature was greater than the average lower temperature during the approximate period of late September 1999 through mid-January 2000 for ECP-8, and for the approximate period of late August 1999 through January 2000 for SATA-7.

The upper and lower temperature averages for borings within a specified area are provided in Attachment 14. The objective of these graphs is to provide interpretations of changes in temperature patterns with respect to areas encompassed by this study. The first set of graphs compare the upper temperatures for specific areas. The graphs indicate that the peak temperatures in the upper zone continued to rise even as the ambient temperatures started to decrease. The historical data for November 1999 through February 2000 was downloaded from the NOAA's National Climatic Data Center from the Wilkes-Barre/Scranton Airport National Weather Station. The mean temperature graph is presented for comparison to the borehole graphs.

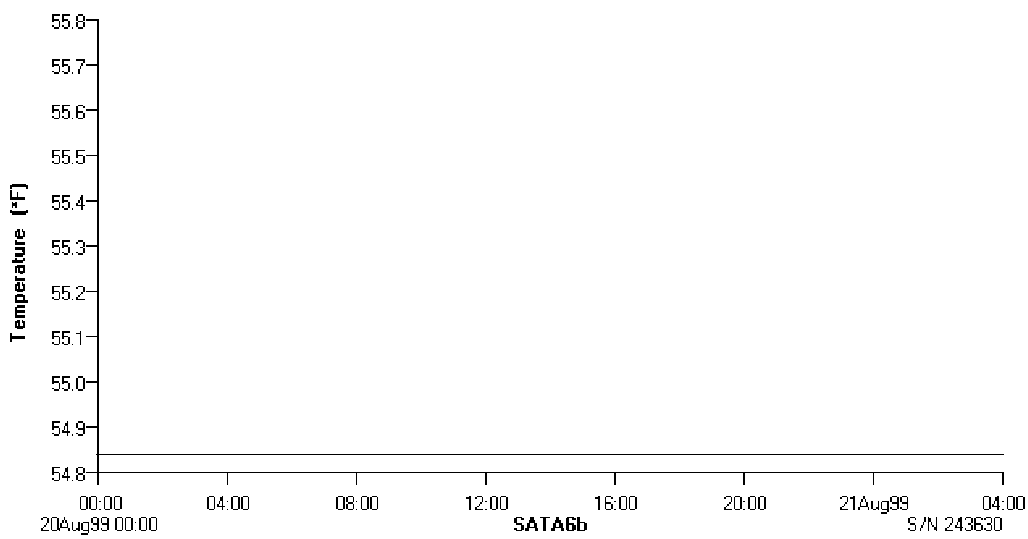


The comparison appears to show that while the mean ambient air temperatures showed an overall expected seasonal decrease some of the upper zone temperatures in the borings showed patterns, which may reflect subsurface factors. The peak temperatures of the borings located North of Reeves Street show higher maximum temperature averages. This is particularly noticeable at SATA-5, where the averages remained above the 60.0-degree (F) mark through early January 2000. The referenced four wells, with the exception of ECP-4, indicate that the peak temperatures occur during late September. ECP-4 appears to show similar trends with the borings South of Reeves Street and North of Drinker Street (two graphs) with the exception of SATA-6 and possibly ECP-4. These exceptions appear to show peak temperatures during late September-early October 1999 time frame. SATA-6 showed relatively high temperatures that sharply decreased to mid-50s during this time frame.

The above information describes the period average temperatures. However, the review of the individual period data was also important in the interpretations. The data from SATA-6 noted extreme oxygen fluctuations in weekly continuous data, and during the review of the packer test data. The reviews during the weekly report submissions had noted an unusual pattern in the graphs of the upper zone in this boring. Note that the lower zone showed a relatively constant temp for this time interval. Although this continuous fluctuation represents a relatively small temperature change, this may indicate that air current is relatively fast at this (and possibly other) location. The following graphs of the data are provided for a typical day. The zoom on a smaller time interval provides resolution of the fluctuations.



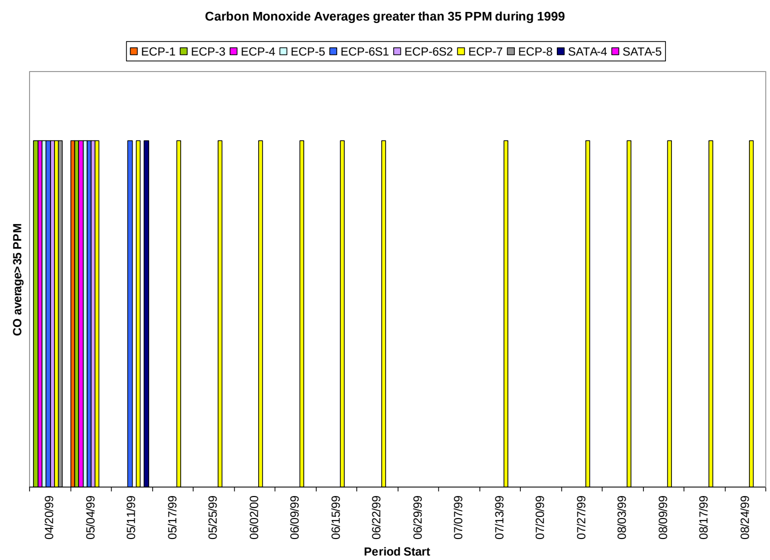
week 18 data Upper Zone SATA-6



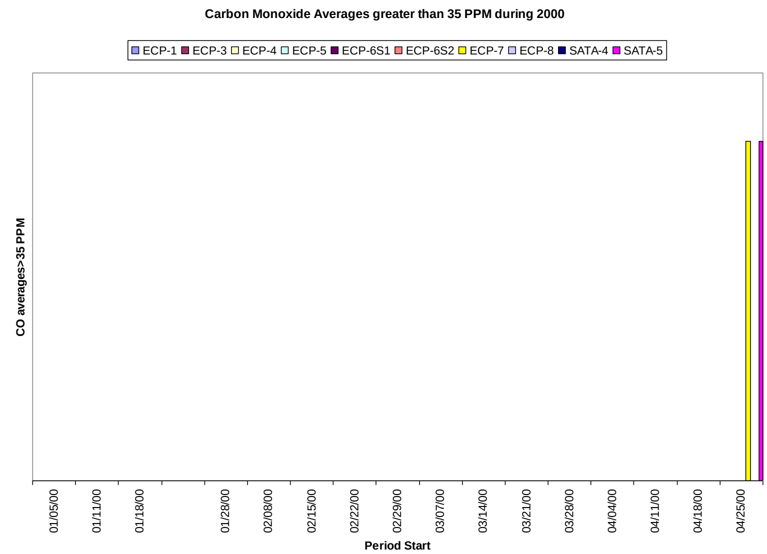
Carbon Monoxide

The carbon monoxide was found at high levels at the borings north of Reeves Street during the initial monitoring phase. The carbon monoxide sensor was damaged during the initial week and required the removal of one bolt from the boring cap to provide some air circulation. These initial readings continued for the initial months of the investigation before decreasing to low levels. The carbon monoxide graphs for ECP-7, ECP-4, and ECP-5 are provided in respective Attachments 15, 16, and 17. These graphs illustrate the high carbon monoxide readings that occurred during the early phase of the investigation, but decreased to low levels for the majority of the monitoring period. However, note that increases are observed at approximately week 50 during the termination period of the monitoring program. The Tetratech report provides Surfer contour maps of the 21 weeks. The Tetratech interpretation states that the decrease of carbon monoxide below 50 parts per million after week 19 would not provide sufficient rationale to suggest the unlined portion of Keystone Landfill as the source. However, additional comparison of the temperature data (and other parameters) would still suggest that this is the probable seasonal source.

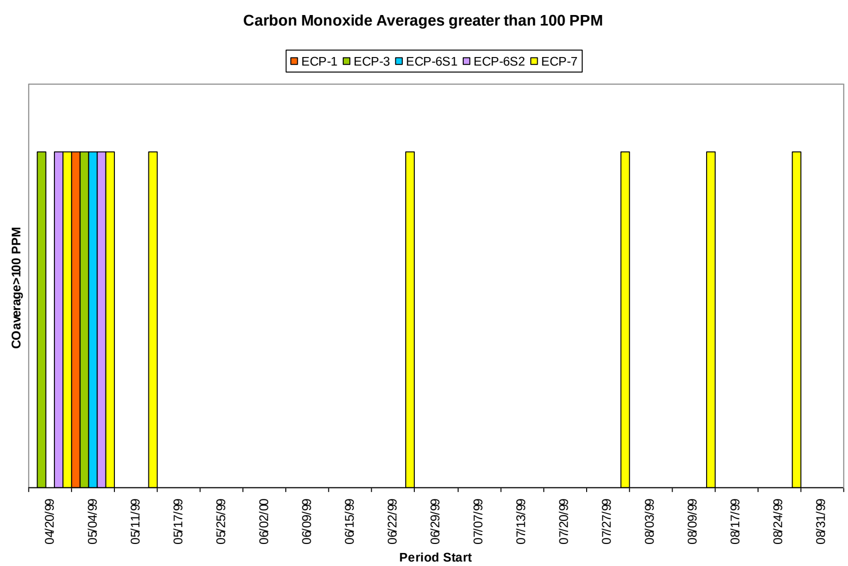
The Tetratech summaries for maximum and average carbon monoxide for each period were reviewed as part of this report. The following bar charts provide comparison when carbon monoxide averages were above 35 and 100 parts per million.



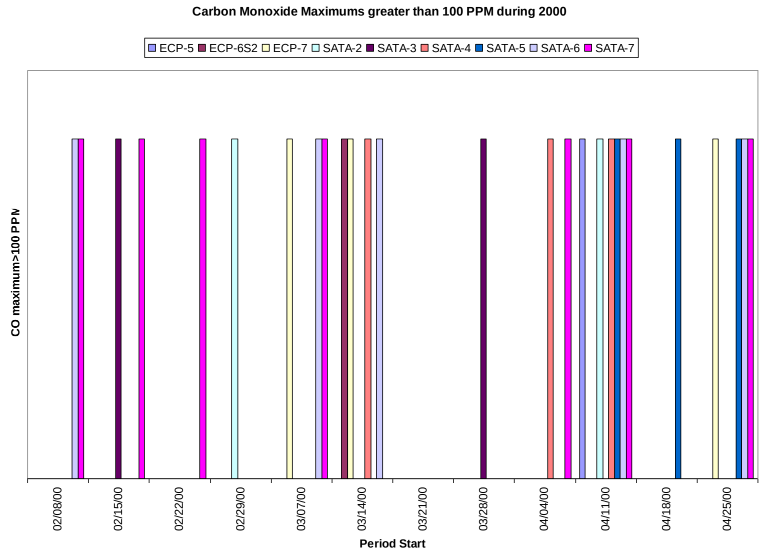
The first chart (above) shows borings where the carbon monoxide average, for a specific period, exceeded 35 parts per million during 1999. The charts were split into two periods and only considered the borings which exceed the benchmark concentration of greater than 35 parts per million. This was necessary to provide visual resolution of the bars in the Excel chart option. Note that the number of borings decreased during May 1999, but ECP-7 continued to have consistent averages above 35 parts per million through most of August 1999. Another important factor was the absence of high SATA-5 measurements during the April through May 1999 period. An important factor would be that measurements from SATA-5 were not initiated until the period starting on June 2, 1999. The following chart needs to be considered in these evaluations.



The chart for the 2000 monitoring period shows that only ECP-7 and SATA-5 exceed the 35 part per million average during the last phase of the monitoring program. The entire 2000 period is provided for visual comparison to additional charts, and the data summaries in the Tetratech report. These charts appear to show a consistent pattern that carbon monoxide will likely have seasonal high concentrations that would likely occur during late winter through late spring.



The above chart raises the carbon monoxide benchmark to a period average greater than 100 parts per million for the borings which had at least one period average above this concentration, and for the portion of the monitoring program where this benchmark was exceeded. Note that the averages occurred for most of the borings (again note lack of data for SATA-5) prior to mid-May 1999, with ECP-7 continuing to show relatively high averages through most of the summer. Although there were no averages greater than 100 parts per million during 2000, the distinct possibility exists that the data was limited due to the termination of data collection period to meet the DEP date for a final report by June 8, 2000.



The above chart illustrates the borings which had (at least one) a maximum carbon monoxide maximum above 100 parts per million during the 2000 monitoring period. The objective of this chart is for comparison of the above charts, and the temperature data (and graphs) in the preceding section. The above chart does support the interpretation that carbon monoxide concentrations did show an increase during the final phase as well as during the initial phase of the monitoring program. The carbon monoxide maximum for periods greater than 100 parts per million was not provided in a chart for the 1999 monitoring period. This is due to the extended period for ECP-7 and other borings, which limits the visual resolution of a chart.

The interpretations of seasonal high carbon monoxide readings would also require comparison to the temperature data in the above section. The graphs provided in Attachment 13 appear to support the above interpretation. Note that the graphs show an upward temperature gradient during 1999, which continues from the initial period during April and extends into the June-July period. The graph for ECP-7 shows an upward temperature gradient extending into June 1999. At this point the temperature gradient slope shows a heat gradient downward. Approximately during late September 1999, the upper temperature slope starts to decrease. The upper temperature continues to decrease and becomes less than the lower temperature during early January 2000. The graph continues to indicate an upward temperature gradient from this point that continues to the termination of the monitoring program.

BORING	SAMPLE ID	INTERVAL (FEET)	DATE	TOLUENE	DIMETHYL ACETAMIDE	HEPTANE	3-METHYL HEXANE	DIMETHYL BENZENE	METHYL CYCLOHEXANE
ECP-1	**C**	42-62	7/7/99	detected					
ECP-1	**B**	146-166	7/7/99	detected					
ECP-1	**A**	180-BOTTOM	7/7/99	detected					
ECP-2	**A**	60-BOTTOM	7/7/99	detected					
ECP-5	**C**	72-92	7/8/99						
ECP-5	**B**	114-134	7/8/99						
ECP-5	**A**	134-BOTTOM	7/8/99						
ECP-6	**C**	70-90	7/6/99	detected					
ECP-6	**B**	164-184	7/6/99	detected					
ECP-6	**A**	185-215	7/6/99	detected					
ECP-6-S1	**B**	16-36	7/7/99	detected					
ECP-6-S1	**A**	36-50	7/7/99	detected					
ECP-6-S2	**A**	18-BOTTOM	7/7/99	detected					
ECP-7	**B**	21-41	7/8/99	detected	detected	detected	detected	detected	detected
ECP-7	**A**	45-BOTTOM	7/8/99	detected					
SATA-5	**A**	154-BOTTOM	7/8/99	detected					

LEGEND

Bureau of Laboratories Report dated 7/22/99

blank entries note no detection

SECTION FOUR

Home A

The initial phase of monitoring by Tetratech EM Inc. (Tetratech) during the continued USEPA investigation included weekly monitoring of approximately fifty residences which included Home A. The weekly monitoring was done from October 30, 1997 to March 27, 1998. The MSA Passport meter was used to record oxygen, carbon monoxide, Lower Explosive Level, and hydrogen sulfide. The data from this period of weekly monitoring indicated the detection of carbon monoxide during twelve of the thirteen weekly observations when the residents were home. The carbon monoxide ranged from 0 to 32 parts per million in the basement, and 0 to 26 parts per million on the first floor. There also was detection of 2 per-cent LEL at both locations on December 4, 1997, and during January 8,1998 in the basement. The weekly monitoring for carbon dioxide was performed using an Riken 411 meter and a Telaire 1320 meter. The carbon dioxide ranged from 50 to 1,100 parts per million in the basement, and 400 to 2,700 parts per million on the first floor. During this phase of the investigation PennDOT was performing continuous monitoring utilizing the Metrosonics AQ-501 recorder. However, limited PennDOT information was provided for evaluation. The PADEP evaluation[9] of the data collected during this period, and PA Department of Health had recommended additional monitoring at this location.

The Hazardous Sites Cleanup Program investigation utilized the continued data collection by Tetratech. The period of data collection continued from April 21, 1999 to May 3, 2000. The basic statistics are presented in Attachment 18. This period represented thirty-five data collection periods. The basic statistics has indicated that carbon monoxide has been detected during each of the periods. Note that due to a computer problem, no carbon monoxide was recorded for four of these periods. The carbon monoxide averages range from zero to six parts per million. The carbon monoxide averages represent zero to one part per million accounting for thirteen of the thirty-five data collection periods. The maximum carbon monoxide ranged from three to ninety-eight parts per million. The maximum carbon monoxide concentration was noted to exceed thirty-five part per million during eighteen of the thirty-five periods of collection intervals. The higher average and maximum carbon monoxide concentrations were observed from September 1999 through mid-April 2000.

The review of the carbon monoxide peaks has indicated a strong pattern of a high peak in the morning (around 09:00) and in the afternoon (around 14:00). This pattern is consistent with the residents entering and exiting with the automobile from the attached garage. Representatives of USEPA, PADEP, and Tetratech for their action have informed the residents of this pattern in the past. The review of the complete data would appear to indicate that the detection of carbon monoxide may be during use of the automobile to some degree, all detections of carbon monoxide cannot be attributed to this source. Regardless of source the carbon monoxide would appear to routinely exceed the PA DOH Health Level of 35 parts per million for a one-hour exposure.

The canister data collected over a 24-hour period during the fourth packer testing of the boreholes is provided in the Tetratech Final Report (Appendix I). The summary of detected volatile organic compounds is presented in the following table. Chloroform, benzene, methylene chloride, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene exceeded the EPA Region III Risk Based Concentration (RBC) for ambient air.

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[9] Department of Environmental Protection, Dunmore Gas Site Project Report, John S. Mellow, June 17, 1998.

Summary of Home A Volatile Organic Compounds

COMPOUND	PARTS PER BILLION
Dichlorodifluoromethane	1.42
Methylene Chloride	1.90
Chloroform	0.09
Benzene	6.94
Toluene	39.50
Ethylbenzene	6.22
m/p-Xylene	12.50
o-Xylene	9.42
1,3,5-Trimethylbenzene	5.43
1,2,4-Trimethylbenzene,	17.97

The detection of these volatile organic compounds would require comparison to the adjacent mine borings and residential samples collected in the same vicinity to determine if this may represent contaminants from the subsurface voids. The location of Home B is in the same general location. Therefore, this comparison of both residences and adjacent will be illustrated in the following section.

Home B

The evaluation[10] [11]of the data from the period extending from March 20, 1998 to April 15, 1999 indicated carbon dioxide showed a decreasing trend as the temperature increased. The carbon monoxide peaks were sporadic with a range of 1 to 11 parts per million for the data generated from March 20, 1998 to October 26, 1998. The eighteen data collection periods showed zero averages for fifteen of these periods and three periods with a one part per million average.

The data from October 26, 1998 thru April 5, 1999 showed the anticipated increase in the carbon dioxide averages with periods during December 1998 thru early March 1999 showing maximum carbon dioxide greater than the upper limit (5000 parts per million) of the Metrosonics AQ-501 recorder. The seventeen data collection periods showed more sporadic carbon monoxide peaks with averages ranging from one to five parts per million, and maximum concentrations ranging from six to eighteen parts per million.

[10] Department of Environmental Protection, Dunmore Gas Site Project Report Supplement, John S. Mellow, November 17, 1998.
[11] Department of Environmental Protection, Dunmore Gas Site Project Report Supplement Two, John S. Mellow, April 22, 1999.


Home B Area

The Hazardous Sites Cleanup Program investigation utilized the continued data collection by Tetratech The period of data collection continued from April 28, 1999 to May 3, 2000. The basic statistics are presented in 15. This period represented twenty-five data collection periods. The carbon monoxide averages ranged from zero to four parts per million. The carbon monoxide maximum concentrations ranged from zero to sixteen parts per million. Note that there was three missing carbon monoxide periods due to collection error during this period. The highest carbon monoxide (average and maximum concentrations) was noted from the period extending from early December 1999 thru February 2000. However, the carbon monoxide maximum concentrations continued to range from six to twelve parts per million from March 2000 to the May 2000 completion of data collection. This was consistent with the highest carbon dioxide averages and maximum concentrations. The carbon dioxide maximum concentrations for the three data collection periods extending from December 22, 1999 to February 11, 2000 were above the upper limit (5000 parts per million) of the Metrosonics AQ-501 recorder. One additional maximum above the upper limit of the recorder was also observed during early April 2000.

During the fourth and final round of packer testing of the boreholes, a Summa canister with calibrated valves was also placed in the residence for a 24-hour collection period. Note that methylene chloride, chloroform, benzene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene exceed the EPA Region III RBCs. The summary of detected volatile organic compounds is presented in the following table.

Summary of Home B Volatile Organic Compounds

COMPOUND	PARTS PER BILLION
Dichlorodifluoromethane	1.14
Methylene Chloride	2.56
Chloroform	1.22
Benzene	3.02
Toluene	24.00
Ethylbenzene	3.06
m/p-Xylene	6.57
o-Xylene	4.84
1,3,5-Trimethylbenzene	3.65
1,2,4-Trimethylbenzene,	14.88

The adjacent boring would be anticipated to have similar volatile compounds if the detected volatile organic compounds in the residence would be coming from the mine voids. The adjacent borings at Home B would be the ECP-6 cluster of wells. The shallow borings were designed to intercept an inclined mineshaft indicated on the Office of Surface Mines (OSM) folios, and evidence by conversation with the residents. The ECP-6S2 boring had intercepted this shaft as evidenced by the drilling and subsequent geophysics/video logs. The ECP-6S1 and ECP-6 borings intercepted deeper intervals. The detected volatile organic compounds in these adjacent boring are presented in the following table for comparison. The header indicates the sample and the depth interval below the surface casing.

COMPOUND	ECP-6A	185-215	ECP-6A (DUPE)	185-215	ECP-6B	164-184	ECP-6C	70-90	ECP-6S1A	36-50	ECP-6S1A (DUPE)	36-50	ECP-6S1B	16-36	ECP-6S1B (DUPE)	16-36	ECP-6S2	18-28	ECP-6S2 (DUPE)
Dichlorodifluoromethane	19.64		15.51		5.91		1.79	J	0.86	J	20.00	ND	0.79	J	1.60	ND	0.54	J	1.60
1,2-dichlorotetrafluoroethane	1.77	J	1.60	ND	0.40	ND	0.40	ND	0.40	ND	20.00	ND	0.40	ND	1.60	ND	0.40	ND	1.60
Trichlorofluoromethane	6.50		1.60	ND	2.12	J	0.70	J	0.27	J	20.00	ND	0.45	J	1.60	ND	0.26	J	1.60
Methylene Chloride	1.85	J	1.60	ND	1.79	J	2.00	J	1.74	J	20.00	ND	2.19	J	1.60	ND	1.82	J	1.60
cis-1,2-Dichloroethene	0.40	ND	1.60	ND	0.40	ND	0.40	ND	0.86	J	20.00	ND	0.40	ND	1.60	ND	0.40	ND	1.60
Chloroform	0.14	J	0.30	J	0.07	J	0.40	ND	0.40	ND	20.00	ND	0.40	ND	0.26	J	0.01	J	1.60
1,1,1-Trichloroethane	7.67		7.06	J	2.28	J	0.70	J	0.29	J	20.00	ND	0.40	ND	1.60	ND	0.40	ND	1.60
Benzene	0.16	J	1.60	ND	0.31	J	0.37	J	0.43	J	20.00	ND	0.57	J	1.60	ND	0.40	ND	1.60
Carbon Tetrachloride	0.40	ND	1.60	ND	0.40	ND	0.09	J	0.40	ND	20.00	ND	0.40	ND	1.60	ND	0.08	J	1.60
Trichloroethylene	0.40	ND	1.60	ND	0.40	ND	0.40	ND	1.33	J	20.00	ND	0.31	J	1.60	ND	0.40	ND	1.60
Toluene	20.00	E	63.51		52.29		27.49		20.00	E	1263.79		20.00	E	367.60		20.00	E	87.21
Tetrachloroethylene	0.40	ND	1.60	ND	0.14	J	0.26	J	0.85	J	20.00	ND	0.40	ND	1.60	ND	0.40	ND	1.60
Ethylbenzene	0.40	ND	1.60	ND	0.28	J	0.35	J	1.74	J	20.00	ND	1.26	J	1.60	ND	0.40	ND	1.60
m/p-Xylene	0.40	ND	1.60	ND	0.48	J	0.61	J	2.27	J	20.00	ND	3.03	J	1.60	ND	0.40	ND	1.60
o-Xylene	0.40	ND	1.60	ND	0.44	J	0.59	J	1.27	J	20.00	ND	3.09	J	1.60	ND	0.40	ND	1.60
1,3,5-Trimethylbenzene	0.40	ND	1.60	ND	0.40	ND	0.40	ND	0.40	ND	20.00	ND	2.87	J	1.60	ND	0.40	ND	1.60
1,2,4-Trimethylbenzene,	0.40	J	1.60	ND	1.67	J	2.25	J	2.52	J	20.00	ND	12.21		1.60	ND	0.40	ND	1.60

This table does indicate that the volatile organic compounds present at Home B are also present in the packer intervals in the adjacent borings. The compound found in the highest concentrations in many of the borings has been toluene. The detection of toluene in relatively high concentrations has been observed during the four rounds of packer testing. The detection of toluene in relatively similar proportions in the residence would also support the possibility of a source in the mine voids.

The previous discussion of Home A shows that the detected volatile organic compounds at both these residences in the same vicinity have consistent detection of these volatile organic compounds. The general area where these residences are located have been indicative of rising air from the mine voids during this time of the year. The general area of Home C and Home D would not be indicative of rising air from the voids during this time of the year. Therefore, the volatile organic compounds detected in the mine voids should not be present in the same proportions for the samples collected at these locations. The discussion of these residences will follow. However, note that volatile organic compounds (particularly toluene) are not present above trace concentrations.

Home C

The historical investigations by USEPA, and the initial monitoring by PADEP and Tetratech had not included this residence. The resident had contacted the site trailer during the early stage of the current investigation and had informed Tetratech representatives about carbon dioxide problems that extended back twenty years. The PADEP Regional Project Officer notified Tetratech to install one of the Metrosonics AQ-501 recorders at this location. The review of the Bureau of Abandoned Mines printout of complaints in this area had indicated past investigations by PADEP at this residence, and at other residences in this area. The first two digits of the BAMR Inquiry indicate the year of the complaint investigation. This summary of complaints had indicated that Home C and Home D had a previous history of complaints. The general complaints for the historical investigations of all these residences ranged from long-term odors, pilot lights going out, to alleged respiratory problems. The Department's Geographical Information System (GIs) intern performed a survey of these residents, and existing boreholes during August 1999. The following table presents the location of residences and the coordinates utilizing the Department's Global Positioning System (GPS) unit.

BAMR INQUIRY	ADDRESS	STREET	LATITUDE PADEP GPS	LONGITUTE PADEP GPS
8505180	512	Butler Street	41 24 47.25	75 37 58.50
8709201	213	Cherry Street	41 24 51.28	75 38 01.10
8804089	146	Chestnut Street	41 25 12.03	75 37 48.28
8905099	500	Fifth Street	41 24 54.58	75 37 56.07
9305193	506	Fifth Street	41 24 54.00	75 37 56.34
7906063	508	Fifth Street	41 24 53.78	75 37 56.56
7906063	510	Fifth Street	41 24 53.73	75 37 56.81
8709218	514	Fifth Street	41 24 53.02	75 37 57.30
9708217	518	Fifth Street	41 24 52.85	75 37 57.53
8610297	526	Fifth Street	41 24 51.12	75 37 58.12
8612350	715	Moritz	41 24 58.64	75 37 08.08
9702033	604	N. Apple Street	41 25 33.52	75 37 28.18
8707155	3	N. Webster Drive	41 25 12.61	75 38 21.86
8502031	818	Second Avenue	41 24 42.49	75 38 20.36
HSCP	612	Shirley Lane	41 25 28.34	75 36 53.69
HSCP	618	Shirley Lane	41 25 27.34	75 36 50.97
9702031	717	Shirley Lane	41 25 23.05	75 36 39.91
9702031	719	Shirley Lane	41 25 21.77	75 36 39.98
9702031	721	Shirley Lane	41 25 21.29	75 36 39.98
9702031	723	Shirley Lane	41 25 20.48	75 36 40.91
7910119	523	Third Street	41 24 55.34	75 38 04.87
9605257	54	Veterans Drive	41 25 07.61	75 38 17.79
9510237	511	Ward Street	41 25 28.67	75 37 27.56

The Metrosonics AQ-501 recorder was placed in the developed basement of this residence and data was collected from May 21, 1999 to May 4, 2000. During the first data collection period it was noted that carbon dioxide concentrations that exceeded the upper range (5000 parts per million) of the recorder would likely bias the carbon dioxide average low. Subsequent monitoring had indicated that carbon monoxide was not a problem during this phase of the investigation. However, carbon dioxide concentrations exceeded the Department of Health's habitability criteria (5000 part per million average for a 24-hour period) frequently during the spring, summer, and fall. The summary of basic statistics for Home C is provided in Attachment 18. Note that the maximum carbon dioxide concentration was greater than 5000 parts per million during thirty of forty-two periods. The carbon dioxide concentrations showed decreases from December 1999 thru part of February 2000. However, the period from February 23, 2000 through the end of data collection during May 2000 showed seven periods of maximum carbon dioxide concentrations exceeding 5000 parts per million, and average carbon dioxide concentrations ranging from 660 to greater than 5000 parts per million. There was only thirteen periods of data which showed carbon dioxide averages less than 1000 parts per million. Three of these averages would likely be biased low due to some observations being above the recorder limits.

During the two monitoring periods extending from February 23, 2000 to March 8, 2000 all of the carbon dioxide concentrations were above the upper range of the Metrosonics AQ-501 recorder. Tetratech had checked the recorder after the first data collection period when this was observed to insure proper operation. Tetratech confirmed[12] that the recorder was operating properly and noted that the carbon dioxide was the highest seen during the time of this investigation. Tetratech utilized the MSA Passport for oxygen readings. The oxygen stabilized at 18.8 per-cent which is below the OSHA "oxygen deficient" defined level[13] [14] of 19.5 per-cent. The historical data was presented to the OSM. The OSM determined that the data warranted the installation of a venting system at this residence and the required paperwork was initiated. However, the owner declined the OSM installation due the required lien condition in the access paperwork. The OSM has provided documentation[15] on the resident declining this system.

This writer had provided previous preliminary assessments of the elevated carbon dioxide concentrations at Home C. The MSA Passport observations collected on July 22, 1999 noted an oxygen level of 19.7 in the basement. The carbon dioxide was noted as "INV" (above 5000 parts per million) on the Metrosonics AQ-501 recorder at this time. The brief assessment[16] indicated that low oxygen levels approaching or falling below the "oxygen deficient" level might be anticipated during the periods of high carbon dioxide. The limited comparison of carbon dioxide and oxygen measurements from the second round of borehole packer tests appeared to show high correlation between these parameters. The second brief assessment[17] evaluated the data from May 21, 1999 thru August 10, 1999. During this period it was noted that the carbon dioxide evaluation might be on the conservative side due to low biased averages, and possible health effects noted at concentrations below 50,000 parts per million. The limited oxygen measurements, collected during the data downloads, showed oxygen ranging from ambient concentrations to a low of 19.7 per-cent. The third assessment[18] reviewed the latest information at that time and provided some brief comparisons to the third round of borehole packer tests. The MSA Passport was utilized to compare oxygen levels at adjacent borehole SATA-7 and in the Home C basement on October 14, 1999. The oxygen readings for Home C and SATA-7 were respectively 19.7 and 15.5 per-cent. The carbon dioxide readings for Home C and SATA-7 were respectively greater than 5000 and 3,200 parts per million. Carbon monoxide was not detected at either location. This memorandum also compared the continuous oxygen from October 13, 1999 thru October 15, 1999 time frame. The oxygen data from the continuous GasTech recorder, which would be located, near the surface (versus the referenced packer isolating the 20 to bottom interval) showed that the oxygen was typically greater than 19 per-cent. This would indicate that the carbon dioxide at Home C may rise well above the upper limit of the Metrosonics AQ-501 recorder (5000 parts per million) during summer periods when oxygen levels from the GasTech recorder are commonly approaching 10 per-cent.

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[12] Email dated March 09, 2000 8:29 AM and March 09, 2000 4:10 PM. John Mellow to multiple addresses.
[13] NIOSH/OSHA/USCG/EPA; Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities; October 1985.
[14] OSHA 1910.120-Hazadous Waste Operations and Emergency Response; Section (a)(3) Definitions.
[15] Office of Surface Mines memorandum, April 4, 2000.
[16] Memorandum to file; John S. Mellow; July 23, 1999.
[17] Memorandum to file; John S. Mellow; September 20, 1999.
[18] Memorandum to file; John S. Mellow; October 21, 1999.

During the fourth and final round of packer testing of the boreholes, a Summa canister with calibrated valves was also placed in the residence for a 24-hour collection period. The complete data from the laboratory analysis is presented in the Tetratech Final Report (Appendix I). The volatile organic data is also presented with adjacent SATA-7 borehole data for comparison. This round of packer tests and resident sampling was performed during February 2000.

COMPOUND	HOME C	PARTS PER BILLION	SATA-7	PARTS PER BILLION
Dichlorodifluoromethane	1.46		0.60	J
Trichlorofluoromethane	0.40	ND	0.29	J
Methylene Chloride	1.82		2.20	J
Chloroform	0.08		0.14	J
Benzene	0.52		1.57	J
Carbon Tetrachloride	0.40	ND	0.10	J
Toluene	1.31		2201.00	D
Tetrachloroethylene	0.40	ND	0.93	J
Ethylbenzene	0.40	ND	1.90	J
m/p-Xylene	0.40	ND	2.96	J
o-Xylene	0.40	ND	2.18	J
1,3,5-Trimethylbenzene	0.40	ND	2.93	J
1,2,4-Trimethylbenzene,	0.40	ND	5.24	

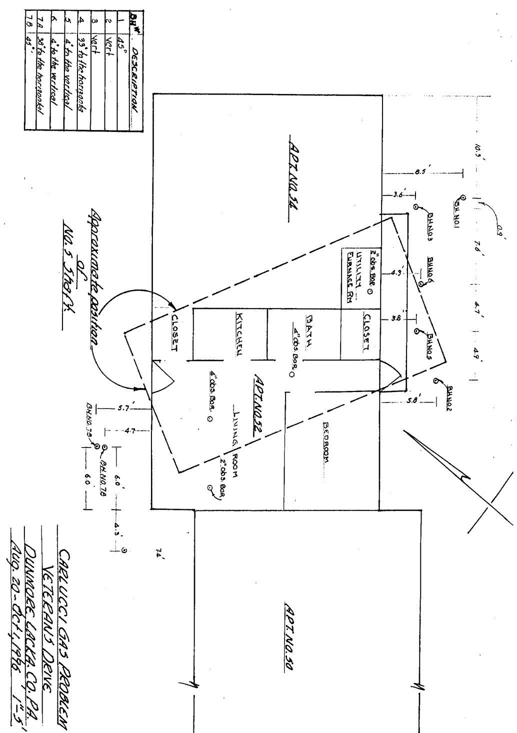
This round of packer tests and resident sampling was performed during February 2000. The historical data would indicate that the air from the mine voids should not be venting during this time frame. Therefore, the volatile organic compounds noted at the residents where mine venting would be occurring to the North (Homes A and B) should not be present to the same degree at Home C or at Home D. Note that although high toluene was detected in SATA-7in relatively high concentrations, it was found at trace levels at Home C. The concentrations of methylene chloride and benzene were slightly above the USEPA Region III RBCs. The comparison of these homes will be detailed in the next section.

Home D

The initial investigation of complaints at this residence was performed by the OSM[19] during 1996. The evaluation of borings performed had found the existence of a vertical mine shaft approximately 10-feet by 21-feet in cross-section, and at least 300-feet deep. The OSM investigation had determined that this vertical shaft was a pathway for high levels of carbon dioxide, and a potential subsidence threat. The multiple apartment units that include Home D had been condemned and recommended for continued monitoring. The sketch in the OSM files and the delineation (dashed line) of the mineshaft cross-section is presented with a picture of this Apartment building for perspective.

[19] Office of Surface Mines; Project No: WB-96-317.

Home D



OSM Sketch

Tetratech had continued to monitor this location during the weekly monitoring conducted from October 30, 1997 through March 27, 1998. The weekly monitoring[20] had indicated only one elevated (3000 parts per million) carbon dioxide observation. The historical information available from OSM and the weekly monitoring, indicated that one of the Metrosonics AQ-501 recorders would be warranted at this location. The continuous recorder was installed on March 25, 1999. The data collected by Tetratech and subsequently by the PADEP Regional Project Officer was evaluated from the period of March 25, 1999 through June 12, 1999. The initial PADEP Project Report[21] had noted that carbon dioxide peaks increased in magnitude and frequency as the ambient temperature increased. The increase in carbon dioxide averages with increasing temperatures was also noted. The evaluation of carbon dioxide with barometric data (downloaded form the Avoca National Weather Station) did not show a influence by these parameters. This comparison included the barometric pressure during a severe weather pattern during June 1, 1998 and June 3, 1998.

The two PADEP Project Report Supplements[22] [23] continued to evaluate the data collected from March 13, 1998 through March 22, 1999 . This consisted to thirty-two data collection periods. The evaluation of graphic trends continued to show strong correlation of temperature with carbon dioxide. During the colder periods smaller rises and falls of carbon dioxide may not correlate as well. In addition, the humidity did not show any consistent trend with these data sets.

The final HSCP investigation continued the data collection at this residence, and included the installation of a borehole behind this apartment unit. Several additional shallow wells were originally planned for installation into the section of the vertical shaft where it extended beyond the structure. However, the slight potential for structural damage (discussions on-site with drillers and OSM) warranted the change to eliminate the proposed shallow borings.

The continued data collection by Tetratech extended from May 27, 1999 through May 4, 2000. The summarized statistics are provided in Attachment 18. The carbon monoxide appeared to be more frequent than from the initial investigations. However, the maximum concentration noted during this investigation was 9.0 parts per million. The carbon dioxide continued to show strong correlation with temperature. During the warmer months, carbon dioxide frequently exceeded the upper range of 5000 parts per million of the Metrosonics AQ-501 recorder. The basic statistics summary shows that sixteen of the forty-three data collection periods had a maximum concentration above 5000 parts per million. The maximum carbon dioxide fell below 5000 parts per million during the data collection period starting on September 30, 1999. The average carbon dioxide fell below 1000 parts per million during the data collection period starting on October 16, 1999. The comparison of the carbon dioxide data indicates that the decrease below 5000 parts per million occurred earlier in the Fall than at Home C. The data also shows that the carbon dioxide maximum increases later in the Spring than at Home C. The anticipated increase of carbon dioxide above 5000 parts per million would be mid to late Spring based on historical monitoring. However, the data collection period ended as this seasonal period approached. Note that the maximum temperature for the fifteen data collection periods during the Year 2000 were below sixty-five degrees (F).

As previously stated during the discussion of Home C, the 24-hour sample for volatile organic compounds was collected during the fourth round of packer testing of the boreholes. The complete analytical results are

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[20] Tetra Tech EM Inc.; Final Air Quality Investigation Report, Dunmore CO Site, Lackawanna County, Pennsylvania, June 29, 1998.

[21] Department of Environmental Protection, Dunmore Gas Site Project Report, John S. Mellow, June 17, 1998.

[22] Department of Environmental Protection, Dunmore Gas Site Project Report Supplement, John S. Mellow, November 17, 1998.

[23] Department of Environmental Protection, Dunmore Gas Site Project Report Supplement Two, John S. Mellow, April 22, 1999.

presented in the Tetratech Final Report (Appendix I). The summary of detected volatile organic compounds at Home D is presented in the following table. Note that methylene chloride, chloroform, and benzene were slightly above the USEPA Region III RBCs. The detected volatile organic compounds at adjacent boring ECP-8 are also provided for comparisons. The identification of duplicate samples and specific monitoring are provided in the header.

COMPOUND	HOME D	PARTS PER BILLION	ECP-8A	170-200	ECP-8A	170-200	ECP-8B	148-168	ECP-8B	148-168	ECP-8C	118-138	ECP-8C	118-138	ECP-8D	56-76	ECP-8E	14-34
Dichlorodifluoromethane	0.90		1.28	J	3.2	ND	3.52	J	3.2	ND	0.4	ND	1.6	ND	5.65	J	0.4	ND
Trichlorofluoromethane	4.56		0.5	J	3.2	ND	0.96	J	3.2	ND	0.4	ND	1.6	ND	0.4	ND	0.4	ND
Methylene Chloride	1.87		6.81	J	27.07	J	2.65	J	17.22	J	2.14	J	8.17	J	2.29	J	2.27	J
Chloroform	0.10		1.18	J	1.11	J	1.98	J	1.78	J	1.31	J	1.64	J	11.09	J	0.47	J
1,1,1-Trichloroethane	0.40	ND	0.4	ND	3.2	ND	0.43	J	3.2	ND	0.4	ND	1.6	ND	0.4	ND	0.4	ND
Benzene	0.48		1.62	J	3.2	ND	0.72	J	3.2	ND	0.4	ND	1.6	ND	0.4	ND	0.42	J
Carbon Tetrachloride	0.40	ND	0.14	J	3.2	ND	0.13	J	3.2	ND	0.4	ND	1.6	ND	0.4	ND	0.4	ND
Toluene	1.14		-20	E	479.67		471.15		534.08		-20	E	251.03		79.97		61.81	
Tetrachloroethylene	0.40	ND	0.99	J	3.2	ND	0.86	J	3.2	ND	0.4	ND	1.6	ND	0.21	J	0.4	ND
Ethylbenzene	0.40	ND	0.92	J	3.2	ND	0.54	J	3.2	ND	0.4	ND	1.6	ND	0.4	ND	0.2	J
m/p-Xylene	0.40	ND	1.21	J	3.2	ND	0.56	J	3.2	ND	0.4	ND	1.6	ND	0.4	ND	0.26	J
o-Xylene	0.40	ND	0.85	J	3.2	ND	0.37	J	3.2	ND	0.4	ND	1.6	ND	0.4	ND	0.24	J
1,2,4-Trimethylbenzene,	0.40	ND	1.69	J	3.2	ND	1.02	J	3.2	ND	0.4	ND	1.6	ND	0.4	ND	0.4	ND

The volatile organic compounds detected in small concentrations at Home C (dichlorodifluoromethane, methylene chloride, chloroform, benzene, and toluene) were also detected at Home D. The toluene levels in the mine voids were relatively high as with SATA-7. The flow of air from the mine voids would not be anticipated to be upward during the time of the packer tests. The volatile compounds detected would appear to support the anticipated airflow patterns anticipated in this section of Dunmore. The relatively low levels compared with Home A and Home B would also support the probability that the volatile organic compounds in these areas are due to flow from the mines.

SECTION FIVE

CASE HISTORIES OF CARBON DIOXIDE

The toxicity of carbon dioxide has been presented in correspondence from the Pennsylvania Department of Health to the Dunmore Borough Council, and in correspondence to William McDonnell in a subsequent correspondence. The potential significance of carbon dioxide was also discussed during a meeting held at the PADEP Regional Office on October 28, 1999. Representatives of PADEP, PADOH, USEPA, OSM, and the Dunmore Borough were briefed on the status of the monitoring program. Subsequent to this meeting, the two action items discussed were addressed to the Borough. The items were the possible monitoring devices (CO2 and/or O2) practical for residential monitoring, and the rough delineation of the areas that might be susceptible to high CO2 and CO. These items were addressed in correspondence dated December 13, 1999.

The documented cases of health effects from carbon dioxide have also been searched on the Internet. There have been specific cases where carbon dioxide has caused fatalities. The objective of the citations presented in Attachment 19 would be to demonstrate that while CO2 might not be considered a hazardous substance under CERCLA or RCRA, it can reach concentrations which may be considered toxic, and/or displace oxygen to hazardous levels.

The first case was the fatality in Britain's former coalfields near Northumberland. An unusual weather condition created a pressure drop which vented accumulated carbon dioxide from an abandoned mine working which overcome a 60-year old male walking in the area. The dangers of carbon dioxide (stythe), is presented in the attached news releases from the British Geological Survey and other sources.

The second case was the fatality of a refrigeration repairman in Boston. The repairman was overcome by dangerous levels of carbon dioxide from the evaporation of blocks of dry ice. The carbon dioxide released from the dry ice accumulated in a walk in freezer in a restaurant. This citation was from an OSHA Region I News Release. The various citations and proposed penalties against the restaurant included failure to provide the place of employment free from recognized hazards, citing an immediately dangerous to life and health (IDLH) carbon dioxide concentration of 40,000 parts per million.

The third case represents the carbon dioxide study at Mammoth Mountain, California. This study is on the release of magmatic carbon dioxide. The carbon dioxide originates at depth and migrates to the surface and in the soil void space. The accumulation of carbon dioxide in the soil void space was not recognized until 1994. This U.S. Geological Survey (USGS) study has documented that carbon dioxide exceeding OSHA standards have been measured in test pits in soil, snow, and in poorly ventilated buildings. The samples of soil gas showed a range of less than 1 per-cent (background) to greater than 95 per-cent by volume. The chemical analysis has shown that the soil gas in anomaly areas is significantly greater than local atmospheric levels (0.037 percent), and at the control area (0.498 percent). The USGS notes that natural or man-made depressions (with or without tree kills), in this vicinity may be a risk to human health. The most visible effects have been the tree kill zones where carbon dioxide has accumulated to toxic concentrations in the root zone. However, a U.S. Forest Service ranger reported symptoms of asphyxia (March 1990) when he entered a snow-covered cabin near Horseshoe Lake.

The fourth case is briefly discussed on the USGS Volcano Hazards program. The brief information on common lethal carbon dioxide concentrations that are monitored in the East African Rift Zone. The significance of this information is the "sharp boundary" of high carbon dioxide and ambient air. The attached photographs show that lowering a torch several centimeters can cause the flame to go out.

The fifth case represents an evaluation of indoor air quality at the Beverly Hills Unified School District (BHUSD). The Phylar Group, Inc evaluated the indoor air quality data collected by CTL Environmental Services, Inc. The action levels were determined using the standard risk assessment protocols developed by USEPA, and the California Environmental Protection Agency. The action level for carbon dioxide based on the class size was determined to be 1000 parts per million for the 8-hour time weighted average, and 2000 parts per million for the peak exposure. The triggering of an action level was noted as possibly not necessarily dangerous to human health, but may warrant sampling or more detailed evaluation.

The sixth case is summarized on an OSHA Hazard Informational Bulletin (June 5, 1996) regarding a fatality of a tractor-trailer driver. During a routine delivery to a restaurant supply company, an incomplete seal on the CO2 delivery system and a below ground fill station created dangerous levels to accumulate at the fill point.

The seventh case also is summarized on an OSHA News Release (July 31, 1996). The objective of the News Release was to present the dangers of oxygen displacement by carbon dioxide in decorative waterfalls and fountains. The one example presents the case where an employee adjusting the valves in a fountain pit lost consciousness. His partner also lost consciousness in a rescue attempt. A security guard and a passerby attempted a rescue but abandoned the attempt as they became dizzy. The Fire Department provided an adequate rescue, and both employees were treated and released.

The eighth case represents the summary of the findings by the U.S. Geological Survey and other domestic and foreign researchers on the release of carbon dioxide from two Cameroon lakes. The violent turnover of Lake Monoun (1984) and Lake Nyos (1986) resulted in approximately 1,800 human fatalities, and thousands of domestic and wild animals. The basic elements of a proposed degassing program, tentatively scheduled to start during 2000, is attached. The basic findings indicate that carbon dioxide from springs enters the bottoms of these highly stratified lakes creating high concentrations of trapped carbon dioxide at lower levels. The mechanism creating the violent overturn of the lower lake levels has not been defined at this point in time.

The ninth case represents gases from abandoned mines in the Eastern part of Russia. The Associated Press article describes the problems encountered in the town of Partizansk (pop. Approximately 59,000) due to high carbon dioxide and associated low oxygen from the abandoned mines closed in 1996. The Russian officials had prohibited residents from using about 600 cellars. However, the residents have improvised novel ways of short trips to retrieve food from their cellars.

FINAL REPORT ADDENDUM:

The objective of this supplement is to compare the historical concentrations of volatile organic compounds, specifically benzene, with the recent PA. Department of Health (PADOH) standard of 8.0 ug/M^3. This supplement can be considered an Addendum to the Regional Project Officer Final Project Report (August 10, 2000). The referenced report documents the potential problems with low oxygen, high carbon dioxide, seasonal high carbon monoxide, and other volatile organics exceeding USEPA Region III Risk Based Concentrations (RBCs). This supplement only provides an additional comparison on the recent establishment of residential benzene levels.

The canister data collected over a 24-hour period during the fourth packer testing of the boreholes is provided in the Tetratech Final Report (Appendix I). The summary of detected volatile organic compounds is presented in the following table. Chloroform, benzene, methylene chloride, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene exceeded the EPA Region III Risk Based Concentration (RBC) for ambient air.

Summary of Home A Volatile Organic Compounds

COMPOUND	PARTS PER BILLION
Dichlorodifluoromethane	1.42
Methylene Chloride	1.90
Chloroform	0.09
Benzene	6.94
Toluene	39.50
Ethylbenzene	6.22
m/p-Xylene	12.50
o-Xylene	9.42
1,3,5-Trimethylbenzene	5.43
1,2,4-Trimethylbenzene,	17.97

The detection of these volatile organic compounds would require comparison to the adjacent mine borings and residential samples collected in the same vicinity to determine if this may represent contaminants from the subsurface voids. The location of Home B is in the same general location. Therefore, this comparison of both residences and adjacent will be illustrated in the following section.

Home B

During the fourth and final round of packer testing of the boreholes, a Summa canister with calibrated valves was also placed in the residence for a 24-hour collection period. Note that methylene chloride, chloroform, benzene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene exceed the EPA Region III RBCs. The summary of detected volatile organic compounds is presented in the following table.

Summary of Home B Volatile Organic Compounds

COMPOUND	PARTS PER BILLION
Dichlorodifluoromethane	1.14
Methylene Chloride	2.56
Chloroform	1.22
Benzene	3.02
Toluene	24.00
Ethylbenzene	3.06
m/p-Xylene	6.57
o-Xylene	4.84
1,3,5-Trimethylbenzene	3.65
1,2,4-Trimethylbenzene,	14.88

The adjacent boring would be anticipated to have similar volatile compounds if the detected volatile organic compounds in the residence would be coming from the mine voids. The adjacent borings at Home B would be the ECP-6 cluster of wells. The shallow borings were designed to intercept an inclined mineshaft indicated on the Office of Surface Mines (OSM) folios, and evidence by conversation with the residents. The ECP-6S2 boring had intercepted this shaft as evidenced by the drilling and subsequent geophysics/video logs. The ECP-6S1 and ECP-6 borings intercepted deeper intervals. The detected volatile organic compounds in these adjacent boring are presented in the following table for comparison. The header indicates the sample and the depth interval below the surface casing.

COMPOUND	ECP-6A	185-215	ECP-6A (DUPE)	185-215	ECP-6B	164-184	ECP-6C	70-90	ECP-6S1A	36-50	ECP-6S1A (DUPE)	36-50	ECP-6S1B	16-36	ECP-6S1B (DUPE)	16-36	ECP-6S2	18-28	ECP-6S2 (DUPE)
Dichlorodifluoromethane	19.64		15.51		5.91		1.79	J	0.86	J	20.00	ND	0.79	J	1.60	ND	0.54	J	1.60
1,2-dichlorotetrafluoroethane	1.77	J	1.60	ND	0.40	ND	0.40	ND	0.40	ND	20.00	ND	0.40	ND	1.60	ND	0.40	ND	1.60
Trichlorofluoromethane	6.50		1.60	ND	2.12	J	0.70	J	0.27	J	20.00	ND	0.45	J	1.60	ND	0.26	J	1.60
Methylene Chloride	1.85	J	1.60	ND	1.79	J	2.00	J	1.74	J	20.00	ND	2.19	J	1.60	ND	1.82	J	1.60
cis-1,2-Dichloroethene	0.40	ND	1.60	ND	0.40	ND	0.40	ND	0.86	J	20.00	ND	0.40	ND	1.60	ND	0.40	ND	1.60
Chloroform	0.14	J	0.30	J	0.07	J	0.40	ND	0.40	ND	20.00	ND	0.40	ND	0.26	J	0.01	J	1.60
1,1,1-Trichloroethane	7.67		7.06	J	2.28	J	0.70	J	0.29	J	20.00	ND	0.40	ND	1.60	ND	0.40	ND	1.60
Benzene	0.16	J	1.60	ND	0.31	J	0.37	J	0.43	J	20.00	ND	0.57	J	1.60	ND	0.40	ND	1.60
Carbon Tetrachloride	0.40	ND	1.60	ND	0.40	ND	0.09	J	0.40	ND	20.00	ND	0.40	ND	1.60	ND	0.08	J	1.60
Trichloroethylene	0.40	ND	1.60	ND	0.40	ND	0.40	ND	1.33	J	20.00	ND	0.31	J	1.60	ND	0.40	ND	1.60
Toluene	20.00	E	63.51		52.29		27.49		20.00	E	1263.79		20.00	E	367.60		20.00	E	87.21
Tetrachloroethylene	0.40	ND	1.60	ND	0.14	J	0.26	J	0.85	J	20.00	ND	0.40	ND	1.60	ND	0.40	ND	1.60
Ethylbenzene	0.40	ND	1.60	ND	0.28	J	0.35	J	1.74	J	20.00	ND	1.26	J	1.60	ND	0.40	ND	1.60
m/p-Xylene	0.40	ND	1.60	ND	0.48	J	0.61	J	2.27	J	20.00	ND	3.03	J	1.60	ND	0.40	ND	1.60
o-Xylene	0.40	ND	1.60	ND	0.44	J	0.59	J	1.27	J	20.00	ND	3.09	J	1.60	ND	0.40	ND	1.60
1,3,5-Trimethylbenzene	0.40	ND	1.60	ND	0.40	ND	0.40	ND	0.40	ND	20.00	ND	2.87	J	1.60	ND	0.40	ND	1.60
1,2,4-Trimethylbenzene,	0.40	J	1.60	ND	1.67	J	2.25	J	2.52	J	20.00	ND	12.21		1.60	ND	0.40	ND	1.60

This table does indicate that the volatile organic compounds present at Home B are also present in the packer intervals in the adjacent borings. The compound found in the highest concentrations in many of the borings has been toluene. The detection of toluene in relatively high concentrations has been observed *during the four rounds of packer testing. The detection of toluene in relatively similar proportions in the residence would also support the possibility of a source in the mine voids.*

The previous discussion of Home A shows that the detected volatile organic compounds at both these residences in the same vicinity have consistent detection of these volatile organic compounds. The general area where these residences are located have been indicative of rising air from the mine voids during this time of the year. The general area of Home C and Home D would not be indicative of rising air from the voids during this time of the year. Therefore, the volatile organic compounds detected in the mine voids should not be present in the same proportions for the samples collected at these locations. The discussion of these residences will follow. However, note that volatile organic compounds (particularly toluene) are not present above trace concentrations.

Home C

During the fourth and final round of packer testing of the boreholes, a Summa canister with calibrated valves was also placed in the residence for a 24-hour collection period. The complete data from the laboratory analysis is presented in the Tetratech Final Report (Appendix I). The volatile organic data is also presented with adjacent SATA-7 borehole data for comparison. This round of packer tests and resident sampling was performed during February 2000.

COMPOUND	HOME C	PARTS PER BILLION	SATA-7	PARTS PER BILLION
Dichlorodifluoromethane	1.46		0.60	J
Trichlorofluoromethane	0.40	ND	0.29	J
Methylene Chloride	1.82		2.20	J
Chloroform	0.08		0.14	J
Benzene	0.52		1.57	J
Carbon Tetrachloride	0.40	ND	0.10	J
Toluene	1.31		2201.00	D
Tetrachloroethylene	0.40	ND	0.93	J
Ethylbenzene	0.40	ND	1.90	J
m/p-Xylene	0.40	ND	2.96	J
o-Xylene	0.40	ND	2.18	J
1,3,5-Trimethylbenzene	0.40	ND	2.93	J
1,2,4-Trimethylbenzene,	0.40	ND	5.24	

This round of packer tests and resident sampling was performed during February 2000. The historical data would indicate that the air from the mine voids should not be venting during this time frame. Therefore, the volatile organic compounds noted at the residents where mine venting would be occurring to the North (Homes A and B) should not be present to the same degree at Home C or at Home D. Note that although high toluene was detected in SATA-7in relatively high concentrations, it was found at trace levels at Home

C. The concentrations of methylene chloride and benzene were slightly above the USEPA Region III RBCs. The comparison of these homes will be detailed in the next section.

Home D

As previously stated during the discussion of Home C, the 24-hour sample for volatile organic compounds was collected during the fourth round of packer testing of the boreholes. The complete analytical results are presented in the Tetratech Final Report (Appendix I). The summary of detected volatile organic compounds at Home D is presented in the following table. Note that methylene chloride, chloroform, and benzene were slightly above the USEPA Region III RBCs. The detected volatile organic compounds at adjacent boring ECP-8 are also provided for comparisons. The identification of duplicate samples and specific monitoring are provided in the header.

COMPOUND	HOME D	PARTS PER BILLION	ECP-8A	170-200	ECP-8A	170-200	ECP-8B	148-168	ECP-8B	148-168	ECP-8C	118-138	ECP-8C	118-138	ECP-8D	56-76	ECP-8E	14-34
Dichlorodifluoromethane	0.90		1.28	J	3.2	ND	3.52	J	3.2	ND	0.4	ND	1.6	ND	5.65	J	0.4	ND
Trichlorofluoromethane	4.56		0.5	J	3.2	ND	0.96	J	3.2	ND	0.4	ND	1.6	ND	0.4	ND	0.4	ND
Methylene Chloride	1.87		6.81	J	27.07	J	2.65	J	17.22	J	2.14	J	8.17	J	2.29	J	2.27	J
Chloroform	0.10		1.18	J	1.11	J	1.98	J	1.78	J	1.31	J	1.64	J	11.09	J	0.47	J
1,1,1-Trichloroethane	0.40	ND	0.4	ND	3.2	ND	0.43	J	3.2	ND	0.4	ND	1.6	ND	0.4	ND	0.4	ND
Benzene	0.48		1.62	J	3.2	ND	0.72	J	3.2	ND	0.4	ND	1.6	ND	0.4	ND	0.42	J
Carbon Tetrachloride	0.40	ND	0.14	J	3.2	ND	0.13	J	3.2	ND	0.4	ND	1.6	ND	0.4	ND	0.4	ND
Toluene	1.14		-20	E	479.67		471.15		534.08		-20	E	251.03		79.97		61.81	
Tetrachloroethylene	0.40	ND	0.99	J	3.2	ND	0.86	J	3.2	ND	0.4	ND	1.6	ND	0.21	J	0.4	ND
Ethylbenzene	0.40	ND	0.92	J	3.2	ND	0.54	J	3.2	ND	0.4	ND	1.6	ND	0.4	ND	0.2	J
m/p-Xylene	0.40	ND	1.21	J	3.2	ND	0.56	J	3.2	ND	0.4	ND	1.6	ND	0.4	ND	0.26	J
o-Xylene	0.40	ND	0.85	J	3.2	ND	0.37	J	3.2	ND	0.4	ND	1.6	ND	0.4	ND	0.24	J
1,2,4-Trimethylbenzene,	0.40	ND	1.69	J	3.2	ND	1.02	J	3.2	ND	0.4	ND	1.6	ND	0.4	ND	0.4	ND

The volatile organic compounds detected in small concentrations at Home C (dichlorodifluoromethane, methylene chloride, chloroform, benzene, and toluene) were also detected at Home D. The toluene levels in the mine voids were relatively high as with SATA-7. The flow of air from the mine voids would not be anticipated to be upward during the time of the packer tests. The volatile compounds detected would appear to support the anticipated airflow patterns anticipated in this section of Dunmore. The relatively low levels compared with Home A and Home B would also support the probability that the volatile organic compounds in these areas are due to flow from the mines.

Scope of Work-Dunmore Gas Site Background Characterization

Objective: The following Scope of Work (SOW) is to perform a continued and focused investigation that characterizes the volatile organic compounds within the former anthracite mining areas within the former Dunmore Gas Site study area, and within areas outside of this area. The objective is based on the recommendations of the evaluations of technical representatives of the Department of Environmental Protection (Hazardous Sites Cleanup Program, Special Projects Program, Emergency Management, and Bureau of Abandoned Mine Reclamation), U.S. Office of Surface Mines (OSM), and U.S. Environmental Protection Agency (EPA). The focused objectives are based on the review of the historical investigations by various Federal and State Agencies that was initiated during 1996 The most recent investigation was completed by the Department's former HSCP contractor Tetratech EM Inc. (Tetratech) during June 2000.

Contractor common tasks: The contractor will be provided with the basic information on the historical investigations performed in the Dunmore area. Specifically, borehole information and summarized field and laboratory analysis performed during the four rounds of packer testing. The contractor will become familiar with the basic information on the contaminants of concern concurrent with the scheduling of the initial scoping meeting. The contractor shall provide equipment and manpower to complete drilling boreholes and perform air monitoring as described in the following sections. The contractor will provide a basic cost analysis for renting versus purchasing equipment which will be utilized during the air monitoring of the residences and drilling boreholes prior to mobilization to the site. The contractor shall provide necessary maintenance of site instrumentation, and insure that routine calibration (as recommended by the specific manufacturer) is performed and scheduled accordingly.

The contractor shall collect and analyze air samples from selected intervals at the OSM borings to be selected during the one-year time frame of this investigation. The number of intervals within a specific boring will be dependant on the borehole information to be collected during the drilling, and the subsequent borehole videos to be performed by OSM. The Regional Project Officer anticipates that twenty borings would be feasible during this one-year period with up to five zones per boring. The samples will be analyzed for field methane, carbon monoxide, carbon dioxide, oxygen, and lower explosive limit. The field parameters will be allowed to stabilize prior to the collection of the volatile organic sample. The analytical methods will be discussed during the scoping meeting and detailed in the contractor's Work Plan. Sample containers shall be equivalent of SUMMA® canisters.

The contractor shall collect air samples and provide oversight during the sampling of the existing Dunmore Gas Site borings by the Department of Energy contractor. The Department anticipates approximately ten existing borings with a maximum amount of five intervals per boring.

The contractor shall assign a designated Professional Geologist responsible for the oversight of the data collection. The contractor shall also be tasked with attending and providing briefings at meetings, which may be requested, by the Department and/or the community.

Department common tasks: The PADEP representatives shall provide initial recommendations for the locations of the existing shallow and deep boreholes to be sampled by the Department of Energy contractor. The PADEP Environmental Cleanup Program representatives shall also approve the sampling of OSM borings to insure these are within representative anthracite zones that will meet the objectives of this investigation. The technical recommendations will be based on discussions with technical representatives of the PADEP's Environmental Cleanup Program, the HSCP contractor, and the Office of Surface Mines.and the Bureau of Abandoned Mines. Additional technical representatives from appropriate Federal or State agencies may be consulted during this investigation.

Office of Surface Mines: The Office of Surface Mines will perform the drilling and subsequent downhole video logging of borings to be drilled during this one-year period. As discussed with representatives of OSM, the anticipated diameter will be eight-inch diameter.

Special Requirements: The contractor shall provide cost estimates for this investigation prior to mobilization. The sampling of any additional boreholes will be at the direction of the Department's Hazardous Sites Cleanup Program Project and will require a change order by the Department representative.

The contractor will provide a Final Report on the project. The specific elements will discuss the details of the sampling program, and the contractor's independent conclusions and recommendations based on the data evaluation. The Final Report will include a base map which locates OSM borings and the Dunmore Gas SIte project area on hard copy and digital form. The existing map provided by the Tetratech subcontractor will be provided to assist in this task. The final boring locations, existing monitoring points (residential and historical boreholes) shall be incorporated on this map. The basic outline of the Final Report will be discussed during the later stage of the project.