Northcentral Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Report

May 6, 2011

Commonwealth of Pennsylvania
Department of Environmental Protection

Tom Corbett, Governor
Commonwealth of Pennsylvania

Michael L. Krancer, Secretary
Department of Environmental Protection

Prepared by
PA DEP, Bureau of Air Quality

www.depweb.state.pa.us

Table of Contents

Executive Summary

Since the beginning of 2008, natural gas exploration activities in the Marcellus Shale Formation have increased significantly in the Commonwealth of Pennsylvania—more than 2,349 wells have been drilled, primarily in the southwest, northeast and northcentral regions. In response to the increased number of well sites and concerns about the impact of the Marcellus Shale natural gas development activities on air quality, the Pennsylvania Department of Environmental Protection (PA DEP or Department) launched a short-term, screening-level air quality sampling initiative in the northcentral region in August 2010, culminating in December 2010. This report includes the findings of the screening air sampling surveys conducted by PA DEP in Bradford, Lycoming and Tioga counties and background sampling conducted in Sullivan County.

The scope of this short-term sampling effort was limited to several natural gas facilities in northcentral Pennsylvania. Due to the limited scope and duration of the sampling and the limited number of sources and facilities sampled, the findings only represent conditions at the time of the sampling and do not represent a comprehensive study of emissions. While this short-term sampling effort does not address the cumulative impact of air emissions from natural gas operations in northcentral Pennsylvania, the sampling results do provide basic information on the type of pollutants emitted to the atmosphere during selected phases of gas extraction operations in the Marcellus Shale formation. This information will also be utilized to determine if the scope of the study should be expanded and will identify areas where additional sampling may be warranted.

Samples were collected during four "sampling weeks" using the Department's Bureau of Laboratories Mobile Analytical Unit (MAU) to measure the concentrations of a target list of pollutants associated with gas development operations. The Mobile Analytical Unit used Gas Chromatography/ Mass Spectrometry (GC/MS) and Open Path Fourier Transform Infrared (OP-FTIR or Open Path) samplers to screen for approximately 48 volatile organic compounds (VOCs) including methane and benzene. Additional air samples were collected in canisters over a 24-hour period and analyzed by the PA DEP Laboratory. The four sampling weeks focused on ambient air pollution levels near two different compressor stations, a well site during flaring operations, an active well-drilling site, and a background site.

The project goals include the short-term screening of ambient air concentrations of target pollutants near certain of Marcellus Shale gas drilling operations, assessing preliminary air quality impacts and determining if there were any immediate health risks from ambient pollutant concentrations to nearby residents or communities.

The key findings of short-term air sampling in northcentral Pennsylvania are:

- Concentrations of certain natural gas constituents including methane, ethane, propane and butane, and associated compounds in the air near Marcellus Shale drilling operations were detected during sampling.

- Elevated methane levels were detected in the ambient air during short-term sampling conducted at two compressor stations (the Thomas and Shaw compressor stations) and at a well site prior to flaring (Chicken Hawk well site). Elevated methane levels were not found at the active drilling well site (Hagemeyer well) where methane production had not yet begun.

- Certain compounds, mainly methyl mercaptan, were detected at levels which generally produce odors.

- Results of the limited ambient air sampling initiative in the northcentral region did not identify concentrations of any compound that would likely trigger air-related health issues associated with Marcellus Shale drilling activities.

- Sampling for carbon monoxide, nitrogen dioxide, sulfur dioxide and ozone, did not detect concentrations above National Ambient Air Quality Standards at any of the sampling sites. However, the Department is unable to determine at this time whether the potential cumulative emissions of criteria pollutants from natural gas exploration activities will result in violations of the health and welfare-based federal standards.

This is the third report on short-term ambient air sampling near Marcellus Shale natural gas operations in the Commonwealth. Air sampling in Washington and Greene counties in southwestern Pennsylvania was conducted April through July 2010 and the report on that effort was published on November 1, 2010. The results of air sampling in Sullivan and Susquehanna counties in northeastern Pennsylvania conducted by PA DEP in August through October 2010 were published in a report dated January 12, 2010.

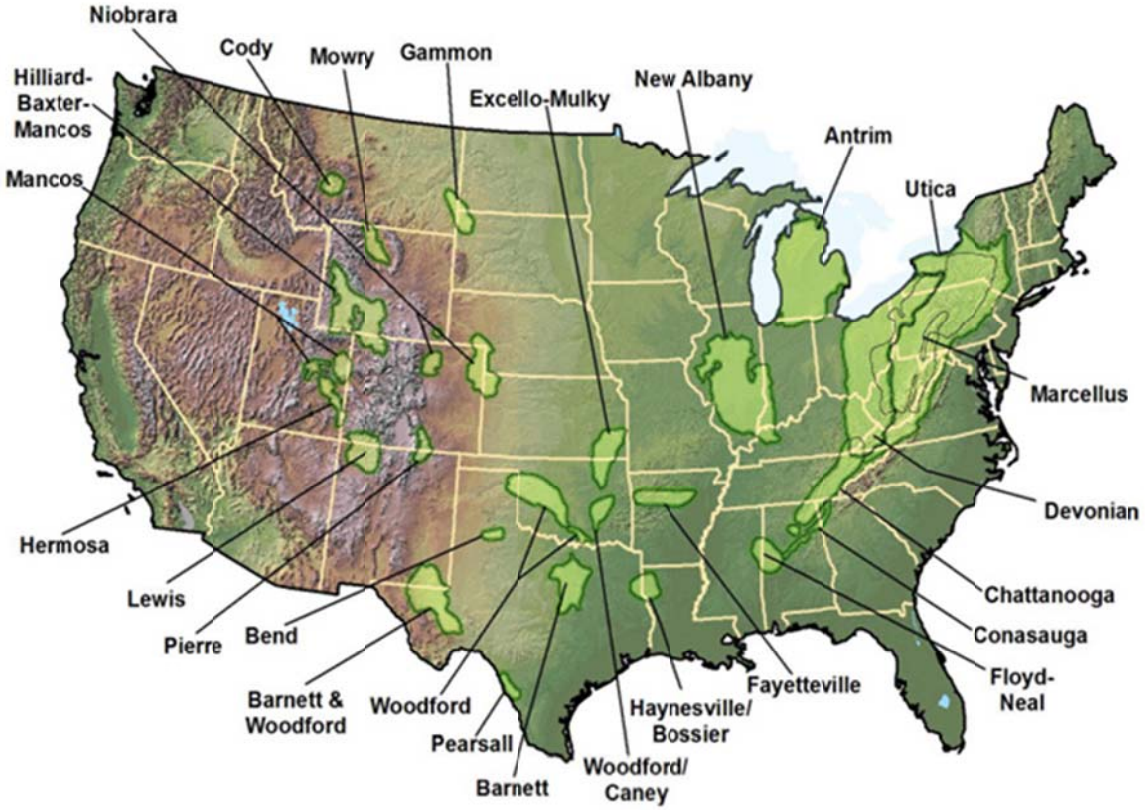
Sampling in all three regions found natural gas constituents in the ambient air near gas drilling and processing operations. The same pollutants (e.g., methane, ethane, propane and butane) were measured at compressor stations in all three regions and at comparable levels. The elevated methane results at the sampling sites would seem to confirm that the natural gas production infrastructure in general, from well sites to condensate tank farms to compressor stations, is a source of pollutant emissions through fugitive and/or direct means.

However, when looking at the individual operations, the PA DEP limited sampling effort did not find that these emissions created ambient air pollution conditions where acute adverse health impacts would be expected.

PA DEP will compare results from the surveyed regions to determine any regional differences where wet gas is extracted in the southwest region versus dry gas in the northcentral and northeast regions of the Commonwealth. Following the completion of the comparative analysis, the Department will determine whether additional, longer-term sampling is warranted.

Introduction

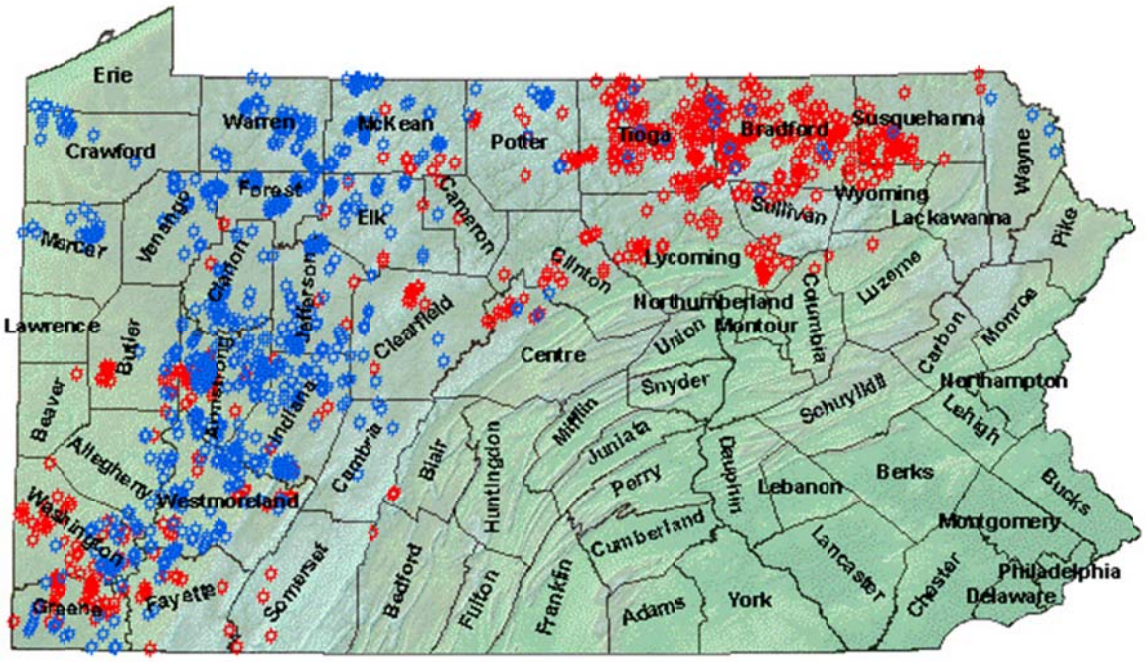
Shale gas is available in many basins across the United States (Figure 1). The Marcellus Shale Formation, which extends from New York into Pennsylvania, Maryland, Ohio, Virginia, and West Virginia, and covers approximately 95,000 square miles, is the most expansive shale gas "play" in the United States. The Marcellus play located within the borders of Pennsylvania is now one of the most active shale plays in terms of drilling, with operations primarily in the southwest, northcentral and northeast portions of the state. However, the Barnett Shale play in the Fort Worth, Texas, basin is the most active play in the country.



Source: U.S. DOE, 2009

Figure 1: Gas shale formations in the United States (U.S. DOE, 2009).

In recent years, the number of Marcellus Shale wells drilled in Pennsylvania has rapidly increased. In 2008, the number of wells drilled to tap Marcellus Shale gas was 195. In 2009 that number jumped to 768. Since January 2010, over 1,386 wells have been drilled (Figure 2) (PA DEP, 2010a).



Source: Pa. DEP, 2010a

Figure 2: Map of Marcellus (red) and non-Marcellus (blue) wells drilled in Pennsylvania in 2010 (PA DEP, 2010a).

The extraction of natural gas from Marcellus Shale involves many stages and provides many opportunities for the release of air pollutants during the process. The major stages of natural gas extraction include:

- Pad, Impoundment and Road Construction – All drilling operations need a flat area of certain acreage to conduct the drilling activities. Impoundments for fresh water or wastewater may also be built. Pollutants are emitted from diesel engines and dust is produced from truck traffic and heavy equipment.
- Drilling – Drilling rigs require power from diesel engines. Again more emissions from these engines.
- Fracturing – During this stage, large amounts of water and fracturing fluid are pumped into the well to create fractures for the gas to escape from the shale. A portion of the fluid is returned into a wastewater impoundment where it is eventually trucked for treatment. Emissions can come from diesel engines, the evaporation of the wastewater and the release of fracturing fluid chemicals, heavy metals and volatile organic compounds.
- Flaring – Flaring is done to test the gas well before production. Emissions are created from the burning of gas and atmospheric venting of non-combusted gas.
- Condensate Tanks – Gas pumped from the well may contain brine and other volatile organic compounds that condense into collection tanks. Air space in the tanks is vented to the atmosphere during periods of filling. If the nature of

the gas is considered "wet" (vs. "dry"), the condensate may contain many other compounds such as benzene, toluene and xylenes.

- Compressor stations – Raw gas is piped from wells to compressor stations where the gas is pre-treated and compressed. Emissions from engines that power the compressors, fugitive emissions from compression equipment, pipes and tanks are possible.

Along with the increased drilling operations described above, there has been an increase in the number of complaints to the Department's regional offices. The majority of the complaints pertained to odors and nuisance dust from truck traffic.

Ambient Air Sampling

Prior to launching its Marcellus Shale short-term monitoring initiative, the PA DEP examined air sampling projects conducted by other states in separate shale basins (i.e. Barnett Shale in Forth Worth, Texas) during the development of the sampling protocol for this project. The sampling goals for this project were to obtain preliminary Pennsylvania-specific concentrations of certain pollutants emitted at, or near, natural gas Marcellus Shale exploration activities. As a result, the sampling goals are to:

- screen for ambient air concentrations of target pollutants near certain Marcellus Shale gas drilling operations;
- assess potential air quality impacts;
- assess potential health risks from exposure to ambient concentrations; and
- determine whether the scope of the short-term Marcellus sampling initiative should be expanded.

The PA DEP conducted short-term air sampling near natural gas operations in densely-drilled areas in the southwest, northcentral and northeast regions of the Commonwealth. This report focuses solely on Marcellus ambient air sampling completed in the northcentral region (Bradford, Lycoming, Sullivan and Tioga counties) from August through December of 2010. This report does not address water quality or other environmental issues dealing with natural gas extraction.

Air sampling in Washington and Greene counties in southwestern Pennsylvania was completed earlier in the year (April through July) and the report on that effort was published on November 1, 2010 (PA DEP, 2010c). The results of air sampling in Sullivan and Susquehanna counties in northeastern Pennsylvania from August through October was published in a report dated January 12, 2010 (PA DEP, 2010d). Sampling in the northcentral regions including Bradford, Lycoming, Sullivan and Tioga counties was completed in December, 2010, and is the subject of this report.

Table 1 provides a list of target compounds selected by PA DEP for this project. The list was compiled based on target information from other shale gas studies (Texas Commission on Environmental Quality [TCEQ], 2010; NYDEC, 2009; Town of Dish, 2009; Fed. Reg. 72:1; PA DEP, 2010b; Texas Environmental Research Consortium [TERC], 2009). The list also shows the PA DEP Bureau of Laboratories (BOL) capability to "detect" these target compounds by the various methods utilized during the project.

The main constituent of natural gas is methane. There are other compounds in natural gas found in lesser quantities (ethane, propane and butane), and still more in trace amounts.

- Methane, Ethane, Propane and Butane – Simple straight-chained molecules containing carbon and hydrogen; these compounds, when isolated or combined, are used mainly as fuels. Burning these compounds in the presence of excess oxygen produces carbon dioxide and water. Incomplete combustion can produce undesirable pollutants such as carbon monoxide and formaldehyde. Methane itself is a potent greenhouse gas. Standards have been established for acceptable concentrations of these compounds in workplace settings. However, there are no standards for acceptable levels in ambient air.
- "BTEX" – A group of compounds, namely Benzene, Toluene, Ethylbenzene and Xylene that are primarily found in petroleum derivatives are the main constituents of gasoline; however, they are naturally occurring in some shale gas formations. They are also used as solvents and/or intermediates in the production of other chemicals. There are many health–related issues associated with chronic exposure to these compounds, mainly neurological effects. Benzene is also associated with hematological and carcinogenic effects.
- Methyl mercaptan – Methyl mercaptan is a naturally occurring compound present in some shale gas formations as well as in crude oil. Methyl mercaptan has a strong unpleasant smell that can be detected by the human nose at very low levels. Olfactory fatigue, or the inability to no longer smell methyl mercaptan, occurs after prolonged exposure.
- Carbon Monoxide, Nitrogen Dioxide, Ozone – These pollutants are part of a group of six criteria air pollutants that are considered harmful to public health and the environment above certain levels. These pollutants come from or are caused by reactions of emissions from a wide variety of sources such as industry, energy production and mobile sources. The federal government has created ambient air standards for these pollutants that states strive to meet through monitoring, permitting and planning.

Equipment

Mobile Analytical Unit

The Department's BOL Mobile Analytical Unit (MAU) was deployed for each sampling week. The BOL utilized two MAU sampling vehicles, the MAU-1 and the MAU-4, when sampling:

> **MAU-1** – A RV-sized vehicle that houses an Agilent 6890/5975 MSD Gas Chromatograph/Mass Spectrometer (GC/MS) with a Dynatherm IACEM 980 Air Sampler. For each sample, a total of 0.5L of air was acquired at a constant rate over a 5-minute time period, either through direct sampling of the outside air or through remote air collection in Tedlar bags. Air samples were collected once per hour for the duration of the sampling session.
>
> **MAU-4** – A utility-sized truck that houses a RAM 2000 Open Path Fourier Transform Infrared Spectrometer (OP-FTIR or Open Path sampler). Pollutants in air between the MAU-4, containing the OP-FTIR, and a strategically-placed mirror are measured using an infrared beam that bounces off the mirror and back to a detector (referred to as the open path). The actual emplacement of the OPFTIR equipment depends on factors including topography, site layout, safety considerations and current meteorological conditions. A tradeoff exists between the length of the open path and detection limits; the longer the path, the higher the detection limits. The minimum length of the open path as well as other operational procedures, are based on the U. S. Environmental Protection Agency's (EPA) Compendium Method TO-16 (U.S. EPA, 1999a). A list of compounds that the OP-FTIR can detect can be found in the data files in Appendix A.

The MAU equipment was set up downwind of the target source and operated continuously during selected sampling windows. The sampling windows were designed to capture pollutant concentrations during the early morning hours and late evening hours, to reflect the predominate times when complaints related to Marcellus gas exploration activities received by the Department.

During the sampling week, the BOL personnel would drive the MAU from Harrisburg to the sampling site and conduct six sampling sessions before returning to Harrisburg. Three of the sessions would run from 5:00 am to 12:00 pm and three would run from 5:00 pm to 12:00 am. PA DEP regional personnel familiar with the area, the drilling activities and reported complaints provided support during the MAU sampling sessions.

Table 1: List of target compounds and PA DEP sampling capability.

CAS#	Target Compounds	DEP Sampling Capability		
		MAU	Canister	FLIR Camera[1]
71-55-6	1,1,1-Trichloroethane		x	
79-34-5	1,1,2,2-Tetrachloroethane		x	
79-00-5	1,1,2-Trichloroethane		x	
75-34-3	1,1-Dichloroethane		x	
75-35-4	1,1-Dichloroethene		x	
95-63-6	1,2,4-Trimethylbenzene	x	x	
106-93-4	1,2-Dibromoethane		x	
107-06-2	1,2-Dichloroethane		x	
78-87-5	1,2-Dichloropropane		x	
106-99-0	1,3-Butadiene		x	
542-75-6	1,3-Dichloropropene		x	
67-64-1	Acetone		x	
71-43-2	Benzene	x	x	x
74-83-9	Bromomethane		x	
75-15-0	Carbon Disulfide	x	x	
56-23-5	Carbon Tetrachloride		x	
108-90-7	Chlorobenzene		x	
75-01-4	Chloroethene		x	
67-66-3	Chloroform		x	
74-87-3	Chloromethane	x	x	
630-08-0	Carbon monoxide	x		
110-82-7	Cyclohexane		x	
74-84-0	Ethane	x		x
100-41-4	Ethylbenzene	x	x	x
107-21-1	Ethylene Glycol			
50-00-0	Formaldehyde	x		
7647-01-0	Hydrogen Chloride	x		
7783-06-4	Hydrogen Sulfide	x		
74-82-8	Methane	x		x
67-56-1	Methanol	x		x
75-09-2	Methylene Chloride		x	
108-38-3	m-Xylene	x		
91-20-3	Naphthalene	x		
106-97-8	n-Butane	x		x
110-54-3	n-Hexane	x	x	x
	Nitrogen oxides	x		
95-47-6	o-Xylene	x	x	x
74-98-6	Propane	x		x
115-07-1	Propene		x	
106-42-3	p-Xylene	x		x
100-42-5	Styrene	x	x	
127-18-4	Tetrachloroethene		x	
108-88-3	Toluene	x	x	x
79-01-6	Trichloroethylene		x	
1330-20-7	Xylenes, Mixture		x	x

[1] The FLIR can detect thousands of compounds. The compounds checked have associated minimum detected leak rates.

Canister Sampling

Air canister samples were collected using a method based on EPA Compendium Method TO-15 (U.S. EPA, 1999b). The method uses a specially-prepared canister and sampler that collects an air sample over a 24-hour period, which is then sent to the Department's BOL in Harrisburg for analysis using GC/MS. The equipment and methods used for this project are the same as is used in the statewide toxics monitoring network. Detection limits are low and in the sub part-per-billion volume (ppbv) level. A list of quantifiable compounds can be found in the data files in Appendix B.

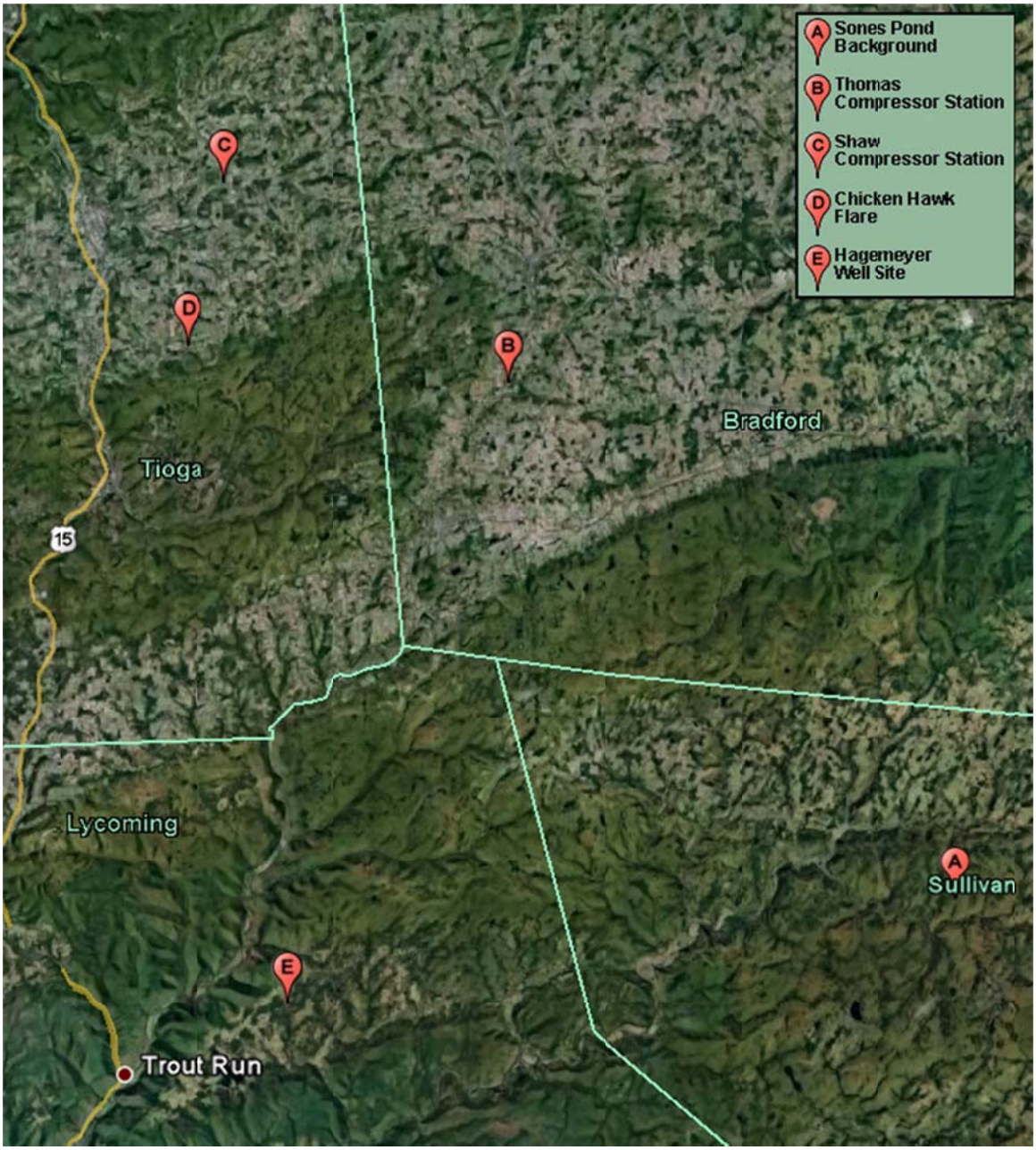
The canisters are analyzed by the Department's BOL utilizing a 61-compound calibration mix. The calibration mix covers compounds-of-interest for various toxics work (Urban Air Toxics, Ozone, Fuel Spill, Superfund, etc.) and includes alkanes, alkenes, aromatics, CFC's, chlorobenzenes and oxygenated compounds.

The compounds of interest for this project that are not detected or quantified by this method include the simpler alkanes (methane, ethane, propane and butane) and criteria pollutants like carbon monoxide and nitrogen oxides. However, these compounds are able to be detected by the MAU's Open Path sampler.

The PA DEP, Bureau of Air Quality, Toxics Monitoring Section provided the canisters and samplers to collect air samples and the training for regional field personnel to collect the air samples.

Sampling Sites

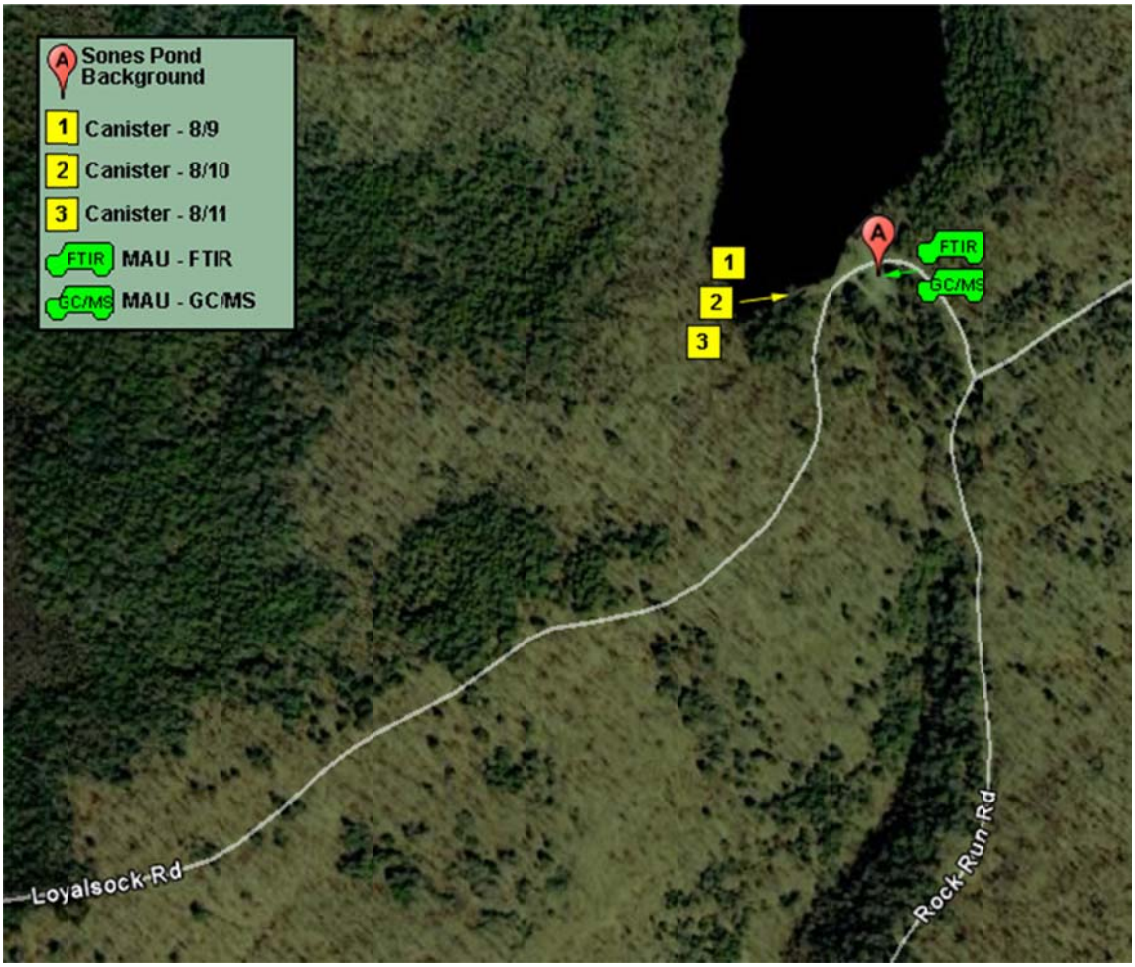
The map in Figure 3 shows the overall sampling area in northcentral Pennsylvania. The four sampling weeks were conducted in Bradford, Lycoming, Sullivan and Tioga counties. The satellite maps used in this report were generated from Google Earth (Google, 2010) and in most cases, are from a period before drilling operations began. These maps show the approximate sampling locations and the surrounding terrain and population impacts.



Source: Google, 2010

Figure 3: Map of sampling sites in the northcentral region of Pennsylvania.

Sones Pond Background – Week of August 9, 2010

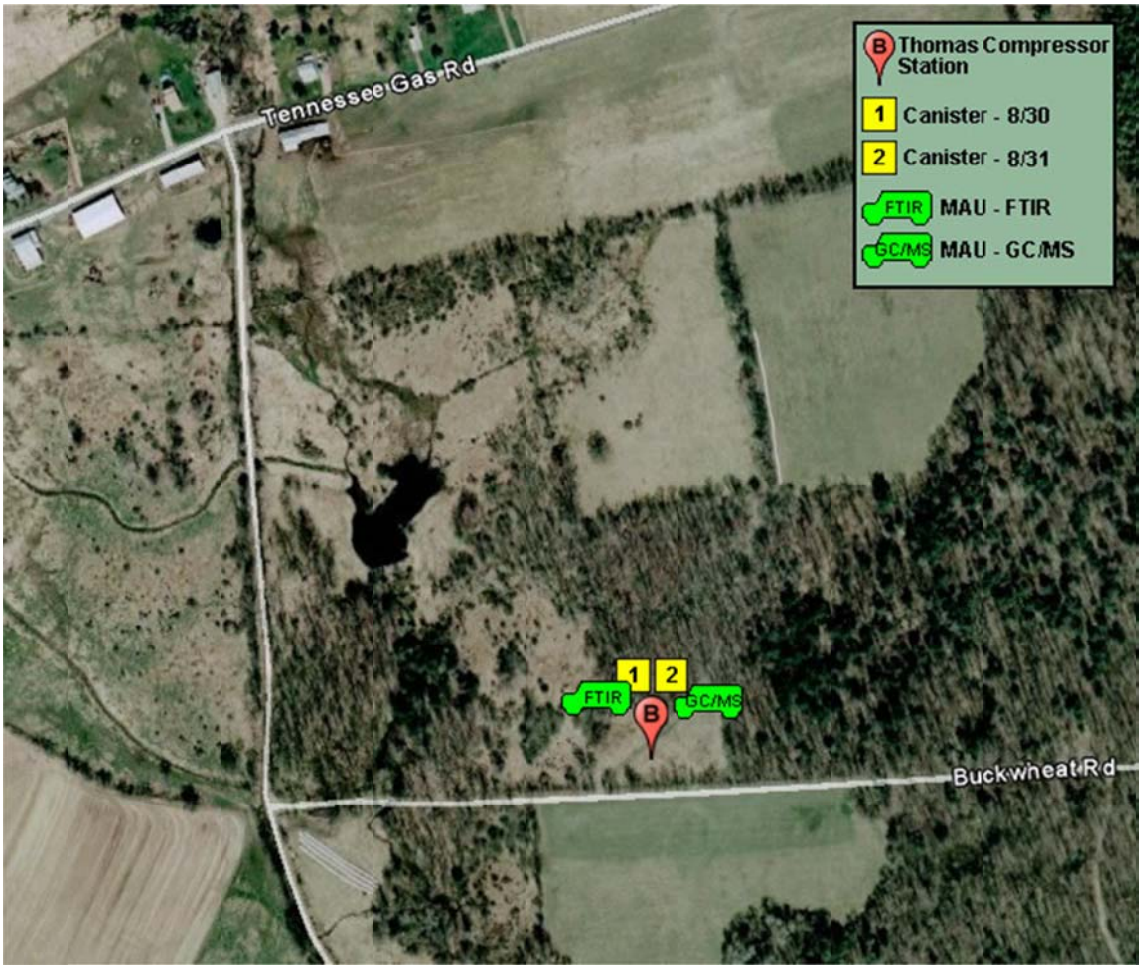


Source: Google, 2010

Figure 4: Map of the Sones Pond background site and sampling locations.

Both MAUs were located at the Sones Pond parking lot in the Loyalsock State Forest in Sullivan County for the duration of the sampling period. Three canister samples were collected at the site at an open site near the pavilion. The weather during the sampling week was mostly clear with calm winds and a bit of rain Tuesday and Thursday morning (Appendix F). Sampling was conducted at this site to collect background information on pollutant concentrations in the area to compare to the future sampling weeks near drilling operations.

Thomas Compressor Station Site – Week of August 30, 2010

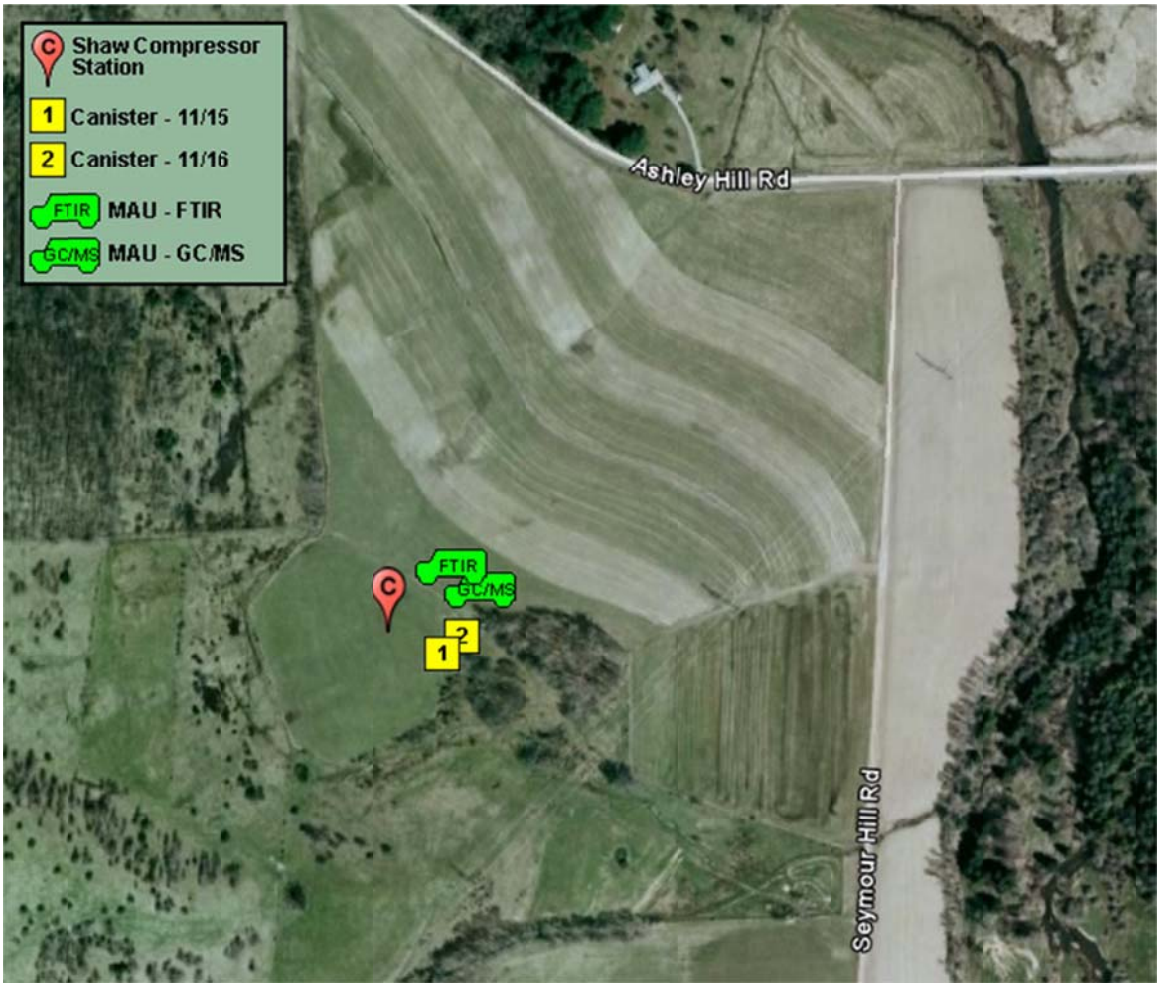


Source: Google, 2010

Figure 5: Map of the Thomas Compressor Station site and sampling locations.

During the second sampling week, PA DEP monitored ambient air pollutant concentrations next to Talisman Energy's Thomas Compressor Station off of Buckwheat Road in Troy Township, Bradford County, PA. Both MAU samplers were situated next to the compressor station. The weather during the week was clear with light winds from the west and southwest. Canister samples were collected downwind and next to the station.

Shaw Compressor Station – Week of November 15, 2010



Source: Google, 2010

Figure 6: Map of the Shaw Compressor Station site and sampling locations.

During the third sampling week, the Department monitored ambient air pollutant concentrations downwind of East Energy's Shaw Compressor Station off of Seymore Hill Road in Mainesburg Township, Tioga County, PA. For the first three days of sampling (November 15-17, 2010), both MAU samplers were situated next to and downwind of the compressor station. On November 17, 2010, the MAU equipment was moved to the Chicken Hawk Well site where a scheduled flaring event was to occur. The weather during the week was mostly cloudy with a period of rain in the middle of the sampling week and moderate winds. Canister samples were collected at the station as well.

Chicken Hawk Flare Site – Week of November 15, 2010

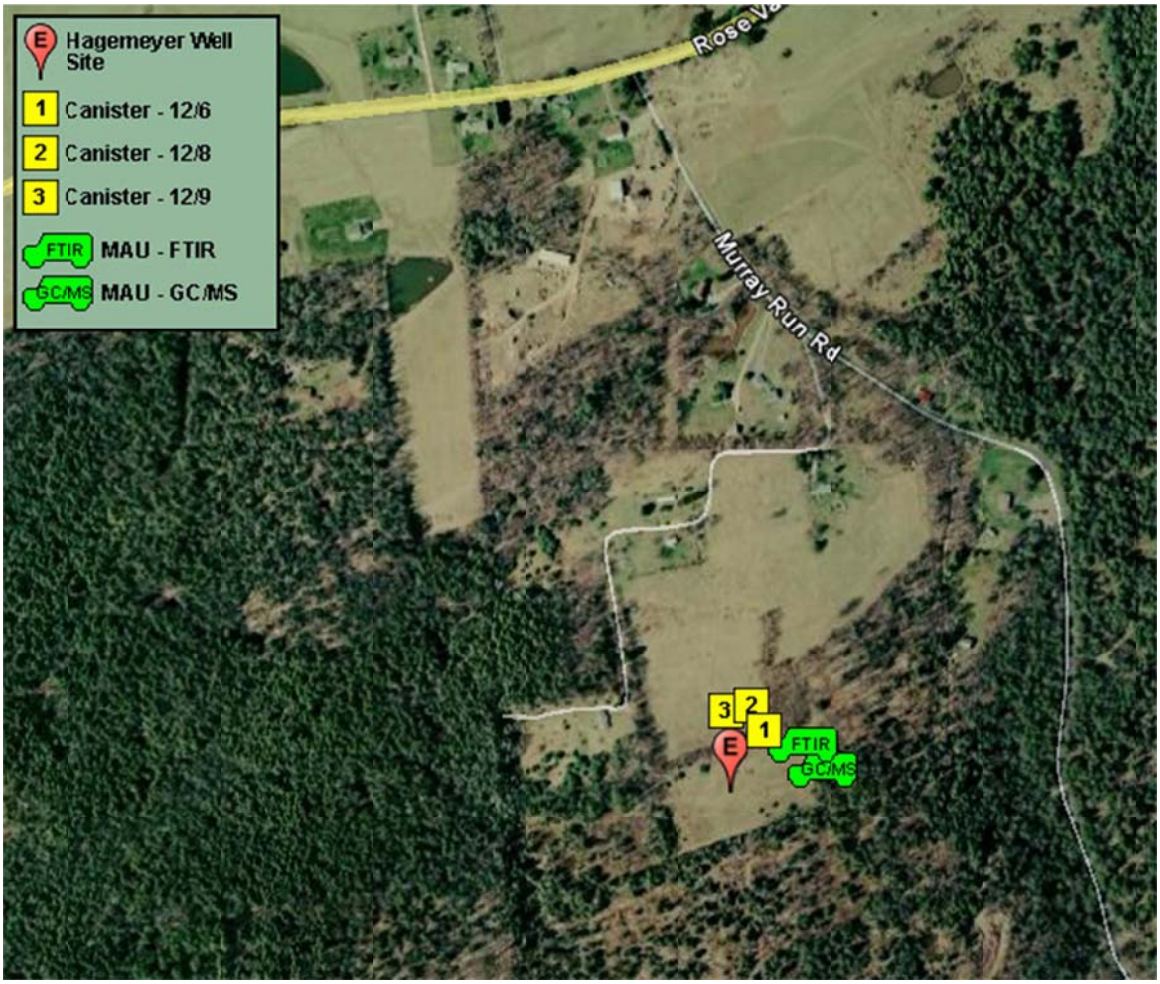
Source: Google, 2010

Figure 7: Map of the Chicken Hawk flaring site and sampling locations.

For the evening sampling session on Wednesday November 17, the MAU equipment was diverted from the Shaw Compressor Station to East Energy's Chicken Hawk well site off of Tanglewood Road, south of Mainesburg, Tioga County, PA. This site was chosen to measure ambient toxic concentrations during a scheduled well-flaring event. The MAU sampling hours were changed to maximize sampling time during the flaring. Sampling was continuous from 6:30 pm on November 17 to 7:00 am the next morning.

In addition, the MAU sampled prior to the flaring event (for one-half hour) to document the existing ambient conditions. The weather during the sampling was cloudy with gradual clearing and winds from the west and northwest. A canister sample was also collected over the course of the flaring event.

Hagemeyer Well Site – Week of December 6, 2010



Source: Google, 2010

Figure 8: Map of the Hagemeyer well site and sampling locations.

During the fourth sampling week, PA DEP monitored ambient air pollutant concentrations next to Anadarko Petroleum's Hagemeyer well site located off of Murray Run Road in Gamble Township, Lycoming County, PA. Both MAU samplers were located next to the well site. During the week, three canister samples were collected close to the tree line near the well. The weather during the week was overcast with snow flurries and moderate to light winds.

Sampling Results

Mobile Analytical Units

Results of the MAU Open Path sampling are presented in Appendix A. These results are reported in separate tables for each site and in two types of units, parts per billion volume (ppbv) and micrograms per cubic meter (ug/m3). The ppbv unit is simply the number of parts of a chemical contained within a billion parts of air. The results are converted from ppbv to ug/m^3 by multiplying by the compound's molecular weight and dividing by the molar volume. The ug/m^3 units are useful when comparing the result to reference concentrations discussed in the Acute Risk Characterization section.

The OP-FTIR, an open path sampler, typically reports the highest 2-minute value if a compound was detected (unless otherwise noted). If the compound was detected at levels during the sampling session (approximately 8 hours) that could be used to calculate a time-weighted average greater than the method detection limit (MDL), that average was reported. The Open Path sampling results provided in Appendix A also include the detection limits for each compound during the sampling period. The OP-FTIR detection limits will vary depending on factors including the mode of deployment, humidity, and the distance traversed; water vapor will also interfere with the detection limits. Many of the compounds listed in Appendix A were not detected (neither an average nor maximum concentration was reported). For the compounds that were detected, most of the compounds had just the 2-minute maximum concentration reported rather than maximum and average concentrations.

When comparing the OP-FTIR data between sites, the Sones Pond background site had fewer detects of natural gas constituents than the other sites. For the sites other than the background, natural gas components such as methane, ethane, propane and butane were detected during every sampling session except one. Methane concentrations detected at the Thomas Compressor Station site were slightly higher but on par with the levels detected at the Shaw Compressor Station. Less methane was detected at the Hagemeyer well site where drilling was in progress and prior to the production of natural gas. As would be expected at the Chicken Hawk well site, more methane was detected prior to the flaring than was measured during the flaring event when the gas was being burned. Other compounds seen during the OP-FTIR sampling besides the natural gas constituents include carbon monoxide and the odor-producing methyl mercaptan.

At the Sones Pond background site located in the interior of the Loyalsock State Forest, the OP-FTIR did not detect concentrations of any pollutant at high enough levels to produce a reportable average. However, there was one 2-minute maximum benzene reading of 400 ppb made during the evening session on August 10, 2010 that will be discussed later in this report. Because of where the OP-FTIR was situated (next to a parking lot and road), this one benzene reading is most likely due to a mobile source. The three canister samples collected during the week, which were sited away from the parking lot, did not detect elevated levels of benzene.

The Thomas Compressor Station does appear to be a source of natural gas emissions with maximum methane concentrations detected in the 12 to 41 parts per million (ppm) range (1 ppm = 1,000 ppb). During the six 7-hour sampling sessions at the site, average methane concentrations were calculated for all six sampling sessions. The highest average methane concentration was approximately 3.3 ppm. Other compounds detected include carbon monoxide, methanol, methyl mercaptan and low levels of methyl tertiary butyl ether (MTBE) and nitric acid. Besides carbon monoxide, these other compounds were detected infrequently and in low enough concentrations to not produce an average over the sampling session. In 1979, MTBE was used at low levels in gasoline to help reduce engine knocking following the phase-out of lead in gasoline. Following the enactment of the 1990 Clean Air Act Amendments, MTBE was blended at higher concentrations (minimum of 2 percent oxygen by weight) in reformulated gasoline to reduce ground-level ozone (smog) in certain ozone nonattainment areas including the five-county Philadelphia area (Bucks, Chester, Delaware, Montgomery and Philadelphia counties). MTBE was eventually banned for use in gasoline due to its contribution to groundwater pollution issues. The MTBE findings are not related to Marcellus Shale gas activities because the compound is a man-made chemical—the compound is not used in the fracturing process nor was it detected in the 24-hour canister samples.

OP-FTIR sampling at the Shaw compressor station also detected the same type of pollutants with methane being the predominate pollutant. The maximum methane concentration detected at the Shaw facility was 12.5 ppm with a high average of 2.1 ppm. The methane concentrations at the Shaw Station were lower compared to the Thomas station. Contrarily, there was no detection of the odor-producing compound methyl mercaptan at the Shaw site.

OP-FTIR sampling at the Chicken Hawk well site consisted of pre-flare sampling for one-half hour and an extended sampling event during flaring from 6:30 pm on November 17 to 7:00 the next morning. As would be expected, the amount of methane detected in the ambient air prior to the flaring (29.2 ppm maximum and 5.5 ppm average) was greater than concentrations detected during the flaring when the methane was being burned (2.3 ppm maximum and 1 ppm average). Concentrations of carbon monoxide and ethylbenzene were also detected at the well site. Ethylbenzene is a component of gasoline and because the concentrations detected prior to and during the flaring were similar, its detection was most likely not related to the flaring.

Except for the background site, the maximum methane concentration detected at the Hagemeyer well site was considerably lower than the other sampling sites in this study. The maximum concentration detected was 0.7 ppm with not enough methane being detected to produce average results over the sampling period. The lower methane results are most likely due to the fact that the site was in the process of being drilled and had not yet been fractured to produce natural gas. The other compounds seen previously were also detected in similar amounts along with low levels of other compounds: n-pentane, n-hexane, styrene and nitrogen dioxide. These results may be due to the activities associated

with the drilling. Again, besides two carbon monoxide averages, none of the compounds were detected in high enough concentrations to produce averages.

During the four-week ambient air sampling project in the Northcentral region, the Department's GC/MS only detected benzene and toluene, and mainly at levels below 1.3 ppbv. Other tentatively identified compounds were detected by the GC/MS, but at levels below the quantitation limit of the instrument of approximately 0.5 ppbv; the quantitation limit of 0.5 ppbv is the lowest amount of compound in a sample that can be quantitatively determined with suitable precision and accuracy. The types of compounds detected are widely variable, but do include components of natural gas and fuels. Because those compounds cannot be quantified, they are not included in this report.

Canister Sampling

Results of the canister sampling can be found in Appendix B. Most of the 57 compounds in the analysis were not detected. This is common and seen at most sampling sites in the Commonwealth, simply because of the variety of compounds analyzed. However, more compounds were detected at the two PA DEP monitoring network sites in Arendtsville (Adams County) and Marcus Hook (Delaware County) in 2009 simply because the larger sample set provides a greater chance of detection over the year. The averages for the two network sites in Adams and Delaware counties are based on results from a possible 61 samples collected over an entire year.

For compounds not detected, one-half the method detection limit was used in the tables as well as in any risk calculations. Note that the method detection limits shown in Appendix B are for samples collected after August 23, 2010. For the samples collected at the Sones Pond, Arendtsville and Marcus Hook sites other method detection limits were used that are not provided in this report.

Of the compounds detected, some are found everywhere in the atmosphere and present in stable amounts. For example, the compounds 1,1,2-trichloro-1,2,2-trifluoroethane, dichlorodifluoromethane, trichlorofluoromethane and chloromethane were once used as refrigerants and propellants, but have been phased out due to their impact on the ozone layer. Carbon tetrachloride was used to produce these refrigerants, but its production declined as their use was banned. However, even though these compounds are no longer being used or had their use curtailed, they persist at certain levels in the atmosphere.

Other compounds detected in the canister sampling are also seen at the PA DEP network sites across the Commonwealth. Results for 2-butanone (MEK) and acrolein were found at similar levels at monitoring sites in other regions of the Commonwealth where there are no natural gas drilling operations.

The following compounds that were detected at low concentrations may be related to the Marcellus Shale natural gas activities: acetone, benzene, propene and toluene.

Concentrations of these pollutants were at, or close to, levels detected in the PA DEP monitoring network sites. However, none were detected at levels of concern.

Recently, EPA determined that acrolein data from their School Air Toxics Monitoring Initiative was unreliable (U.S. EPA, 2010b). That initiative used the same canister collection method used in this project. PA DEP has adopted the same approach as EPA, which is to present the acrolein data in an effort of transparency, but to note the data should not be used for any type of analysis because of the uncertainty.

There was a wide variety of tentatively identified compounds in the canister samples. Again, these are compounds determined by the Department to be present in a sample, but cannot be quantified. Most compounds were estimated to be less than 1.0 ppb concentration, are compounds not associated with natural gas drilling operations and/or found at other sites (including non-Marcellus sites) in the Commonwealth.

Acute Risk Characterization

The sampling results were used to characterize the acute non-cancer health risks of ambient pollutant concentrations found around Marcellus Shale drilling operations to nearby residences or communities. To this end, the PA DEP compared sampling results to available reference concentrations (RfCs) and standards.

RfC and standards are concentrations of a particular pollutant, below which (non-cancer) adverse health effects are not expected to occur over a period of continuous exposure. There are RfCs and standards available for different periods of time. For example, there are chronic RfCs to compare against data collected over at least a one-year period. For this study, acute reference concentrations representing time periods of one day or less were used for the characterization. Values found above a reference concentration do not necessarily mean that adverse health effects will occur, but that there is more of a potential.

Appendix C lists the RfCs available for comparison to the OP-FTIR and canister results. A total of 33 of the 45 target compounds have an associated RfC for comparison. Because the Open Path sampling and canister samples were collected over different time periods, different sets of RfCs were used. In order to make the comparison between the sample result and the RfC, a hazard quotient is calculated. A hazard quotient (HQ) is simply the sampling result (in ug/m^3) divided by the RfC. If the value is less than one, then non-cancer health effects are not expected. To be even more conservative in the risk assessment, and to account for effects from multiple pollutants that may be additive, the individual hazard quotients of a sample may be added to produce a hazard index (HI). Again, if the HI is less than one, then non-cancer health effects are not expected.

Any estimate of acute risk is based on a number of assumptions, and some of the assumptions made for this study include the following:

- concentrations measured at the sampling sites are representative

of exposures to the population in the area;
- effects from exposure to multiple chemicals are additive, and;
- only inhalation risk is considered in this report.

The lifetime cancer risk was not calculated for this short-term sampling study. Typically, a sampling period of at least one year is necessary for a lifetime cancer risk analysis.

Hazard Quotients for MAU Samples

The hazard quotient and index calculations for the OP-FTIR and GC/MS data are provided in Appendix D. In order to be more conservative with the risk estimates, hazard quotients were calculated using three different sets of RfCs used for screening risk assessments (U.S. EPA, 2010a). The three sets of RfCs include:

- Reference Exposure Levels (RELs) - California Environmental Protection Agency's Reference Exposure Levels for no adverse effects. Most of the RELs used in this study are for 1-hour exposures.
- Acute Exposure Guideline Levels (AEGL) - EPA's Office of Prevention, Pesticides and Toxic Substances established the National Advisory Committee to develop Acute Exposure Guideline Levels (AEGL). The AEGL values are used by local, state and federal agencies for emergency planning, prevention and response to provide guidance in situations where the general public may be accidentally exposed to certain chemicals. PA DEP mainly used AEGL-1 values where the general population may experience mild transient and reversible effects. When these values were not available, AEGL-2 values were used where moderate effects may occur in the general population.
- Emergency Response Planning Guidelines (ERPGs) – American Industrial Hygiene Association, Emergency Response Planning Guidelines. Again, PA DEP mainly used ERPG-1 values that represent concentrations for exposure of the general population for up to 1 hour with effects to be mild.

The hazard quotient and indices in Appendix D were calculated using the OP-FTIR 2-minute maximum data. In doing this, an assumption is made that the 2-minute maximum represents a 1-hour average. Even with this assumption, most of the calculated hazard quotients and indices were well below the acceptable limit of 1.0 indicating non-cancer health effects are not expected when breathing pollutants in air at concentrations detected during the short-term sampling initiative. In fact, most hazard quotient calculations are so low they appear to be zero, but this is only due to rounding.

Only one hazard quotient close to 1.0 was calculated for a single 2-minute benzene concentration of 400 ppb, which was detected at the Sones Pond background site. The calculated HQ value of 0.98 for benzene during the Sones Pond background sampling is most likely not a concern due to the "2-minute equals 1-hour" assumption and the fact that the other two RfCs for benzene produce acceptable hazard quotient calculations well below 1.0. Furthermore, canister sampling results in the Sones Pond area were within acceptable levels as well. The Department believes that the location of the OP-FTIR

sampler next to a parking lot and road where the one-time benzene concentration was detected could be associated with nearby mobile sources. The Department does not believe that there is a risk of adverse health effects from the MTBE concentrations detected in the area.

The report does not include the hazard quotient and indices for OP-FTIR 7-hour average data because only a few averages were generated. Because there are fewer 8-hour RfCs available for comparison, only a small number of quotients were calculated. All of these quotients were well under the acceptable limit range and therefore not included in this report.

Hazard Quotients for Canister Samples

The hazard quotient and index calculations for the canister data are presented in Appendix E. Because canister samples are 24 hours in duration, the hazard quotients were calculated using a different set of reference concentrations that are for the most part more conservative (are smaller values) than the ones used for the MAU data. Acute RfC values were taken from the Department of Energy's Risk Assessment Information System (RAIS) database (U.S. DOE, 2010). The list of RfC values in the database were compiled from a variety of sources using a selection hierarchy accepted by the PA DEP.

None of the calculated hazard quotients or indices approached the value of 1.0, indicating non-cancer health effects are not expected when breathing pollutants in air at concentrations during sampling.

National Ambient Air Quality Standards

Section 109(a)(1)(A) of the Clean Air Act (CAA) mandates that the EPA Administrator publish regulations prescribing national primary and secondary national ambient air quality standards (NAAQS) for each air pollutant for which the agency has issued air quality criteria. The standards must be set for "criteria pollutants" at a level that provides protection from adverse effects on the public health and welfare. Section 109(b) of the CAA provides for "primary standards" for the protection of public health within an adequate margin of safety and "secondary standards" for the protection of public welfare from any known or anticipated adverse effects including decreased visibility, and damage to wildlife, crops, vegetation, and buildings. 42 U.S.C.A. § 7409. To date, EPA has promulgated NAAQS for the following criteria pollutants shown in Table 2: carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter and sulfur dioxide.

The criteria pollutants monitored in this study by the MAU OP-FTIR include carbon monoxide, nitrogen dioxide, sulfur dioxide and ozone. The carbon monoxide standard for an 8-hour averaging time is 9,000 ppbv. EPA's recently adopted 1-hour nitrogen dioxide NAAQS is 100 ppb. The new 1-hour sulfur dioxide health-based standard is 75 ppb. In 2008, EPA issued a revised 8-hour ozone standard of 75 ppb; EPA intends to issue a more protective ozone standard by July 31, 2011.

Table 2: The National Ambient Air Quality Standards.

Pollutant	Primary Standards		Secondary Standards	
	Level	Averaging Time	Level	Averaging Time
Carbon Monoxide	9 ppm	8-hour	None	
	35 ppm	1-hour		
Lead	0.15 µg/m3	Rolling 3-Month Avg	Same as Primary	
	1.5 µg/m3	Quarterly Average	Same as Primary	
Nitrogen Dioxide	53 ppb	Annual (Arithmetic Avg)	Same as Primary	
	100 ppb	1-hour	None	
Particulate Matter (PM10)	150 µg/m^3	24-hour	Same as Primary	
Particulate Matter (PM2.5)	15.0 µg/m^3	Annual (Arithmetic Avg)	Same as Primary	
	35 µg/m^3	24-hour	Same as Primary	
Ozone	0.075 ppm (2008 std)	8-hour	Same as Primary	
	0.08 ppm (1997 std)	8-hour	Same as Primary	
	0.12 ppm	1-hour	Same as Primary	
Sulfur Dioxide	0.03 ppm	Annual (Arithmetic Avg)	None	
	0.14 ppm	24-hour		
	75 ppb	1-hour	0.5 ppm	3-hour

The EPA specifies how data is to be collected for comparison to the NAAQS. Although the federal methods were not employed for this study, the OP-FTIR did not detect concentrations of nitrogen dioxide, sulfur dioxide nor ozone to produce a 7-hour average result. Furthermore, for the four 7-hour averages calculated for carbon monoxide (the maximum being 676 ppb), none were close to the standard.

Although it is unlikely that drilling operations at a single site will cause an exceedance or violation of the NAAQS, combined effects from many of these operations in an area, along with other sources, may contribute to exceedances or violations of the NAAQS or interfere with the maintenance of the health-based standards in attainment areas.

Odors

The Open Path sampler did detect certain compounds in concentrations above their odor thresholds. Methyl mercaptan, a sulfur-containing colorless gas with an unpleasant odor described as rotten cabbage, is detectable by the nose at 1 ppb. This compound was detected at the Thomas Compressor Station and Hagemeyer well sites (and even the Sones Pond background site) for short periods. The highest two-minute reading for methyl mercaptan was 1,089 ppb during sampling at the Thomas Compressor Station.

Discussion

Sampling by the PA DEP using OP-FTIR, GC/MS and canister methods did detect concentrations of natural gas constituents including methane, ethane and butane in the air near various Marcellus Shale drilling operations. Appreciable concentrations of methane were detected by the OP-FTIR at all sampling events other than the background event and Hagemeyer well site. Methane was measured at a maximum level of 40,955 ppb (or 41.0 ppm) during sampling at the Thomas compressor station.

Some compounds detected at low levels by the OP-FTIR and GC/MS, other than the basic natural gas constituents, could be attributed to Marcellus Shale gas operations including the measured benzene, toluene, ethylbenzene, carbon monoxide and nitrogen dioxide. Other compounds mentioned in the report, including MTBE nitric acid, are not used by the gas industry and are most likely from other sources.

Benzene was one of the major pollutants of concern in the Texas Commission on Environmental Quality monitoring projects of the Barnett Shale formation (TCEQ, 2010). Although all three sampling methods employed by the PA DEP for this study detected benzene, none were at the levels found in the Texas study. Only one benzene concentration (measured over a two-minute period) of 400 ppb produced a hazard quotient close to 1.0, when compared to the most conservative of the three health-based reference concentrations (i.e. California EPA Reference Exposure Level) used in this study. Considering the assumptions made during the acute risk characterization and that this single high benzene value was measured at the background site, the PA DEP has determined that benzene should not be considered a pollutant of concern near Pennsylvania Marcellus Shale operations.

Certain compounds were detected at levels to produce odors; mainly the methyl mercaptan concentrations measured at brief intervals during all sampling events. The levels detected could cause violations of PA DEP odor emission provisions in 25 *Pa. Code* Section 123.31 (relating to limitations) if they persisted off the property and the Department determined that the odors were "malodors" as defined in 25 *Pa. Code* Section 121 (relating to definitions).[1] Prolonged or repeated exposures to strong odors may produce odor-related health effects such as headaches and nausea.

Even though constituents of natural gas and a few other associated target compounds were detected in the northcentral region, the screening results do not indicate a potential for major air-related health issues associated with the Marcellus Shale drilling activities.

How do the sampling results reported above for the northcentral portion of the state compare to those in southwestern and northeastern Pennsylvania? Sampling in all three regions found natural gas constituents in the ambient air near gas drilling and processing operations. The same pollutants (e.g., methane, ethane, propane and butane) were measured at compressor stations in all three regions and at comparable levels. For example, the maximum ambient methane concentrations near the Energy Corp.

[1] *Malodor*—An odor which causes annoyance or discomfort to the public and which the Department determines to be objectionable to the public.

compressor station in Greene County were in the range of 2,124 ppb to 44,744 ppb; the maximums near the Lathrop and Teel facilities in Susquehanna County were 2,722 ppb to 21,874 ppb; and the maximums near the Thomas compressor station were 12,204 ppb to 40,955 ppb.

Methane levels at the Hagemeyer well site were low and closer to the background level. The well was in the process of being drilled when PA DEP sampling occurred and therefore was not yet producing natural gas. The lack of elevated methane results at the Hagemeyer site, and the elevated methane results at the other sampling sites, would seem to confirm that the natural gas production infrastructure in general, from well sites to condensate tank farms to compressor stations, is a source of pollutant emissions through fugitive and/or direct means.

However, when looking at the individual operations, the results of short-term sampling conducted by PA DEP in the northcentral region did not indicate that these emissions created ambient air pollution conditions where acute adverse health impacts would be expected.

Next Steps

In conducting the short-term, screening-level air quality sampling initiative in the southwest, northeast and northcentral areas of the Commonwealth where a majority of the Marcellus Shale gas is being extracted, the PA DEP has not found an immediate health risk to the general public.

Overall, the Department collected samples over a period of 12 weeks at 15 different sites including two background sites, six compressor stations and six well sites. The well site sampling occurred at two completed wells, one well during active fracking, one well after fracking when fracking water was being produced, and one well during a flaring event. A total of 1,500 sampling hours was conducted using the OP-FTIR, GC/MS and canister methods. PA DEP will compare results from the surveyed regions to determine if any regional differences exist where wet gas is extracted in the southwest region versus dry gas in the northcentral and northeast regions of the Commonwealth. Following the completion of the comparative analysis, the Department will determine whether additional, longer-term sampling is warranted. The PA DEP will also determine if additional measures will be necessary for the protection of public health and the environment during natural gas development operations in the Commonwealth.

The Department will continue to respond, on a case-by-case basis, to reported air pollution episodes from natural gas operations in the Marcellus Shale Play. The existing Commonwealth criteria pollutant monitoring network should provide data to assess the cumulative impacts of Marcellus Shale Gas operations on a larger scale, specifically the effects the industry has on a Pennsylvania region's ability to attain or maintain the national air quality standards for criteria pollutants including ozone and fine particulate matter.

References

FLIR Systems Inc. 2010. FLIR Web Site. *How does an IR camera work?* (Available at http://www.flir.com/thermography/americas/us/content/?id=17868).

Google Inc. 2010. Google Earth Pro (Version 4.3.7204.0836 beta) [Software].

National Emission Standards for Hazardous Air Pollutants for Source Categories From Oil and Natural Gas Production Facilities. Federal Register Vol. 72, No. 1 (January 3, 2007) p. 28. (Available at http://www.gpoaccess.gov/fr/search.html).

New York Department of Environmental Conservation. September 2009. *Supplemental Generic Environmental Impact Statement On The Oil, Gas and Solution Mining Regulatory Program (Draft)*. Division of Mineral Resources. (Available at http://www.dec.ny.gov/energy/58440.html).

PA Department of Environmental Protection. 2010a. 2010 Permits Issued & Wells Drilled Maps. Bureau of Oil & Gas Management web site. (Available at http://www.dep.state.pa.us/dep/deputate/minres/oilgas/new_forms/marcellus/marcellus.htm).

PA Department of Environmental Protection. 2010b. *Chemicals Used by Hydraulic Fracturing Companies in Pennsylvania*. Bureau of Oil & Gas Management website. (Available at http://www.dep.state.pa.us/dep/deputate/minres/oilgas/new_forms/marcellus/marcellus.htm).

PA Department of Environmental Protection. 2010c. *Southwestern Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Report*. Bureau of Air Quality website. (Available at http://www.dep.state.pa.us/dep/deputate/airwaste/aq/default.htm).

PA Department of Environmental Protection. 2010d. *Northeastern Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Report*. Bureau of Air Quality website. (Available at http://www.dep.state.pa.us/dep/deputate/airwaste/aq/default.htm).

Texas Commission on Environmental Quality. Memorandum dated January 4, 2010. *Barnett Shale Formation Area Monitoring Projects*. Document Number BS0912-FR. Page 10. (Available at http://www.tceq.state.tx.us/assets/public/implementation/barnett_shale/2010.01.27-BarnettShaleMonitoringReport.pdf).

Texas Environmental Research Consortium. Revised April 2, 2009. *VOC Emissions From Oil and Condensate Storage Tanks – Final Report*. (Available at http://files.harc.edu/Projects/AirQuality/Projects/H051C/H051CFinalReport.pdf).

Town of Dish, Texas. September 15, 2009. *Ambient Air Monitoring Analysis Final Report*. Prepared by Wolf Eagle Environmental Engineers and Consultants. (Available at http://www.townofdish.com/objects/DISH_-_final_report_revised.pdf).

U.S. Department of Energy. 2009. *Modern Shale Gas Development in the United States: A Primer*. (Available at http://www.netl.doe.gov/technologies/oil-gas/publications/EPreports/Shale_Gas_Primer_2009.pdf).

U.S. Department of Energy. 2010. Risk Assessment Information System (RAIS) web site. (Available at http://rais.ornl.gov/).

U.S Environmental Protection Agency. 1999a. *Compendium Method TO-16, Long-Path Open-Path Fourier Transform Infrared Monitoring Of Atmospheric Gases*. Technology Transfer Network. Ambient Monitoring Technology Information Center. (Available at http://www.epa.gov/ttn/amtic/airtox.html#compendium).

U.S Environmental Protection Agency. 1999b. Compendium Method TO-15, Determination Of Volatile Organic Compounds (VOCs) In Air Collected In Specially-Prepared Canisters And Analyzed By Gas Chromatography/Mass Spectrometry (GC/MS). Technology Transfer Network. Ambient Monitoring Technology Information Center. (Available at http://www.epa.gov/ttn/amtic/airtox.html#compendium).

U.S Environmental Protection Agency. 2010a. *Table 2. Acute Dose-Response Values for Screening Risk Assessments (4/27/2010)*. Technology Transfer Network. Air Toxics Web Site. (Available at http://www.epa.gov/ttn/atw/toxsource/acutesources.html).

U.S. Environmental Protection Agency. 2010b. Assessing Outdoor Air Near Schools Web Site. (Available at http://www.epa.gov/schoolair/).

Appendices

Appendix A: Mobile Analytical Unit OP-FTIR Data
Appendix B: Canister Data
Appendix C: Reference Concentrations
Appendix D: Mobile Analytical Unit Hazard Calculations
Appendix E: Canister Hazard Calculations
Appendix F: Mobile Analytical Unit Meteorological Data

Appendix A: Mobile Analytical Unit OP-FTIR Data

Sones Pond Background Concentrations (expressed in ppb)

Compound	8/9/10			8/10/10						8/11/10						8/12/10		
	5:00 pm - 12:00 pm			5:00 am - 12:00 pm			5:00 pm - 12:00 am			5:00 am - 12:00 pm			5:00 pm - 12:00 am			5:00 am - 12:00 pm		
	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)
1,2,4-Trimethylbenzene	242	--	--	173	--	--	164	--	--	167	--	--	137	--	--	151	--	--
2-Methoxy-2-methylpropane (MTBE)	6	--	41	8	--	22	11	--	58	31	--	98	4	--	--	7	--	24
2-Methyl Butane	38	--	--	25	--	56	16	--	69	31	--	452	14	--	--	29	--	--
2-Methyl Pentane	46	--	--	36	--	--	24	--	--	60	--	853	19	--	--	34	--	--
3-Methyl Pentane	46	--	--	32	--	--	20	--	--	45	--	130	18	--	--	34	--	--
Benzene	72	--	--	71	--	150	77	--	400	92	--	269	57	--	--	69	--	--
Carbon Disulfide	40	--	--	38	--	--	49	--	--	110	--	--	32	--	--	48	--	--
Carbon Monoxide	24	--	70	18	--	103	10	--	27	21	--	--	9	--	121	18	--	1573
Carbonyl Sulfide	5	--	--	4	--	--	7	--	--	11	--	--	2	--	--	4	--	--
Chloromethane	97	--	--	110	--	--	140	--	353	443	--	--	79	--	--	103	--	--
Dimethyl sulfide	30	--	--	33	--	--	41	--	--	110	--	--	24	--	--	35	--	--
Ethane	114	--	--	84	--	--	54	--	--	129	--	--	47	--	--	85	--	--
Ethylbenzene	115	--	--	79	--	--	62	--	--	108	--	317	46	--	--	96	--	--
Formaldehyde	13	--	--	12	--	--	8	--	--	25	--	--	7	--	--	12	--	--
Hydrogen Chloride	18	--	--	15	--	--	11	--	--	35	--	--	9	--	--	17	--	--
Hydrogen Sulfide	3468	--	--	3590	--	--	4204	--	--	8319	--	--	2720	--	--	3816	--	--
iso-Butane	25	--	--	19	--	--	13	--	--	32	--	--	12	--	--	22	--	--
Methane	113	--	--	78	--	--	47	--	208	114	--	--	42	--	186	92	--	--
Methanol	7	--	--	7	--	--	8	--	--	8	--	--	5	--	--	6	--	--
Methyl mercaptan	73	--	340	86	--	350	145	--	--	263	--	--	51	--	--	81	--	--
m-Xylene	58	--	--	46	--	--	36	--	--	48	--	--	33	--	--	46	--	112
Naphthalene	24	--	--	18	--	--	15	--	--	19	--	--	13	--	--	18	--	--
n-Butane	34	--	--	27	--	--	20	--	--	56	--	--	17	--	--	29	--	--
n-Heptane	215	--	--	165	--	360	123	--	--	285	--	609	105	--	--	180	--	510
n-Hexane	74	--	--	53	--	--	37	--	--	81	--	455	34	--	--	60	--	--
Nitric Acid	6	--	--	7	--	--	11	--	32	21	--	--	5	--	13	6	--	--
Nitric Oxide	382	--	--	320	--	--	536	--	--	899	--	--	177	--	--	291	--	--
Nitrogen Dioxide	41	--	--	45	--	--	60	--	--	160	--	--	31	--	--	48	--	--
Nitrous Acid	2	--	--	2	--	--	3	--	--	3	--	10	2	--	3	2	--	--
n-Octane	163	--	--	130	--	--	100	--	--	227	--	1911	81	--	--	137	--	--
n-Pentane	68	--	--	45	--	--	27	--	--	58	--	--	25	--	--	52	--	--
o-Xylene	45	--	--	38	--	--	24	--	--	68	--	--	31	--	--	38	--	--
Ozone	13	--	--	12	--	--	17	--	--	15	--	75	10	--	--	12	--	--
Propane	53	--	--	36	--	--	21	--	--	48	--	530	20	--	--	41	--	--
p-Xylene	167	--	--	114	--	--	77	--	--	125	--	--	89	--	--	124	--	--
Styrene	18	--	--	14	--	--	14	--	--	25	--	--	12	--	--	14	--	--
Sulfur Dioxide	68	--	--	78	--	--	90	--	--	120	--	--	54	--	--	85	--	--
Toluene	92	--	--	68	--	172	47	--	154	102	--	--	61	--	--	85	--	--

8/11/10 - Nitric Acid - 7-10 (9:10 sustained through noon)
8/11/10 - Ozone - 75 (9:07 sustained through noon)
8/11/10 - Methane - 186 (occurred twice)
8/12/10 - MTBE - 24 (occurred twice)
8/12/10 - n-Heptane - 510 (occurred twice)

Thomas Compressor Station Concentrations (expressed in ppb)

Compound	8/30/10			8/31/10						9/1/10						9/2/10		
	5:00 pm - 12:00 pm			4:30 am - 12:00 pm			5:00 pm - 12:00 am			4:30 am - 12:00 pm			5:00 pm - 12:00 am			4:30 am - 12:00 pm		
	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)
1,2,4-Trimethylbenzene	124	--	--	247	--	--	180	--	--	257	--	--	170	--	--	242	--	--
2-Methoxy-2-methylpropane (MTBE)	6	--	33	21	--	113	6	--	40	6	--	20	7	--	28	6	--	56
2-Methyl Butane	45	--	--	101	--	--	95	--	--	188	--	--	185	--	--	239	--	--
2-Methyl Pentane	44	--	--	106	--	--	94	--	--	185	--	--	197	--	--	242	--	--
3-Methyl Pentane	46	--	--	109	--	--	95	--	--	201	--	--	201	--	--	261	--	--
Benzene	72	--	--	97	--	--	71	--	--	91	--	--	82	--	--	93	--	--
Carbon Disulfide	40	--	--	525	--	--	172	--	--	722	--	--	856	--	--	573	--	--
Carbon Monoxide	10	--	135	27	266	2603	16	97	1794	30	475	3338	30	676	5718	33	515	2640
Carbonyl Sulfide	3	--	--	11	--	--	4	--	--	5	--	--	6	--	--	5	--	--
Chloromethane	101	--	--	345	--	--	106	--	--	110	--	--	112	--	--	108	--	--
Dimethyl sulfide	40	--	--	87	--	--	50	--	--	69	--	--	64	--	--	74	--	--
Ethane	103	--	--	240	--	913	217	--	--	430	--	--	445	--	934	562	--	--
Ethylbenzene	94	--	--	176	--	--	151	--	--	228	--	--	184	--	--	238	--	--
Formaldehyde	10	--	--	23	--	--	14	--	--	25	--	--	24	--	--	31	--	--
Hydrogen Chloride	12	--	--	29	--	--	17	--	--	31	--	--	31	--	--	39	--	--
Hydrogen Sulfide	3542	--	--	7359	--	--	3923	--	--	5035	--	--	4706	--	--	5725	--	--
iso-Butane	32	--	--	78	--	--	72	--	--	139	--	--	146	--	--	178	--	--
Methane	66	509	12204	166	1215	40955	98	1327	29631	174	2492	17827	177	2640	32584	238	3325	25914
Methanol	5	--	422	8	--	111	5	--	71	8	--	63	7	--	26	8	--	16
Methyl mercaptan	89	--	392	328	--	1089	131	--	958	171	--	700	157	--	620	192	--	608
m-Xylene	33	--	--	72	--	--	51	--	--	71	--	--	54	--	--	74	--	--
Naphthalene	12	--	--	28	--	--	19	--	--	28	--	--	19	--	--	29	--	--
n-Butane	30	--	83	59	--	--	46	--	171	86	--	--	81	--	--	106	--	--
n-Heptane	394	--	--	857	--	--	813	--	--	1668	--	--	1656	--	--	2120	--	--
n-Hexane	109	--	--	243	--	--	232	--	--	452	--	--	444	--	--	577	--	--
Nitric Acid	6	--	13	16	--	--	6	--	--	6	--	12	6	--	13	6	--	18
Nitric Oxide	225	--	--	1018	--	--	239	--	--	290	--	--	337	--	--	323	--	--
Nitrogen Dioxide	115	--	--	345	--	--	255	--	--	447	--	--	422	--	--	630	--	--
Nitrous Acid	2	--	--	4	--	9	2	--	--	2	--	--	2	--	--	2	--	--
n-Octane	291	--	--	650	--	--	636	--	--	1261	--	--	1274	--	--	1634	--	--
n-Pentane	65	--	--	149	--	--	132	--	--	267	--	--	257	--	--	333	--	--
o-Xylene	55	--	143	73	--	--	77	--	--	58	--	--	64	--	36	60	--	--
Ozone	11	--	185	14	--	--	12	--	--	15	--	--	15	--	36	16	--	--
Propane	62	--	--	144	--	--	132	--	--	266	--	--	262	--	--	341	--	--
p-Xylene	79	--	--	222	--	--	144	--	--	199	--	--	103	--	--	209	--	--
Styrene	12	--	--	22	--	--	16	--	--	20	--	--	14	--	--	22	--	--
Sulfur Dioxide	65	--	--	93	--	--	64	--	--	72	--	--	73	--	--	74	--	--
Toluene	84	--	--	153	--	--	126	--	--	153	--	--	136	--	--	140	--	--

8/30/10 - Methane - 12204 (3-minute episode)
8/30/10 - o-Xylene - 143 (occurred 3 times)
8/31/10 - MTBE - 40 (occurred twice)
9/1/10 - MTBE - 28 (occurred twice)
9/1/10 - Nitric Acid - 13 (occurred twice)
9/2/10 - Methanol - 16 (occurred twice)
9/2/10 - Methyl mercaptan - 608 (occurred twice)

Shaw Compressor Station Concentrations (expressed in ppb)

Compound	11/15/10			11/16/10						11/17/10					
	5:00 pm - 12:00 pm			5:00 am - 12:00 pm			5:00 pm - 12:00 am			5:00 am - 12:00 pm					
	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)
1,2,4-Trimethylbenzene	367	--	--	376	--	--	367	--	--	361	--	--			
2-Methoxy-2-methylpropane (MTBE)	4	--	19	5	--	37	10	--	41	6	--	44			
2-Methyl Butane	155	--	--	139	--	--	68	--	--	128	--	--			
2-Methyl Pentane	121	--	--	110	--	--	65	--	--	104	--	--			
3-Methyl Pentane	137	--	--	124	--	--	73	--	--	117	--	--			
Benzene	96	--	--	88	--	--	134	--	--	83	--	--			
Carbon Disulfide	48	--	--	94	--	--	62	--	--	317	--	--			
Carbon Monoxide	49	--	412	41	129	791	33	--	97	39	265	1511			
Carbonyl Sulfide	2	--	--	3	--	--	4	--	--	5	--	--			
Chloromethane	66	--	--	88	--	--	148	--	--	113	--	--			
Dimethyl sulfide	48	--	--	51	--	--	58	--	--	66	--	--			
Ethane	294	--	--	262	--	--	169	--	--	247	--	--			
Ethylbenzene	257	--	550	265	--	--	241	--	--	300	--	--			
Formaldehyde	19	--	--	18	--	--	22	--	--	18	--	--			
Hydrogen Chloride	23	--	--	22	--	--	29	--	--	22	--	--			
Hydrogen Sulfide	2886	--	--	3426	--	--	4853	--	--	4255	--	--			
iso-Butane	89	--	--	86	--	--	51	--	--	79	--	--			
Methane	162	2091	11004	148	1974	9046	125	634	843	142	1643	12502			
Methanol	8	--	24	8	--	32	12	--	--	8	--	--			
Methyl mercaptan	97	--	--	129	--	--	132	--	--	177	--	--			
m-Xylene	83	--	--	83	--	--	135	--	--	85	--	--			
Naphthalene	35	--	--	30	--	--	38	--	--	27	--	--			
n-Butane	106	--	776	99	--	--	62	--	--	90	--	552			
n-Heptane	1396	--	--	1157	--	--	532	--	--	1045	--	--			
n-Hexane	376	--	--	337	--	--	166	--	--	311	--	--			
Nitric Acid	6	--	--	6	--	12	12	--	40	8	--	18			
Nitric Oxide	140	--	--	312	--	--	308	--	--	460	--	--			
Nitrogen Dioxide	153	--	--	171	--	--	74	--	--	181	--	--			
Nitrous Acid	2	--	--	2	--	--	3	--	--	2	--	--			
n-Octane	967	--	--	876	--	--	403	--	--	793	--	--			
n-Pentane	225	--	--	203	--	--	114	--	--	185	--	--			
o-Xylene	140	--	--	152	--	--	148	--	--	136	--	--			
Ozone	15	--	--	15	--	--	23	--	--	14	--	--			
Propane	210	--	--	189	--	--	102	--	--	176	--	--			
p-Xylene	238	--	--	253	--	--	302	--	--	248	--	--			
Styrene	22	--	--	22	--	--	32	--	72	23	--	--			
Sulfur Dioxide	40	--	--	51	--	--	110	--	--	70	--	--			
Toluene	225	--	--	222	--	--	308	--	--	225	--	--			

11/15/10 - MTBE - 19 (occurred 3 times)
11/15/10 - Ethylbenzene - 550 (occurred twice)
11/15/10 - Methanol - 24 (occurred twice)
11/17/10 - Nitric Acid - 18 (occurred twice)

Chicken Hawk Flare Concentrations (expressed in ppb)

Compound	11/17/10[1]												11/17/10-11/18/10					
										5:30 pm - 6:00 pm			6:30 pm - 7:00 am					
	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)
1,2,4-Trimethylbenzene										428	--	--	366	--	--			
2-Methoxy-2-methylpropane (MTBE)										8	--	26	8	--	46			
2-Methyl Butane										276	--	--	89	--	--			
2-Methyl Pentane										396	--	--	71	--	--			
3-Methyl Pentane										306	--	--	81	--	--			
Benzene										74	--	--	94	--	--			
Carbon Disulfide										72	--	--	76	--	--			
Carbon Monoxide										25	57	70	27	61	325			
Carbonyl Sulfide										6	--	--	5	--	--			
Chloromethane										100	--	--	106	--	--			
Dimethyl sulfide										85	--	--	63	--	--			
Ethane										786	--	--	180	--	--			
Ethylbenzene										243	--	560	290	--	589			
Formaldehyde										71	--	--	17	--	--			
Hydrogen Chloride										86	--	--	19	--	--			
Hydrogen Sulfide										6581	--	--	4453	--	--			
iso-Butane										276	--	--	56	--	--			
Methane										542	5509	29182	132	977	2274			
Methanol										8	--	--	9	--	--			
Methyl mercaptan										224	--	--	186	--	--			
m-Xylene										80	--	--	96	--	--			
Naphthalene										34	--	--	30	--	--			
n-Butane										124	--	720	63	--	--			
n-Heptane										2447	--	--	665	--	--			
n-Hexane										659	--	--	217	--	--			
Nitric Acid										9	--	--	10	--	25			
Nitric Oxide										649	--	--	608	--	--			
Nitrogen Dioxide										1575	--	--	121	--	--			
Nitrous Acid										2	--	--	2	--	--			
n-Octane										2035	--	--	504	--	--			
n-Pentane										379	--	--	138	--	--			
o-Xylene										136	--	--	130	--	--			
Ozone										14	--	--	15	--	--			
Propane										408	--	--	122	--	--			
p-Xylene										228	--	--	237	--	--			
Styrene										21	--	--	25	--	--			
Sulfur Dioxide										77	--	--	72	--	--			
Toluene										241	--	--	251	--	--			

[1] The data collected during this half-hour period is pre-flaring, to document ambient conditions before the flaring event.

11/18/10 - Ethylbenzene - 589 (occurred four times)

11/18/10 - Methane - 2274 (occurred twice)

Hagemeyer Well Site Concentrations (expressed in ppb)

Compound	12/6/10			12/7/10				12/8/10				12/9/10			
	4:56 pm - 12:00 pm			5:00 am - 12:00 pm			5:00 pm - 12:00 am	5:00 am - 12:00 pm			5:00 pm - 12:00 am	5:00 am - 12:00 pm			
	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)	Detect. Limit (ppb)	Avg. Conc. (ppb)	Max. Conc. (ppb)
1,2,4-Trimethylbenzene	191	--	--	144	--	--	335	--	--	93	--	--	88	--	--	85	--	--
2-Methoxy-2-methylpropane (MTBE)	6	--	19	4	--	8	5	--	29	4	--	13	8	--	62	5	--	38
2-Methyl Butane	27	--	--	23	--	--	53	--	--	18	--	--	15	--	32	14	--	33
2-Methyl Pentane	35	--	--	28	--	--	57	--	--	22	--	--	20	--	--	19	--	--
3-Methyl Pentane	31	--	--	27	--	--	57	--	--	20	--	--	19	--	--	17	--	--
Benzene	87	--	--	60	--	--	99	--	--	57	--	--	55	--	180	56	--	133
Carbon Disulfide	45	--	--	37	--	--	35	--	--	45	--	--	74	--	--	71	--	--
Carbon Monoxide	16	--	82	14	--	82	26	--	67	12	--	210	9	30	180	12	49	343
Carbonyl Sulfide	4	--	--	3	--	--	3	--	--	4	--	--	7	--	--	5	--	--
Chloromethane	90	--	--	62	--	--	75	--	--	67	--	--	103	--	--	87	--	--
Dimethyl sulfide	39	--	--	29	--	--	30	--	--	41	--	--	44	--	--	37	--	--
Ethane	84	--	--	74	--	--	151	--	--	56	--	--	51	--	--	48	--	--
Ethylbenzene	84	--	--	72	--	--	156	--	402	61	--	340	52	--	--	49	--	--
Formaldehyde	12	--	--	9	--	--	17	--	--	7	--	--	8	--	--	7	--	--
Hydrogen Chloride	17	--	--	12	--	--	22	--	--	11	--	--	11	--	--	10	--	--
Hydrogen Sulfide	2660	--	--	1730	--	--	2273	--	--	2020	--	--	3733	--	--	2361	--	--
iso-Butane	20	--	--	18	--	--	34	--	--	17	--	--	14	--	--	13	--	--
Methane	90	--	--	71	--	553	146	--	507	60	--	730	45	--	223	49	--	280
Methanol	7	--	38	5	--	--	9	--	18	5	--	131	5	--	25	5	--	18
Methyl mercaptan	82	--	170	58	--	196	65	--	198	83	--	852	107	--	330	80	--	184
m-Xylene	51	--	--	39	--	--	100	--	--	25	--	--	27	--	--	23	--	--
Naphthalene	20	--	--	15	--	--	43	--	--	9	--	--	11	--	--	8	--	--
n-Butane	27	--	--	24	--	--	45	--	--	22	--	56	19	--	--	18	--	73
n-Heptane	177	--	--	150	--	629	278	--	--	126	--	696	127	--	261	112	--	280
n-Hexane	57	--	--	49	--	--	95	--	--	38	--	--	37	--	--	33	--	--
Nitric Acid	7	--	19	5	--	--	7	--	15	5	--	15	8	--	16	5	--	21
Nitric Oxide	244	--	--	188	--	--	196	--	--	231	--	--	661	--	--	321	--	--
Nitrogen Dioxide	53	--	120	38	--	--	38	--	82	56	--	170	63	--	180	45	--	--
Nitrous Acid	2	--	--	1	--	3	2	--	4	1	--	--	2	--	--	2	--	--
n-Octane	139	--	--	114	--	--	213	--	--	98	--	--	99	--	--	89	--	--
n-Pentane	49	--	250	40	--	554	97	--	455	38	--	390	27	--	240	25	--	242
o-Xylene	44	--	--	36	--	--	91	--	--	23	--	--	22	--	--	23	--	--
Ozone	14	--	--	9	--	--	15	--	--	9	--	39	9	--	--	10	--	31
Propane	38	--	--	33	--	--	74	--	--	26	--	--	22	--	--	20	--	--
p-Xylene	108	--	--	77	--	--	248	--	--	47	--	--	65	--	--	44	--	--
Styrene	15	--	47	11	--	36	22	--	45	9	--	24	12	--	--	10	--	22
Sulfur Dioxide	54	--	--	36	--	--	47	--	--	45	--	--	67	--	--	51	--	--
Toluene	75	--	--	62	--	--	137	--	--	50	--	--	46	--	--	53	--	--

12/6/10 - Styrene - 47 (occurred twice)
12/7/10 - Methane - 507 (occurred twice)
12/9/10 - Benzene - 133 (occurred twice)
12/9/10 - Carbon monoxide - 343 (occurred twice)

Sones Pond Background Concentrations (expressed in ug/m^3)

Compound	MW	8/9/10			8/10/10						8/11/10						8/12/10		
		5:00 pm - 12:00 pm			5:00 am - 12:00 pm			5:00 pm - 12:00 am			5:00 am - 12:00 pm			5:00 pm - 12:00 am			5:00 am - 12:00 pm		
		Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)
1,2,4-Trimethylbenzene	120.2	1190	--	--	850	--	--	806	--	--	821	--	--	673	--	--	742	--	--
2-Methoxy-2-methylpropane (MTBE)	88.2	22	--	148	29	--	79	40	--	209	112	--	353	14	--	--	25	--	87
2-Methyl Butane	72.2	112	--	--	74	--	165	47	--	204	91	--	1334	41	--	--	86	--	--
2-Methyl Pentane	86.2	162	--	--	127	--	--	85	--	--	211	--	3006	67	--	--	120	--	--
3-Methyl Pentane	86.2	162	--	--	113	--	--	71	--	--	159	--	458	63	--	--	120	--	--
Benzene	78.1	230	--	--	227	--	479	246	--	1278	294	--	859	182	--	--	220	--	--
Carbon Disulfide	76.1	125	--	--	118	--	--	153	--	--	342	--	--	100	--	--	149	--	--
Carbon Monoxide	28.0	27	--	80	21	--	118	11	--	31	24	--	--	10	--	139	21	--	1802
Carbonyl Sulfide	60.1	12	--	--	10	--	--	17	--	--	27	--	--	5	--	--	10	--	--
Chloromethane	50.5	200	--	--	227	--	--	289	--	729	915	--	--	163	--	--	213	--	--
Dimethyl sulfide	62.1	76	--	--	84	--	--	104	--	--	279	--	--	61	--	--	89	--	--
Ethane	30.1	140	--	--	103	--	--	66	--	--	159	--	--	58	--	--	105	--	--
Ethylbenzene	106.2	499	--	--	343	--	--	269	--	--	469	--	1377	200	--	--	417	--	--
Formaldehyde	30.0	16	--	--	15	--	--	10	--	--	31	--	--	9	--	--	15	--	--
Hydrogen Chloride	36.5	27	--	--	22	--	--	16	--	--	52	--	--	13	--	--	25	--	--
Hydrogen Sulfide	34.1	4833	--	--	5003	--	--	5859	--	--	11594	--	--	3791	--	--	5318	--	--
iso-Butane	58.1	59	--	--	45	--	--	31	--	--	76	--	--	29	--	--	52	--	--
Methane	16.0	74	--	--	51	--	--	31	--	136	75	--	--	28	--	122	60	--	--
Methanol	32.0	9	--	--	9	--	--	10	--	--	10	--	--	7	--	--	8	--	--
Methyl mercaptan	48.1	144	--	669	169	--	689	285	--	--	517	--	--	100	--	--	159	--	--
m-Xylene	106.2	252	--	--	200	--	--	156	--	--	208	--	--	143	--	--	200	--	486
Naphthalene	128.2	126	--	--	94	--	--	79	--	--	100	--	--	68	--	--	94	--	--
n-Butane	58.1	81	--	--	64	--	--	48	--	--	133	--	--	40	--	--	69	--	--
n-Heptane	100.2	881	--	--	676	--	1475	504	--	--	1168	--	2495	430	--	--	738	--	2090
n-Hexane	86.2	261	--	--	187	--	--	130	--	--	286	--	1604	120	--	--	212	--	--
Nitric Acid	63.0	15	--	--	18	--	--	28	--	82	54	--	--	13	--	33	15	--	--
Nitric Oxide	30.0	469	--	--	393	--	--	658	--	--	1103	--	--	217	--	--	357	--	--
Nitrogen Dioxide	46.0	77	--	--	85	--	--	113	--	--	301	--	--	58	--	--	90	--	--
Nitrous Acid	47.0	4	--	--	4	--	--	6	--	--	6	--	19	4	--	6	4	--	--
n-Octane	114.2	761	--	--	607	--	--	467	--	--	1060	--	8927	378	--	--	640	--	--
n-Pentane	72.2	201	--	--	133	--	--	80	--	--	171	--	--	74	--	--	153	--	--
o-Xylene	106.2	195	--	--	165	--	--	104	--	--	295	--	--	135	--	--	165	--	--
Ozone	48.0	26	--	--	24	--	--	33	--	--	29	--	147	20	--	--	24	--	--
Propane	44.1	96	--	--	65	--	--	38	--	--	87	--	956	36	--	--	74	--	--
p-Xylene	106.2	725	--	--	495	--	--	334	--	--	543	--	--	386	--	--	538	--	--
Styrene	104.2	77	--	--	60	--	--	60	--	--	107	--	--	51	--	--	60	--	--
Sulfur Dioxide	64.1	178	--	--	204	--	--	236	--	--	314	--	--	141	--	--	223	--	--
Toluene	92.1	346	--	--	256	--	648	177	--	580	384	--	--	230	--	--	320	--	--

Thomas Compressor Station Concentrations (expressed in ug/m^3)

Compound	MW	8/30/10			8/31/10						9/1/10						9/2/10		
		5:00 pm - 12:00 pm			4:30 am - 12:00 pm			5:00 pm - 12:00 am			4:30 am - 12:00 pm			5:00 pm - 12:00 am			4:30 am - 12:00 pm		
		Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)
1,2,4-Trimethylbenzene	120.2	610	--	--	1214	--	--	885	--	--	1263	--	--	836	--	--	1190	--	--
2-Methoxy-2-methylpropane (MTBE)	88.2	22	--	119	76	--	408	22	--	144	22	--	72	25	--	101	22	--	202
2-Methyl Butane	72.2	133	--	--	298	--	--	280	--	--	555	--	--	546	--	--	705	--	--
2-Methyl Pentane	86.2	155	--	--	374	--	--	331	--	--	652	--	--	694	--	--	853	--	--
3-Methyl Pentane	86.2	162	--	--	384	--	--	335	--	--	709	--	--	709	--	--	920	--	--
Benzene	78.1	230	--	--	310	--	--	227	--	--	291	--	--	262	--	--	297	--	--
Carbon Disulfide	76.1	125	--	--	1635	--	--	536	--	--	2248	--	--	2665	--	--	1784	--	--
Carbon Monoxide	28.0	11	--	155	31	305	2982	18	111	2055	34	544	3823	34	774	6550	38	590	3024
Carbonyl Sulfide	60.1	7	--	--	27	--	--	10	--	--	12	--	--	15	--	--	12	--	--
Chloromethane	50.5	209	--	--	712	--	--	219	--	--	227	--	--	231	--	--	223	--	--
Dimethyl sulfide	62.1	102	--	--	221	--	--	127	--	--	175	--	--	163	--	--	188	--	--
Ethane	30.1	127	--	--	295	--	1123	267	--	--	529	--	--	547	--	1149	691	--	--
Ethylbenzene	106.2	408	--	--	764	--	--	656	--	--	990	--	--	799	--	--	1034	--	--
Formaldehyde	30.0	12	--	--	28	--	--	17	--	--	31	--	--	29	--	--	38	--	--
Hydrogen Chloride	36.5	18	--	--	43	--	--	25	--	--	46	--	--	46	--	--	58	--	--
Hydrogen Sulfide	34.1	4936	--	--	10256	--	--	5467	--	--	7017	--	--	6558	--	--	7979	--	--
iso-Butane	58.1	76	--	--	185	--	--	171	--	--	330	--	--	347	--	--	423	--	--
Methane	16.0	43	334	8005	109	797	26864	64	870	19436	114	1635	11693	116	1732	21373	156	2181	16998
Methanol	32.0	7	--	553	10	--	145	7	--	93	10	--	83	9	--	34	10	--	21
Methyl mercaptan	48.1	175	--	771	645	--	2142	258	--	1885	336	--	1377	309	--	1220	378	--	1196
m-Xylene	106.2	143	--	--	313	--	--	221	--	--	308	--	--	234	--	--	321	--	--
Naphthalene	128.2	63	--	--	147	--	--	100	--	--	147	--	--	100	--	--	152	--	--
n-Butane	58.1	71	--	197	140	--	--	109	--	406	204	--	--	193	--	--	252	--	--
n-Heptane	100.2	1614	--	--	3512	--	--	3331	--	--	6835	--	--	6785	--	--	8687	--	--
n-Hexane	86.2	384	--	--	857	--	--	818	--	--	1593	--	--	1565	--	--	2034	--	--
Nitric Acid	63.0	15	--	33	41	--	--	15	--	--	15	--	31	15	--	33	15	--	46
Nitric Oxide	30.0	276	--	--	1249	--	--	293	--	--	356	--	--	414	--	--	396	--	--
Nitrogen Dioxide	46.0	216	--	--	649	--	--	480	--	--	841	--	--	794	--	--	1185	--	--
Nitrous Acid	47.0	4	--	--	8	--	17	4	--	--	4	--	--	4	--	--	4	--	--
n-Octane	114.2	1359	--	--	3036	--	--	2971	--	--	5890	--	--	5951	--	--	7633	--	--
n-Pentane	72.2	192	--	--	440	--	--	389	--	--	788	--	--	758	--	--	983	--	--
o-Xylene	106.2	239	--	621	317	--	--	334	--	--	252	--	--	278	--	156	261	--	--
Ozone	48.0	22	--	363	27	--	--	24	--	--	29	--	--	29	--	71	31	--	--
Propane	44.1	112	--	--	260	--	--	238	--	--	480	--	--	472	--	--	615	--	--
p-Xylene	106.2	343	--	--	964	--	--	625	--	--	864	--	--	447	--	--	907	--	--
Styrene	104.2	51	--	--	94	--	--	68	--	--	85	--	--	60	--	--	94	--	--
Sulfur Dioxide	64.1	170	--	--	244	--	--	168	--	--	189	--	--	191	--	--	194	--	--
Toluene	92.1	316	--	--	576	--	--	475	--	--	576	--	--	512	--	--	527	--	--

Shaw Compressor Station Concentrations (expressed in ug/m^3)

Compound	MW	11/15/10			11/16/10						11/17/10								
		5:00 pm - 12:00 pm			5:00 am - 12:00 pm			5:00 pm - 12:00 am			5:00 am - 12:00 pm								
		Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)
1,2,4-Trimethylbenzene	120.2	1804	--	--	1848	--	--	1804	--	--	1774	--	--						
2-Methoxy-2-methylpropane (MTBE)	88.2	14	--	69	18	--	133	36	--	148	22	--	159						
2-Methyl Butane	72.2	457	--	--	410	--	--	201	--	--	378	--	--						
2-Methyl Pentane	86.2	426	--	--	388	--	--	229	--	--	367	--	--						
3-Methyl Pentane	86.2	483	--	--	437	--	--	257	--	--	412	--	--						
Benzene	78.1	307	--	--	281	--	--	428	--	--	265	--	--						
Carbon Disulfide	76.1	149	--	--	293	--	--	193	--	--	987	--	--						
Carbon Monoxide	28.0	56	--	472	47	148	906	38	--	111	45	304	1731						
Carbonyl Sulfide	60.1	5	--	--	7	--	--	10	--	--	12	--	--						
Chloromethane	50.5	136	--	--	182	--	--	306	--	--	233	--	--						
Dimethyl sulfide	62.1	122	--	--	130	--	--	147	--	--	168	--	--						
Ethane	30.1	362	--	--	322	--	--	208	--	--	304	--	--						
Ethylbenzene	106.2	1116	--	2389	1151	--	--	1047	--	--	1303	--	--						
Formaldehyde	30.0	23	--	--	22	--	--	27	--	--	22	--	--						
Hydrogen Chloride	36.5	34	--	--	33	--	--	43	--	--	33	--	--						
Hydrogen Sulfide	34.1	4022	--	--	4775	--	--	6763	--	--	5930	--	--						
iso-Butane	58.1	212	--	--	204	--	--	121	--	--	188	--	--						
Methane	16.0	106	1372	7218	97	1295	5934	82	416	553	93	1078	8200						
Methanol	32.0	10	--	31	10	--	42	16	--	--	10	--	--						
Methyl mercaptan	48.1	191	--	--	254	--	--	260	--	--	348	--	--						
m-Xylene	106.2	360	--	--	360	--	--	586	--	--	369	--	--						
Naphthalene	128.2	183	--	--	157	--	--	199	--	--	142	--	--						
n-Butane	58.1	252	--	1844	235	--	--	147	--	--	214	--	1312						
n-Heptane	100.2	5720	--	--	4741	--	--	2180	--	--	4282	--	--						
n-Hexane	86.2	1325	--	--	1188	--	--	585	--	--	1096	--	--						
Nitric Acid	63.0	15	--	--	15	--	31	31	--	103	21	--	46						
Nitric Oxide	30.0	172	--	--	383	--	--	378	--	--	565	--	--						
Nitrogen Dioxide	46.0	288	--	--	322	--	--	139	--	--	341	--	--						
Nitrous Acid	47.0	4	--	--	4	--	--	6	--	--	4	--	--						
n-Octane	114.2	4517	--	--	4092	--	--	1883	--	--	3704	--	--						
n-Pentane	72.2	664	--	--	599	--	--	336	--	--	546	--	--						
o-Xylene	106.2	608	--	--	660	--	--	643	--	--	591	--	--						
Ozone	48.0	29	--	--	29	--	--	45	--	--	27	--	--						
Propane	44.1	379	--	--	341	--	--	184	--	--	317	--	--						
p-Xylene	106.2	1033	--	--	1098	--	--	1311	--	--	1077	--	--						
Styrene	104.2	94	--	--	94	--	--	136	--	307	98	--	--						
Sulfur Dioxide	64.1	105	--	--	134	--	--	288	--	--	183	--	--						
Toluene	92.1	847	--	--	836	--	--	1160	--	--	847	--	--						

Chicken Hawk Flare Concentrations (expressed in ug/m^3)

Compound	MW	11/17/10[1]										11/17/10-11/18/10					
								5:30 pm - 6:00 pm				6:30 pm - 7:00 am					
		Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)
1,2,4-Trimethylbenzene	120.2							2104	--	--	1799	--	--
2-Methoxy-2-methylpropane (MTBE)	88.2							29	--	94	29	--	166
2-Methyl Butane	72.2							814	--	--	263	--	--
2-Methyl Pentane	86.2							1396	--	--	250	--	--
3-Methyl Pentane	86.2							1079	--	--	286	--	--
Benzene	78.1							236	--	--	300	--	--
Carbon Disulfide	76.1							224	--	--	237	--	--
Carbon Monoxide	28.0							29	65	80	31	70	372
Carbonyl Sulfide	60.1							15	--	--	12	--	--
Chloromethane	50.5							207	--	--	219	--	--
Dimethyl sulfide	62.1							216	--	--	160	--	--
Ethane	30.1							967	--	--	221	--	--
Ethylbenzene	106.2							1055	--	2432	1259	--	2558
Formaldehyde	30.0							87	--	--	21	--	--
Hydrogen Chloride	36.5							128	--	--	28	--	--
Hydrogen Sulfide	34.1							9172	--	--	6206	--	--
iso-Butane	58.1							656	--	--	133	--	--
Methane	16.0							356	3614	19141	87	641	1492
Methanol	32.0							10	--	--	12	--	--
Methyl mercaptan	48.1							441	--	--	366	--	--
m-Xylene	106.2							347	--	--	417	--	--
Naphthalene	128.2							178	--	--	157	--	--
n-Butane	58.1							295	--	1711	150	--	--
n-Heptane	100.2							10027	--	--	2725	--	--
n-Hexane	86.2							2323	--	--	765	--	--
Nitric Acid	63.0							23	--	--	26	--	64
Nitric Oxide	30.0							796	--	--	746	--	--
Nitrogen Dioxide	46.0							2963	--	--	228	--	--
Nitrous Acid	47.0							4	--	--	4	--	--
n-Octane	114.2							9506	--	--	2354	--	--
n-Pentane	72.2							1118	--	--	407	--	--
o-Xylene	106.2							591	--	--	565	--	--
Ozone	48.0							27	--	--	29	--	--
Propane	44.1							736	--	--	220	--	--
p-Xylene	106.2							990	--	--	1029	--	--
Styrene	104.2							89	--	--	107	--	--
Sulfur Dioxide	64.1							202	--	--	189	--	--
Toluene	92.1							908	--	--	945	--	--

[1] The data collected during this half-hour period is pre-flaring, to document ambient conditions before the flaring event.

Hagemeyer Well Site Concentrations (expressed in ug/m^3)

Compound	MW	12/6/10			12/7/10						12/8/10						12/9/10					
		4:56 pm - 12:00 pm			5:00 am - 12:00 pm			5:00 pm - 12:00 am			5:00 am - 12:00 pm			5:00 pm - 12:00 am			5:00 am - 12:00 pm					
		Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)	Detect. Limit (ug/m3)	Avg. Conc. (ug/m3)	Max. Conc. (ug/m3)			
1,2,4-Trimethylbenzene	120.2	939	--	--	708	--	--	1647	--	--	457	--	--	433	--	--	418	--	--			
2-Methoxy-2-methylpropane (MTBE)	88.2	22	--	69	14	--	29	18	--	105	14	--	47	29	--	224	18	--	137			
2-Methyl Butane	72.2	80	--	--	68	--	--	156	--	--	53	--	--	44	--	94	41	--	97			
2-Methyl Pentane	86.2	123	--	--	99	--	--	201	--	--	78	--	--	70	--	--	67	--	--			
3-Methyl Pentane	86.2	109	--	--	95	--	--	201	--	--	71	--	--	67	--	--	60	--	--			
Benzene	78.1	278	--	--	192	--	--	316	--	--	182	--	--	176	--	575	179	--	425			
Carbon Disulfide	76.1	140	--	--	115	--	--	109	--	--	140	--	--	230	--	--	221	--	--			
Carbon Monoxide	28.0	18	--	94	16	--	94	30	--	77	14	--	241	10	34	206	14	56	393			
Carbonyl Sulfide	60.1	10	--	--	7	--	--	7	--	--	10	--	--	17	--	--	12	--	--			
Chloromethane	50.5	186	--	--	128	--	--	155	--	--	138	--	--	213	--	--	180	--	--			
Dimethyl sulfide	62.1	99	--	--	74	--	--	76	--	--	104	--	--	112	--	--	94	--	--			
Ethane	30.1	103	--	--	91	--	--	186	--	--	69	--	--	63	--	--	59	--	--			
Ethylbenzene	106.2	365	--	--	313	--	--	677	--	1746	265	--	1477	226	--	--	213	--	--			
Formaldehyde	30.0	15	--	--	11	--	--	21	--	--	9	--	--	10	--	--	9	--	--			
Hydrogen Chloride	36.5	25	--	--	18	--	--	33	--	--	16	--	--	16	--	--	15	--	--			
Hydrogen Sulfide	34.1	3707	--	--	2411	--	--	3168	--	--	2815	--	--	5202	--	--	3290	--	--			
iso-Butane	58.1	48	--	--	43	--	--	81	--	--	40	--	--	33	--	--	31	--	--			
Methane	16.0	59	--	--	47	--	363	96	--	333	39	--	479	30	--	146	32	--	184			
Methanol	32.0	9	--	50	7	--	--	12	--	24	7	--	172	7	--	33	7	--	24			
Methyl mercaptan	48.1	161	--	334	114	--	386	128	--	390	163	--	1676	211	--	649	157	--	362			
m-Xylene	106.2	221	--	--	169	--	--	434	--	--	109	--	--	117	--	--	100	--	--			
Naphthalene	128.2	105	--	--	79	--	--	225	--	--	47	--	--	58	--	--	42	--	--			
n-Butane	58.1	64	--	--	57	--	--	107	--	--	52	--	133	45	--	--	43	--	174			
n-Heptane	100.2	725	--	--	615	--	2577	1139	--	--	516	--	2852	520	--	1069	459	--	1147			
n-Hexane	86.2	201	--	--	173	--	--	335	--	--	134	--	--	130	--	--	116	--	--			
Nitric Acid	63.0	18	--	49	13	--	--	18	--	39	13	--	39	21	--	41	13	--	54			
Nitric Oxide	30.0	299	--	--	231	--	--	241	--	--	283	--	--	811	--	--	394	--	--			
Nitrogen Dioxide	46.0	100	--	226	71	--	--	71	--	154	105	--	320	119	--	339	85	--	--			
Nitrous Acid	47.0	4	--	--	2	--	6	4	--	8	2	--	--	4	--	--	4	--	--			
n-Octane	114.2	649	--	--	533	--	--	995	--	--	458	--	--	462	--	--	416	--	--			
n-Pentane	72.2	145	--	738	118	--	1635	286	--	1342	112	--	1151	80	--	708	74	--	714			
o-Xylene	106.2	191	--	--	156	--	--	395	--	--	100	--	--	96	--	--	100	--	--			
Ozone	48.0	27	--	--	18	--	--	29	--	--	18	--	77	18	--	--	20	--	61			
Propane	44.1	69	--	--	60	--	--	133	--	--	47	--	--	40	--	--	36	--	--			
p-Xylene	106.2	469	--	--	334	--	--	1077	--	--	204	--	--	282	--	--	191	--	--			
Styrene	104.2	64	--	200	47	--	153	94	--	192	38	--	102	51	--	--	43	--	94			
Sulfur Dioxide	64.1	141	--	--	94	--	--	123	--	--	118	--	--	176	--	--	134	--	--			
Toluene	92.1	282	--	--	234	--	--	516	--	--	188	--	--	173	--	--	200	--	--			

Appendix B: Canister Data

Canister Data All Sites (expressed in ppbv)

Compounds	2010 MDL	Annual Average (ppbv)												
		Sones Pond 8-09	Sones Pond 8-10	Sones Pond 8-11	Thomas Compressor 8-30	Thomas Compressor 8-31	Shaw Compressor 11-15	Shaw Compressor 11-16	Chicken Hawk Flare 11-17	Hagemeyer Well 12-06	Hagemeyer Well 12-08	Hagemeyer Well 12-09	Arendtsville 2009	Marcus Hook 2009
1,1,1-Trichloroethane	0.051	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.021	0.021
1,1,2,2-Tetrachloroethane	0.042	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.034	0.034
1,1,2-Trichloro-1,2,2-trifluoroethane	0.059	0.030	0.030	0.11	0.079	0.077	0.076	0.076	0.083	0.077	0.079	0.081	0.084	0.081
1,1,2-Trichloroethane	0.039	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.012	0.012
1,1-Dichloroethane	0.057	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.018	0.018
1,1-Dichloroethene	0.038	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.012	0.012
1,2,4-Trichlorobenzene	0.514	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.042	0.062
1,2,4-Trimethylbenzene	0.087	0.044	0.044	0.044	0.044	0.22	0.044	0.044	0.044	0.044	0.044	0.044	0.028	0.089
1,2-Dibromoethane	0.055	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.013	0.013
1,2-Dichloro-1,1,2,2-tetrafluoroethane	0.059	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.013	0.013
1,2-Dichlorobenzene	0.102	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.025	0.025
1,2-Dichloroethane	0.032	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.013	0.012
1,2-Dichloropropane	0.057	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.017	0.015
1,3,5-Trimethylbenzene	0.076	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.032	0.033
1,3-Butadiene	0.062	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.082	0.082
1,3-Dichlorobenzene	0.083	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.025	0.025
1,4-Dichlorobenzene	0.095	0.048	0.048	0.048	0.68	0.30	0.048	0.048	0.048	0.048	0.048	0.048	0.025	0.026
1-Bromopropane	0.069	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.011	0.011
1-Ethyl-4-methylbenzene	0.087	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.037	0.036
2-Butanone (MEK)	0.187	0.094	0.68	0.60	1.6	0.62	0.094	0.20	0.24	0.29	0.35	0.094	0.89	0.79
2-Hexanone	0.053	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.13	0.081
2-Methoxy-2-methylpropane (MTBE)	0.098	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.021	0.021
4-Methyl-2-pentanone (MIBK)	0.121	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.074	0.074
Acetone	0.078	11	7.4	7.0	15	6.2	2.5	4.0	2.8	12	5.4	3.9	7.9	7.4
Acrolein	0.047	0.69	0.59	0.44	0.69	0.34	0.13	0.25	0.36	0.090	0.43	0.27	0.86	0.54
Benzene	0.093	0.047	0.047	0.13	0.20	0.20	0.22	0.40	0.10	0.047	0.12	0.37	0.16	0.54
Bromodichloromethane	0.035	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.012	0.012
Bromoform	0.036	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.012	0.012
Bromomethane	0.042	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.014	0.027
Carbon disulfide	0.047	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.076	0.079
Carbon tetrachloride	0.068	0.034	0.034	0.12	0.034	0.034	0.090	0.094	0.093	0.084	0.087	0.089	0.11	0.10
Chlorobenzene	0.032	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.017	0.031
Chloroethane	0.060	0.030	0.030	0.030	0.078	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.055	0.032
Chloroethene	0.071	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.013	0.016
Chloroform	0.035	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.013	0.016
Chloromethane	0.048	0.71	0.67	0.64	0.52	0.53	0.36	0.47	0.47	0.024	0.57	0.54	0.56	0.55
cis-1,2-Dichloroethene	0.091	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.012	0.011
cis-1,3-Dichloro-1-propene	0.084	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.020	0.020
Cyclohexane	0.053	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.026	0.17
Dibromochloromethane	0.028	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.012	0.012
Dichlorodifluoromethane	0.053	0.79	0.69	0.68	0.50	0.50	0.27	0.39	0.31	0.48	0.54	0.48	0.56	0.55
Ethylbenzene	0.083	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.019	0.083
Hexachloro-1,3-butadiene	0.031	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.029	0.032
m&p-Xylene	0.133	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.043	0.29
Methylene chloride	0.340	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.23	0.15
n-Heptane	0.068	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.044	0.18
n-Hexane	0.096	0.048	0.048	0.048	0.048	0.048	0.048	0.10	0.048	0.048	0.048	0.048	0.053	0.44
o-Xylene	0.075	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.018	0.096
Propene	0.031	1.1	0.38	0.38	1.0	0.84	0.20	0.69	0.82	0.28	0.46	0.55	0.60	14
Styrene	0.095	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.024	0.018
Tetrachloroethene (PERC)	0.064	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.016	0.037
Tetrahydrofuran (THF)	0.173	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.027	0.029
Toluene	0.044	0.022	0.10	0.13	0.18	0.18	0.14	0.44	0.066	0.076	0.064	0.14	0.17	1.7
trans-1,2-Dichloroethene	0.077	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.015	0.013
trans-1,3-Dichloro-1-propene	0.039	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
Trichloroethylene (TCE)	0.064	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.013	0.012
Trichlorofluoromethane	0.053	0.027	0.36	0.33	0.22	0.027	0.24	0.24	0.24	0.23	0.26	0.25	0.26	0.25

- Detected compounds

Canister Data All Sites (expressed in ug/m^3)

Compounds	2010 MDL	Annual Average (ug/m3)												
		Sones Pond 8-09	Sones Pond 8-10	Sones Pond 8-11	Thomas Compressor 8-30	Thomas Compressor 8-31	Shaw Compressor 11-15	Shaw Compressor 11-16	Chicken Hawk Flare 11-17	Hagemeyer Well 12-06	Hagemeyer Well 12-08	Hagemeyer Well 12-09	Arendtsville 2009	Marcus Hook 2009
1,1,1-Trichloroethane	0.278	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.12	0.12
1,1,2,2-Tetrachloroethane	0.288	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.23	0.23
1,1,2-Trichloro-1,2,2-trifluoroethane	0.452	0.23	0.23	0.84	0.61	0.59	0.58	0.58	0.64	0.59	0.61	0.62	0.64	0.62
1,1,2-Trichloroethane	0.213	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.066	0.066
1,1-Dichloroethane	0.231	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.071	0.071
1,1-Dichloroethene	0.151	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.046	0.046
1,2,4-Trichlorobenzene	3.813	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.31	0.46
1,2,4-Trimethylbenzene	0.428	0.21	0.21	0.21	0.21	1.1	0.21	0.21	0.21	0.21	0.21	0.21	0.14	0.44
1,2-Dibromoethane	0.423	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.099	0.099
1,2-Dichloro-1,1,2,2-tetrafluoroethane	0.412	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.092	0.092
1,2-Dichlorobenzene	0.613	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.15	0.15
1,2-Dichloroethane	0.130	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.054	0.051
1,2-Dichloropropane	0.263	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.076	0.067
1,3,5-Trimethylbenzene	0.374	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.16	0.16
1,3-Butadiene	0.137	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.18	0.18
1,3-Dichlorobenzene	0.499	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.15	0.15
1,4-Dichlorobenzene	0.571	0.29	0.29	0.29	4.1	1.8	0.29	0.29	0.29	0.29	0.29	0.29	0.15	0.15
1-Bromopropane	0.347	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.054	0.054
1-Ethyl-4-methylbenzene	0.428	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.18	0.17
2-Butanone (MEK)	0.551	0.28	2.0	1.8	4.7	1.8	0.28	0.59	0.71	0.86	1.0	0.28	2.6	2.3
2-Hexanone	0.217	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.51	0.33
2-Methoxy-2-methylpropane (MTBE)	0.353	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.074	0.074
4-Methyl-2-pentanone (MIBK)	0.496	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.30	0.30
Acetone	0.185	26	18	17	36	15	5.9	9.5	6.7	29	13	9.3	19	18
Acrolein	0.108	1.6	1.4	1.0	1.6	0.78	0.30	0.57	0.83	0.21	0.99	0.62	2.0	1.2
Benzene	0.297	0.15	0.15	0.42	0.64	0.64	0.70	1.3	0.32	0.15	0.38	1.2	0.52	1.7
Bromodichloromethane	0.234	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.080	0.080
Bromoform	0.372	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.13	0.13
Bromomethane	0.163	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.053	0.11
Carbon disulfide	0.146	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.24	0.25
Carbon tetrachloride	0.428	0.21	0.21	0.75	0.21	0.21	0.57	0.59	0.58	0.53	0.55	0.56	0.67	0.63
Chlorobenzene	0.147	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.077	0.14
Chloroethane	0.158	0.079	0.079	0.079	0.21	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.14	0.084
Chloroethene	0.181	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.032	0.041
Chloroform	0.171	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.062	0.077
Chloromethane	0.099	1.5	1.4	1.3	1.1	1.1	0.74	0.97	0.97	0.050	1.2	1.1	1.2	1.1
cis-1,2-Dichloroethene	0.361	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.049	0.045
cis-1,3-Dichloro-1-propene	0.381	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.091	0.091
Cyclohexane	0.182	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.090	0.57
Dibromochloromethane	0.239	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.10	0.10
Dichlorodifluoromethane	0.262	3.9	3.4	3.4	2.5	2.5	1.3	1.9	1.5	2.4	2.7	2.4	2.8	2.7
Ethylbenzene	0.360	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.084	0.36
Hexachloro-1,3-butadiene	0.330	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.31	0.34
m&p-Xylene	0.578	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.18	1.3
Methylene chloride	1.180	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.79	0.51
n-Heptane	0.279	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.18	0.75
n-Hexane	0.338	0.17	0.17	0.17	0.17	0.17	0.17	0.35	0.17	0.17	0.17	0.17	0.19	1.6
o-Xylene	0.326	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.078	0.41
Propene	0.053	1.9	0.65	0.65	1.7	1.4	0.34	1.2	1.4	0.48	0.79	0.95	1.0	24
Styrene	0.405	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.10	0.079
Tetrachloroethene (PERC)	0.434	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.11	0.25
Tetrahydrofuran (THF)	0.510	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.080	0.085
Toluene	0.166	0.083	0.38	0.49	0.68	0.68	0.53	1.7	0.25	0.29	0.24	0.53	0.64	6.4
trans-1,2-Dichloroethene	0.305	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.059	0.052
trans-1,3-Dichloro-1-propene	0.177	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.091	0.091
Trichloroethylene (TCE)	0.344	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.068	0.067
Trichlorofluoromethane	0.298	0.15	2.0	1.9	1.2	0.15	1.3	1.3	1.3	1.3	1.5	1.4	1.4	1.4

Appendix C: Reference Concentrations

MAU – Reference Concentrations (RfC)

CAS#	Compound	RfC		
		REL (ug/m3)	AEGL (ug/m3)	ERPG-1 (ug/m3)
622-96-8	1-Ethyl-4-methylbenzene			
95-63-6	1,2,4-Trimethylbenzene			
1634-04-4	2-Methoxy-2-methylpropane (MTBE)		180000	
78-78-4	2-Methyl Butane			
73513-42-5	2-Methyl Pentane			
96-14-0	3-Methyl Pentane			
71-43-2	Benzene	1300	170000	170000
75-15-0	Carbon Disulfide	6200	40000	40000
630-08-0	Carbon Monoxide			
463-58-1	Carbonyl Sulfide		**140000**	
74-87-3	Chloromethane		**1900000**	
75-18-3	Dimethyl sulfide			
74-84-0	Ethane			
100-41-4	Ethylbenzene		140000	
50-00-0	Formaldehyde	55	1100	1100
7647-01-0	Hydrogen Chloride	2100	2700	2700
7783-06-4	Hydrogen Sulfide	42	710	710
75-28-5	iso-Butane			
74-82-8	Methane			
67-56-1	Methanol	28000	690000	690000
74-93-1	Methyl mercaptan			
1330-20-7	m-Xylene	22000		
91-20-3	Naphthalene			
106-97-8	n-Butane			
142-82-5	n-Heptane			
110-54-3	n-Hexane		**12000000**	
7697-37-2	Nitric Acid			
	Nitric Oxide			
10102-44-0	Nitrogen Dioxide			
7782-77-6	Nitrous Acid			
111-65-9	n-Octane			
109-66-0	n-Pentane			
95-47-6	o-Xylene			
10028-15-6	Ozone			
74-98-6	Propane			
1330-20-7	p-Xylene	22000		
100-42-5	Styrene	21000	85000	85000
7446-09-5	Sulfur Dioxide			
127-18-4	Tetrachloroethene	20000	240000	240000
108-88-3	Toluene	37000	750000	750000
75-69-4	Trichloroethene		700000	700000

Sources
REL - CalEPA Recommended Exposure Limits (1-hr)
AEGL-1 - EPA Acute Exposure Guideline Levels for Mild Effects (1-hr)
AEGL-2 - EPA Acute Exposure Guideline Levels for Moderate Effects (1-hr)
ERPG-1 - DOE Emergency Removal Program Guidelines for Mild or Transient Effects (1-hr)

Canister – Acute Reference Concentrations (RfC)

CAS#	Preferred Compound Names	Acute RfC (ug/m3)	Source RfC
71-55-6	1,1,1-Trichloroethane	9000	IRIS
79-34-5	1,1,2,2-Tetrachloroethane		
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane		
79-00-5	1,1,2-Trichloroethane		
75-34-3	1,1-Dichloroethane		
75-35-4	1,1-Dichloroethene		
120-82-1	1,2,4-Trichlorobenzene		
95-63-6	1,2,4-Trimethylbenzene		
106-93-4	1,2-Dibromoethane		
76-14-2	1,2-Dichloro-1,1,2,2-tetrafluoroethane		
95-50-1	1,2-Dichlorobenzene		
107-06-2	1,2-Dichloroethane		
78-87-5	1,2-Dichloropropane	231	ATSDR
108-67-8	1,3,5-Trimethylbenzene		
106-99-0	1,3-Butadiene	220	ATSDR
541-73-1	1,3-Dichlorobenzene		
106-46-7	1,4-Dichlorobenzene	12000	ATSDR
106-94-5	1-Bromopropane		
622-96-8	1-Ethyl-4-methylbenzene		
78-93-3	2-Butanone (MEK)	13000	CALEPA
591-78-6	2-Hexanone		
1634-04-4	2-Methoxy-2-methylpropane (MTBE)	7210	ATSDR
108-10-1	4-Methyl-2-pentanone (MIBK)		
67-64-1	Acetone	61800	ATSDR
107-02-8	Acrolein	6.88	ATSDR
71-43-2	Benzene	28.8	ATSDR
75-27-4	Bromodichloromethane		
75-25-2	Bromoform		
74-83-9	Bromomethane	194	ATSDR
75-15-0	Carbon disulfide	6200	CALEPA
56-23-5	Carbon tetrachloride	1900	CALEPA
108-90-7	Chlorobenzene		
75-00-3	Chloroethane	39600	ATSDR
75-01-4	Chloroethene	1280	ATSDR
67-66-3	Chloroform	488	ATSDR
74-87-3	Chloromethane	1030	ATSDR
156-59-2	cis-1,2-Dichloroethene		
10061-01-5	cis-1,3-Dichloro-1-propene		
110-82-7	Cyclohexane		
124-48-1	Dibromochloromethane		
75-71-8	Dichlorodifluoromethane		
100-41-4	Ethylbenzene	43400	ATSDR
87-68-3	Hexachloro-1,3-butadiene		
108-38-3	m&p-Xylene	8680	ATSDR
75-09-2	Methylene chloride	2080	ATSDR
142-82-5	n-Heptane		
110-54-3	n-Hexane		
95-47-6	o-Xylene	22000	CALEPA
115-07-1	Propene		
100-42-5	Styrene	8520	ATSDR
127-18-4	Tetrachloroethene (PERC)	1360	ATSDR
109-99-9	Tetrahydrofuran (THF)		
108-88-3	Toluene	3770	ATSDR
156-60-5	trans-1,2-Dichloroethene	793	ATSDR
10061-02-6	trans-1,3-Dichloro-1-propene		
79-01-6	Trichloroethylene (TCE)	10700	ATSDR
75-69-4	Trichlorofluoromethane		

Sources
ATSDR - Agency for Toxics Substances and Disease Registry
CalEPA - California EPA
IRIS - EPA's Integrated Risk Information System
HEAST - EPA's Health Effects Assessment Summary Tables
NCEA - EPA's National Center for Environmental Assessment
PROV - EPA's Provisional Peer Reviewed Toxicity Values

Appendix D: Mobile Analytical Unit Hazard Calculations

OP-FTIR – Sones Pond Background (based on maximum concentrations)

Compound	Hazard Quotient (Highest Conc/REL)						Hazard Quotient (Highest Conc/AEGL)						Hazard Quotient (Highest Conc/ERPG-1)					
	8/9/10	8/10/10		8/11/10		8/12/10	8/9/10	8/10/10		8/11/10		8/12/10	8/9/10	8/10/10		8/11/10		8/12/10
	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning
1,2,4-Trimethylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methoxy-2-methylpropane (MTBE)	--	--	--	--	--	--	0.00	0.00	0.00	0.00	--	0.00	--	--	--	--	--	--
2-Methyl Butane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methyl Pentane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3-Methyl Pentane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzene	--	0.37	0.98	0.66	--	--	--	0.00	0.01	0.01	--	--	--	0.00	0.01	0.01	--	--
Carbon Disulfide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon Monoxide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbonyl Sulfide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloromethane	--	--	--	--	--	--	--	--	0.00	--	--	--	--	--	--	--	--	--
Dimethyl sulfide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	--	--	--	--	--	--	--	--	0.01	--	--	--	--	--	--	--	--
Formaldehyde	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydrogen Chloride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydrogen Sulfide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
iso-Butane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methanol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methyl mercaptan	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
m-Xylene	--	--	--	--	--	0.02	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
n-Butane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
n-Heptane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
n-Hexane	--	--	--	--	--	--	--	--	--	0.00	--	--	--	--	--	--	--	--
Nitric Acid	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitric Oxide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen Dioxide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrous Acid	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
n-Octane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
n-Pentane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
o-Xylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ozone	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Propane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
p-Xylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Styrene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfur Dioxide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	--	0.02	0.02	--	--	--	--	0.00	0.00	--	--	--	--	0.00	0.00	--	--	--
Hazard Index	--	0.39	1.00	0.66	--	0.02	0.00	0.00	0.01	0.02	--	0.00	--	0.00	0.01	0.01	--	--

OP-FTIR – Thomas Compressor Station (based on maximum concentrations)

Compound	Hazard Quotient (Highest Conc/REL)						Hazard Quotient (Highest Conc/AEGL)						Hazard Quotient (Highest Conc/ERPG-1)					
	8/30/10	8/31/10		9/1/10		9/2/10	8/30/10	8/31/10		9/1/10		9/2/10	8/30/10	8/31/10		9/1/10		9/2/10
	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning
1,2,4-Trimethylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methoxy-2-methylpropane (MTBE)	--	--	--	--	--	--	0.00	0.00	0.00	0.00	0.00	0.00	--	--	--	--	--	--
2-Methyl Butane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methyl Pentane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3-Methyl Pentane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon Disulfide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon Monoxide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbonyl Sulfide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloromethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dimethyl sulfide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Formaldehyde	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydrogen Chloride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydrogen Sulfide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
iso-Butane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methanol	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methyl mercaptan	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
m-Xylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
n-Butane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
n-Heptane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
n-Hexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitric Acid	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitric Oxide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen Dioxide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrous Acid	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
n-Octane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
n-Pentane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
o-Xylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ozone	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Propane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
p-Xylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Styrene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfur Dioxide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hazard Index	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

OP-FTIR – Shaw Compressor Station (based on maximum concentrations)

Compound	Hazard Quotient (Highest Conc/REL)						Hazard Quotient (Highest Conc/AEGL)						Hazard Quotient (Highest Conc/ERPG-1)					
	11/15/10	11/16/10		11/17/10			11/15/10	11/16/10		11/17/10			11/15/10	11/16/10		11/17/10		
	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning
1,2,4-Trimethylbenzene	--	--	--	--			--	--	--	--			--	--	--	--		
2-Methoxy-2-methylpropane (MTBE)	--	--	--	--			0.00	0.00	0.00	0.00			--	--	--	--		
2-Methyl Butane	--	--	--	--			--	--	--	--			--	--	--	--		
2-Methyl Pentane	--	--	--	--			--	--	--	--			--	--	--	--		
3-Methyl Pentane	--	--	--	--			--	--	--	--			--	--	--	--		
Benzene	--	--	--	--			--	--	--	--			--	--	--	--		
Carbon Disulfide	--	--	--	--			--	--	--	--			--	--	--	--		
Carbon Monoxide	--	--	--	--			--	--	--	--			--	--	--	--		
Carbonyl Sulfide	--	--	--	--			--	--	--	--			--	--	--	--		
Chloromethane	--	--	--	--			--	--	--	--			--	--	--	--		
Dimethyl sulfide	--	--	--	--			--	--	--	--			--	--	--	--		
Ethane	--	--	--	--			--	--	--	--			--	--	--	--		
Ethylbenzene	--	--	--	--			0.02	--	--	--			--	--	--	--		
Formaldehyde	--	--	--	--			--	--	--	--			--	--	--	--		
Hydrogen Chloride	--	--	--	--			--	--	--	--			--	--	--	--		
Hydrogen Sulfide	--	--	--	--			--	--	--	--			--	--	--	--		
iso-Butane	--	--	--	--			--	--	--	--			--	--	--	--		
Methane	--	--	--	--			--	--	--	--			--	--	--	--		
Methanol	0.00	0.00	--	--			0.00	0.00	--	--			0.00	0.00	--	--		
Methyl mercaptan	--	--	--	--			--	--	--	--			--	--	--	--		
m-Xylene	--	--	--	--			--	--	--	--			--	--	--	--		
Naphthalene	--	--	--	--			--	--	--	--			--	--	--	--		
n-Butane	--	--	--	--			--	--	--	--			--	--	--	--		
n-Heptane	--	--	--	--			--	--	--	--			--	--	--	--		
n-Hexane	--	--	--	--			--	--	--	--			--	--	--	--		
Nitric Acid	--	--	--	--			--	--	--	--			--	--	--	--		
Nitric Oxide	--	--	--	--			--	--	--	--			--	--	--	--		
Nitrogen Dioxide	--	--	--	--			--	--	--	--			--	--	--	--		
Nitrous Acid	--	--	--	--			--	--	--	--			--	--	--	--		
n-Octane	--	--	--	--			--	--	--	--			--	--	--	--		
n-Pentane	--	--	--	--			--	--	--	--			--	--	--	--		
o-Xylene	--	--	--	--			--	--	--	--			--	--	--	--		
Ozone	--	--	--	--			--	--	--	--			--	--	--	--		
Propane	--	--	--	--			--	--	--	--			--	--	--	--		
p-Xylene	--	--	--	--			--	--	--	--			--	--	--	--		
Styrene	--	--	--	0.01	--		--	--	0.00	--			--	--	0.00	--		
Sulfur Dioxide	--	--	--	--			--	--	--	--			--	--	--	--		
Toluene	--	--	--	--	--		--	--	--	--			--	--	--	--	--	
Hazard Index	0.00	0.00	0.01	--			0.02	0.00	0.00	0.00			0.00	0.00	0.00	--		

OP-FTIR – Chicken Hawk Flare Site (based on maximum concentrations)

Compound	Hazard Quotient (Highest Conc/REL)						Hazard Quotient (Highest Conc/AEGL)						Hazard Quotient (Highest Conc/ERPG-1)					
	11/17/10				11/17-11/18		11/17/10				11/17-11/18		11/17/10				11/17-11/18	
	Evening	Morning	Evening	Morning	Evening	Eve-Morn	Evening	Morning	Evening	Morning	Evening	Eve-Morn	Evening	Morning	Evening	Morning	Evening	Eve-Morn
1,2,4-Trimethylbenzene					--	--					--	--					--	--
2-Methoxy-2-methylpropane (MTBE)					--	--					0.00	0.00					--	--
2-Methyl Butane					--	--					--	--					--	--
2-Methyl Pentane					--	--					--	--					--	--
3-Methyl Pentane					--	--					--	--					--	--
Benzene					--	--					--	--					--	--
Carbon Disulfide					--	--					--	--					--	--
Carbon Monoxide					--	--					--	--					--	--
Carbonyl Sulfide					--	--					--	--					--	--
Chloromethane					--	--					--	--					--	--
Dimethyl sulfide					--	--					--	--					--	--
Ethane					--	--					--	--					--	--
Ethylbenzene					--	--					0.02	0.02					--	--
Formaldehyde					--	--					--	--					--	--
Hydrogen Chloride					--	--					--	--					--	--
Hydrogen Sulfide					--	--					--	--					--	--
Iso-Butane					--	--					--	--					--	--
Methane					--	--					--	--					--	--
Methanol					--	--					--	--					--	--
Methyl mercaptan					--	--					--	--					--	--
m-Xylene					--	--					--	--					--	--
Naphthalene					--	--					--	--					--	--
n-Butane					--	--					--	--					--	--
n-Heptane					--	--					--	--					--	--
n-Hexane					--	--					--	--					--	--
Nitric Acid					--	--					--	--					--	--
Nitric Oxide					--	--					--	--					--	--
Nitrogen Dioxide					--	--					--	--					--	--
Nitrous Acid					--	--					--	--					--	--
n-Octane					--	--					--	--					--	--
n-Pentane					--	--					--	--					--	--
o-Xylene					--	--					--	--					--	--
Ozone					--	--					--	--					--	--
Propane					--	--					--	--					--	--
p-Xylene					--	--					--	--					--	--
Styrene					--	--					--	--					--	--
Sulfur Dioxide					--	--					--	--					--	--
Toluene					--	--					--	--					--	--
Hazard Index					--	--					0.02	0.02					--	--

OP-FTIR – Hagemeyer Well Site (based on maximum concentrations)

Compound	Hazard Quotient (Highest Conc/REL)						Hazard Quotient (Highest Conc/AEGL)						Hazard Quotient (Highest Conc/ERPG-1)					
	12/6/10	12/7/10		12/8/10		12/9/10	12/6/10	12/7/10		12/8/10		12/9/10	12/6/10	12/7/10		12/8/10		12/9/10
	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening	Morning
1,2,4-Trimethylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methoxy-2-methylpropane (MTBE)	--	--	--	--	--	--	0.00	0.00	0.00	0.00	0.00	0.00	--	--	--	--	--	--
2-Methyl Butane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methyl Pentane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3-Methyl Pentane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	0.44	0.33	--	--	0.00	--	0.00	0.00	--	--	--	--	0.00	0.00
Carbon Disulfide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon Monoxide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbonyl Sulfide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloromethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dimethyl sulfide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	--	--	--	--	--	--	--	0.01	0.01	--	--	--	--	--	--	--	--
Formaldehyde	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydrogen Chloride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydrogen Sulfide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iso-Butane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methanol	0.00	--	0.00	0.01	0.00	0.00	0.00	--	0.00	0.00	0.00	0.00	0.00	--	0.00	0.00	0.00	0.00
Methyl mercaptan	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
m-Xylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
n-Butane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
n-Heptane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
n-Hexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitric Acid	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitric Oxide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen Dioxide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrous Acid	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
n-Octane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
n-Pentane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
o-Xylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ozone	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Propane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
p-Xylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Styrene	0.01	0.01	0.01	0.00	--	0.00	0.00	0.00	0.00	0.00	--	0.00	0.00	0.00	0.00	0.00	--	0.00
Sulfur Dioxide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hazard Index	0.01	0.01	0.01	0.01	0.44	0.33	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

GC/MS – All Sites

Site	Date	Time	Compound	Conc. (ppbv)	MW	Conc. (ug/m3)	RfC			Hazard Quotient (HQ)		
							REL ug/m3	AEGL ug/m3	ERPG-1 ug/m3	Conc/ REL	Conc/ AEGL	Conc/ ERPG-1
Sones Pond			None									
Thomas Compressor Station	9/1/10	7:13	Benzene	0.55	78.1	1.76	1300	170000	170000	0.00	0.00	0.00
		8:00	Benzene	0.64	78.1	2.04	1300	170000	170000	0.00	0.00	0.00
		6:50	Benzene	0.66	78.1	2.11	1300	170000	170000	0.00	0.00	0.00
		7:37	Benzene	1.30	78.1	4.15	1300	170000	170000	0.00	0.00	0.00
Shaw Compressor Station	11/15/10	20:33	Toluene	0.50	92.1	1.88	37000	750000	750000	0.00	0.00	0.00
Chickenhawk Flare			None									
Hagemeyer Well	12/8/10	16:31	Benzene	0.51	78.1	1.63	1300	170000	170000	0.00	0.00	0.00
	12/9/10	7:52	Toluene	0.49	92.1	1.85	37000	750000	750000	0.00	0.00	0.00

Appendix E: Canister Hazard Calculations

Canister - All Sites

Compounds	12/13/10 RfC Acute (ug/m3)	Source RfC	Hazard Quotient (HQ) Acute												
			Sones Pond 8-09	Sones Pond 8-10	Sones Pond 8-11	Thomas Compressor 8-30	Thomas Compressor 8-31	Shaw Compressor 11-15	Shaw Compressor 11-16	Chicken Hawk Flare 11-17	Hagemeyer Well 12-06	Hagemeyer Well 12-08	Hagemeyer Well 12-09	Arendtsville 2009	Marcus Hook 2009
1,1,1-Trichloroethane	9000	IRIS													
1,1,2,2-Tetrachloroethane															
1,1,2-Trichloro-1,2,2-trifluoroethane															
1,1,2-Trichloroethane															
1,1-Dichloroethane															
1,1-Dichloroethene															
1,2,4-Trichlorobenzene															
1,2,4-Trimethylbenzene															
1,2-Dibromoethane															
1,2-Dichloro-1,1,2,2-tetrafluoroethane															
1,2-Dichlorobenzene															
1,2-Dichloroethane															
1,2-Dichloropropane	231	ATSDR													
1,3,5-Trimethylbenzene															
1,3-Butadiene	220	ATSDR													
1,3-Dichlorobenzene															
1,4-Dichlorobenzene	12000	ATSDR				0.00	0.00								
1-Bromopropane															
1-Ethyl-4-methylbenzene															
2-Butanone (MEK)	13000	CALEPA		0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00		0.00	0.00
2-Hexanone															
2-Methoxy-2-methylpropane (MTBE)	7210	ATSDR													
4-Methyl-2-pentanone (MIBK)															
Acetone	61800	ATSDR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acrolein	6.88	ATSDR													
Benzene	28.8	ATSDR			0.01	0.02	0.02	0.02	0.04	0.01		0.01	0.04	0.02	0.06
Bromodichloromethane															
Bromoform															
Bromomethane	194	ATSDR													
Carbon disulfide	6200	CALEPA													
Carbon tetrachloride	1900	CALEPA			0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chlorobenzene															
Chloroethane	39600	ATSDR				0.00								0.00	0.00
Chloroethene	1280	ATSDR													
Chloroform	488	ATSDR													0.00
Chloromethane	1030	ATSDR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
cis-1,2-Dichloroethene															
cis-1,3-Dichloro-1-propene															
Cyclohexane															
Dibromochloromethane															
Dichlorodifluoromethane															
Ethylbenzene	43400	ATSDR												0.00	0.00
Hexachloro-1,3-butadiene															
m&p-Xylene	8680	ATSDR												0.00	0.00
Methylene chloride	2080	ATSDR												0.00	0.00
n-Heptane															
n-Hexane															
o-Xylene	22000	CALEPA												0.00	0.00
Propene															
Styrene	8520	ATSDR												0.00	0.00
Tetrachloroethene (PERC)	1360	ATSDR												0.00	0.00
Tetrahydrofuran (THF)															
Toluene	3770	ATSDR		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
trans-1,2-Dichloroethene	793	ATSDR													
trans-1,3-Dichloro-1-propene															
Trichloroethylene (TCE)	10700	ATSDR													
Trichlorofluoromethane															
	Acute Hazard Index		0.00	0.00	0.02	0.02	0.02	0.03	0.05	0.01	0.00	0.02	0.04	0.02	0.06

Appendix F: Mobile Analytical Unit Meteorological Data

Sones Pond Background

8/9/10				8/10/10						8/11/10						8/12/10			
Evening				Morning				Evening			Morning			Evening			Morning			
Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)	Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)	Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)	Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)	Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)
5:30 PM	84	2	180	4:45 AM	72	0	80	4:40 PM	78	4	317	4:45 AM	65	0	45	4:58 PM	85	1	323	4:45 AM	67	0	123
6:00 PM	83	0	270	5:00 AM	69	0	180	5:00 PM	81	1	292	5:00 AM	64	0	135	5:30 PM	84	7	269	5:00 AM	67	0	123
6:30 PM	82	0	265	5:30 AM	68	0	90	5:30 PM	83	2	208	5:30 AM	63	0	135	6:00 PM	83	2	308	5:30 AM	67	0	123
7:00 PM	81	0	199	6:00 AM	67	0	90	6:00 PM	83	3	270	6:00 AM	63	0	135	6:30 PM	83	0	317	6:00 AM	67	1	123
7:30 PM	78	0	164	6:30 AM	65	0	90	6:30 PM	83	0	317	6:30 AM	63	0	135	7:00 PM	81	0	315	6:30 AM	67	0	123
8:00 PM	77	0	164	7:00 AM	67	0	90	7:00 PM	84	0	227	7:00 AM	63	0	135	7:30 PM	80	1	333	7:00 AM	67	0	123
8:30 PM	76	0	164	7:30 AM	68	0	38	7:30 PM	82	0	232	7:30 AM	64	0	135	8:00 PM	78	0	333	7:30 AM	67	0	123
9:00 PM	74	0	209	8:00 AM	68	0	38	8:00 PM	78	0	321	8:00 AM	64	0	135	8:30 PM	76	0	333	8:00 AM	68	1	123
9:30 PM	74	0	221	8:30 AM	68	0	40	8:30 PM	77	0	331	8:30 AM	65	0	135	9:00 PM	75	1	333	8:30 AM	69	0	123
10:00 PM	73	0	225	9:00 AM	70	0	40	9:00 PM	75	0	331	9:00 AM	69	0	135	9:30 PM	75	0	290	9:00 AM	70	0	178
10:30 PM	72	0	225	9:30 AM	71	0	43	9:30 PM	73	0	331	9:30 AM	71	2	285	10:00 PM	74	0	343	9:30 AM	71	0	180
11:00 PM	71	0	225	10:00 AM	71	0	46	10:00 PM	72	0	331	10:00 AM	72	2	355	10:30 PM	73	0	317	10:00 AM	72	0	180
11:30 PM	71	0	350	10:30 AM	73	0	46	10:30 PM	70	0	331	10:30 AM	74	2	291	11:00 PM	72	0	317	10:30 AM	72	1	63
12:00 PM	70	0	347	11:00 AM	76	1	46	11:00 PM	69	0	331	11:00 AM	75	3	335	11:30 PM	71	0	321	11:00 AM	71	0	163
				11:30 AM	75	0	263	11:30 PM	69	0	331	11:30 AM	75	3	279	12:00 AM	69	0	321	11:30 AM	71	0	36
				12:00 PM	75	0	265	12:00 PM	69	0	331	12:00 PM	76	3	239					12:00 PM	70	0	36

Thomas Compressor Station

8/30/10				8/31/10						9/1/10						9/2/10			
Evening				Morning				Evening			Morning			Evening			Morning			
Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)	Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)	Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)	Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)	Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)
5:00 PM	86	2	42	4:30 AM	61	0	343	5:00 PM	87	5	256	4:30 AM	62	0	274	5:00 PM	87	8	235	4:30 AM	64	2	134
5:30 PM	87	3	346	5:00 AM	61	1	273	5:30 PM	88	4	221	5:00 AM	64	0	229	5:30 PM	87	6	223	5:00 AM	65	2	167
6:00 PM	86	3	346	5:30 AM	63	1	240	6:00 PM	88	1	227	5:30 AM	64	0	228	6:00 PM	87	8	223	5:30 AM	65	2	100
6:30 PM	85	1	331	6:00 AM	62	0	255	6:30 PM	85	2	247	6:00 AM	63	1	289	6:30 PM	84	4	257	6:00 AM	65	2	144
7:00 PM	82	2	331	6:30 AM	61	1	259	7:00 PM	82	1	303	6:30 AM	61	0	285	7:00 PM	82	3	251	6:30 AM	65	2	263
7:30 PM	78	1	331	7:00 AM	61	0	276	7:30 PM	78	0	264	7:00 AM	61	0	283	7:30 PM	81	1	232	7:00 AM	64	0	244
8:00 PM	76	0	333	7:30 AM	67	0	276	8:00 PM	75	0	273	7:30 AM	63	0	291	8:00 PM	79	1	269	7:30 AM	67	2	275
8:30 PM	73	0	333	8:00 AM	68	3	311	8:30 PM	73	0	273	8:00 AM	65	2	265	8:30 PM	74	0	282	8:00 AM	69	7	242
9:00 PM	71	0	333	8:30 AM	69	0	250	9:00 PM	71	0	273	8:30 AM	70	3	254	9:00 PM	72	0	282	8:30 AM	71	3	258
9:30 PM	69	0	333	9:00 AM	73	1	284	9:30 PM	70	0	273	9:00 AM	73	2	140	9:30 PM	71	0	282	9:00 AM	75	6	252
10:00 PM	67	0	333	9:30 AM	77	1	347	10:00 PM	69	0	273	9:30 AM	75	1	217	10:00 PM	69	1	204	9:30 AM	77	2	191
10:30 PM	67	0	333	10:00 AM	79	4	130	10:30 PM	69	0	161	10:00 AM	78	1	143	10:30 PM	68	0	195	10:00 AM	80	7	167
11:00 PM	67	0	333	10:30 AM	81	4	125	11:00 PM	67	0	179	10:30 AM	80	6	241	11:00 PM	73	4	225	10:30 AM	82	2	246
11:30 PM	67	0	333	11:00 AM	84	2	120	11:30 PM	66	0	185	11:00 AM	82	6	140	11:30 PM	72	6	259	11:00 AM	84	7	234
12:00 AM	65	0	333	11:30 AM	87	2	202	12:00 AM	66	0	181	11:30 AM	85	7	223	12:00 AM	72	4	265	11:30 AM	85	6	162
				12:00 PM	87	5	346					12:00 PM	86	3	295					12:00 PM	86	7	215

Shaw Compressor Station

11/15/10				11/16/10				11/17/10			
Evening				Morning				Evening			
Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)	Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)	Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)
5:00 PM	50	0	238	5:00 AM	38	1	158	5:00 PM	47	4	98
5:30 PM	45	0	195	5:30 AM	38	0	158	5:30 PM	48	1	153
6:00 PM	42	0	191	6:00 AM	38	0	158	6:00 PM	48	0	175
6:30 PM	41	0	191	6:30 AM	38	0	123	6:30 PM	49	6	190
7:00 PM	40	0	191	7:00 AM	38	0	123	7:00 PM	49	6	142
7:30 PM	39	0	191	7:30 AM	38	0	123	7:30 PM	49	1	63
8:00 PM	38	0	191	8:00 AM	38	0	144	8:00 PM	49	4	166
8:30 PM	38	0	169	8:30 AM	39	0	144	8:30 PM	50	0	113
9:00 PM	37	1	12	9:00 AM	41	0	144	9:00 PM	51	8	150
9:30 PM	37	0	138	9:30 AM	43	0	117	9:30 PM	52	9	156
10:00 PM	37	1	355	10:00 AM	45	0	117	10:00 PM	52	7	157
10:30 PM	37	1	360	10:30 AM	47	4	111	10:30 PM	53	15	154
11:00 PM	37	0	360	11:00 AM	47	7	98	11:00 PM	53	14	166
11:30 PM	37	0	150	11:30 AM	47	6	103	11:30 PM	53	4	165
12:00 PM	37	0	333	12:00 PM	46	0	150	12:00 AM	53	13	164

11/17/10								11/18/10			
Morning				Evening				Morning			
Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)	Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)	Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)
5:00 AM	52	8	180								
5:30 AM	51	5	167								
6:00 AM	51	6	188								
6:30 AM	51	15	161								
7:00 AM	49	6	147								
7:30 AM	47	15	173								
8:00 AM	47	19	209								
8:30 AM	48	4	209								
9:00 AM	47	9	159								
9:30 AM	47	12	261								
10:00 AM	47	4	333								
10:30 AM	47	3	302								
11:00 AM	47	6	252								
11:30 AM	46	6	277								
12:00 PM	46	6	275								

Chicken Hawk Flare Site

11/17/10								11/18/10			
Evening				Morning				Evening			
Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)	Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)	Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)
								5:30 PM	44	16	305
								5:40 PM	45	24	300
								5:50 AM	45	14	313
								6:00 PM	45	14	313
								6:30 PM	45	21	340
								7:00 PM	45	20	301
								7:30 PM	45	10	306
								8:00 PM	45	17	339
								8:30 PM	43	15	326
								9:00 PM	43	7	330
								9:30 PM	42	6	306
								10:00 PM	41	5	310
								10:30 PM	41	5	296
								11:00 PM	41	7	333
								11:30 PM	42	6	309
								12:00 AM	42	7	286

11/18/10			
Morning			
Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)
12:30 AM	41	3	303
1:00 AM	40	5	286
1:30 AM	40	7	305
2:00 AM	40	6	291
2:30 AM	40	9	275
3:00 AM	40	8	266
3:30 AM	41	7	302
4:00 AM	41	6	338
4:30 AM	41	4	292
5:00 AM	41	7	328
5:30 AM	41	4	280
6:00 AM	41	2	312
6:30 AM	40	3	286
7:00 AM	39	0	279

Hagemeyer Well Site

12/6/10				12/7/10						12/8/10						12/9/10			
Evening				Morning			Evening			Morning			Evening			Morning			
Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)	Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)	Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)	Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)	Time	Temp (°F)	Wind Speed (mph)	Wind Dir. (Deg.)
5:00 PM	27	2	260	5:00 AM	26	7	315	5:00 PM	28	0	331	5:00 AM	22	1	310	5:00 PM	23	1	334	5:00 AM	14	2	279
5:30 PM	27	5	321	5:30 AM	26	0	287	5:30 PM	28	6	327	5:30 AM	22	4	241	5:30 PM	24	0	327	5:30 AM	13	0	315
6:00 PM	27	8	285	6:00 AM	26	2	299	6:00 PM	28	3	336	6:00 AM	22	1	210	6:00 PM	23	1	327	6:00 AM	11	0	313
6:30 PM	27	4	323	6:30 AM	26	11	275	6:30 PM	28	1	253	6:30 AM	22	0	272	6:30 PM	23	2	346	6:30 AM	10	0	315
7:00 PM	27	11	290	7:00 AM	26	2	336	7:00 PM	28	11	313	7:00 AM	22	1	252	7:00 PM	22	2	320	7:00 AM	10	0	314
7:30 PM	26	9	337	7:30 AM	26	3	288	7:30 PM	28	0	325	7:30 AM	22	1	281	7:30 PM	21	1	305	7:30 AM	9	0	327
8:00 PM	26	1	329	8:00 AM	26	1	311	8:00 PM	27	5	335	8:00 AM	21	1	246	8:00 PM	20	1	285	8:00 AM	10	0	327
8:30 PM	26	7	337	8:30 AM	26	12	355	8:30 PM	27	9	350	8:30 AM	22	1	295	8:30 PM	20	2	293	8:30 AM	13	0	293
9:00 PM	26	6	302	9:00 AM	27	3	348	9:00 PM	27	8	329	9:00 AM	22	3	321	9:00 PM	17	0	321	9:00 AM	17	0	231
9:30 PM	26	3	337	9:30 AM	27	4	325	9:30 PM	27	1	243	9:30 AM	23	3	271	9:30 PM	18	1	320	9:30 AM	19	2	235
10:00 PM	26	5	326	10:00 AM	28	9	304	10:00 PM	26	3	326	10:00 AM	24	6	319	10:00 PM	20	1	245	10:00 AM	20	0	255
10:30 PM	26	8	324	10:30 AM	29	4	336	10:30 PM	26	6	346	10:30 AM	24	4	338	10:30 PM	18	0	280	10:30 AM	20	3	325
11:00 PM	26	5	315	11:00 AM	28	5	323	11:00 PM	25	7	306	11:00 AM	25	6	355	11:00 PM	19	1	300	11:00 AM	21	3	329
11:30 PM	26	3	21	11:30 AM	29	8	341	11:30 PM	24	3	277	11:30 AM	25	2	331	11:30 PM	19	1	290	11:30 AM	22	2	321
				12:00 PM	29	6	249	12:00 AM	23	1	322	12:00 PM	27	3	350	12:00 AM	17	0	310	12:00 PM	22	3	241