dep

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May 28, 2013

Hand Delivered

The Honorable Jeffrey V. Kessler
Senate President
Building 1, Room 227-M
State Capitol Complex
Charleston, WV 25305

The Honorable Richard Thompson
Speaker of the House of Delegates
Building 1, Room 228-M
State Capitol Complex
Charleston, WV 25305

Re: W. Va. Code §22-6A-12(e) Noise, Light, Dust and Volatile Organic Compounds Study

Dear President Kessler and Speaker Thompson:

As directed by the Natural Gas Horizontal Well Control Act enacted by the West Virginia Legislature on December 14, 2011, please find enclosed the Department of Environmental Protection's (DEP) Office of Oil and Gas (OOG) report on noise, light, dust and volatile organic compounds generated by the drilling of horizontal wells as they relate to the well location restriction regarding occupied dwelling structures. *See* W. Va. Code § 22-6A-12(e). Also, please find enclosed the accompanying study documents by West Virginia University's (WVU) School of Public Health provided via contract under the administration of WVU's West Virginia Water Research Institute (WRI).

It should be emphasized that this study characterized activities, emissions, and exposures that will not be present continuously over a long period of time. There are no indications of a public health emergency or threat based on the data obtained from this study.

While the statutorily-specified location restriction is defined to be from the center of the well pad, there are a wide variety of pad sizes and configurations that may allow an occupied dwelling to be close to a well pad.[1] Because of the potential for different well pad geometries, DEP recommends that the Legislature reconsider the reference point (i.e., from the center of the well pad) for the location restriction to occupied dwellings to reduce potential exposures.

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[1] Under W. Va. Code §22-6-21, no well shall be drilled nearer than two hundred feet from a dwelling without first obtaining the written consent of the owner of such dwelling.

One option to consider would be to establish a location restriction from the Limit of Disturbance (LOD) of the well pad to provide for a more consistent and protective safeguard for residents in affected areas. The outermost sediment control barrier establishes the LOD around the well pad.

DEP also continues to review its regulatory approach, as well as the authorities of its oil and gas and air quality programs, for further improvements even as implementation of current standards and practices remain in effect. The results of this WVU study will be used to inform the air quality report due to the Legislature by July 1, 2013. *See* W. Va. Code §22-6A-22.

Should you have any questions or require additional information, please do not hesitate to contact me.

Sincerely,

James A. Martin, Chief
Office of Oil and Gas

Enclosure: Report on Noise, Dust, Light, and Volatile Organic Compounds

cc (*with enclosures*):

Honorable Lynwood Ireland
Joseph A. Lazell, Chief Counsel to Senate Judiciary Committee
Joseph A. Altizer, Chief Counsel to House Judiciary Committee

NOISE, LIGHT, DUST, AND VOLATILE ORGANIC COMPOUNDS GENERATED BY THE DRILLING OF HORIZONTAL WELLS RELATED TO THE WELL LOCATION RESTRICTION REGARDING OCCUPIED DWELLING STRUCTURES

By the West Virginia Department of Environmental Protection
Office of Oil and Gas
Pursuant to W.Va. Code §22-6A-12(e)
May 28, 2013

INTRODUCTION

As directed by the Natural Gas Horizontal Well Control Act (the Act) enacted by the West Virginia Legislature on December 14, 2011, the following fulfills the requirement of W. Va. Code §22-6A-12(e) that the West Virginia Department of Environmental Protection's (DEP) Office of Oil and Gas (OOG) report on noise, light, dust, and volatile organic compounds generated by the drilling of horizontal wells as they relate to the well location restrictions of the Act [W. Va. Code §22-6A-12(a)] regarding occupied dwelling structures. The sampling, data analysis, and literature review comprising the study supporting this report were performed by faculty and students of West Virginia University's (WVU) School of Public Health and under the administration of WVU's West Virginia Water Research Institute (WRI).

BACKGROUND

The Act established that the center of a well pad may not be located within six hundred twenty-five (625) feet of an occupied dwelling structure, unless waived in writing by the surface owner, or upon issuance of a protective variance by the secretary. *See* W. Va. Code §22-6A-12(a). The legislative mandate directed OOG to determine whether the well location restriction was adequate or otherwise required alteration based on the noise, light, dust, and volatile organic compounds related to drilling horizontal wells.

The study covered five stages of well pad development: Site clearing and preparation; vertical drilling; horizontal drilling; hydraulic fracturing; and flowback and completion. These activities are all temporary, ending when a well is producing natural gas. Ambient air measurements of at least six days duration were obtained at seven well pads in West Virginia and collected during the development stages. The seven well pads were located in Brooke, Marion, and Wetzel Counties and included three different companies. Field monitoring took place from July 2012 to October 2012, and approximately 46 days of measurements of noise, light, dust, and volatile organic compounds, as well as other air pollutants, were obtained. In addition, the

Department of Energy's (DOE) National Energy Technology Laboratory operated a mobile air monitoring trailer, equipped with a suite of continuous monitors, at six of the seven sites.

During the ambient air monitoring conducted around each well pad, an on-pad sample of water or waste streams was also obtained. WVU's School of Public Health conducted the air sampling, while WRI conducted the water and waste stream sampling. The water sampling results were submitted to the Legislature as part of the agency's response to the impoundment and pit safety study required pursuant to W. Va. Code §22-6A-23.

West Virginia has a number of unique terrain features, which presented challenges in siting air monitoring equipment, as well as an opportunity to gather data across a variety of conditions. The range of terrain features encountered in the field at each well pad led to a robust data set. Siting scenarios included those with residences located approximately 250 feet to 1,250 feet from the well pad center; remote pads in a wildlife management area; pads abutted into hillsides; pads sited atop ridgelines; and a site located in a hollow with channeled air flow. Even with the quality control measures that were in place, not all of the air monitoring equipment operated at every site for the complete duration of the monitoring, due to weather-related events, equipment malfunction and maintenance, and miscommunication with well pad operators.

WVU operated a solar-powered wireless air monitoring system (WAMS), which enabled the continuous collection and recording of noise, light, dust, and hydrocarbon data except during sample equipment downtime. In addition, WVU collected 72-hour volatile organic compounds samples for laboratory analysis. WVU co-located at least one WAMS and volatile organic compounds sampling device with the DOE trailer in order to cross-check results. The environmentally-controlled DOE trailer used sampling methods more in line with national regulatory sampling requirements, while the WAMS used portable instrumentation that tended to show broad potential issues. Multiple WAMS were deployed around each well pad to the extent allowed by the terrain, allowing for more complete ambient air monitoring around each pad. The DOE trailer siting was limited by the availability of electrical power.

The agency wishes to recognize and acknowledge the private citizens who allowed not only DEP personnel, but also the researchers from WVU and DOE, access to their property in order to site air monitoring equipment to record ambient air samples off-pad. Private residents also provided electricity to the DOE trailer at two pads, and the well operator provided electricity from a diesel-fueled generator at the remaining pads.

CONCLUSIONS

While a comprehensive air monitoring assessment of noise, light, dust and volatile organic compounds emitted during well pad development in West Virginia was conducted as part of this study, it is important to note that not all operational, terrain, and meteorological conditions can be captured by short-term air monitoring alone, due to the wide variety of site specific conditions that may exist. Measureable noise, light, dust, and volatile organic compounds levels were recorded with some, but not all, of the monitoring devices. In some cases, ambient levels were below the detection capabilities of the equipment.

Noise, Light, and Radiation

WVU obtained one-minute and one-hour noise measurements at the WAMS locations around well pads. The results of WVU's noise assessment indicated average levels were below the United States Environmental Protection Agency's (EPA) guideline of 70 decibels (dB). The EPA 70 dB threshold over a 24-hour period is a guideline over which hearing loss may occur if exposure at this level occurred for a lifetime.

EPA also has noise guidelines regarding annual average daily exposure levels over forty years of 55 dB to prevent outdoor activity from interfering with the ability to hear and causing annoyance, and 45 dB to prevent indoor activity interference and annoyance. In some instances, one-hour noise levels near well pads, based on approximately six days of averaged data, were above these guidelines, indicating the potential for interference if experienced for forty years. Sound barriers were not used at the sites monitored during this study. As recognized by EPA, sound levels inside stores, offices, and residences with normal conversation or television listening normally fall within the 40-65 dB range also. Due to the transient nature and/or frequency of sound, the agency recognizes that noises may be perceived as a nuisance, even though measurements indicate no harm.

Some of WVU's recommendations to minimize noise are useful practices that OOG shared in a workshop with the regulated community. OOG already works with individual operators and companies on a case-by-case basis to facilitate discussion and resolve citizen complaints. Inspectors will continue to work with operators to deploy sound mitigation measures, such as sound barriers, based on site specific circumstances.

WVU's assessment of the light data from the WAMS and DOE equipment indicate there was no impact on nighttime illumination from well pad activities. The noise and light results were consistent across various distances from the well pad. Ionizing radiation levels measured from filtered airborne dust were near zero. WVU states on page 24, "Radiation levels for alpha and beta sources were well below established background levels in air."

Dust and Volatile Organic Compounds

EPA established National Ambient Air Quality Standards (NAAQS) for certain pollutants, including particulate matter and ozone (of which volatile organic compounds and oxides of nitrogen are precursors) in order to protect human health and welfare from the cumulative impact from all sources of air pollution in a given geographic area. Although there is no one-hour $PM_{2.5}$ (particulate matter less than 2.5 microns in diameter) NAAQS, WVU found that some one-hour $PM_{2.5}$ dust results were above the annual NAAQS, but that all results were below the 24-hour $PM_{2.5}$ NAAQS. This would not be uncommon since, by definition, long-term averages incorporate short-term values that are higher.

There were three methods used to sample volatile organic compounds at each drilling location. The portable WAMS sampler provided a total hydrocarbon value, and the other methods provided clearly defined compound data. At some pads, elevated benzene levels, above the benchmark Agency for Toxic Substances and Disease Registry (ATSDR) Minimum Risk Level used by WVU, were observed, although not consistently. ATSDR is a federal public health agency for the United States Department of Health and Human Services. WVU recognizes on page 20, "Lifetime exposures cannot be estimated from a small number of short-term measurements." It should be emphasized that this study characterized the nature of activities, emissions, and exposures that will not be present continuously over a long period of time.

Even in remote locations across the country, as well as in West Virginia, background ambient air is not free of pollutants, including dust and volatile organic compounds. That is, the mere presence and detection of air pollutants in ambient air is not precluded by federal and state rules. Based on WVU's study data, vehicle traffic and engine exhaust are the likely sources of the intermittently high dust and benzene observations. While there are no indications of immediate danger to public health based on data obtained from this study, vehicle traffic associated with well pad development activities may pose a nuisance. The occupied dwelling structure setback of 625 feet from well pad center does not address the inconveniences associated with increased vehicle traffic such as congestion, vehicle idling emissions, and potential road dust and noise.

WVU recommended on page 21 that "Better use [of] roadway wetting agents would reduce many of the peak dust exposures seen from roadside samples that were taken over the course of the survey." Such common sense measures as use of DEP-approved dust suppressants and lower vehicle travel speeds have already been used at various sites to mitigate dust and will continue to be used on an as-needed basis. WVU also recommended on page 21, "Greater spacing of diesel-container trucks, while waiting in line for HF [hydraulic fracturing], could reduce the local concentration of diesel exhaust and may reduce noise as well." As a more practical alternative to spacing requirements, the Diesel-Powered Motor Vehicle Idling Act (W. Va. Code §17C-13A) applies on both private and public property, including staging areas. This statute limits regulated entities to no more than 15 minutes of idling per one-hour period; however, a number of exceptions, including for public safety and manufacturing processes, are contained in the statute. The Diesel-Powered Motor Vehicle Idling Act is enforceable by a law enforcement officer such as local police, county sheriffs, and state police, but does not include DEP inspectors.

For ambient air pollution levels to meet the NAAQS, a broad spectrum of sources of air pollution is regulated by state and federal standards and rules, including the oil and gas sector. The existing federal and state regulatory structure implemented by the DAQ includes rules and policy, as well as permitting and enforcement authority, to prevent and minimize air pollution from a wide range of stationary sources, including oil and gas production and transmission activities. While DEP continues to review its regulatory approach and the authorities of its oil and gas and air quality programs for further improvement, implementation of current standards and practices remain in effect.

There are a number of ambient air studies underway by federal and state agencies that, when completed, will provide additional data on emissions from the oil and gas sector. Further, a new federal regulation affecting air emissions from wellhead operations went into effect in October 2012. While focusing on production activities, the rule requires that well completion operations at hydraulically-fractured wells drilled on or after January 1, 2015 safely maximize resource recovery and minimize releases to the atmosphere during flowback and subsequent recovery.

The results of this WVU study will be used to inform the air quality report due to this body by July 1, 2013. *See* W. Va. Code §22-6A-22.

Location Restriction Recommendation

While there were no indications of a public health emergency or threat based on the data obtained from this study, WVU recognized, "There is no good reason to believe that using the center of the P[p]ad as the reference point from which the setback is taken will assure that activity associated with some possible sources of the studied contaminants will not occur closer than 625 feet from the actual source." (p. 19) Also noted by WVU, "There does not appear to be a simple solution to specifying a setback distance. There is no single geometry to which all drill site activities conform. The activities follow the terrain of the site and the needs of the process." (p. 188).

WVU conducted a literature review of the manner in which various states address setback provisions regarding unconventional drilling activities. Of the state programs reviewed, well location restrictions ranged from 100 feet to 1,532 feet, and used a variety of reference points for the beginning of the setback (for example, outer edge of pad; distance from designated activity area; distance from buildings, public roads, major aboveground utility lines and railroads; distance from high occupancy building unit zone).

While the statutorily-specified location restriction is defined to be from the center of the well pad, there are a wide variety of pad sizes and configurations that may allow an occupied dwelling to be close to a well pad.[1] Because of the potential for different well pad geometries, DEP recommends that the Legislature reconsider the reference point (i.e., from the center of the well pad) for the location restriction to occupied dwellings to reduce potential exposures. One option to consider would be to establish a location restriction from the Limit of Disturbance (LOD) of the well pad to provide for a more consistent and protective safeguard for residents in affected areas. The outermost sediment control barrier establishes the LOD around the well pad.

SUPPORTING INFORMATION

Air, Noise, and Light Monitoring Results for Assessing Environmental Impacts of Horizontal Gas Well Drilling Operations, Michael McCawley, PhD, School of Public Health, West Virginia University, May 3, 2013, submitted May 10, 2013.

Air, Noise, and Light Monitoring Plan for Assessing Environmental Impacts of Horizontal Gas Well Drilling Operations (ETD-10 Project), Michael McCawley, PhD, School of Public Health, West Virginia University, July 1, 2012.

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[1] Under W. Va. Code §22-6-21, no well shall be drilled nearer than two hundred feet from a dwelling without first obtaining the written consent of the owner of such dwelling.

Air, Noise, and Light Monitoring Results

For

Assessing Environmental Impacts of Horizontal Gas Well Drilling Operations
(ETD-10 Project)

Prepared for:

West Virginia Department of Environmental Protection
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May 3, 2013

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List of Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry, a part of CDC
BTEX	organic chemicals Benzene, Toluene, Ethylbenzene and Xylenes
CDC	U.S. Centers for Disease Control and Prevention
CH_4	methane
CO	Carbon Monoxide
CO_2	carbon dioxide
dBA	sound pressure level weighted to human hearing
DEP or WVDEP	West Virginia Department of Environmental Protection
EC	Elemental Carbon
EPA or USEPA	US Environmental Protection Agency
H_2S	Hydrogen Sulfide
HC	Hydrocarbons
HI	hazard index
HI	Sum of Individual Hazard Quotients for a situation
HQ	Hazard Quotient, the sampling result divided by the MRL or RfC
HQV	Hazard Quotient Value
MRL	Minimum Risk Level below which no health effects should occur
NAAQS	National Ambient Air Quality Standards
NO_2	Nitrogen Dioxide
NO_x	oxides of nitrogen
O_3	ozone
OC	Organic Carbon
pCi or pCi/L	picocurie (pCi), an amount of ionizing radiation per liter(pCi/L)
PM	Particulate Matter
PM_{10}	Particulate Matter less than 10 micrometers in diameter
$PM_{2.5}$	Particulate Matter less than 2.5 micrometers in diameter
ppb	parts per billion
ppm	parts per million
RfC	Reference Concentrations for Chronic Inhalation Exposure
skyglow	illumination of the night sky or parts of it
SO_2	Sulfur Dioxide
TEOM	tapered element oscillating microbalance, a particulate monitor
ug/m^3	micrograms per cubic meter of air
WAMS	solar powered mobile monitoring station

Disclaimer

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented. The contents DO NOT necessarily reflect the official views or policies of the State. These reports do not constitute a standard, specification, or regulation. Trade or manufacturers' names which may appear herein are cited only because they are considered essential to the objectives of these reports. The State of West Virginia does not endorse products or manufacturers. This report was prepared for the West Virginia Department of Environmental Protection.

Executive Summary

The West Virginia Natural Gas Horizontal Well Control Act of 2011 required determination of the effectiveness of a 625 foot set-back from the center of the pad of a horizontal well drilling site. An investigation was conducted at seven drilling sites to collect data on dust, hydrocarbon compounds and on noise, radiation and light levels. The findings are:

- Measurements of air contaminants in this study were taken to characterize levels that might be found at 625 feet from the well pad center at unconventional gas drilling sites during the activities at those sites.
- There were detectable levels of dust and volatile organic compounds found to be present at the set-back distance.
- The duration of the specific activity of interest at each of the sites was a week or less. This time constraint did not allow comparison of the collected data to limits in the NAAQS and therefore did not allow recommendations to be made for a setback distance based on the NAAQS values.
- Some benzene concentrations were, however, found to be above what the CDC calls the "the minimum risk level for no health effects." This is a concern for potential health effects that might arise due to these exposures over a long time.
- One or all of the BTEX (i.e. organic chemicals Benzene, Toluene, Ethylbenzene and Xylenes) compounds were found at all drilling sites - which is similar to what other studies have reported. It appears that any of these compounds could come from diesel emissions rather than from drilling at the well pad, but diesel traffic is still part of the activity on all the sites and needs to be taken into account.
- Not all of the studied contaminants emanate from the center of the pad so any new regulations might consider a different reference point or points (such as roadways) from which to measure the setback distance (other State setbacks and their possibly more appropriate points of reference are discussed in **Appendix E**).
- Light levels, measured as skyglow were zero during night time and ionizing radiation levels measured from filtered airborne particulate were near zero as well.
- The average noise levels calculated for the duration of the work at each site, were not above the recommended 70dBA level recommended by the EPA for noise exposure.
- The noise at some locations was above that allowed by EPA regulation for vehicles engaged in interstate commerce and other local limits such as the noise limits for Jefferson County, WV or the city of Morgantown, WV.
- A health effects-based setback distance proposal might require a study with a lengthy (3 years or more) sampling effort, greater detail in the chemical analysis, a larger number of sites and some effort to assure that the sites represent the range of exposures that a typical population could experience.

- Without more appropriate sampling periods than the three year averaging period required for the NAAQS or a health effects study, monitoring in the area of the drilling activity could be undertaken by the industry and used by the industry to assure control of emissions.

1 . Background

Horizontal drilling and hydraulic fracturing methods to extract natural gas from shale beds has been steadily increasing in West Virginia. These techniques have raised environmental concerns from not only citizens, but also state agencies, which regulate these practices. On December 14, 2011, the West Virginia Legislature enacted the new Natural Gas Horizontal Well Control Act. This act requires that the West Virginia Department of Environmental Protection (WVDEP) to prepare a report to the legislature on noise, light dust and volatile organic compounds and their relationship to well location restrictions for occupied dwellings; allowing the secretary to propose guidelines and procedures for controlling and mitigating levels of noise, light, dust and volatile organic compounds in relation to horizontal drilling activities.

1.1 Drilling Operations and Air Emissions

1.1.1 Drilling Operations

The purpose of the monitoring study was to characterize emission during each of the five stages of Horizontal Drilling:

Pad Site Development

Vertical Drilling

Horizontal Drilling

Hydraulic Fracturing (HF)

Flowback and Completion

The pad site development phase involves the construction of well pads, access roads, and other ancillary facilities. A well is then drilled vertically using sections of rigid pipe to form the drill string. Horizontal drilling can be done off of a vertical wellbore in order to expose more open hole to the hydrocarbons. These horizontal legs can be over a mile long. Before natural gas wells begin producing gas for sale, the wellbore and surrounding reservoir must be "cleaned up, i.e., any fluids, sand, coal particles, or drill cuttings within the wellbore must be removed.” The solid and liquid waste materials are then dumped into a pit or tank, and any gas that is removed is flared or vented to the atmosphere. During the production phase, the primary activity conducted is bringing hydrocarbons to the surface. During this phase, additional wells may be drilled within the development area to enhance hydrocarbon recovery. This production phase may last for a number of decades.

1.1.2 Exposure Criteria

Of the six criteria pollutants established by the EPA, there are five (lead is the single one excluded) that may be associated with drilling operations (Table 1). In many cases there are multiple averaging times for which the limits apply, primarily because of different health effects associated with the different averaging times. The Clean Air Act, last amended in 1990, requires the EPA to set National Ambient Air Quality Standards (NAAQS)(40 CFR part 50) for pollutants considered harmful to public health and the environment. The Clean Air Act identifies two types of national ambient air quality standards. Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

A review by the Department of Energy (1) points out that drilling activities often include sources for five of the criteria pollutants under the health-based NAAQS:

- Carbon Monoxide (CO) may be emitted during flaring and from the gas produced by incomplete combustion of carbon-based fuels and from vehicular traffic.
- Particulate Matter (PM) occurs from dust or soil entering the air during pad construction, traffic on access roads, and diesel exhaust from vehicles and engines. Particulate matter can also be emitted during venting and flaring operations.
- Sulfur Dioxide (SO_2) is formed when fossil fuels containing sulfur are burned. Thus, sulfur dioxide may be emitted during flaring of natural gas, or when fossil fuels are combusted to provide power to pump jacks, compressor engines, or other equipment and vehicles at oil and gas production sites.
- Nitrogen Dioxide (NO_2) is formed during flaring operations and when fuel is burned to provide power to machinery such as compressor engines and other heavy equipment.
- Ozone itself is not released during oil and gas development, but two of the main compounds that combine to form ground-level ozone (e.g., volatile organic compounds and Nitrogen Oxides [NO_x]) can be released during drilling operations. Volatile organic compounds (HC) are those compounds of carbon (excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate) which form ozone through atmospheric photochemical reactions. In some applications, HCs are defined as those carbon compounds containing three carbon molecules or greater. Under this definition, methane is not considered a HC.

Table 1.0 National Ambient Air Quality Standards established by the EPA.(2)

Pollutant		Primary / Secondary	Averaging Time	Level	Form
Carbon Monoxide		primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Nitrogen Dioxide		primary	1-hour	100 ppb	98th percentile, averaged over 3 years
		primary and secondary	Annual	53 ppb	Annual Mean
Ozone		primary and secondary	8-hour	0.075 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution	$PM_{2.5}$	primary	Annual	12 μg/m^3	annual mean, averaged over 3 years
		secondary	Annual	15 μg/m^3	annual mean, averaged over 3 years
		primary and secondary	24-hour	35 μg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24-hour	150 μg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide		primary	1-hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

In addition, other non-criteria air pollutants from well-drilling activities that are often regulated include(3):

- BTEX (benzene, toluene, ethyl benzene, and xylene) is a group of compounds that also belong to broader categories of regulated pollutants including volatile organic compounds (HCs) and Hazardous air pollutants (HAPs). BTEX compounds may be emitted from flaring, venting, engine exhaust, and during the dehydration of natural gas.
- Hydrogen Sulfide (H_2S) may be released when "sour" gas is vented, when there is incomplete combustion of flared gas, or via emissions from equipment leaks.
- Hydrocarbons(HC) can be released due to:
    - flashing emissions which occur when a hydrocarbon liquid with entrained gases goes from a higher pressure to a lower pressure. As the pressure on the liquid drops some of the lighter compounds dissolved in the liquid are released as gases or "flashed." Flashing losses increase as the pressure drop increases and as the amount of lighter hydrocarbons in the liquid increases. The temperature of the liquids and the vessel will also influence the amount of flashing losses. These emissions are typically seen as HC losses at tank batteries when produced

  liquids are sent from a pressurized vessel (separator or treater) to a storage tank. In recent years, these flashing losses have gained considerable attention from state and federal regulatory agencies as they can add up to significant quantities of HC emissions, a precursor to ozone formation.

  - the accumulation of fluids in mature gas wells, in the wellbore, which can impede and sometimes halt gas production and may require well blowdowns (venting the well to atmospheric pressure) in which substantial methane and associated HC emissions are released to the atmosphere.

- Also associated with drilling operations but not coming from the actual well, itself, are primary engine emissions including NO_x (oxides of nitrogen, which may include nitrogen dioxide), lesser amounts of CO, hydrocarbons, particulate and sulfur (contained in the fuel).

1.1.3 Comparison Values of Non-criteria Pollutants

1.1.3.1 Hydrocarbons (HCs)

The HCs assessed in this study are those most often considered by the EPA. However, the list is derived from hazardous waste site sampling rather than the gas extraction industry. However, for comparison to previous studies it was useful to maintain the list as it is rather than invent a new one. The list does contain many commonly found HCs but it need to be remembered that there may be others, not analyzed, that do occur. The EPA and other agencies have also developed risk assessment metrics for the list of hazardous waste site HCs which are useful in performing risk assessment analyses.

In order to assess air exposures from the monitoring of drilling activities it is necessary to have some standard against which to compare. A standard could provide a health endpoint in terms of some disease state that is likely to occur in the event of an overexposure, that is, an exposure exceeding the reference value. However, that approach is not preventative. By the time an overexposure occurs so, potentially, has disease. Rather it is preferable to have, instead, a guidance value that indicates a level at which further attention is warranted and perhaps intervention should be considered. Reference Concentrations for Chronic Inhalation Exposure (RfCs), which represent EPA's guidance values and are meant to be interpreted against the risk of long term, chronic exposure, are concentrations of a particular pollutant, below which (non-cancer) adverse health effects are not expected to occur over a period of continuous exposure. Values found above a reference concentration do not necessarily mean that adverse health effects will occur, but that there is more of a potential. To make the comparison between the sample result and the RfC, a hazard quotient is traditionally calculated. A hazard quotient (HQ) is simply the sampling result divided by the RfC. If the value is less than one, then 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 health effects are not expected.

The Minimal Risk Levels (MRLs) published by the U.S. Centers for Disease Control and Prevention (CDC) are guidance values that perform that role. One of the Centers at CDC, the Agency for Toxic Substances and Disease Registry (ATSDR), is mandated by Congress to address potential public health impacts associated with environmental exposures to hazardous substances from waste sites and releases of hazardous substances into the environment. MRLs are similar in value and use to RfCs and are also intended for use as screening values to identify chemicals of potential health concern at hazardous waste sites. They may also serve as trigger values to alert primary care physicians to look for symptoms of exposure. They are not intended as precise values above which adverse health effects will occur. An exposure level exceeding the MRL merely indicates that further evaluation of the exposure scenario and potentially exposed population may be warranted, although the more often the MRL is exceeded and the greater the magnitude of the value by which the MRL is exceeded, the greater the likelihood that an adverse health outcome will occur. Further, the relevance of an HQV (hazard quotient value) to any given exposure scenario will vary from person to person and substance to substance.(6) The selection of which substances to evaluate was based on existing knowledge of toxicology and experience in assessing and evaluating hazardous substances and adverse health outcomes. The chosen adverse health outcomes are:

Birth defects and reproductive disorders

Cancer

Immune function disorders

Kidney dysfunction

Liver dysfunction

Lung & respiratory diseases

Neurotoxic disorders

Exposure to certain hydrocarbons is a concern in this type of industry. The higher the exposure, the greater the concern. This is the basic concept behind what is called risk assessment. Risk assessment evaluates “probabilities”. The higher the probability, the more unfavorable the risk. In the case of the findings here, a hazard quotient greater than 1 based on the chronic exposure MRLs was chosen to highlight the exposure as significant. **Appendix A** lists the MRLs developed by ATSDR and **Appendix B** has the list of organic compounds detected from the SUMMA Canisters and the chronic exposure MRL level. The chronic exposure MRL is the lowest exposure level and so is the most conservative. It does, however, assume that exposures would occur consistently over a year or more at or above that average level. The list of chemicals were arranged in order of the *hazard quotient* (HQ) also called the Hazard Quotient Value (HQV) determined for the exposure levels found from the sampling described in this report. Unlike the RfC's, MRLs are based upon three distinct exposure scenarios, namely acute (14 days or less), intermediate (15-364 days), and chronic (365 days or more). Use of an acute or intermediate MRL value might facilitate a determination of whether, for example, a current air level of a volatile compound would pose an immediate or future health risk to exposed populations or warrant an emergency removal action, but not necessarily be indicative of any effects associated with longer-term continuous, low-level exposure.

The MRL development process also entails internal peer review, external peer review, and an opportunity for public comment. This process is done in a very transparent fashion, and the decisions that are made regarding any internal review comment, public comment, or peer reviewer comments, become part of a legal docket that is available to the public. By contrast, the USEPA RfCs, while undergoing extensive internal peer review, have not historically always been subjected to external peer review or public review prior to incorporation in USEPA's Integrated Risk Information System (IRIS). The agents and the recommended level below which there should be minimal probability of an adverse effect are listed in **Appendix A**.

1.1.4.2 Noise

Noise is generally viewed as being one of a number of general biological stressors. It is felt that excessive exposure to noise might be considered a health risk in that noise may contribute to the development and aggravation of stress related conditions such as high blood pressure, coronary disease, ulcers, colitis, and migraine headaches. Loud sounds can cause an arousal response in which a series of reactions occur in the body. Adrenalin is released into the bloodstream; heart rate, blood pressure, and respiration tend to increase; gastrointestinal motility is inhibited; peripheral blood vessels constrict; and muscles tense. On the conscious level we are alerted and prepared to take action. Even though noise may have no relationship to danger, the body will respond automatically to noise as a warning signal. There are also some indications that noise exposure can increase susceptibility to viral infection and toxic substances.

EPA has identified a 24-hour exposure level of 70 decibels as the level of environmental noise which will prevent any measurable hearing loss over a lifetime. Likewise, levels of 55 decibels outdoors and 45 decibels indoors are identified as preventing activity interference and annoyance. These levels of noise are considered those which will permit spoken conversation and other activities such as sleeping, working and recreation, which are part of the daily human condition.

The levels are not single event, or "peak" levels. Instead, they represent averages of acoustic energy over periods of time such as 8 hours or 24 hours, and over long periods of time such as years. For example, occasional higher noise levels would be consistent with a 24-hour energy average of 70 decibels, so long as a sufficient amount of relative quiet is experienced for the remaining period of time.

Noise levels for various areas are identified according to the use of the area. Levels of 45 decibels are associated with indoor residential areas, hospitals and schools, whereas 55 decibels is identified for certain outdoor areas where human activity takes place. The level of 70 decibels is identified for all areas in order to prevent hearing loss.

1.1.4.2.1 Evidence of Health Effects from Noise Exposure

Growing evidence suggests a link between noise exposure at levels found herein and cardiovascular problems. There is also evidence suggesting that noise may be related to birth defects and low birth-weight babies.(7) The epidemiologic evidence that long-term traffic noise exposure increases the incidence of cardiovascular disease has increased considerably since 2008(8,9). At the same time, the evidence increases that nocturnal noise exposure may be more relevant for the genesis of cardiovascular disease than daytime noise exposure:

- For aircraft noise, there was a non-significant decrease in the risk of hypertension for noise during daytime, but a significant increase for noise (more than 10 dB) at night.(8)
- Road traffic noise exposure increases the risk of cardiovascular disease more in those who sleep with open windows or whose bedroom is oriented toward the road(at levels of 66-70 dBA).(9)
- The risk for hypertension increased in those who slept with open windows during the night, but it decreased in those who had sound insulation installed or where the bedroom was not facing the main road. (10)
- There is evidence of an adverse effect of railway noise increase of 10 dBA over daytime average of 55 dBA) on blood pressure, which was especially associated with night time exposure and those effects were particularly high among persons with physician-diagnosed hypertension, cardiovascular disease, and diabetes.(11)
- Noise levels associated with common activities are given in Table 1.0.1.

1.1.4.2.2 Local Noise Ordinances

The single county noise ordinance for West Virginia is in Jefferson County (although municipalities, such as Morgantown, WV also have noise ordinances). The ZONING & DEVELOPMENT REVIEW ORDINANCE is as follows:

Section 5.8 Residential/Light Industrial/Commercial District

The purpose of this district is to guide the high intensity growth into the perceived growth area.

5.8 (b) Standards

5.8 (b) 2. NOISE. All noise shall be muffled so as not to be objectionable due to intermitting, beat frequency, or shrillness. Noise levels shall not exceed the following sound levels dB(A). The sound-pressure level shall be measured at the property line with a sound level meter.
5.8 (b) 5. VIBRATION. No vibration shall be produced which is transmitted through the ground and is discernible without the aid of instruments at any point beyond the lot line nor shall any vibration produced exceed 0.002g peak measured at or beyond the lot line using either seismic or electronic vibration-measuring equipment.

DAY NIGHT

- Sound Measured In 7 AM - 6 PM 6 PM - 7 AM
- Adjoining Agricultural or
- Residential Growth District 60 dB(A) 50 dB(A)
- Residential Uses in R.L.C. District 65 dB(A) 55 dB(A)
- Commercial Uses 70 dB(A) 60 dB(A)
- Light Industrial Uses adjacent 85 dB(A) 80 dB(A) to noise source

The following sources of noise are exempt:

- Transportation vehicles not under the control of the industrial use.
- Occasionally used safety signals, warning devices, and emergency pressure relief valves.
- Temporary construction activity between 7:00 a.m. and 7:00 p.m.

Table 1.0.1 Typical Activities and the Associated Noise Level(19)

Sound	Level dBA
Grand Canyon at Night (no roads, birds, wind)	10
Quiet basement w/o mechanical equipment	20
Quiet Room	28-33
Whisper, Quiet Library at 6'	30
Computer	37-45
Refrigerator	40-43
Typical Living Room	40
Forced Hot Air Heating System	42-52
Clothes Dryer	56-58
Printer	58-65
Normal conversation at 3'	60-65
Window Fan on High	60-66
Alarm Clock	60-80
Dishwasher	63-66
Clothes Washer	65-70
Phone	66-75
Push Reel Mower	68-72
Inside Car, Windows Closed, 30 MPH	68-73
Handheld Electronic Games	68-76
Kitchen Exhaust Fan, High	69-71
Inside Car, Windows Open, 30 MPH	72-76
Garbage Disposal	76-83
Air Popcorn Popper	78-85
City Traffic (inside car)	85
Jackhammer at 50'	95
Snowmobile, Motorcycle	100
12 Gauge Shotgun Blast	165

Some state and local governments have enacted legislative statutes for land use planning and control. As an example, the state of California has legislation on highway noise and compatible land use development. This State legislation requires local governments to consider the adverse environmental effects of noise in their land development process. In addition, the law gives local governments broad powers to pass ordinances relating to the use of land, including among other things, the location, size, and use of buildings and open space.

There are also county noise ordinances in some surrounding states such as Maryland (Howard Conty, Montgomery County and St. Mary's County) with daytime limits ranging from 70dBA to 90 dBA for industrial areas and nighttime limits lower by 5 dBA, in general. Virginia's Fairfax County allows a maximum of 72 dBA for industrial areas and Charlotte, NC has a limit of 60dBA. These limits appear to be not applied as averages but as single instances and therefore represent a maximum.

Table 1.0.2 Perceptions of Increases in Decibel Level(19)

Clearly Noticeable Change	5dB
About Twice as Loud	10dB
About Four Times as Loud	20dB

The Federal Government advocates that local governments use their power to regulate land development in such a way that the developments are planned, designed, and constructed in such a way that noise impacts are minimized.

Another possible approach to noise control is to adopt a limit on the increase in noise over the background that exists in an area. There is no mandated definition for what constitutes a substantial increase over existing noise levels in an area. Most State Highway agencies, for example, use either a 10 dBA increase or a 15 dBA increase in noise levels to define a "substantial increase" in existing noise levels (Table 1.0.2). Several State highway agencies use a sliding scale to define substantial increase. The sliding scale combines the increase in noise levels with the absolute values of the noise levels, allowing for a greater increase at lower absolute levels before a substantial increase occurs.

For existing (in-use) medium and heavy trucks with a GVWR of more than 4,525 kilograms, the Federal government has authority to regulate the noise emission levels only for those that are engaged in interstate commerce. Regulation of all other in-use vehicles must be done by State or local governments. The EPA emission level standards for in-use medium and heavy trucks engaged in interstate commerce are shown in Table 1.0.3.

Table 1.0.3 Maximum Noise Emission Levels as Required by EPA for In-Use Medium and Heavy Trucks with GVWR Over 4,525 Kilograms Engaged in Interstate Commerce(40CFR202)

Speed	Maximum Noise Level 15 Meters from Centerline of Travel
< 56 kph	83 dBA
> 56 kph	87 dBA
Stationary	85 dBA

1.1.4.3 Light

Light pollution , which can be generally defined as excessive, misdirected, or obtrusive artificial light, has been shown to affect the mating, predation and migration behaviors of many nocturnal wildlife species, in turn affecting entire ecosystems. In addition, there is evidence (see **Appendix D**) that light pollution may, in humans, influence melatonin suppression, circadian rhythms and health. Measurement of light is made in term of several different units. The first, the footcandle, is a unit of light intensity, measured in lumens per square foot. One lumen is the brightness of one candle at a distance of one foot, approximately 10.7639 lux. The lux is a unit of illumination equal to one lumen per square meter. This is the metric equivalent of foot-candles (one lux equals 0.0929 footcandles), and also called a meter-candle. Illuminance is then the total luminous flux incident on a surface, per unit area. Irradiance, on the other hand, is the power of electromagnetic radiation per unit area (radiative flux) incident on a surface and is measured in units of watts per square meter. The frequency of the light can therefore influence the amount of measured irradiance. For sunlight, which has a broad spectrum of frequencies the relationship between Illuminance (measured as lux) and irradiance (measured as watts per square meter) is generally accepted as 100 to 1. That is, 100 lux equals one watt per square meter. For this study measurements were made of the light intensity of the sky. The sky was used because, at all sites, the color (i.e. spectral frequency) should be consistent, unlike the ground or other randomly chosen surfaces. It was assumed that light pollution would be detected as “skyglow”, due to scattering of light by dust and moisture in the atmosphere. Therefore sensors were pointed upward at all sampling sites.

Table 1.0.4 Examples of Illumination and the accompanying amount of Illuminance

Illuminance	**Surfaces illuminated by:**
10^{-4} lux	Moonless, overcast night sky
0.002 lux	Moonless clear night sky
0.27–1.0 lux	Full moon on a clear night
3.4 lux	Dark limit of civil twilight under a clear sky
50 lux	Family living room
80 lux	Office building hallway
100 lux (1 W/m^2)	Very dark overcast day
320–500 lux	Office lighting
400 lux	Sunrise or sunset on a clear day.
1,000 lux	Overcast day
10,000–25,000 lux	Full daylight (not direct sun)
32,000–130,000 lux	Direct sunlight

1.1.4.4 Ionizing Radiation

Ionizing radiation is radiation composed of particles that carry enough energy to cause an electron from an atom or molecule to be removed, thus ionizing it. Ionizing radiation includes Alpha particles and Beta particles. Alpha particles consist of two protons and two neutrons bound together into a particle identical to a helium nucleus. When alpha particle emitting material is inhaled, the alpha particle exposure is far more dangerous than a similar amount of other kinds of radiation due to the higher effectiveness of alpha radiation to cause biological damage. Beta particles are high-energy, high-speed electrons or positrons emitted by certain types of radioactive nuclei, and have a lower relative effectiveness to cause biological damage than do alpha particles. Radiation exposure is measured in terms of the number of particles (in the case of alpha and beta radiation) produced per second. One Curie (Ci) is $3.7x10^{10}$ (37 followed by 9 zeros) particle produced per second. A picocurie (pCi) is one billionth of that or 37 radioactive particles per second. The most important source of materials releasing ionizing radiation that enter the body are terrestrial in origin. Radiation levels depend on uranium and thorium content of the rock, which varies widely across the United States. The highest levels are found in the Appalachians, the upper Midwest, and the Rocky Mountain states. The average indoor radiation level is estimated to be about 1.3 pCi/liter (L) of air, and about 0.4 pCi/L of air is normally found in the outside air.

Table 1.0.5 Risk of Lung Cancer for Smokers and Nonsmokers from Radiation Exposure

Radiation Level	If 1,000 people who smoked were exposed to this level over a lifetime*...	The risk of cancer from radiation exposure compares to**...
20 pCi/L	About 260 people could get lung cancer	250 times the risk of drowning
10 pCi/L	About 150 people could get lung cancer	200 times the risk of dying in a home fire
8 pCi/L	About 120 people could get lung cancer	30 times the risk of dying in a fall
4 pCi/L	About 62 people could get lung cancer	5 times the risk of dying in a car crash
2 pCi/L	About 32 people could get lung cancer	6 times the risk of dying from poison
1.3 pCi/L	About 20 people could get lung cancer	(Average indoor radon level)
0.4 pCi/L	About 3 people could get lung cancer	(Average outdoor radon level)

* Lifetime risk of lung cancer deaths from EPA Assessment of Risks from Radon in Homes (EPA 402-R-03-003).

** Comparison data calculated using the Centers for Disease Control and Prevention's 1999-2001 National Center for Injury Prevention and Control Reports.

Radiation Level	If 1,000 people who never smoked were exposed to this level over a lifetime*...	The risk of cancer from radiation exposure compares to**...
20 pCi/L	About 36 people could get lung cancer	35 times the risk of drowning
10 pCi/L	About 18 people could get lung cancer	20 times the risk of dying in a home fire
8 pCi/L	About 15 people could get lung cancer	4 times the risk of dying in a fall
4 pCi/L	About 7 people could get lung cancer	The risk of dying in a car crash
2 pCi/L	About 4 person could get lung cancer	The risk of dying from poison
1.3 pCi/L	About 2 people could get lung cancer	(Average indoor radon level)
0.4 pCi/L		(Average outdoor radon level)

Note: If you are a former smoker, your risk may be higher.

* Lifetime risk of lung cancer deaths from EPA Assessment of Risks from Radon in Homes (EPA 402-R-03-003).

** Comparison data calculated using the Centers for Disease Control and Prevention's 1999-2001 National Center for Injury Prevention and Control Reports.

2. Interpretation of Potential Health Effects from Exposures Found in the Study

The interpretation of the health effects that may occur due to exposure to air contaminants, noise and light must be tempered by the consideration of the limited number of sites that were sampled and the small number of companies (4) that those sites represent. It is unknown whether these companies represent the best or the worst of the companies or where in between the best and the worst they may fall. For those contaminants for which there are standards under the NAAQS, the characterization of the levels, in theory at least, is simple; either the contaminant levels were above or below the NAAQS. For the HCs a very simple risk assessment was done. The determination was whether the concentration was above or below the MRL. The MRL was chosen conservatively to represent chronic exposures, that is, exposures over a year or more. It is unlikely that any single drill site would expose any location to the levels found in this study for a period of a year or more. The assumption of a chronic exposure was done because of the uncertainty about how far away exposures might occur and the possibility that a given residence might be exposed from operations at several nearby drill sites. Any concentration above the MRL was considered to present a hazard. Any concentration below the MRL did not. There were four out of the seven locations where SUMMA canister samples were taken that showed benzene concentrations in excess of the MRL.

2.1 $PM_{2.5}$ dust levels at the 625 foot setback distance had one-hour average values above the annual NAAQS limit occurring over the course of several days at all but one site (Mills Wetzel 2). This happened for two readily apparent reasons. The first reason was that areas were not kept sufficiently watered to prevent dust buildup on the roadways the construction equipment was using. The second reason was that the heavy equipment was working directly next to where the samplers were located even though the samplers were placed 625 feet from the presumed eventual center of the well pad. The center of the well pad, in this case, was an obviously inappropriate location from which to determine the setback if the purpose of the setback was to remove the source of the dust from nearby residences. The same potential for dust generation was observed at all locations reported on here. Heavy traffic movement could be observed on potentially dusty roads at all sites, at distances 625 feet from the center of the pad (and farther, for that matter).

2.2 The only significant *hazard quotient* was for Benzene which has an MRL (based on immunological system effects) of 9.5 $\mu g/m^3$ for chronic (>365 days), 19 $\mu g/m^3$ for intermediate (14 to 364 days) and 28.5μg/m^3 for acute (1 to14 days) exposure. For comparison, the US EPA RfC's for Benzene is 30 μg/m^3. Even with the higher value for the RfC there were still MRLs above 1.0 at three of the four sites. Assessments in areas of Garfield County Colorado have concluded that the ambient benzene levels associated with drilling operations there demonstrate an increased potential risk for development of cancer as well as chronic and acute noncancerous health effects where natural gas development operations is the only major industry other than agriculture. (14) From a risk assessment standpoint, which is what the MRLs were developed to assist with, there is a potential risk of immunological system health effects in a population that may live within 625 feet of drilling operations. It should be stressed, though, that this is not the same as being out of compliance with the NAAQS. Risk assessment is meant to identify the potential for a health problem. The higher the multiplicative factor over the MRL the more likely it is that a health problem could develop.

2.3 Noise levels above 55 dBA occurred frequently, but averages were below the EPA's recommended long-term level of 70 dBA. As noted above, this could still be problematic, resulting in increased stress levels and their concomitant side effects as noted in studies cited in Section 1.1.4.2.1 which showed health effects associated with noise levels similar to those seen herein. Again, this was a consistent problem throughout operations and not just associated with a single kind of operation. Although the levels for highway noise given in Table 1.0.3 are for 15 meters away from the highway, noise at the 625 foot setback distance exceeded 85 dBA a number of times. These were short-term excursions but the standard for Table 1.0.3 does not specify a time.

2.4 Light levels, measured as skyglow were zero during night time and ionizing radiation levels were near zero as well.

3 Conclusions and Recommendations

3.1 Conclusions

3.1.1 There was activity associated with the drilling site and with the source of air contaminants and noise at 625 feet and farther from the center of the pad. A setback distance of 625 feet from the center of the pad, therefore, does not assure that residences would be unexposed to contaminants from drilling site activity.

3.1.2 There does not appear to be a simple solution to specifying a single point from which to specify the set-back distance to assure exposure control. There is no single geometry to which all drill site activities conform. The activities follow the terrain of the site and the needs of the process. There is no good reason to believe that using the center of the Pad as the reference point from which the setback is taken will assure that activity associated with some possible sources of the studied contaminants will not occur closer than 625 feet from the actual source. Studies have also shown that the meteorology (and topography) may be a more important factor than a distance measured on a map for determining air contaminant concentration (18).

3.1.3 The levels of contaminants that were seen were not unexpected based on previous studies. However, they were seen to fluctuate over a wide range (i.e. have a high standard deviation) so that consideration needs to be given to increased control monitoring of the process.

3.1.4 Unlike the PA DEP study results in **Appendix D**, the hazard quotient for benzene from the SUMMA canister sampling summarized in the Table in **Appendix B** was high enough at the proposed setback distance at four of the drilling locations sampled to be of concern.

3.1.5 One or all of the BTEX compounds were found at all drilling sites. Although any of these compounds could come from diesel emissions, diesel traffic is still part of the activity on all the sites and needs to be taken into account. BTEX and isotopic methane may provide the best substances to use as tracers of activity and control of processes at the drill site, although isotopic methane is more difficult to measure and there are no inexpensive, easily moved units for making the measurement.

3.1.6 $PM_{2.5}$ levels were above the annual NAAQS for at least one hour at certain locations, under certain conditions at 625 feet from the pad center and were never above the twenty four-hour average time value. However, the health effect-based NAAQS is not appropriate for exact comparison with the measurements taken for $PM_{2.5}$ or any other contaminant in the list of those sampled. The short-term nature of the drilling process was apparently not envisioned by the developers of the NAAQS, which requires a minimum of a year's worth of data during which the site is actively operating. It remains an open question as to how to apply intermittent exposures to evidence from studies of continuous exposure used as the basis of the NAAQS. To actually predict whether the exposures will cause health effects in the population, a new health effects study specific to the industry might have to be conducted or a previously published study of the industry (like reference 14) applied to the current conditions.

3.1.7 In a lengthy report by the Energy Institute at the University of Texas at Austin on "Fact-Based Regulation for Environmental Protection in Shale Gas Development" it was pointed out that large, fixed position air sampling units are most appropriate to monitor the cumulative atmospheric impact of effectively non-point sources such as automobile exhausts and widely dispersed point sources such as gasoline stations(**15**). Point sources such as drilling operations and gas processing plants, cannot be appropriately monitored even by several fixed units spread over a large area. It also should be noted that assessment of lifetime exposure levels requires either very long term continuous monitoring such as provided by fixed units or extensive, randomly selected, multiple short duration samples on a long term basis. Lifetime exposures cannot be estimated from a small number of short term measurements. Although the contaminant plumes of point sources ultimately contribute to the average compositions of air they can only be effectively monitored using targeted technologies that allow greater spatial granularity.

3.2 Recommendations

3.2.1 A more definitive sampling and health effects study needs to be done in West Virginia to address the issues of potential exposures from gas drilling to the people in the State. The topography of West Virginia, more so than for the states around it, lends itself to increasing the concentration of emitted contaminants because of the complex terrain, the increased likelihood of atmospheric inversions in that terrain and the microclimatology during certain seasons. Much greater funding and time would be needed, though, than for the study described in this report to come to a conclusion. Input and cooperation should be sought from all concerned parties to assure the success of the study.

3.2.2 Better use of roadway wetting agents would reduce many of the peak dust exposures seen from roadside samples that were taken over the course of the survey. Workers noted that the only use of wetting agents they had seen were when the sampler were being placed on site. While this may be an exaggeration, the amount of fine dust that had collected at the sites and the levels over the $PM_{2.5}$ NAAQS were visible proof that some increased wetting agents use was needed.

3.2.3 Greater spacing of diesel container-trucks while waiting on line for HF could reduce the local concentration of diesel exhaust and may reduce noise as well. For example, noise levels at site C at the Donna pad, next to the roadway during HF operations were some of the highest seen in all the study sites. Trucks had lined up along that roadway for the duration of the operation and provided a consistent noise levels in excess of 60 dBA.

3.2.4 Noise reduction, particularly from traffic may be abated by several well-established methods used with highway construction. These include:

- Sound barriers around the drill site have been used in other locations although none were seen here, so it is not possible to tell what effect they may have, but it is certainly an area that could be explored.
- Vegetation, if it is high enough, wide enough, and dense enough that it cannot be seen over or through, can decrease highway traffic noise. A 61-meter width of dense vegetation can reduce noise by 10 decibels, which cuts in half the loudness of traffic noise. It may not be feasible, however, to plant enough vegetation along a road to achieve such reductions. If vegetation already exists, it can be saved to maintain a psychological relief, if not an actual lessening of traffic noise levels. If vegetation does not exist, it can be planted for psychological relief.
- Insulating buildings can greatly reduce highway traffic noise, especially when windows are sealed and cracks and other openings are filled. Sometimes noise-absorbing material can be placed in the walls of new buildings during construction. However, insulation can be costly because air conditioning is usually necessary once the windows are sealed.
- A noise attenuation measure that should always be considered is the possibility of altering the roadway location to avoid those land use areas which have been determined to have a potential noise impact. Since sound intensity decays with distance from the source, increased distance between the noise source and receiver may reduce the noise impact. It may also be possible to obtain attenuation by depressing the roadway slightly to produce a break in the line of sight from the source to the receiver. Potential noise reduction should be considered with the many other factors that influence the selection of roadway alignment.

3.2.5 The University of Texas at Austin report cited above notes that Industry best practice is to install sound meters on all drill pads, compressor stations etc., such that the site is connected by cellular phone or Wi-Fi to record sound levels 24 hours a day. When the permitted sound levels is exceeded and detected sound engineers investigate to seek the source and report not only the cause but also what steps have been taken to prevent a recurrence. This approach to monitoring of all pertinent hazards should be considered for future regulations.

3.2.6 A review of alternative health effects information outside the scope of EPA regulations or the data from this study is available in **Appendix D** and should be considered in setting regulations.

4 Sampling Site Results

Marcellus gas wells at the various stages of development, as mentioned above, were selected for this project. WVDEP first contacted the natural gas developers to establish site access. Factors that were considered for placement of the sampling equipment include:

- The sites selected for placing sampling equipment should be a minimum of 10 meters from the nearest drip line and when possible have no foliage or obstruction between the drill pad site and the sample location.
- The sampling equipment should be placed a minimum of 625 feet from the center of the drill pad if the drill rig is not in place, starting directly downwind in the dominant wind direction, with one mobile site as close as feasible to every 90 degrees.

Alternative locations were then considered when it was not possible to meet the above specifications. These alternatives, in order of priority, included:

- Any location with no foliage or intervening obstruction closest to within 625 to 1250 feet of the center of the drill pad and within 20 degrees of one of the ideal locations can be selected as a sampling location, with preference given to a residence falling within those bounds and meeting those specifications,.
- Any location within 625 to 1250 feet of the center of the drill pad with no foliage or intervening obstruction at the same level as the drill pad and at least 45 degrees from the nearest ideal sample location it is meant to represent.
- Any location within 625 to 1250 feet of the center of the drill pad with no foliage or intervening obstruction at any level and at least 45 degrees from the nearest other ideal sample location it is meant to represent.

There was always a WAMS location sited near the trailer for comparison. Set up of the equipment was done at the selected sites usually for six days. The equipment was visually inspected every second or third day during the sampling period. Photoionization detectors were checked and calibrated in the field with isobutylene during the study period.

Sample numbers for the Summa Canisters are a combination of the location (e.g., site A, B or C, although not uniquely identified to a particular pad, since the letter designation were repeated for all pads and identified the direct reading equipment that was used along with the canisters) and a consecutive set designation (e.g., 1, 2, 3, 4, etc.). Sample A1, for example, would be from the first set of samples and placed at Sampling Site Location A. All samples with the same set designation number (1, in this example) would have been taken during the same sampling period (e.g. samples A1 and B1 would have been taken during the same time period but at sites A and B respectively).

Two-hour average OC and EC concentrations were obtained using the Sunset Laboratories Aerosol Carbon Field Analyzer. The analyzer had a $PM_{2.5}$ size-selective inlet, so reported concentrations are of OC and EC in $PM_{2.5}$. The analyzer uses a quartz oven and non-dispersive infrared detection. Blank sample analysis was automatically conducted daily at midnight, and a calibration check was conducted at the start and end of the monitoring period at each of the six locations, as well as during weekly site visits. EC is formed by combustion of organic material, such as fossil fuels, and is solely a primary pollutant. OC can be a primary or secondary pollutant. Primary sources can be anthropogenic or biogenic, and secondary sources are atmospheric oxidation processes. Both OC and EC can be emitted from the same source. With respect to natural gas operations, the HCs emitted by gasoline- and diesel-powered engines and the natural gas itself can contribute to OC and diesel exhaust is a source of EC. The OC/EC analyzer experienced multiple problems related to leaks and software during monitoring at the six sites. Only the Maury and Lemons Pads were able to be monitored because of this.

Ammonia is not likely to be emitted in large quantities from natural gas operations. Its inclusion in the laboratory instrumentation was intended for future atmospheric modeling purposes, as ammonia plays an important role in aerosol formation. Because there was very little variation in the ammonia concentration measured at each monitoring location, results for five of the sites are shown in the table below rather than at the particular Site Sections in the report.

Light levels fell to 0 during evening hours for all sites, measured both by the DOE and WAMS instruments.

Radiation levels for alpha and beta sources were well below established background levels in air. The only reason for the ability to detect any radiation of the filter samples was the fact that over 300 liters or air were sampled onto the filters.

Figures for measured meteorological parameters other than wind (temperature, relative humidity, rainfall, and solar intensity) are included in **Appendix C**.

Density Correction Factors for the Dust Track Measurements can be found in **Appendix F.**

A summary of the more important results, by Site, follows.

Table 4.0.1 Summary List of Hydrocarbons* detected by GC-FID in ppb

	Donna Pad	Weekly Pad	Mills-Wetzel Pad #2	Maury Pad	Lemons Pad	WVDNR Pad
1-Butene						
1,2,3-Trimethylbenzene						
1,2,4-Trimethylbenzene						
1,3,5-Trimethylbenzene						
1-Hexene						
1-Pentene						
2,2,4-Trimethylpentane						
2,2-Dimethylbutane						
2,3,4-Trimethylpentane						
2,3-dimethylbutane		0.4				
2,3-Dimethylpentane						
2,4-Dimethylpentane						
2-Methylheptane						
2-Methylhexane						
2-Methylpentane						
2-methylheptane		0.4				
2-methylhexane		1.1				
2-methylpentane	1.3	4.7	2.2	1.0	0.7	0.2
3-methylheptane		0.5				
3-methylhexane		1.1				
3-methylpentane	0.9	3.0	1.2	0.5	0.3	
Acetylene						0.3
Benzene						
cis-2-Butene						
cis-2-Pentene						
Cyclohexane		0.6				
Cyclopentane						
Decane				0.4		
Ethane	59.4	75.9	56.2	40.2	30.4	17.8
Ethyl Benzene						
Ethylene	0.6		0.6	1.7	0.8	1.6
Hexane	1.2	6.2	1.8	1.2		0.4
Isobutane	5.3	20.8	9.0	6.4	5.7	2.5

*Blank cells are compounds that were detected in less than 10% of the samples

Table 4.0.1 cont'd

	Donna Pad	Weekly Pad	Mills-Wetzel Pad #2	Maury Pad	Lemons Pad	WVDNR Pad
Isoprene	5.5	6.6	5.2	4.0		
Isopropylbenzene						
m-diethylbenzene						0.5
m/p-Xylene (combined)						
Methylcyclohexane	0.4	1.4	0.5	0.2		
Methylcyclopentane		0.4				
m-Ethyltoluene						
n-butane	8.9	44.5	16.3	11.3	9.6	6.2
n-Decane						
n-dodecane						3.6
n-heptane	0.4	2.3	0.4	0.3		
n-Hexane						
n-octane		1.0				
Nonane		0.4		0.2		
n-Nonane						
n-pentane	3.7	19.2	7.6	5.1	4.0	2.2
n-Propylbenzene						
n-Undecane						
o-Ethyltoluene						
o-Xylene						
p-Diethylbenzene						
p-Ethyltoluene						
n-undecane						3.4
Propane	22.2	71.9	33.4	24.1	25.1	11.6
Propylene						0.2
Styrene						
Toluene	1.4	0.7	1.0	0.3		1.0
trans-2-Butene						
trans-2-Pentene						
Undecane				0.3		

Table 4.0.2 Summary of PM10 and PM2.5 levels measured by TEOM

		PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)
	NAAQS 24-hour Standard	150	35
Range of 24-hour averages measured at each site	Donna Pad	12-29	6-15
	Weekley Pad	9-32	5-20
	Mills-Wetzel Pad 2	9-54	6-17
	Maury Pad	9-90	5-24
	Lemons Pad	5-24	3-13
	WVDNR Pad	2-50	1-13

Table 4.0.3 Summary of Average sound levels (dBA)

	Donna	Mills Wetzel 2	Mills Wetzel 3	Maury	Lemon
Mean	52	65	64	58	54
Standard Deviation	10	10	8	6	4

Table 4.0.4 Ammonia Values

Well Pad	**Average (ppb)**	**Maximum (ppb)**	**Minimum (ppb)**
Weekley	0.9	1.5	0.4
Mills-Wetzel 2	0.6	1.0	0.2
Maury	0.6	5.3	0.1
Lemons	0.8	2.6	0.2
WVDNR A	0.4	0.6	0.2

Table 4.0.5 Range of Values for Gases by Location

	Donna	**Weekley**	**Mills Wetzel 2**	**Maury**	**Lemons**	**WVDNR**
O_3 (8 hr average)(ppb)	9-56	4-78	20-67	2-69	11-61	14-56
NO_x(1 hr average)(ppb)	1.3-30	3.4-12	7.8-38	23-138	9-151	-
CH_4(6 day average) ppm)	2.1	2	2	2	2.1	1.9
SO_2(3hr average)(ppb)	1.9-10.4	1.1-12.4	1.6-8.4	1.1-9.6	1.7-3.7	2.1-5.3

Table 4.0.6 PID Direct-Reading Analysis of Hydrocarbons

Location	**Mean (ppb)**	**Standard Deviation**
Weekley C	0.66	0.75
Maury D	2.50	2.60
Lemons A	1.66	0.81
Lemons C	8.15	9.72
WVDNR B	0.61	0.09

Table 4.0.7 Airborne Radiation Levels

	Amount on Filter (pCi)	Concentration of Radioactive Materials in Air (pCi/L)	Pad Location (Sample Site)
Alpha	0.244	<0.0001	Weekley (A)
Alpha	0.388	<0.0001	Weekley (C)
Alpha	0.383	<0.0001	Pad 2 (C)
Alpha	0.287	<0.0001	Pad 2 (A)
Alpha	0.572	<0.0001	Pad 3 (A)
Alpha	0.583	<0.0001	Pad 3 (C)
Alpha	0.432	<0.0001	Maury (D)
Alpha	0.567	<0.0001	Lemons (C)
Alpha	0.429	<0.0001	Lemons (A)
Alpha	0.0087	<0.0001	WV DNR (A)
Alpha	0.0814	<0.0001	WV DNR (C)
Beta	-0.017	<0.0001	Weekley (A)
Beta	0.117	<0.0001	Weekley (C)
Beta	0.562	<0.0001	Pad 2 (C)
Beta	Non Detect	<0.0001	Pad 2 (A)
Beta	0.528	<0.0001	Pad 3 (A)
Beta	0.369	<0.0001	Pad 3 (C)
Beta	0.617	<0.0001	Maury (D)
Beta	0.608	<0.0001	Lemons (C)
Beta	0.214	<0.0001	Lemons (A)
Beta	Non Detect	<0.0001	WV DNR (A)
Beta	0.076	<0.0001	WV DNR (C)

4.1 Donna Pad (Hydraulic Fracturing)

The NETL Mobile Air Monitoring Laboratory was deployed to the Donna pad in northern Marion County, WV on July 19, 2012. The laboratory was located approximately 400m southeast of the well pad in the yard of a nearby resident with coordinates of 39°34'20.44"N, 80°17'26.22"W. The resident's electric service was used to power the laboratory, so the impact of diesel generator emissions does not need to be considered for this location. After unpacking, installing, and calibrating, all instruments were fully operational and collecting data on July 20. Monitoring at this site ended on August 1, 2012. During this period, wind typically came from the southeast or northwest; winds from the northwest would likely have carried any plumes from the well pad toward the monitoring laboratory. Figure 2 shows a wind rose and histogram for the wind direction and speed during monitoring at the Donna pad location.

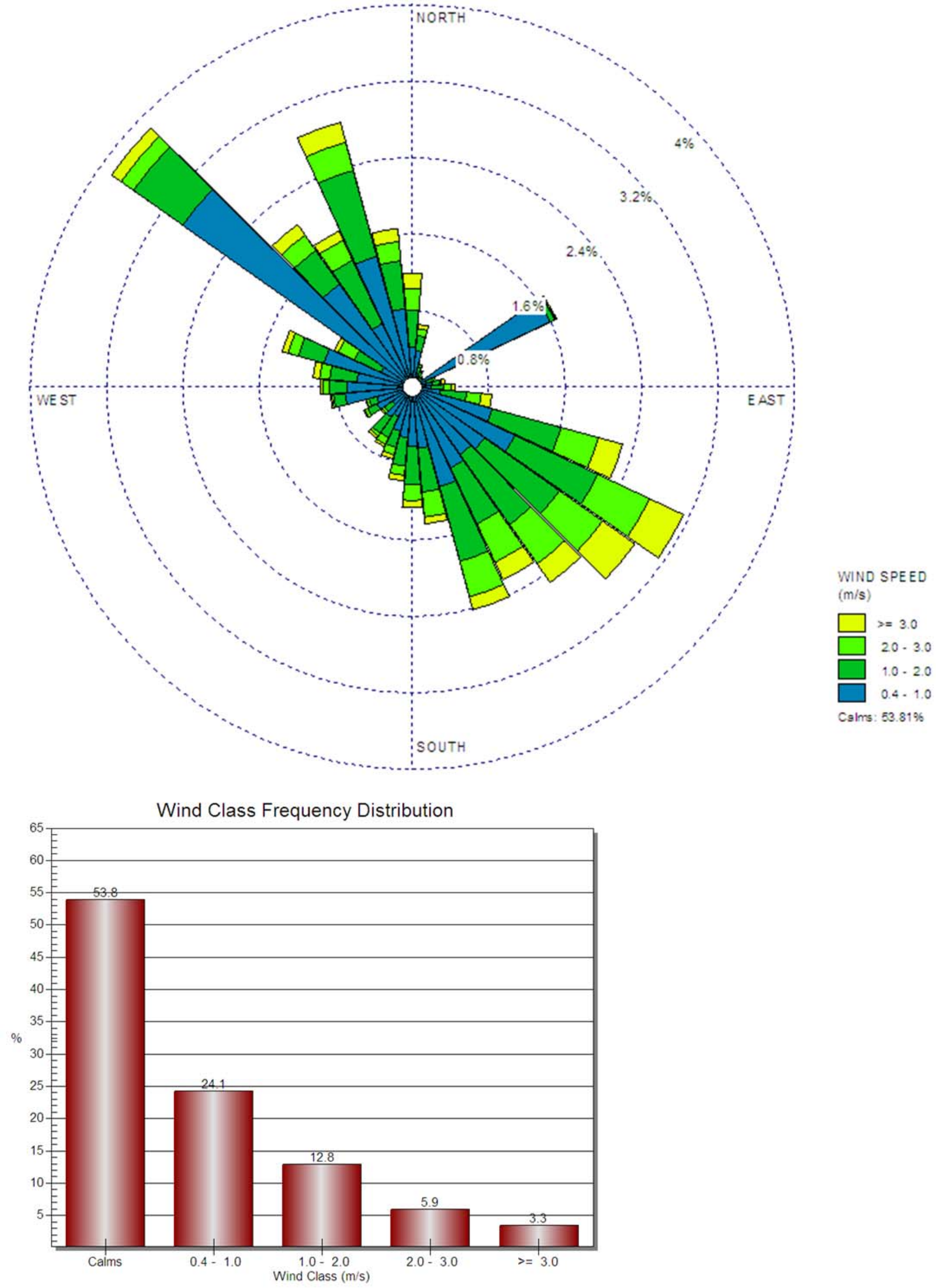


Figure 4.1a. Wind rose and histogram for wind direction and speed during monitoring at the Donna pad location.

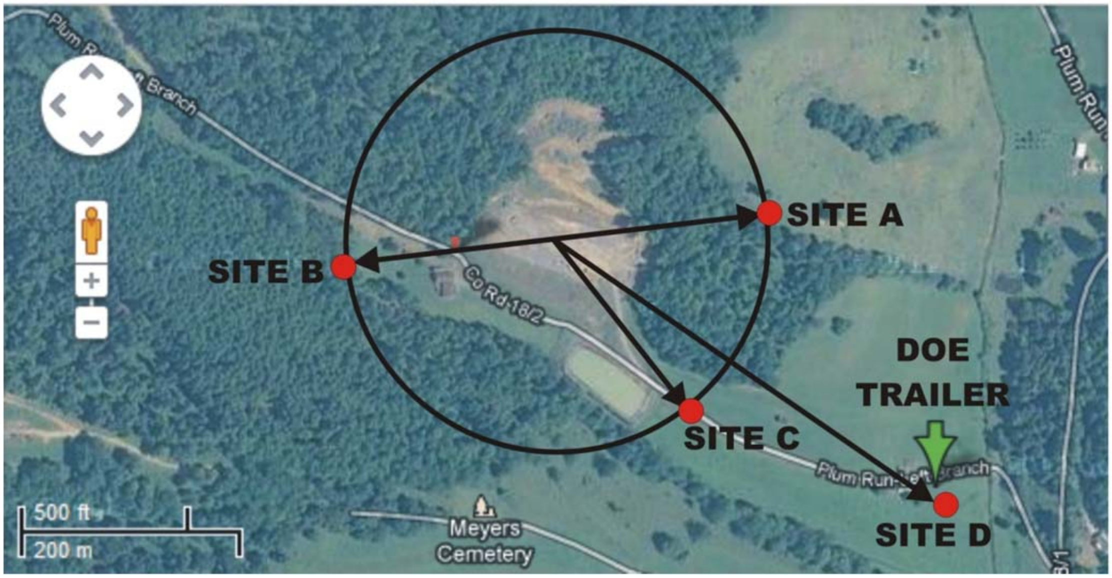


Figure 4.1b. Satellite photo of the Donna pad showing sampling sites (A,B,C, D) as red dots and location of DOE trailer as shown by the green arrow. Black circle is the 625 foot setback distance.

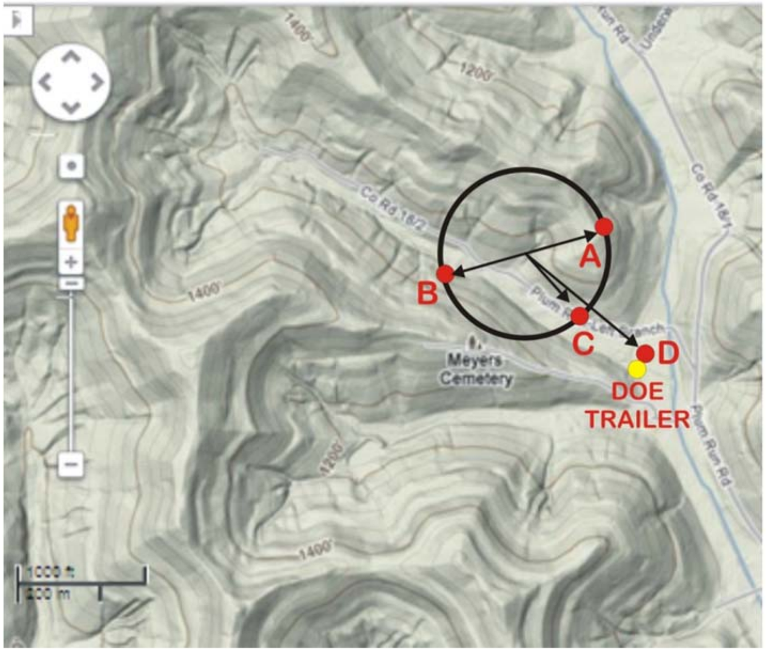


Fig 4.1c Terrain map of the Donna pad showing sampling sites (A,B,C, D) as red dots and location of DOE trailer as a yellow dot. Black circle is the 625 foot setback distance.

4.1.1 Hydrocarbon (HC) Results

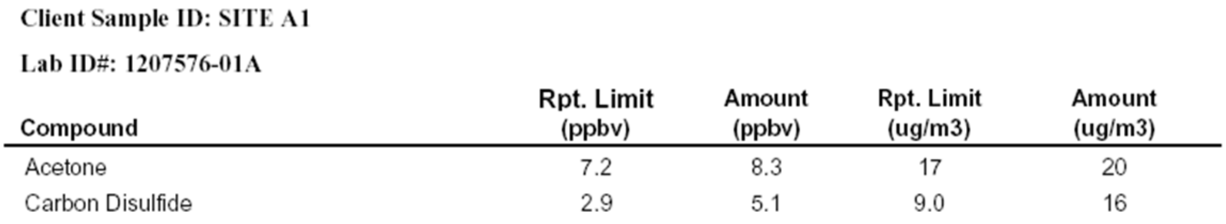
HC data were collected over the entire duration of the Donna pad monitoring campaign, 7/20-8/1, for a total of 226 samples.

Table 4.1 GC-FID HC results

	Average Concentration, ppb	Standard Deviation, ppb	Minimum Concentration, ppb	Maximum Concentration, ppb	Frequency of Detection, %
hexane	1.2	2	0	10.3	42
n-heptane	0.4	1.0	0	5.1	19
methylcyclohexane	0.4	1.0	0	5.2	19
toluene	1.4	0.9	0	4.1	84
ethane	59.4	108.3	9.2	837.5	100
ethylene	0.6	0.8	0	3.5	37
propane	22.2	20.8	3.4	175.9	100
isobutane	5.3	3.9	0.7	31.4	100
n-butane	8.9	7.0	1.5	52.3	100
isopentane	4.9	3.3	0.7	21.6	100
n-pentane	3.7	2.6	0.3	18.4	100
2methylpentane	1.3	1.5	0	6.9	60
3methylpentane	0.9	1.2	0	6.5	50
isoprene	5.5	4.5	0	25.4	94

4.1.2 Summa Canister HC Results

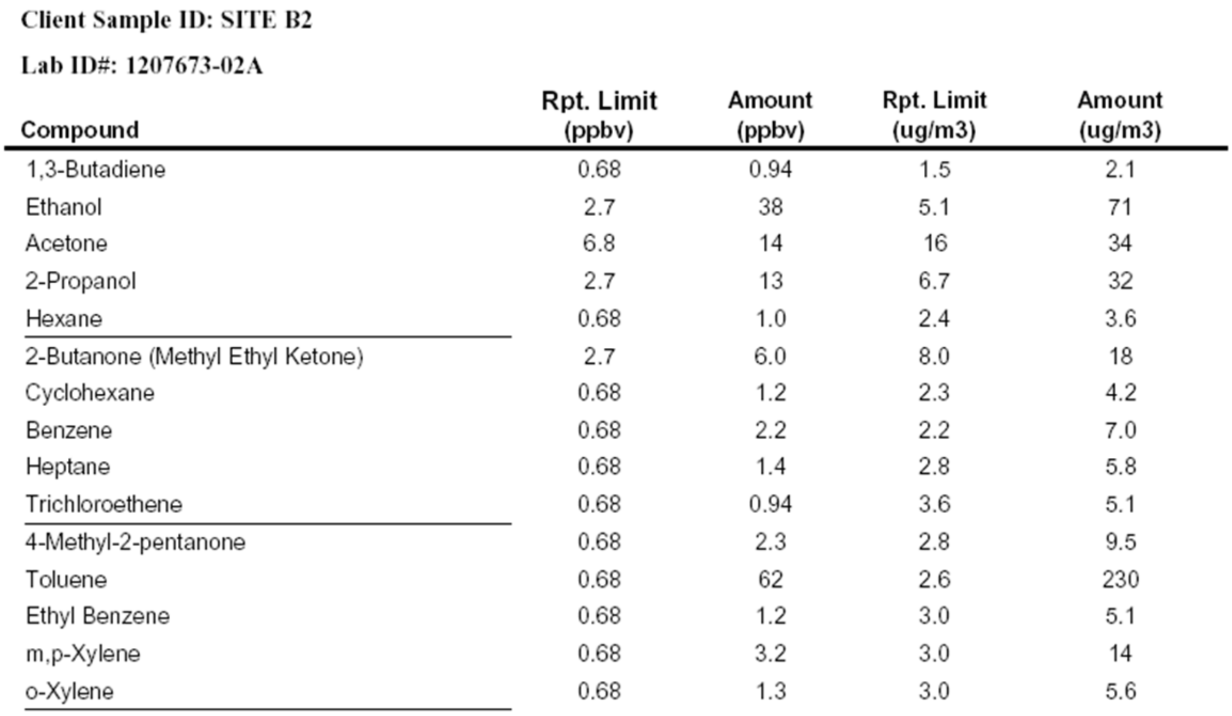
Only results above the reporting limit (Rpt Limit), that is, the concentration detectable with a statistical certainty are reported.



Client Sample ID: SITE A1

Lab ID#: 1207576-01A

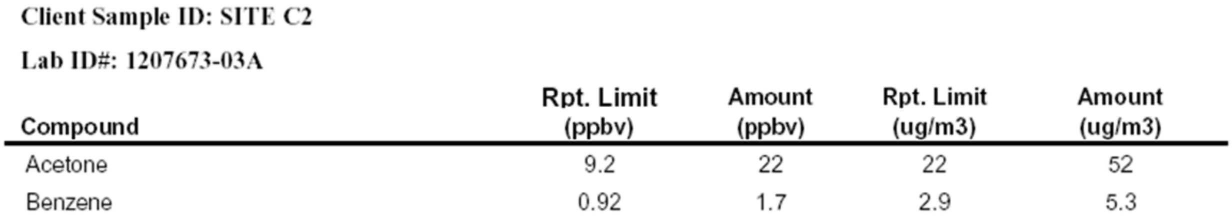
Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Acetone	7.2	8.3	17	20
Carbon Disulfide	2.9	5.1	9.0	16



Client Sample ID: SITE B2

Lab ID#: 1207673-02A

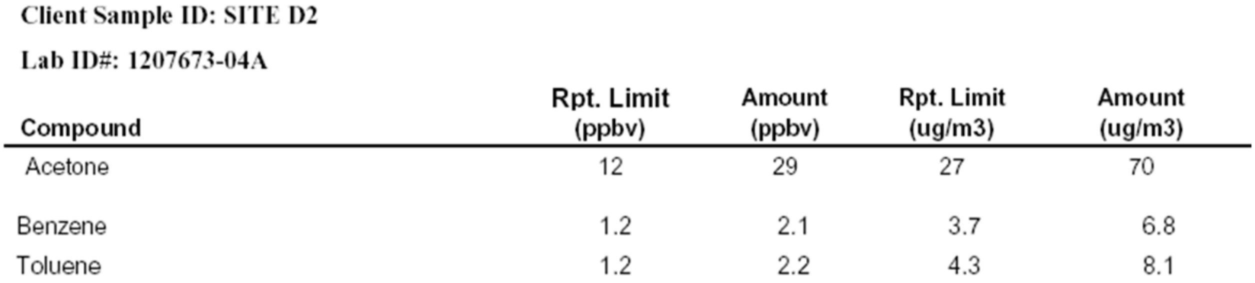
Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
1,3-Butadiene	0.68	0.94	1.5	2.1
Ethanol	2.7	38	5.1	71
Acetone	6.8	14	16	34
2-Propanol	2.7	13	6.7	32
Hexane	0.68	1.0	2.4	3.6
2-Butanone (Methyl Ethyl Ketone)	2.7	6.0	8.0	18
Cyclohexane	0.68	1.2	2.3	4.2
Benzene	0.68	2.2	2.2	7.0
Heptane	0.68	1.4	2.8	5.8
Trichloroethene	0.68	0.94	3.6	5.1
4-Methyl-2-pentanone	0.68	2.3	2.8	9.5
Toluene	0.68	62	2.6	230
Ethyl Benzene	0.68	1.2	3.0	5.1
m,p-Xylene	0.68	3.2	3.0	14
o-Xylene	0.68	1.3	3.0	5.6



Client Sample ID: SITE C2

Lab ID#: 1207673-03A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Acetone	9.2	22	22	52
Benzene	0.92	1.7	2.9	5.3



Client Sample ID: SITE D2

Lab ID#: 1207673-04A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Acetone	12	29	27	70
Benzene	1.2	2.1	3.7	6.8
Toluene	1.2	2.2	4.3	8.1

Samples B1, C1, D1, A2 – no detectable HC compounds

4.1.2.3 Photoionization Detector (PID) Analysis Results

Instrument malfunctions resulted in loss of Photoionization Detector (PID) data for this site.

4.1.3 Ozone Results

Although the instrument was operating on July 20, ozone data are available from July 24 through August 1 (Figure 4.1d). There was a delay in obtaining data from the analyzer due to a faulty wiring connection. The average ozone concentration using one minute data at the Donna pad was 33ppb, and the maximum hourly average concentration was 65ppb. Day-to-night variations were as high as 50ppb. Calculating 8-hour averages to more directly compare to the NAAQS results in a range of 8-hour averages of 9ppb – 56ppb.

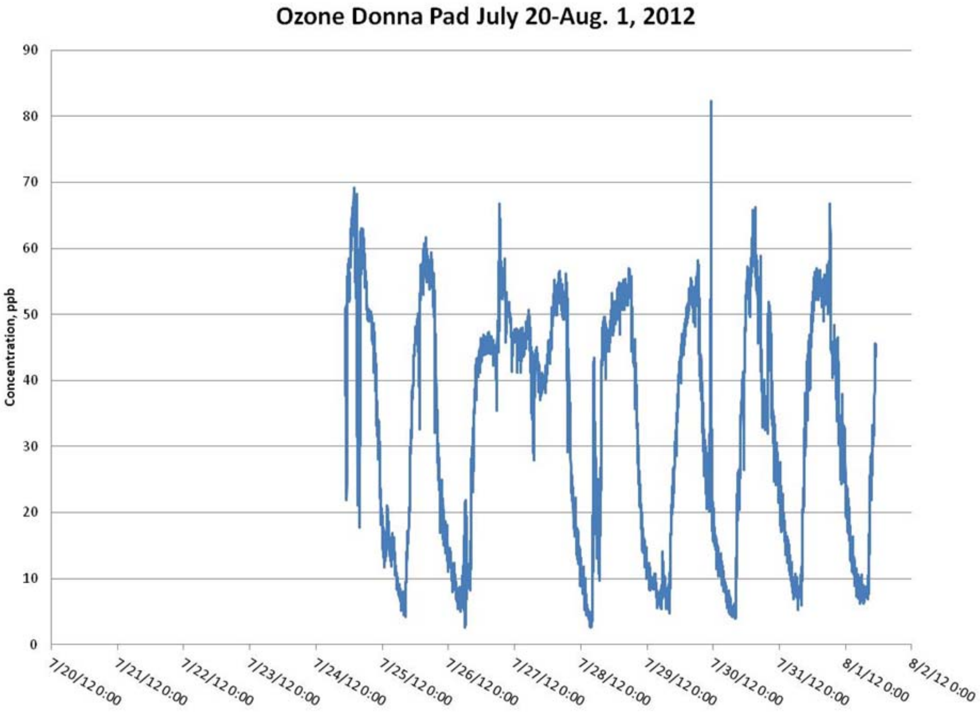


Figure 4.1d. One-minute average ozone concentrations at the Donna pad.

4.1.4 NOx Results

Data for NO_x are available for July 21-24 and July 27-August 1 (Figure 4.1e). The gap between July 21 and 24 was due to an instrument malfunction that occurred during the calibration on July 24. The instrument was brought back to NETL in Pittsburgh for repairs and then returned to the Donna pad location. The average concentration of NO_x at the Donna pad was 1.3ppb, with peaks not exceeding 30ppb.

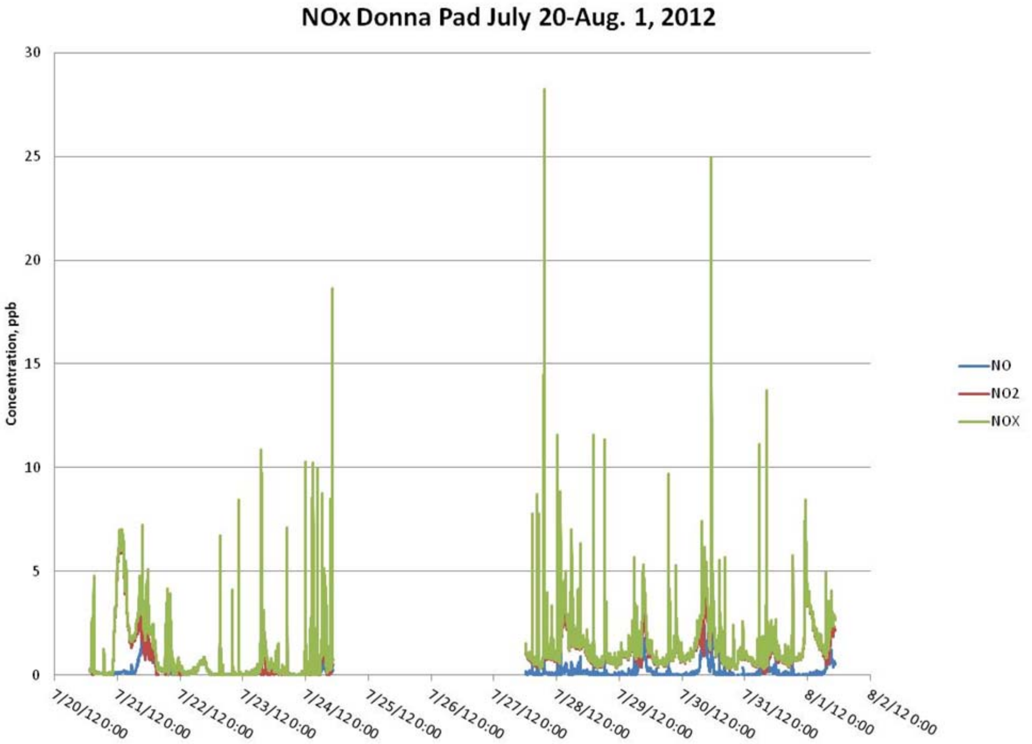


Figure 4.1e. One-minute average NO_x concentrations at the Donna pad.

4.1.5 Methane Results

The ambient methane concentration at the Donna Pad averaged 2.1 ppm (±0.1) with an average isotopic composition of -49.3‰ (±1.3‰) which are typical background atmospheric values (Figures 4.1f and g). With the exception of a few short-term peaks, the only time the concentration exceeded 4 ppm occurred between the evening of 7/28 through mid-day on 7/29. During this time the average concentration of methane was 8.1 ppm with a maximum concentration of 36.2 ppm. The average $\delta^{13}C$ for this time frame increased to -40.8‰ with a maximum value of -35.8‰, indicating a significant contribution from a thermogenic methane source during this time.

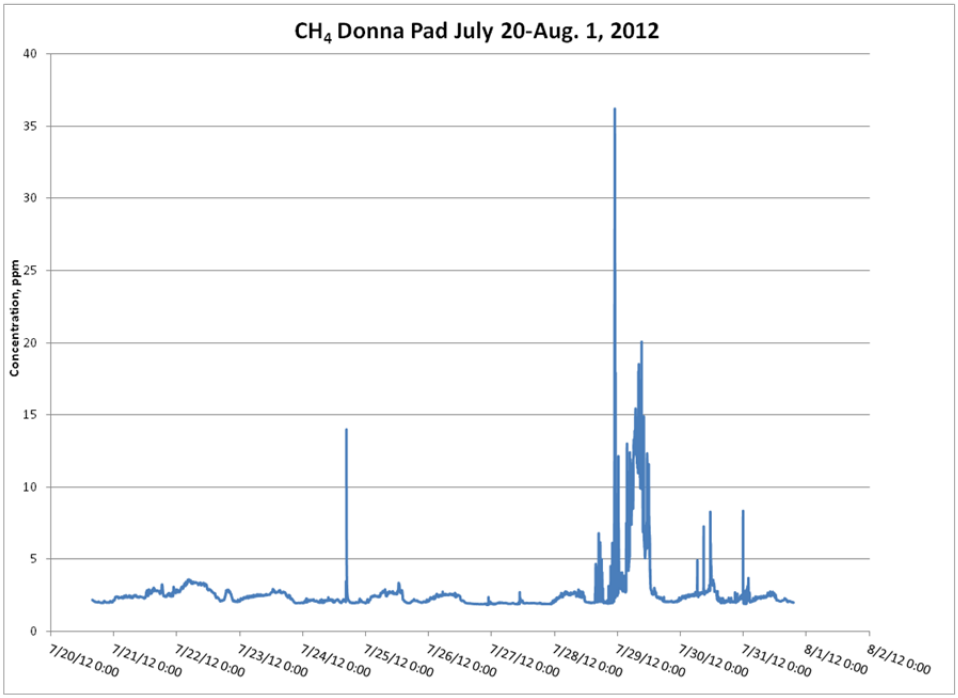


Figure 4.1f. One-minute average CH_4 concentrations at the Donna pad.

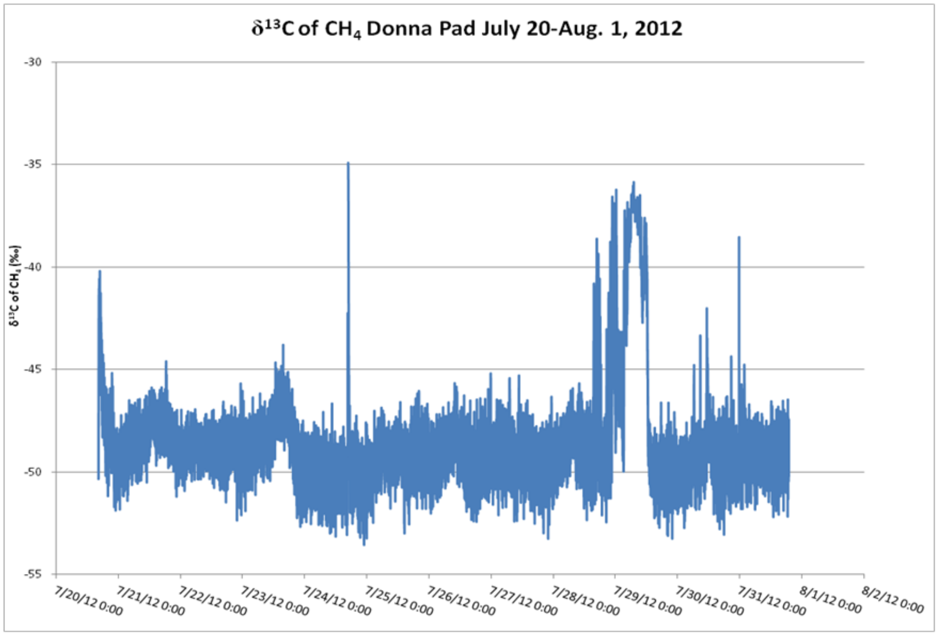


Figure 4.1g. One-minute average $\delta^{13}C$ of CH_4 at the Donna pad.

4.1.6 CO2 Results

Over the two weeks of monitoring at the Donna pad, the CO_2 concentration averaged 425ppm (±49) with $\delta^{13}C$ averaging -12.3‰ (±2.1‰) (Figure 4.1h). Interestingly, the CO_2 concentrations and $\delta^{13}C$ values at the site cycle daily. Starting at approximately 8pm, the CO_2 concentration increased sharply to values typically greater than 450ppm and occasionally greater than 500ppm before dropping back to near ambient levels by 7am. During these times, the corresponding δ^{13}C values become more depleted, dropping to less than -14‰. The maximum CO_2 concentration at the site was 594ppm with a corresponding δ^{13}C value of -16.0‰.

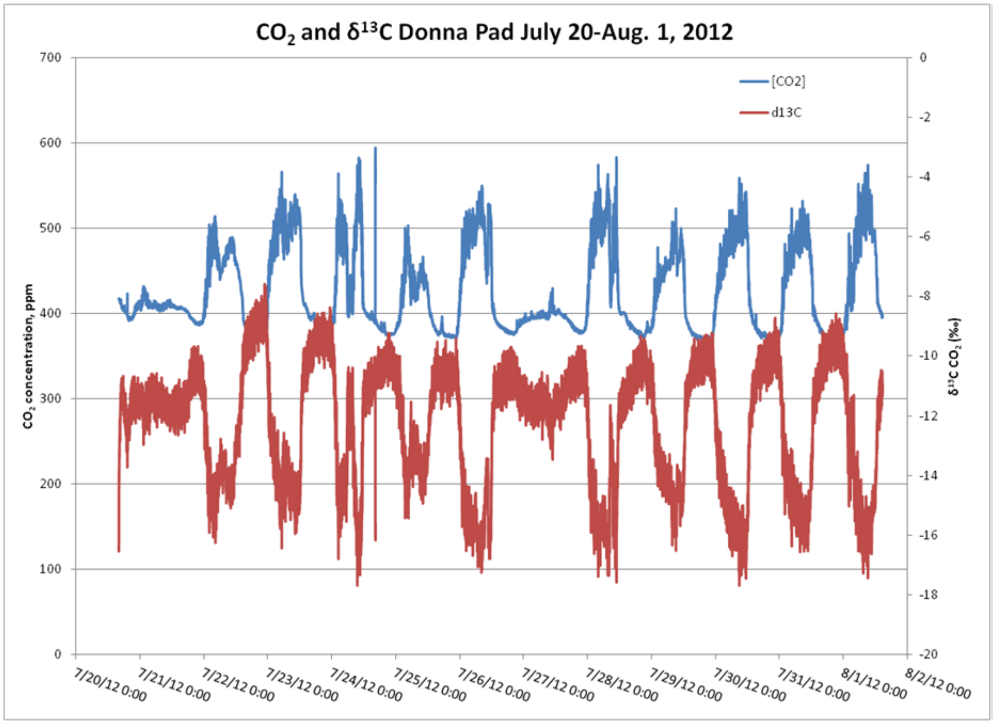


Figure 4.1h. One-minute average CO_2 concentrations and δ^{13}C of CO_2 at the Donna pad.

4.1.7 (Dust) Results

4.1.7.1 TEOM

Data are available for July 20-Aug. 1 (Figure 4.1i). At the Donna pad, Average PM_{10} concentration was 19µg/m^3 and average $PM_{2.5}$ concentration was 11µg/m^3. Maximum one-hour average concentrations of PM_{10} and $PM_{2.5}$ were 76µg/m^3 and 38µg/m^3, respectively.

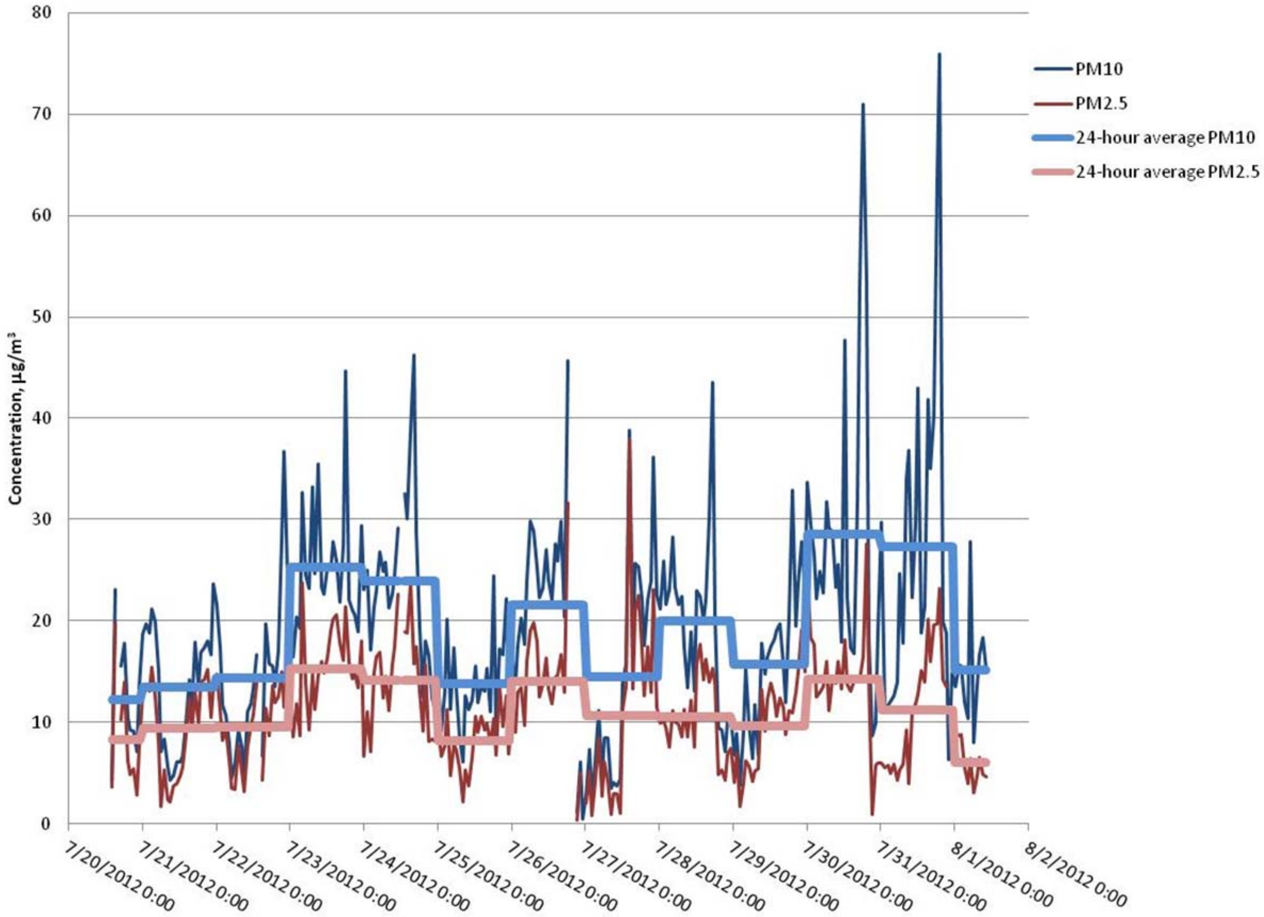


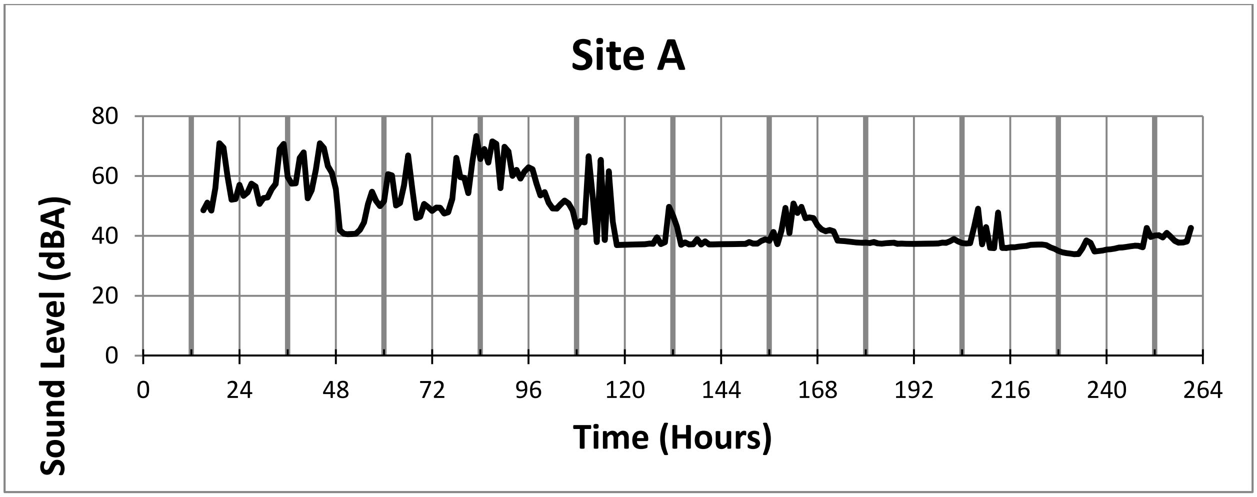
Figure 4.1i. One-hour average PM_{10} and $PM_{2.5}$ concentrations at the Donna pad.

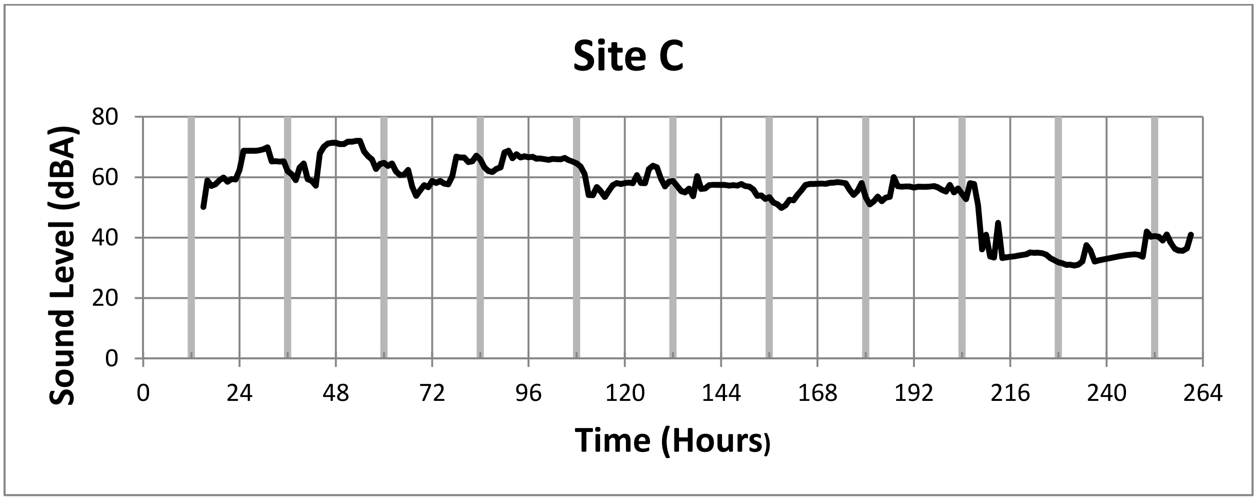
4.1.7.2 Dust Track Results

A software malfunction resulted in loss of Dust Track dust data for this site.

4.1.8 Noise Results

The average noise level was 52 dBA with a standard deviation of 10 for sites A, C and D. Site C which was closest to the road but 625 feet from the center of the pad had the highest continual noise level at 60 with Sites A and D at 49 and 47 dBA respectively. Site B had a failure in the noise monitor.





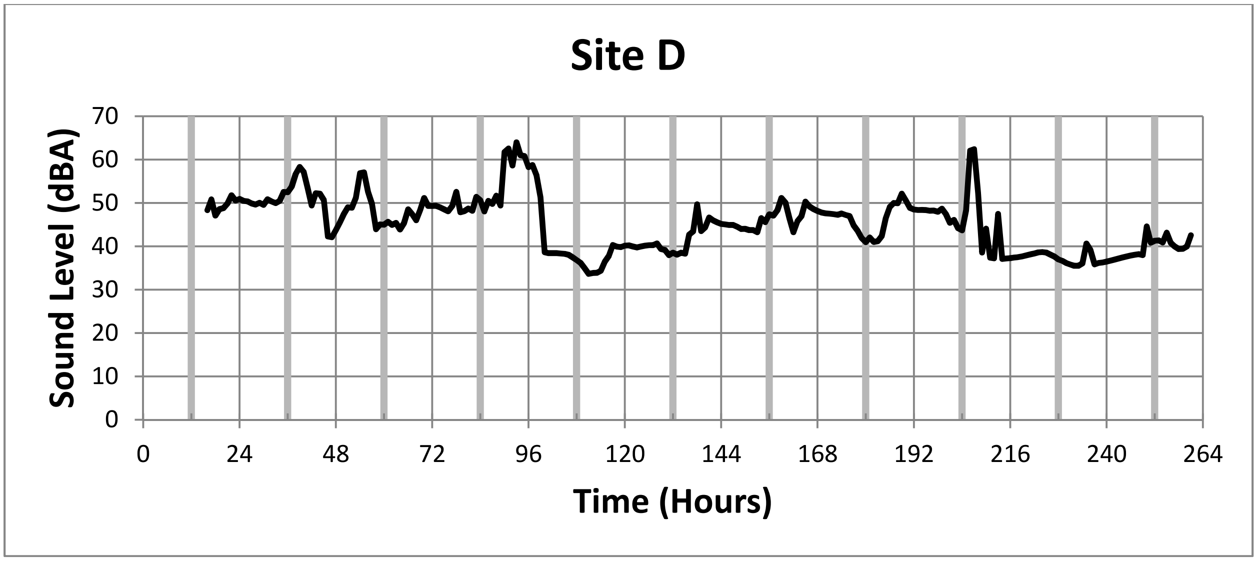


Figure 4.1j. Noise levels for Sites A, C, D at Donna Pad. Hours 0, 24, 48 etc. are midnight. Heavy, vertical lines are noon for each day.

4.1.9 SO2 Results

Data for SO_2 are available for the entire monitoring period, July 21-August 1 (Figure 4.1k). The average concentration of SO_2 at the Donna pad was 3.3ppb, with peaks not exceeding 23ppb. Calculating 1-hour averages from the one-minute data for a more direct comparison with the NAAQS for SO_2 results in a range of 1-hour averages of 1.4ppb – 11.5ppb. Similarly, calculating 3-hour averages from the one-minute data results in a range of 1.9ppb –10.4ppb.

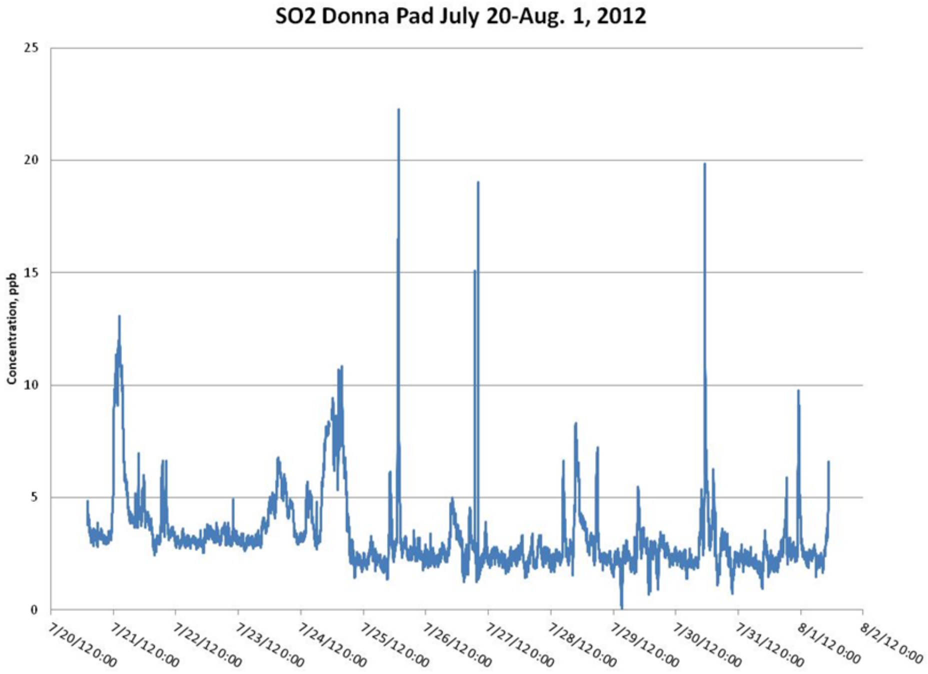


Figure 4.1k. One-minute average SO_2 concentrations .

4.2 Weekley Pad (Flowback)

The laboratory was moved from the Donna pad site to the Weekley pad site near New Martinsville, WV in western Wetzel County on August 2, 2012. The laboratory was located approximately 200m southwest of the well pad in the yard of a nearby resident with coordinates of 39°35'24.94"N, 80°46'44.41"W. The resident's electric service was used to power the laboratory, so the impact of diesel generator emissions does not need to be considered for this location. After unpacking, installing, and calibrating, all instruments were fully operational and collecting data on August 3. Monitoring at this site ended on August 16, 2012. Figure 3 shows a wind rose and histogram for the wind direction and speed during monitoring at the Weekley pad location. Wind speed was typically very low, with calm conditions 82% of the time. When there was wind, it was most frequently blowing from the southwest. At almost all times the laboratory was either monitoring during stagnant conditions or was upwind of the well pad. Figures for other measured meteorological parameters (temperature, relative humidity, rainfall, and solar intensity) are included in **Appendix C.**

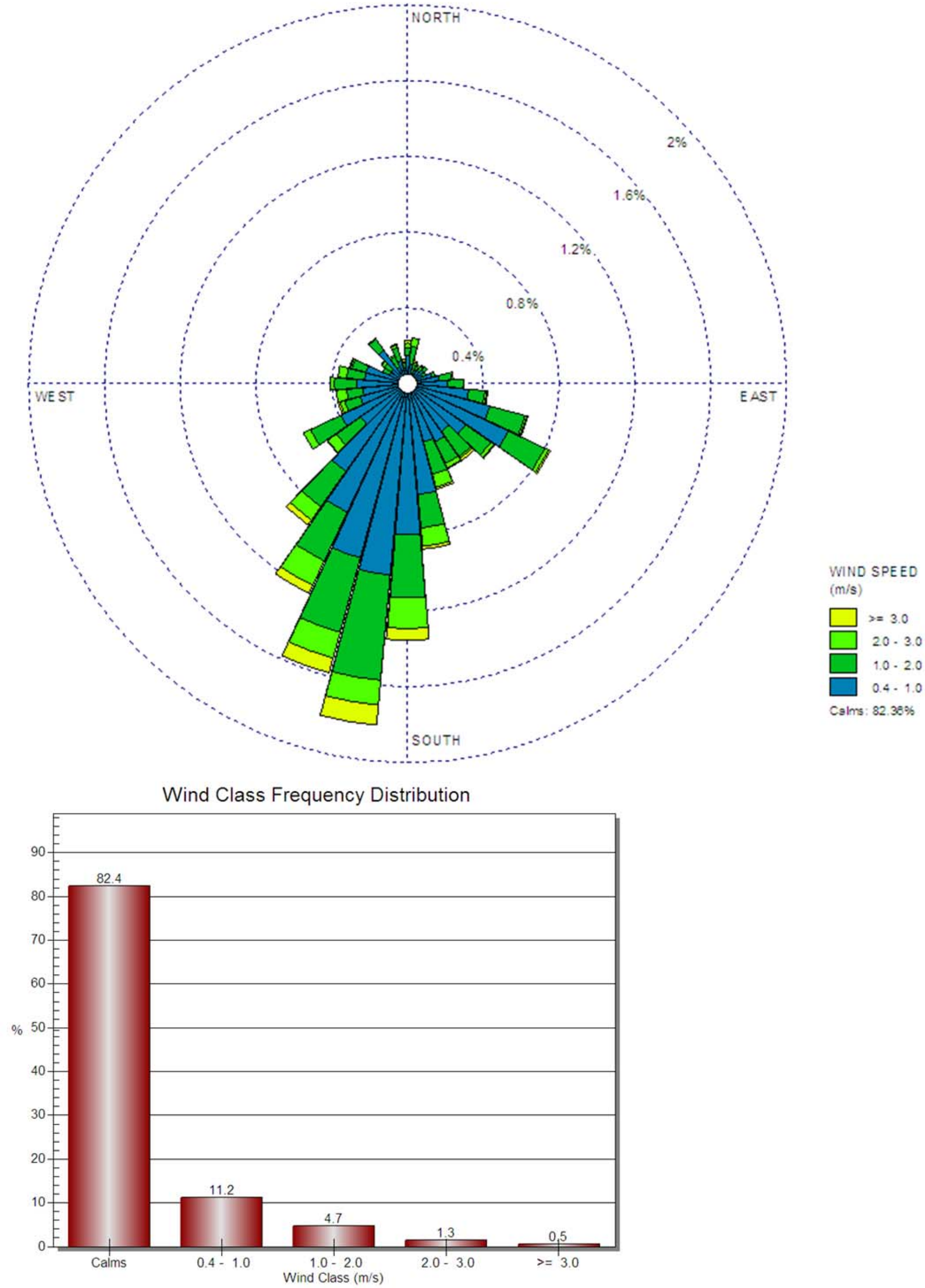


Figure 4.2a. Wind rose and histogram for wind direction and speed during monitoring at the Weekley Pad.

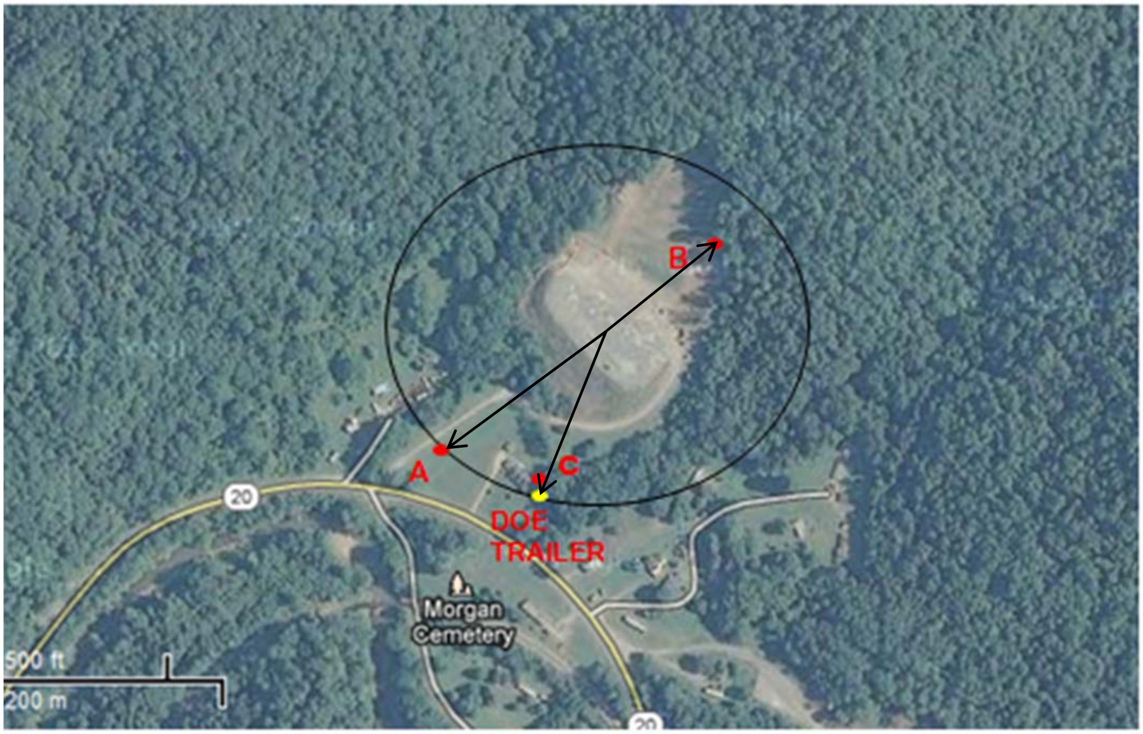


Figure 4.2b. Satellite photo of Weekley pad showing sampling sites (A,B,C) as red dots and location of DOE trailer as yellow dot. Black circle is the 625 foot setback distance.

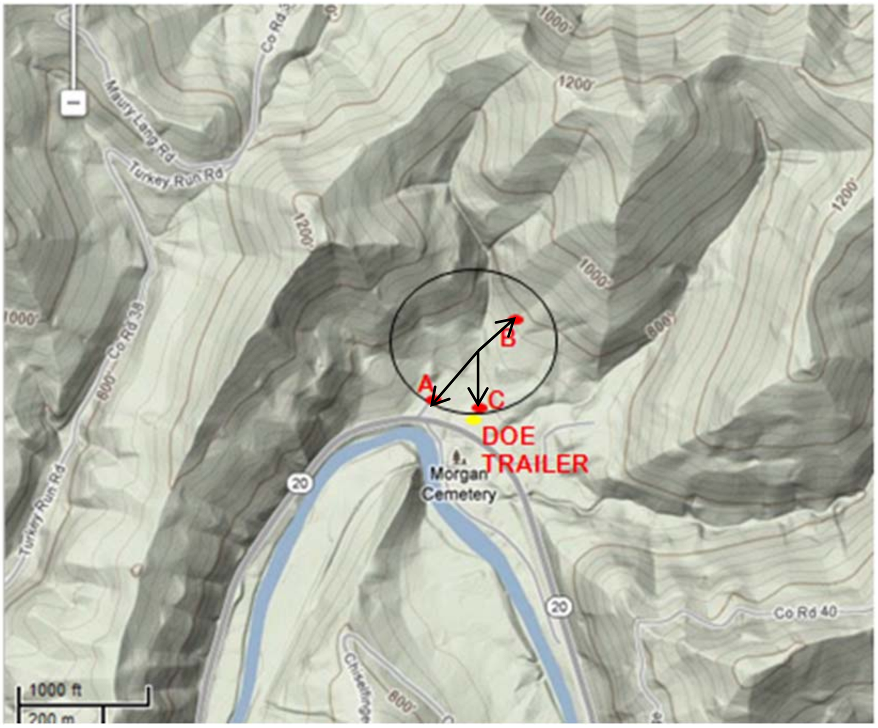


Figure 4.2c Terrain map of Weekley pad showing sampling sites (A,B,C) as red dots and location of DOE trailer as yellow dot. Black circle is the 625 foot setback distance.

4.2.1 HC Results

At the Weekley pad site, there were a total of 274 samples. The analyzer ran continuously from August 3-16, with a break in the data for several hours on August 9 for a scheduled preventative maintenance check by a Perkin Elmer technician.

Table 4.2. GC-FID results

Compound	Average (ppb)	Standard Deviation (ppb)	Minimum (ppb)	Maximum (ppb)	Frequency of Detection (%)
Hexane	6.2	23.9	0.0	375.8	54
Methylcyclopentane	0.4	1.8	0.0	28.1	15
Cyclohexane	0.6	2.5	0.0	36.3	23
2-methylhexane	1.1	4.5	0.0	65.7	23
3-methylhexane	1.1	4.4	0.0	62.1	24
n-heptane	2.3	7.4	0.0	97.9	30
Methylcyclohexane	1.4	4.0	0.0	52.1	30
Toluene	0.7	1.3	0.0	12.1	32
2-methylheptane	0.4	1.5	0.0	15.5	16
3-methylheptane	0.5	1.9	0.0	19.9	17
n-octane	1.0	3.0	0.0	27.6	22
Nonane	0.4	1.4	0.0	11.5	12
Ethane	75.9	199.9	3.3	3,169	100
Propane	71.9	285.1	2.1	4.639	100
Isobutane	20.8	73.3	0.0	1,158	97
n-butane	44.5	199.9	1.0	3,249	100
Isopentane	17.0	24.0	0.0	186	100
n-pentane	19.2	75.6	0.0	1,212	99
2,3-dimethylbutane	0.4	2.3	0.0	35.3	11
2-methylpentane	4.7	15.2	0.0	240	76
3-methylpentane	3.0	9.7	0.0	151	67
Isoprene	6.6	5.2	0.0	23.8	90

4.2.2 Summa Canister HC Results

Only results above the reporting limit (Rpt Limit), that is, the concentration detectable with a statistical certainty are reported.

Client Sample ID: SITE A3

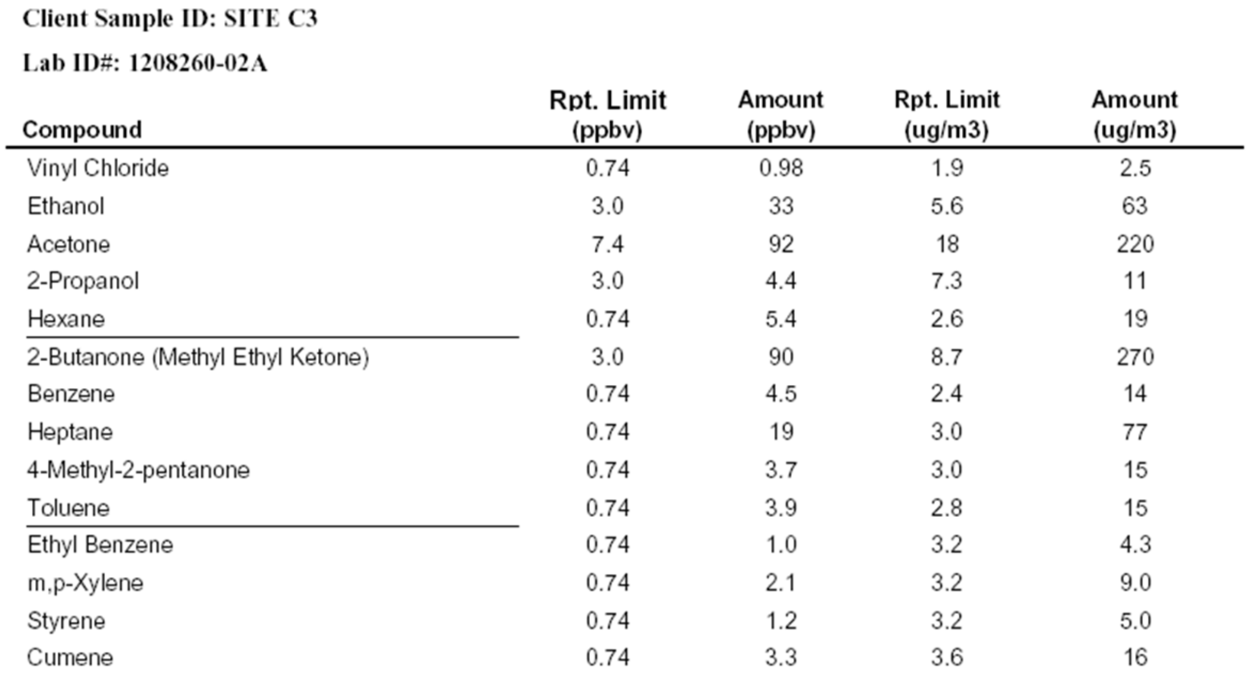
Lab ID#: 1208260-01A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethanol	3.3	47	6.2	88
Acetone	8.3	88	20	210
2-Propanol	3.3	4.5	8.2	11
Hexane	0.83	4.4	2.9	16
2-Butanone (Methyl Ethyl Ketone)	3.3	98	9.8	290
Tetrahydrofuran	0.83	0.89	2.4	2.6
Benzene	0.83	4.2	2.6	13
Heptane	0.83	16	3.4	66
4-Methyl-2-pentanone	0.83	3.9	3.4	16
Toluene	0.83	4.3	3.1	16
Ethyl Benzene	0.83	1.1	3.6	4.7
m,p-Xylene	0.83	2.2	3.6	9.7
Styrene	0.83	1.1	3.5	4.8
Cumene	0.83	3.4	4.1	17

Client Sample ID: SITE B3

Lab ID#: 1208260-03A

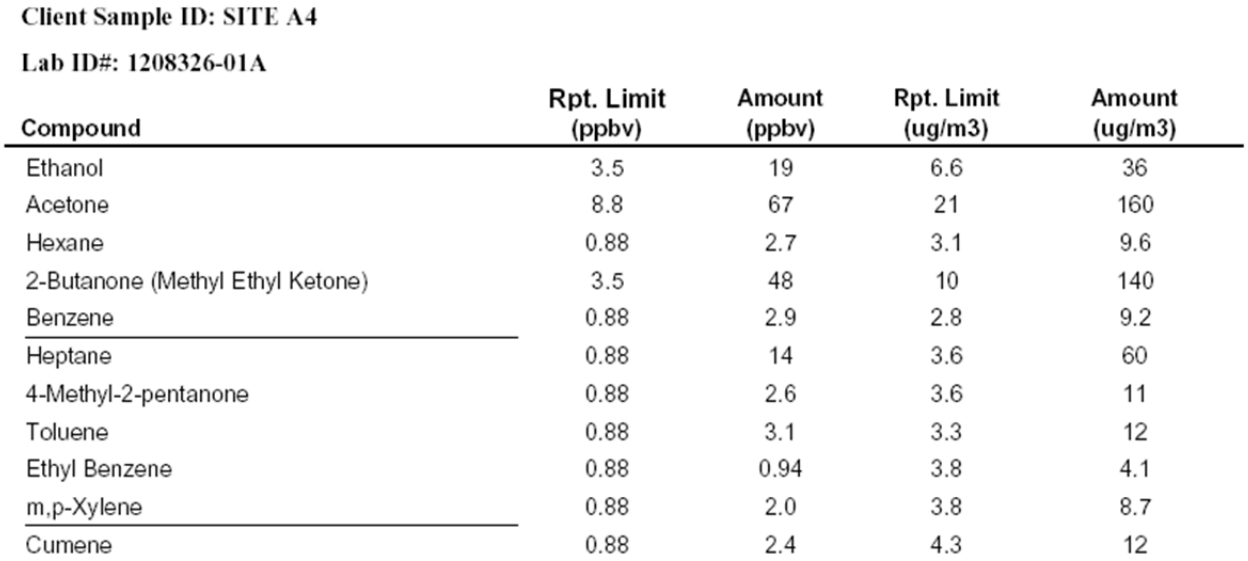
Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Vinyl Chloride	0.95	1.2	2.4	3.0
Ethanol	3.8	41	7.2	77
Acetone	9.5	100	22	250
2-Propanol	3.8	5.9	9.3	14
Hexane	0.95	12	3.3	44
2-Butanone (Methyl Ethyl Ketone)	3.8	91	11	270
Benzene	0.95	8.2	3.0	26
Heptane	0.95	24	3.9	98
4-Methyl-2-pentanone	0.95	3.7	3.9	15
Toluene	0.95	4.6	3.6	17
Ethyl Benzene	0.95	1.2	4.1	5.3
m,p-Xylene	0.95	2.8	4.1	12
Styrene	0.95	1.4	4.0	6.2
Cumene	0.95	2.8	4.7	14



Client Sample ID: SITE C3

Lab ID#: 1208260-02A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Vinyl Chloride	0.74	0.98	1.9	2.5
Ethanol	3.0	33	5.6	63
Acetone	7.4	92	18	220
2-Propanol	3.0	4.4	7.3	11
Hexane	0.74	5.4	2.6	19
2-Butanone (Methyl Ethyl Ketone)	3.0	90	8.7	270
Benzene	0.74	4.5	2.4	14
Heptane	0.74	19	3.0	77
4-Methyl-2-pentanone	0.74	3.7	3.0	15
Toluene	0.74	3.9	2.8	15
Ethyl Benzene	0.74	1.0	3.2	4.3
m,p-Xylene	0.74	2.1	3.2	9.0
Styrene	0.74	1.2	3.2	5.0
Cumene	0.74	3.3	3.6	16



Client Sample ID: SITE A4

Lab ID#: 1208326-01A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethanol	3.5	19	6.6	36
Acetone	8.8	67	21	160
Hexane	0.88	2.7	3.1	9.6
2-Butanone (Methyl Ethyl Ketone)	3.5	48	10	140
Benzene	0.88	2.9	2.8	9.2
Heptane	0.88	14	3.6	60
4-Methyl-2-pentanone	0.88	2.6	3.6	11
Toluene	0.88	3.1	3.3	12
Ethyl Benzene	0.88	0.94	3.8	4.1
m,p-Xylene	0.88	2.0	3.8	8.7
Cumene	0.88	2.4	4.3	12

Client Sample ID: SITE B4

Lab ID#: 1208326-02A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Vinyl Chloride	0.88	1.2	2.2	3.2
Ethanol	3.5	19	6.6	36
Acetone	8.8	79	21	190
Hexane	0.88	6.2	3.1	22
2-Butanone (Methyl Ethyl Ketone)	3.5	47	10	140
Benzene	0.88	3.9	2.8	12
Heptane	0.88	19	3.6	79
4-Methyl-2-pentanone	0.88	2.0	3.6	8.3
Toluene	0.88	2.6	3.3	9.9
m,p-Xylene	0.88	2.0	3.8	8.9
Cumene	0.88	1.8	4.3	8.8

Client Sample ID: SITE C4

Lab ID#: 1208326-03A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Vinyl Chloride	0.70	0.79	1.8	2.0
Ethanol	2.8	13	5.3	25
Acetone	7.0	51	17	120
Hexane	0.70	2.6	2.5	9.0
2-Butanone (Methyl Ethyl Ketone)	2.8	33	8.3	98
Benzene	0.70	1.7	2.2	5.6
Heptane	0.70	13	2.9	54
4-Methyl-2-pentanone	0.70	1.3	2.9	5.2
Toluene	0.70	1.7	2.6	6.4
m,p-Xylene	0.70	0.99	3.1	4.3
Cumene	0.70	1.3	3.5	6.4

4.2.2.1 PID Results

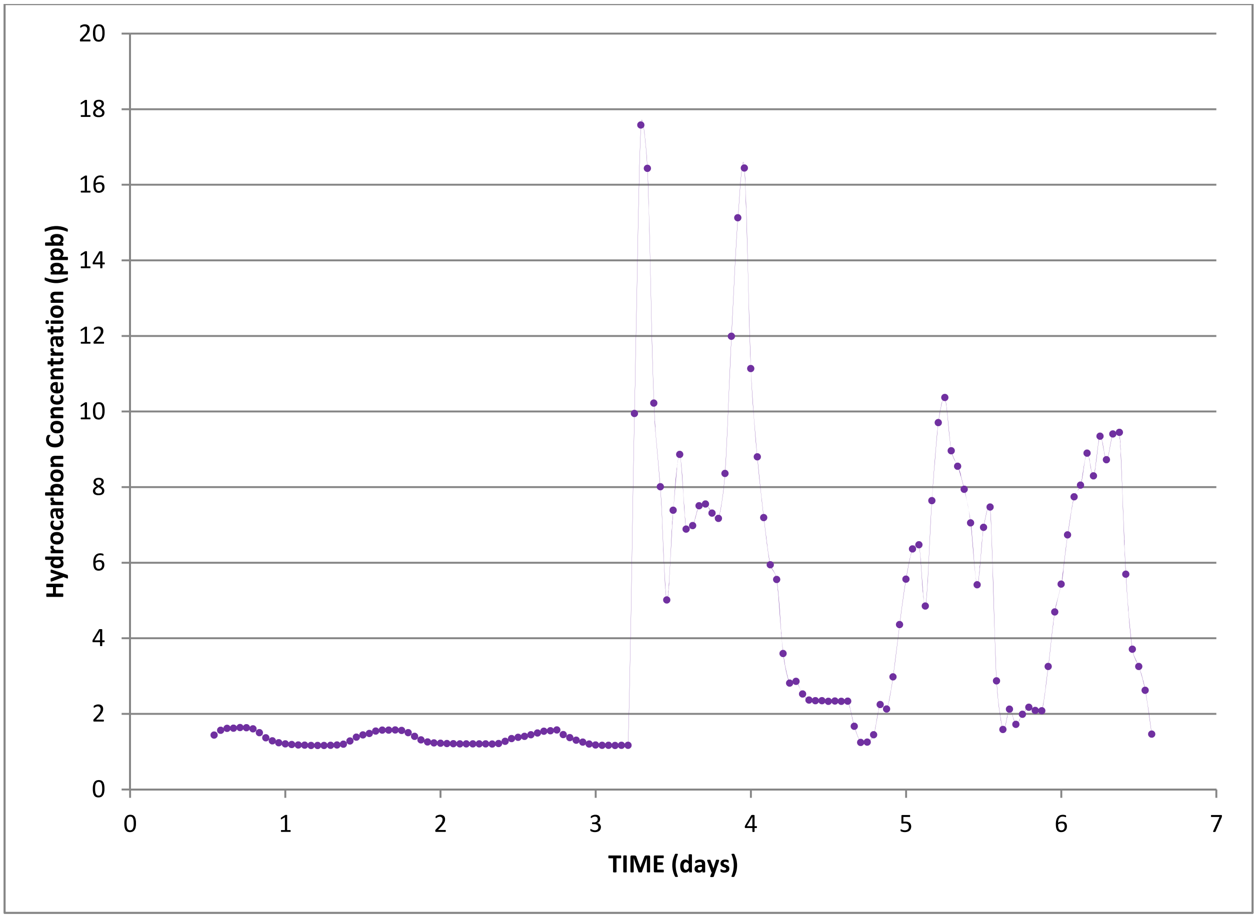


Figure 4.2.2a. Results for Site C for 8/7-13/2012.

Instrument malfunctions occurred at sites A and B resulting in loss of data for those sites for the PID.

4.2.3 Ozone Results

Ozone data are available for the entire monitoring period at this site, August 3-16 (Figure 4.2d). The average ozone concentration using one minute data at the Weekley pad was 30ppb, and the maximum hourly average concentration was 91ppb. Day-to-night variations ranged from 20-85ppb. Calculating 8-hour averages to more directly compare to the NAAQS results in a range of 8-hour averages of 4ppb – 78ppb.

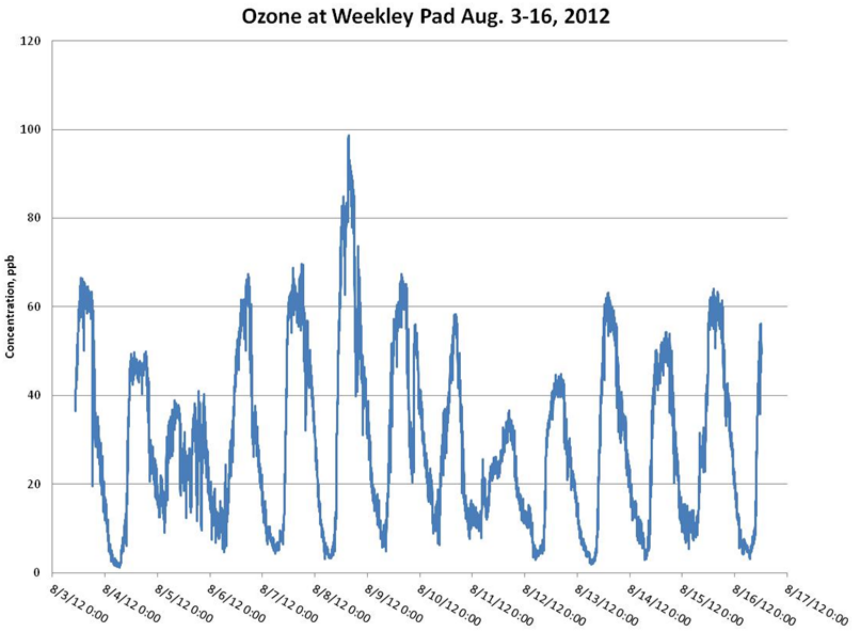


Figure 4.2d. One-minute average ozone concentrations at the Weekley pad.

4.2.4 NOx Results

Data for NO_x are available for the entire monitoring period at the Weekley pad site, August 3-16 (Figure 4.2e). The average of the one-minute NO_x concentration measurements was 3.4ppb, with an hourly average maximum of 12ppb.

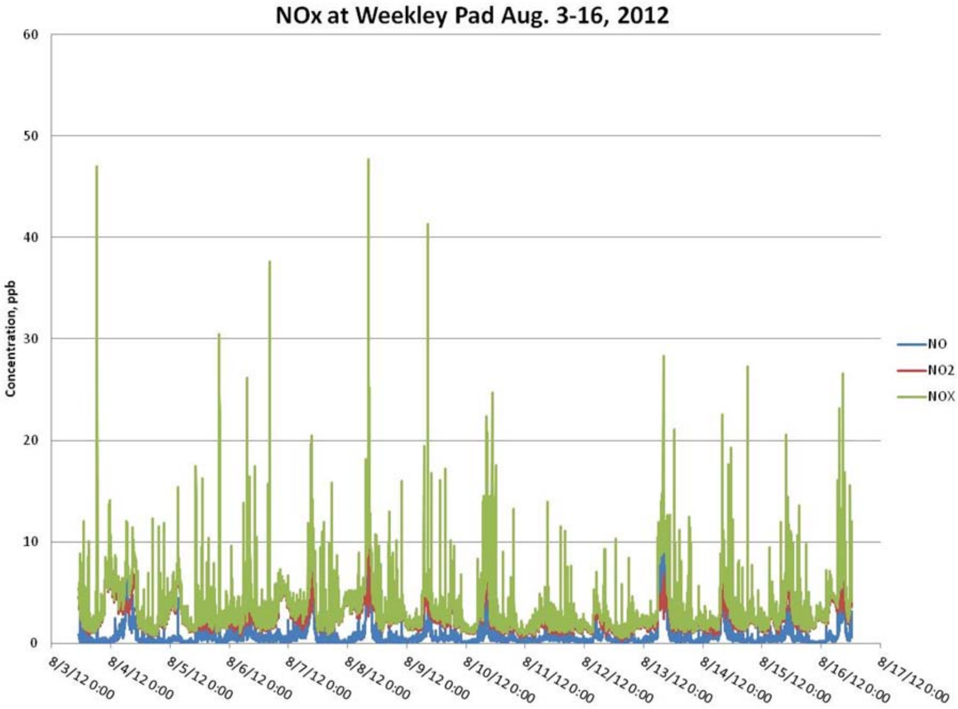


Figure 4.2e. One-minute average NO_x concentrations at the Weekley pad.

4.2.5 Methane Results

The ambient methane concentration at the Weekley Pad averaged 2.0ppm (±0.1ppm) with an average isotopic composition of -51.1‰ (±1.3‰) which are typical background atmospheric values (Figures 4.2f and g). During a period beginning at approximately 8/3/2012 1:30 a.m. to approximately 8:30 a.m. the methane concentration averaged 9.7ppm with an average $\delta^{13}C$ value of -39.2‰. The maximum concentration and most depleted isotopic signature were observed during this time (82.6 ppm and -36.9‰, respectively). The elevated methane concentrations together with more enriched $\delta^{13}C$ values indicate a significant contribution from a thermogenic methane source during this time. For the remainder of the monitoring period at this site, the methane concentration was near ambient levels, exceeding 5ppm on only two occasions.

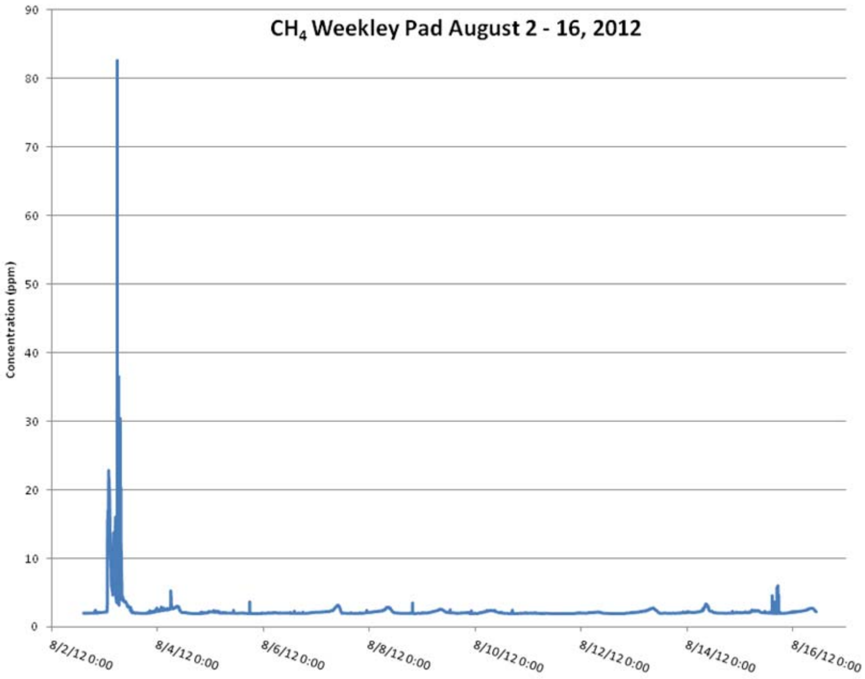


Figure 4.2f. One-minute average CH_4 concentrations at the Weekley pad.

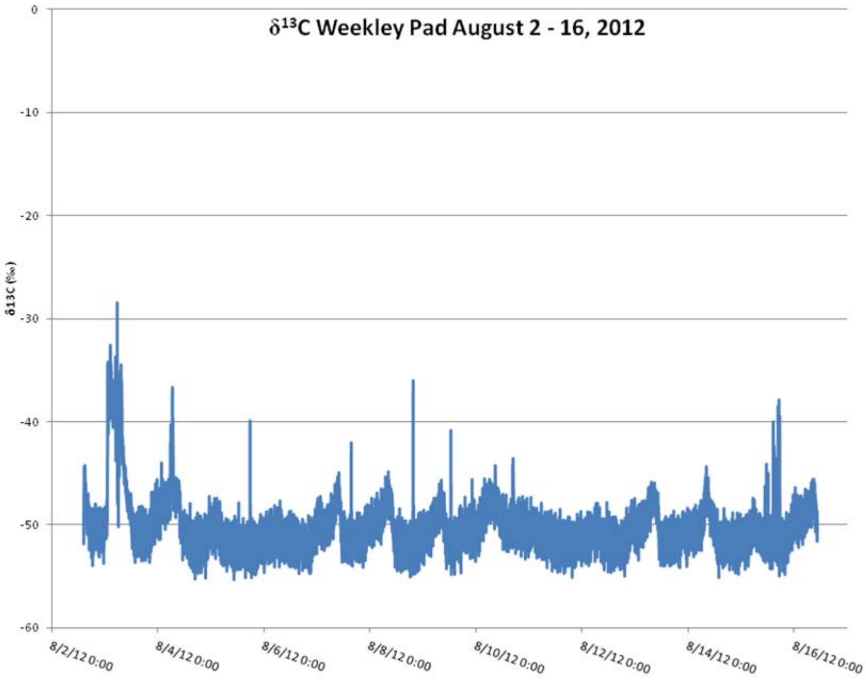


Figure 4.2g. One-minute average $\delta^{13}C$ of CH_4 at the Weekley pad.

4.2.6 CO2 Results

Over the two weeks of monitoring at the Weekley pad site, the CO_2 concentration averaged 405ppm (±27ppm) with $\delta^{13}C$ averaging -12.1‰ (±1.4‰) (Figure 4.2h). The maximum CO_2 concentration at the site was 478ppm with a corresponding $\delta^{13}C$ value of -13.9‰. The CO_2 concentrations and $\delta^{13}C$ values at the site cycled daily. Starting at approximately 8pm, the CO_2 concentration increased sharply to values occasionally greater than 450ppm before dropping back to near ambient levels by 7am. During these times, the corresponding $\delta^{13}C$ values become more depleted, approaching -14‰.

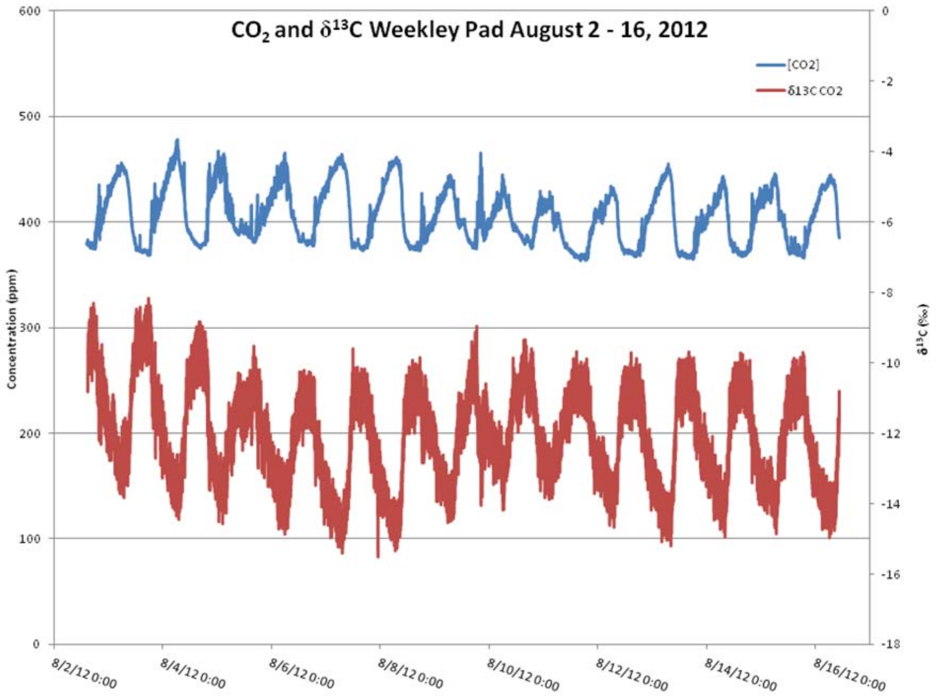


Figure 4.2h. One-minute average CO_2 concentrations and $\delta^{13}C$ of CO_2 at the Weekley pad.

4.2.7 Dust Results

Data are available for August 2-16 (Figure 4.2i-k). At the Weekley pad, Average PM_{10} concentration was 18μg/m^3 and average $PM_{2.5}$ concentration was 12μg/m^3. Maximum one-hour average concentrations of PM_{10} and $PM_{2.5}$ were 109μg/m^3 and 31μg/m^3, respectively.

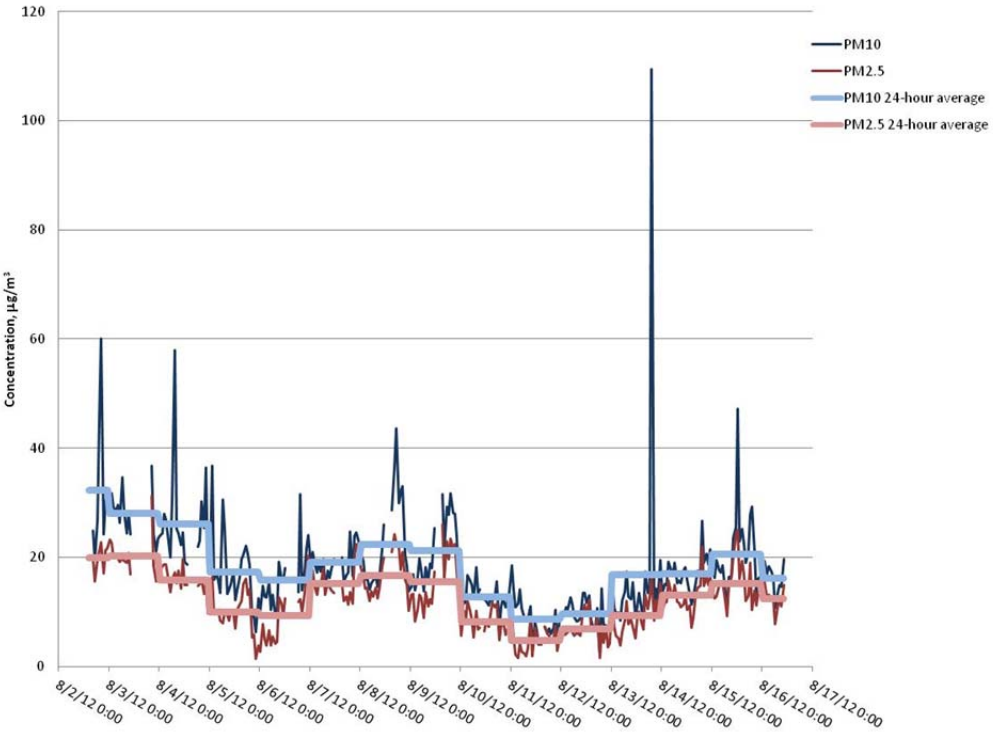


Figure 4.2i. One-hour average PM_{10} and $PM_{2.5}$ concentrations at the Weekley pad from TEOM.

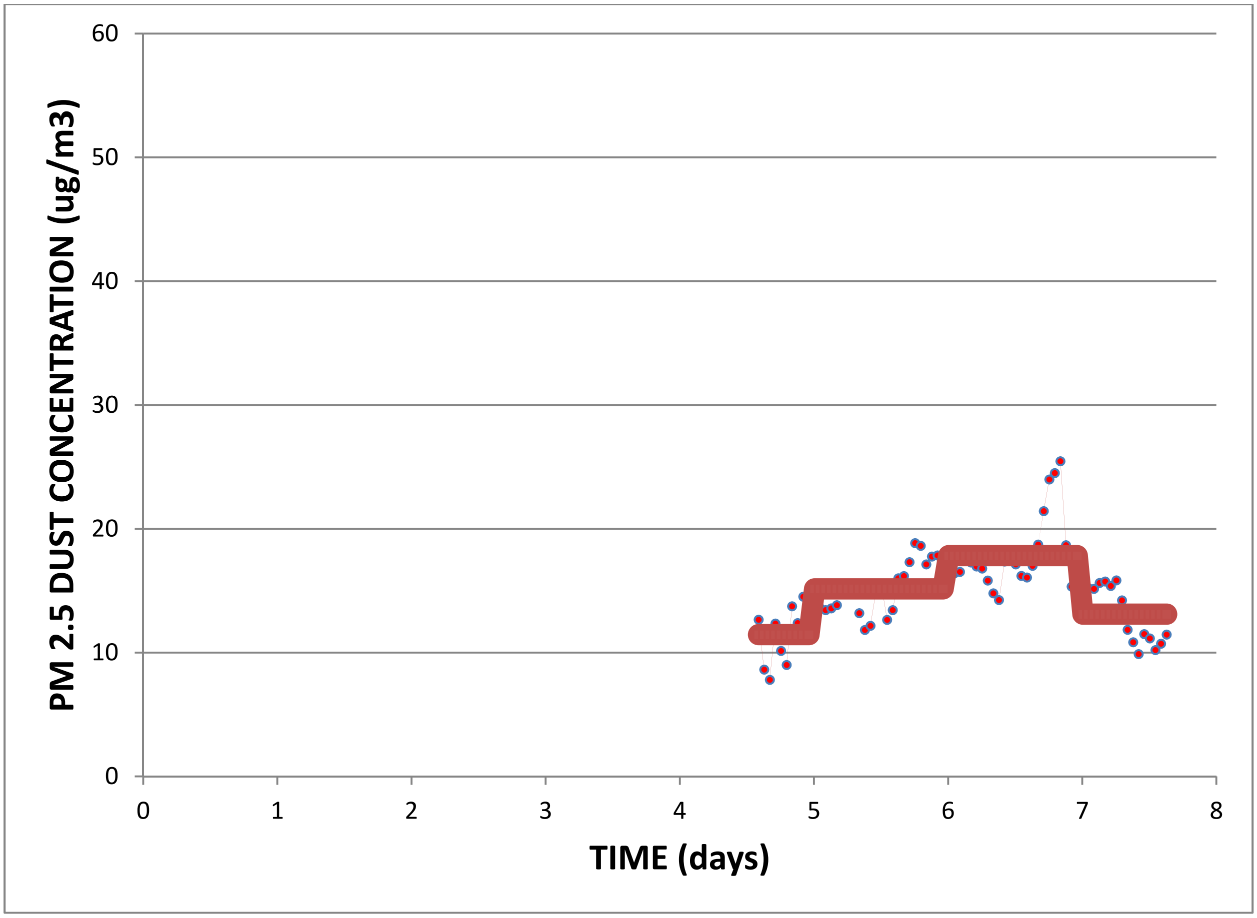


Figure 4.2j.WEEKLEY PM 2.5 Dust Track 8/6-13/2012 data for Site A, with hourly data points and 24 hour averages represented as bar lines.

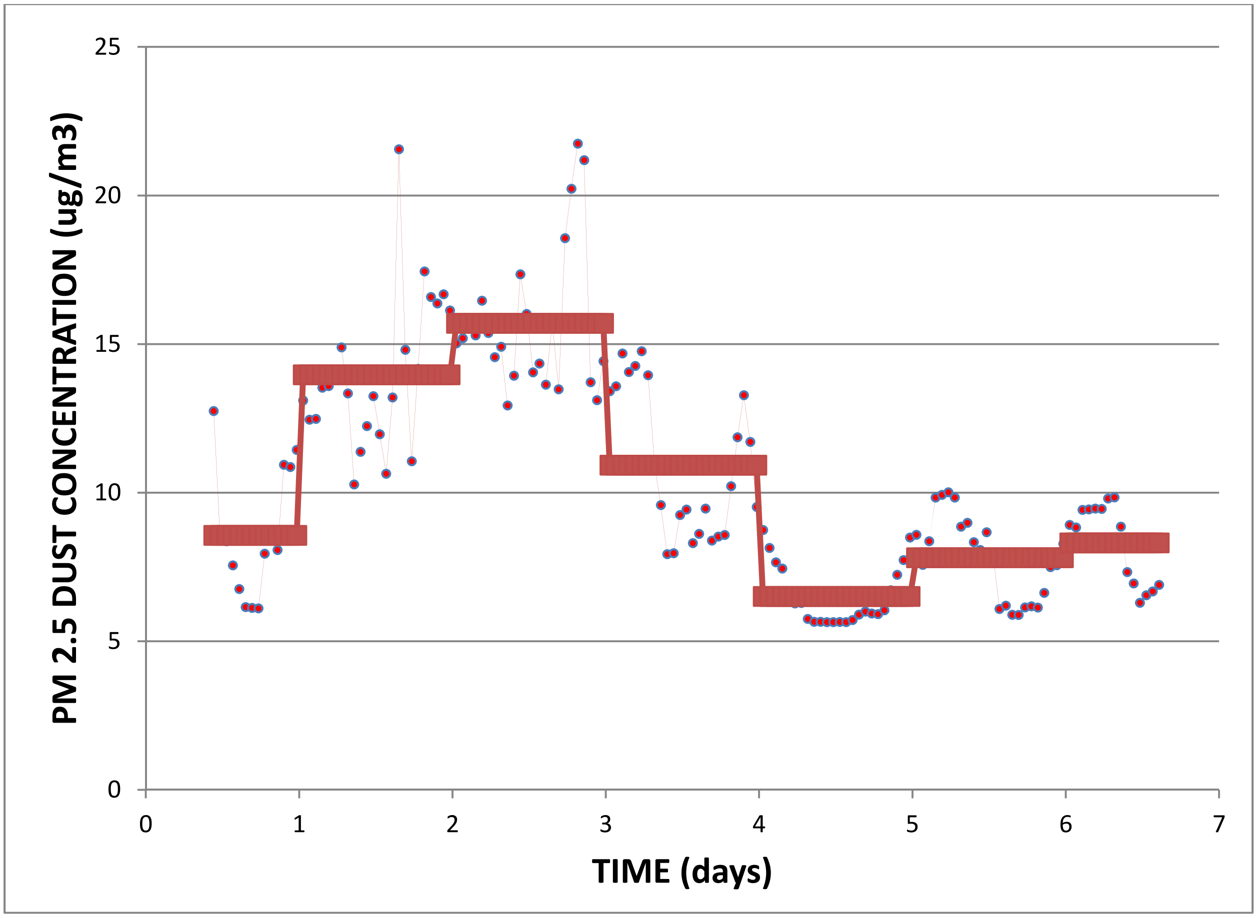


Figure 4.2k. WEEKLEY PM 2.5 Dust Track 8/6-13/2012 data for Site C, with hourly data points and 24 hour averages represented as bar lines.

4.2.8 SO2 Results

Data for SO_2 are available for the entire monitoring period, August 3-16 (Figure 4.2l). The average concentration of SO_2 at the Weekley pad was 2.7ppb, with peaks not exceeding 27ppb. Calculating 1-hour averages from the one-minute data for a more direct comparison with the NAAQS for SO_2 results in a range of 1-hour averages of 0.7ppb – 16.4ppb. Similarly, calculating 3-hour averages from the one-minute data results in a range of 1.1ppb –12.4ppb.

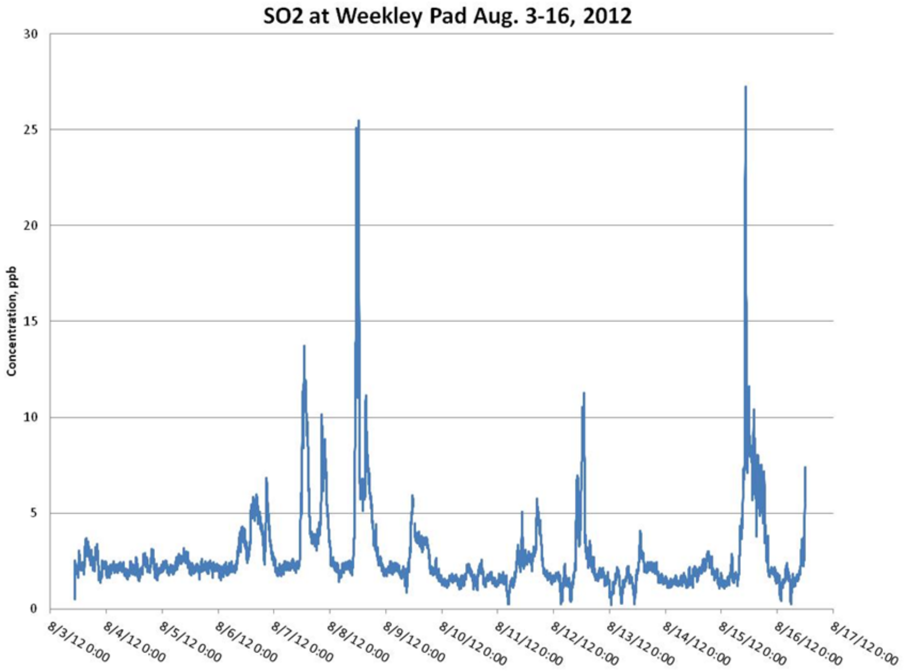
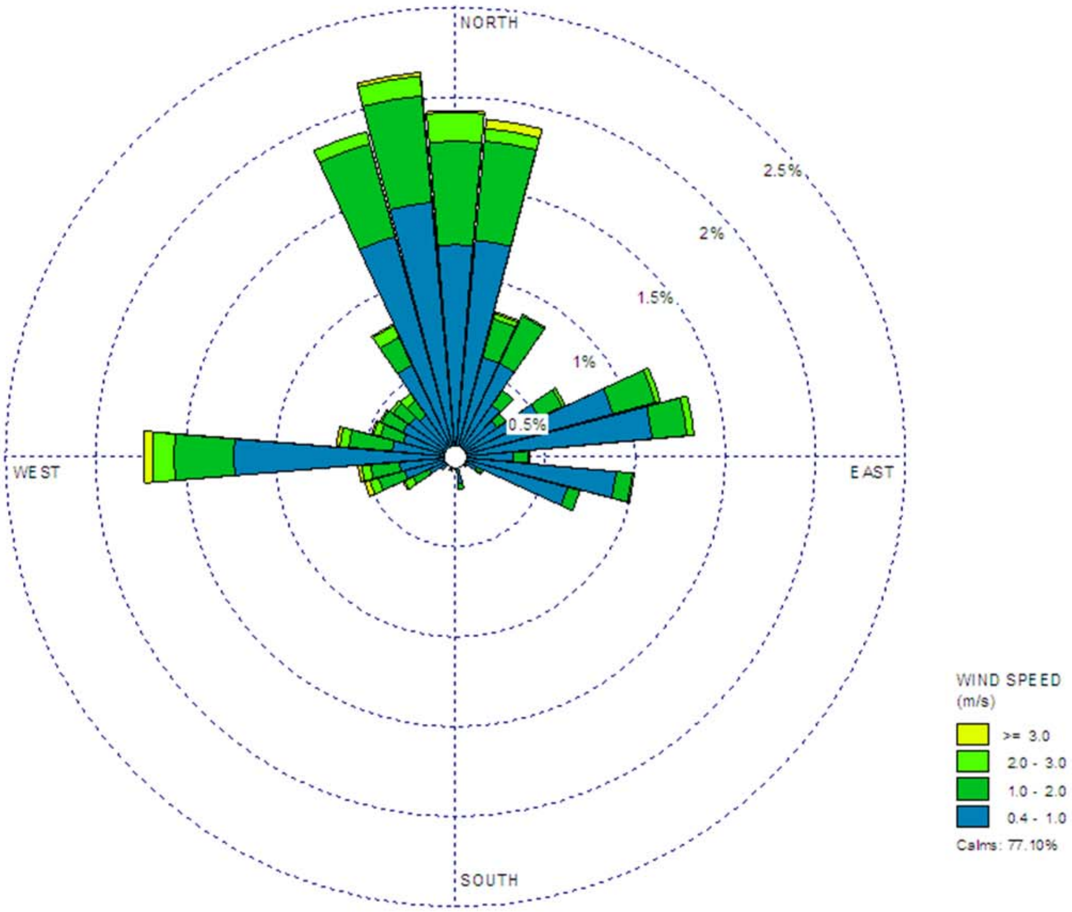


Figure 4.2l. One minute average SO2 data for Weekley Pad.

4.3 Mills Wetzel pad #2 (Purported Vertical Drilling – Site Inactive During Sampling except for Truck Traffic and Construction)

The mobile air monitoring laboratory was moved to the Mills Wetzel pad #2 site in southern Wetzel County on August 16, 2012. The laboratory was located approximately 190m southwest of the well pad on the side of a gravel well pad access road with coordinates of 39°31'16.34"N, 80°39'24.82"W. As there was no available electric service at this site, the laboratory was operated using a diesel fuel-powered generator provided by Stone Energy. The generator was approximately 21m from the laboratory in the approximate direction of the well pad and therefore its emissions may have mixed with emissions coming from the well pad as measured by the monitoring equipment. Also, earth-moving equipment was in use for pipeline construction less than 100m from the laboratory. After unpacking, installing, and calibrating, all instruments were fully operational and collecting data on August 17. Monitoring at this site ended on August 24, 2012. Figure 4 shows a wind rose and histogram for the wind direction and speed during monitoring at the Mills-Wetzel pad #2 location. Wind speed was typically very low, with calm conditions 77% of the time. When there was wind, it was most frequently blowing from the north and sometimes from directly west. At almost all times the laboratory was either monitoring during stagnant conditions or was upwind of the well pad. Figures for other measured meteorological parameters (temperature, relative humidity, rainfall, and solar intensity) are included in **Appendix C**.


NORTH
2.5%
2%
1.5%
1%
0.5%
WEST
EAST
SOUTH
WIND SPEED
(m/s)
>= 3.0
2.0 - 3.0
1.0 - 2.0
0.4 - 1.0
Calms: 77.10%

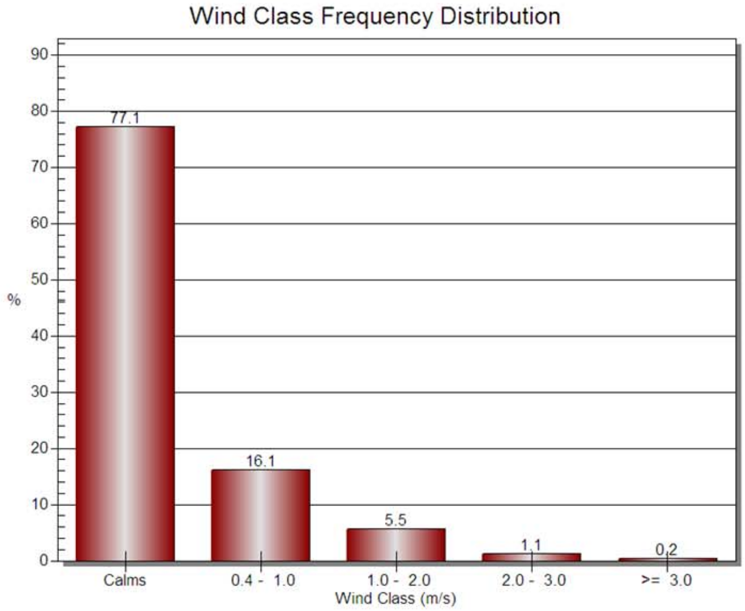

Wind Class Frequency Distribution
90
80
70
60
50
40
30
20
10
0
%
77.1
16.1
5.5
1.1
0.2
Calms
0.4 - 1.0
1.0 - 2.0
2.0 - 3.0
>= 3.0
Wind Class (m/s)

Figure 4.3a. Wind rose and histogram for wind direction and speed during monitoring at the Mills-Wetzel pad #2.

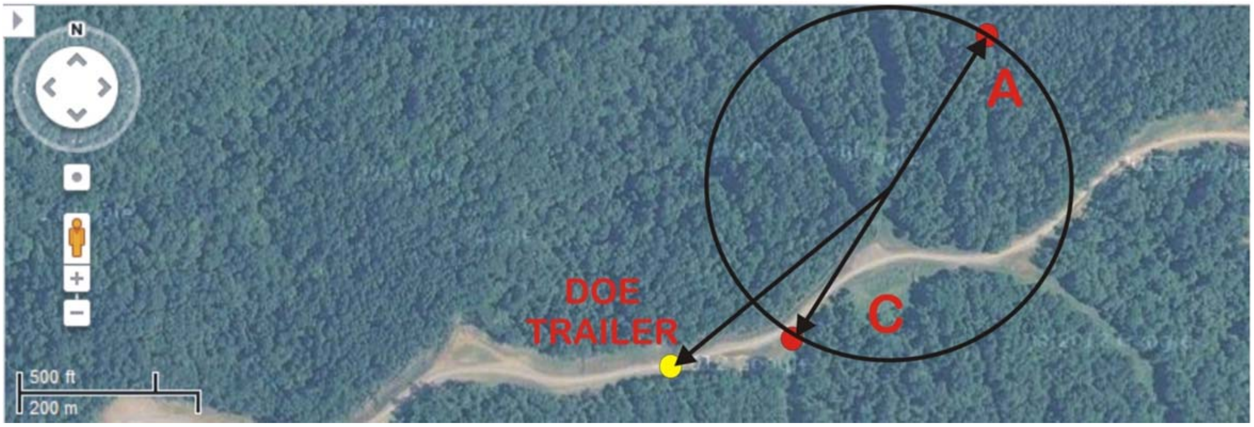


Figure 4.3b. Satellite photo of Mills Wetzel 2 pad showing sampling sites (A,B,C) as red dots and location of DOE trailer as yellow dot. Black circle is the 625 foot setback distance.

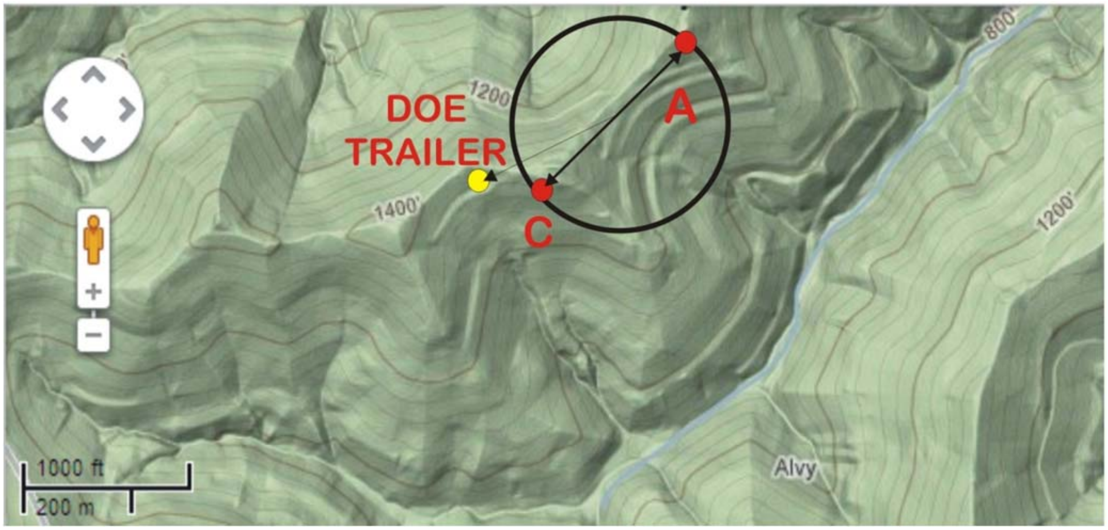


Fig 4.3c. Terrain map of Mills Wetzel 2 pad showing sampling sites (A,B,C) as red dots and location of DOE trailer as yellow dot. Black circle is the 625 foot setback distance.

4.3.1 HC Results

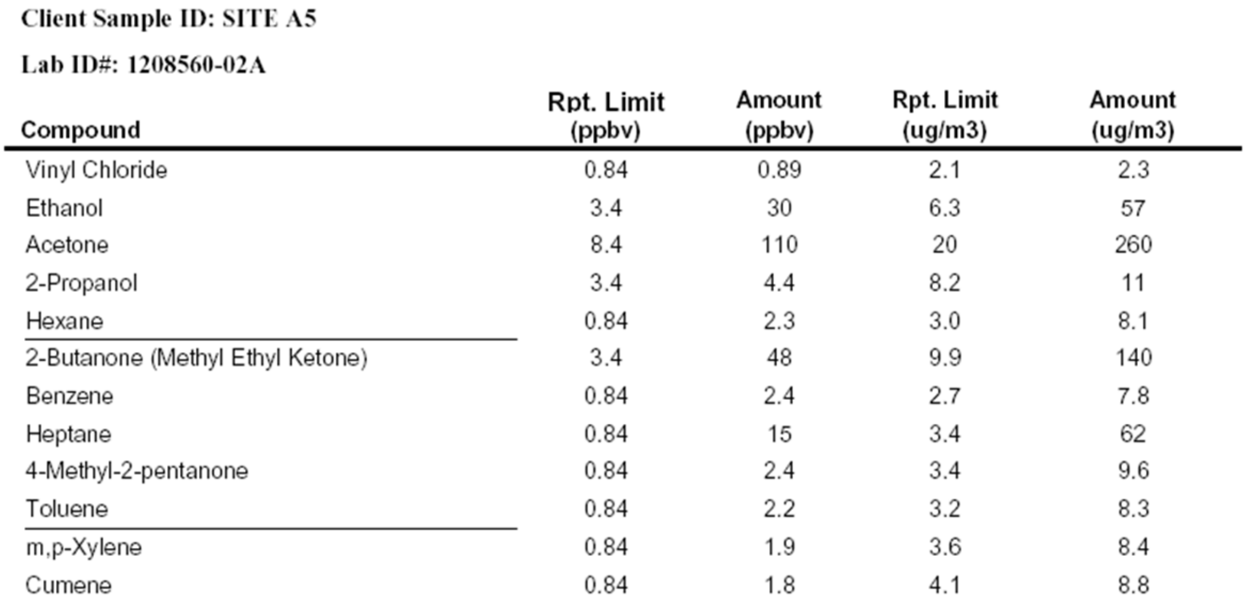
At this site the analyzer ran continuously for the entire monitoring period from August 17-24 for a total of 144 samples.

Table 4.3 GC-FID HC results

Compound	Average (ppb)	Standard Deviation (ppb)	Minimum (ppb)	Maximum (ppb)	Frequency of Detection (%)
Hexane	1.8	2.6	0.0	13.0	56
n-heptane	0.4	0.9	0.0	5.4	22
Methylcyclohexane	0.5	1.0	0.0	5.8	24
Toluene	1.0	1.6	0.0	10.7	44
Ethane	56.2	43.1	7.8	271.7	100
Ethylene	0.6	1.1	0	6.1	34
Propane	33.4	27.0	6.3	168.8	100
Isobutane	9.0	6.9	1.1	40.7	100
n-butane	16.3	13.1	3.9	79.5	100
Isopentane	10.9	10.1	2.1	68.7	100
n-pentane	7.6	6.7	0.7	40.3	100
2-methylpentane	2.2	2.4	0.0	13.1	69
3-methylpentane	1.2	1.8	0.0	9.2	46
Isoprene	5.2	4.7	0.0	21.4	68

4.3.2 Summa Canister HC Results

Only results above the reporting limit (Rpt Limit), that is, the concentration detectable with a statistical certainty are reported.



Client Sample ID: SITE A5

Lab ID#: 1208560-02A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Vinyl Chloride	0.84	0.89	2.1	2.3
Ethanol	3.4	30	6.3	57
Acetone	8.4	110	20	260
2-Propanol	3.4	4.4	8.2	11
Hexane	0.84	2.3	3.0	8.1
2-Butanone (Methyl Ethyl Ketone)	3.4	48	9.9	140
Benzene	0.84	2.4	2.7	7.8
Heptane	0.84	15	3.4	62
4-Methyl-2-pentanone	0.84	2.4	3.4	9.6
Toluene	0.84	2.2	3.2	8.3
m,p-Xylene	0.84	1.9	3.6	8.4
Cumene	0.84	1.8	4.1	8.8

Client Sample ID: SITE C5

Lab ID#: 1208560-01A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Vinyl Chloride	0.80	0.93	2.0	2.4
Ethanol	3.2	34	6.1	65
Acetone	8.0	130	19	310
2-Propanol	3.2	5.1	7.9	12
Hexane	0.80	2.8	2.8	10
2-Butanone (Methyl Ethyl Ketone)	3.2	54	9.5	160
Benzene	0.80	3.0	2.6	9.7
Heptane	0.80	20	3.3	80
4-Methyl-2-pentanone	0.80	2.4	3.3	9.8
Toluene	0.80	2.3	3.0	8.6
m,p-Xylene	0.80	1.8	3.5	8.0
Cumene	0.80	1.4	4.0	6.7

Client Sample ID: SITE A6

Lab ID#: 1208560-04A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethanol	3.7	42	7.0	80
Acetone	9.4	140	22	350
2-Propanol	3.7	27	9.2	67
Hexane	0.94	3.0	3.3	10
2-Butanone (Methyl Ethyl Ketone)	3.7	44	11	130
Benzene	0.94	2.1	3.0	6.7
Heptane	0.94	16	3.8	65
4-Methyl-2-pentanone	0.94	2.9	3.8	12
Toluene	0.94	14	3.5	54
Ethyl Benzene	0.94	1.3	4.0	5.6
m,p-Xylene	0.94	5.9	4.1	26
o-Xylene	0.94	2.9	4.1	13
Styrene	0.94	1.1	4.0	4.6
Cumene	0.94	2.9	4.6	14
1,2-Dichlorobenzene	0.94	2.4	5.6	14

Client Sample ID: SITE C6

Lab ID#: 1208560-03A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Vinyl Chloride	1.2	1.3	3.0	3.3
Ethanol	4.7	26	8.9	49
Acetone	12	160	28	380
Hexane	1.2	3.3	4.2	12
2-Butanone (Methyl Ethyl Ketone)	4.7	56	14	160
Benzene	1.2	2.4	3.8	7.7
Heptane	1.2	22	4.8	88
4-Methyl-2-pentanone	1.2	2.0	4.8	8.3
Toluene	1.2	2.0	4.4	7.6
m,p-Xylene	1.2	2.1	5.1	9.0
Cumene	1.2	1.4	5.8	7.0

4.3.3 Ozone Results

Ozone data are available for the entire monitoring period at this site, August 17-24 (Figure 4.3 d). The average ozone concentration using one minute data at the Mills-Wetzel pad #2 was 46ppb, and the maximum hourly average concentration was 71ppb. Day-to-night variations were as high as 60ppb. Calculating 8-hour averages to more directly compare to the NAAQS results in a range of 8-hour averages of 20ppb – 67ppb.

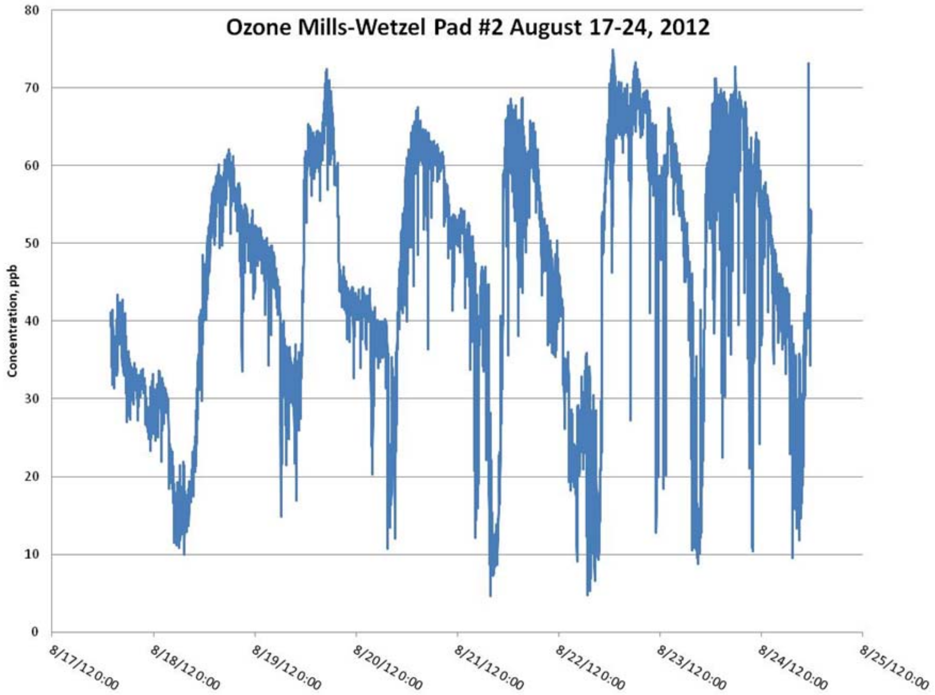


Figure 4.3d. One-minute average ozone concentrations at the Mills-Wetzel pad #2.

4.3.4 NOx Results

Data for NO_x are available for the entire monitoring period at the Mills-Wetzel pad site, August 17-24 (Figure 4.3e). The average of the one-minute NO_x concentration measurements was 7ppb with an hourly average maximum of 38ppb.

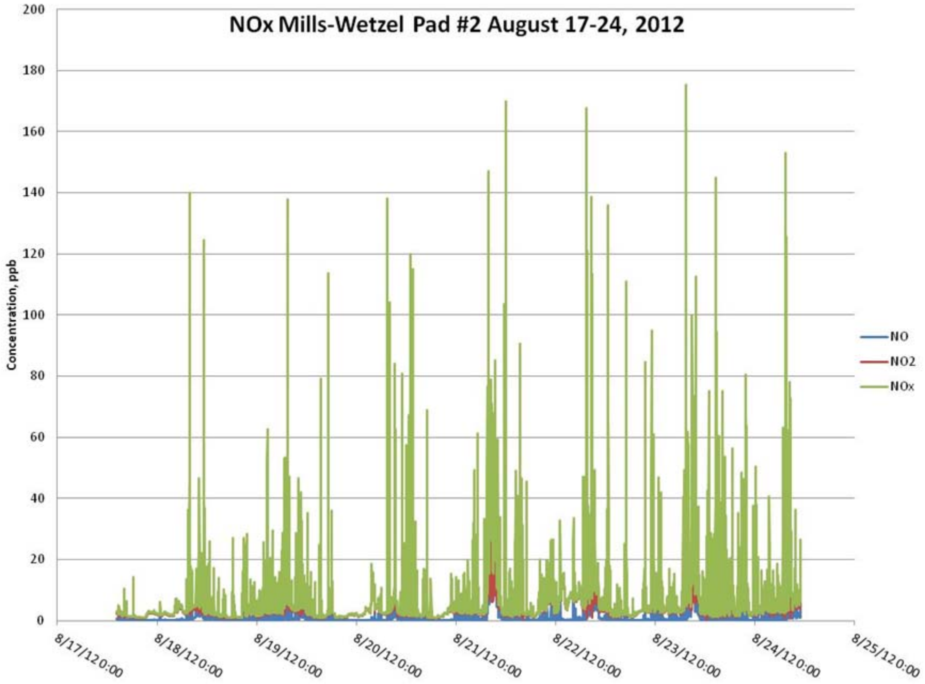


Figure 4.3e. One-minute average NO_x concentrations at the Mills-Wetzel pad #2.

4.3.5 Methane Results

The ambient methane concentration at the Mills-Wetzel pad #2 site averaged 2.0ppm (±0.1) with an average isotopic composition of -46.8‰ (±1.2‰) which are typical background atmospheric values (Figures 4.3f and g). For the duration of the one week monitoring period at this site, the methane concentration was near ambient levels, exceeding 4ppm on only two occasions. The maximum observed methane concentration was 4.6ppm with a $\delta^{13}C$ value of -46.0‰, indicating a very minor contribution from a thermogenic source.

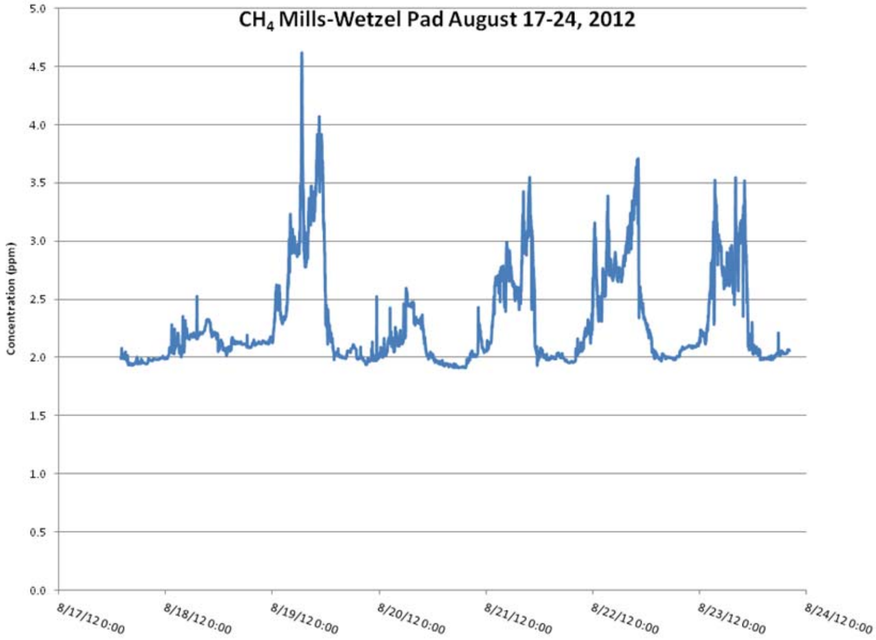


Figure 4.3f. One-minute average CH_4 concentrations at the Mills-Wetzel pad.

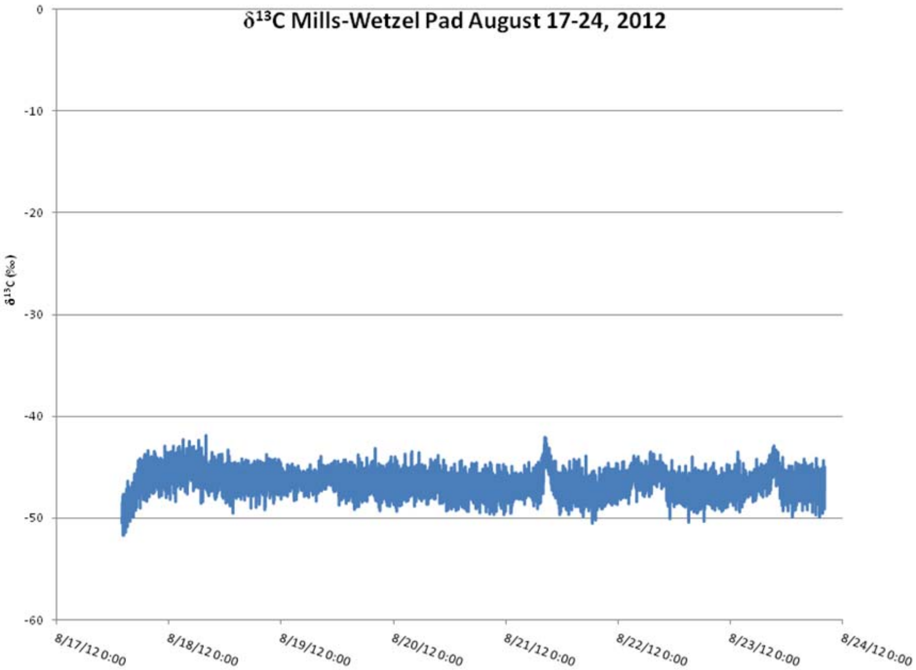


Figure 4.3g. One-minute average $\delta^{13}C$ of CH_4 at the Mills-Wetzel pad.

4.3.6 CO2 Results

Over the one week of monitoring at the Mills Wetzel pad #2 site, the CO_2 concentration averaged 384ppm (±13ppm) with $\delta^{13}C$ averaging -10.8‰ (±1.0‰) (Figure 4.3h). The maximum CO_2 concentration at the site was 509ppm with a corresponding $\delta^{13}C$ value of -14.8‰. The CO_2 concentrations and $\delta^{13}C$ values at the site cycled daily. Starting at approximately 8pm, the CO_2 concentration increased gradually to values occasionally greater than 410ppm before dropping back to near ambient levels by 7am. During these times, the corresponding $\delta^{13}C$ values become more depleted, approaching -12‰.

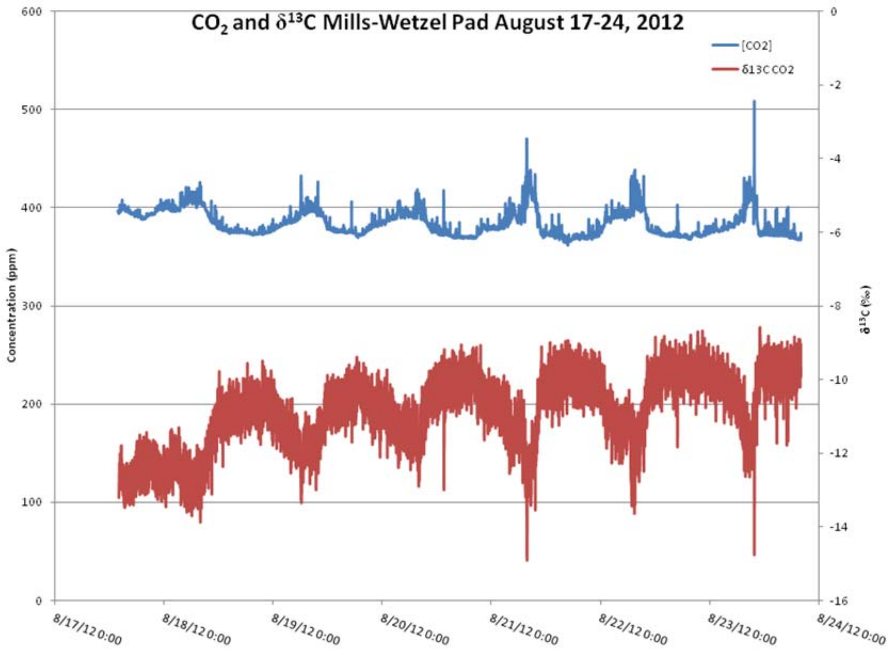


Figure 4.3h. One-minute average CO_2 concentrations and $\delta^{13}C$ of CO_2 at the Mills-Wetzel pad.

4.3.7 TEOM (Dust) Results

Data are available for August 17-24 (Figure 4.3i-k). At the Mills-Wetzel pad, Average PM_{10} concentration was 30μg/m^3 and average $PM_{2.5}$ concentration was 12μg/m^3. Maximum one-hour average concentrations of PM_{10} and $PM_{2.5}$ were 546μg/m^3 and 36μg/m^3, respectively. The substantial peaks in PM_{10} concentration at this site were likely due to the mobile air monitoring laboratory's position on the side of a gravel well pad access road as well as the nearby earth-moving activity for pipeline construction.

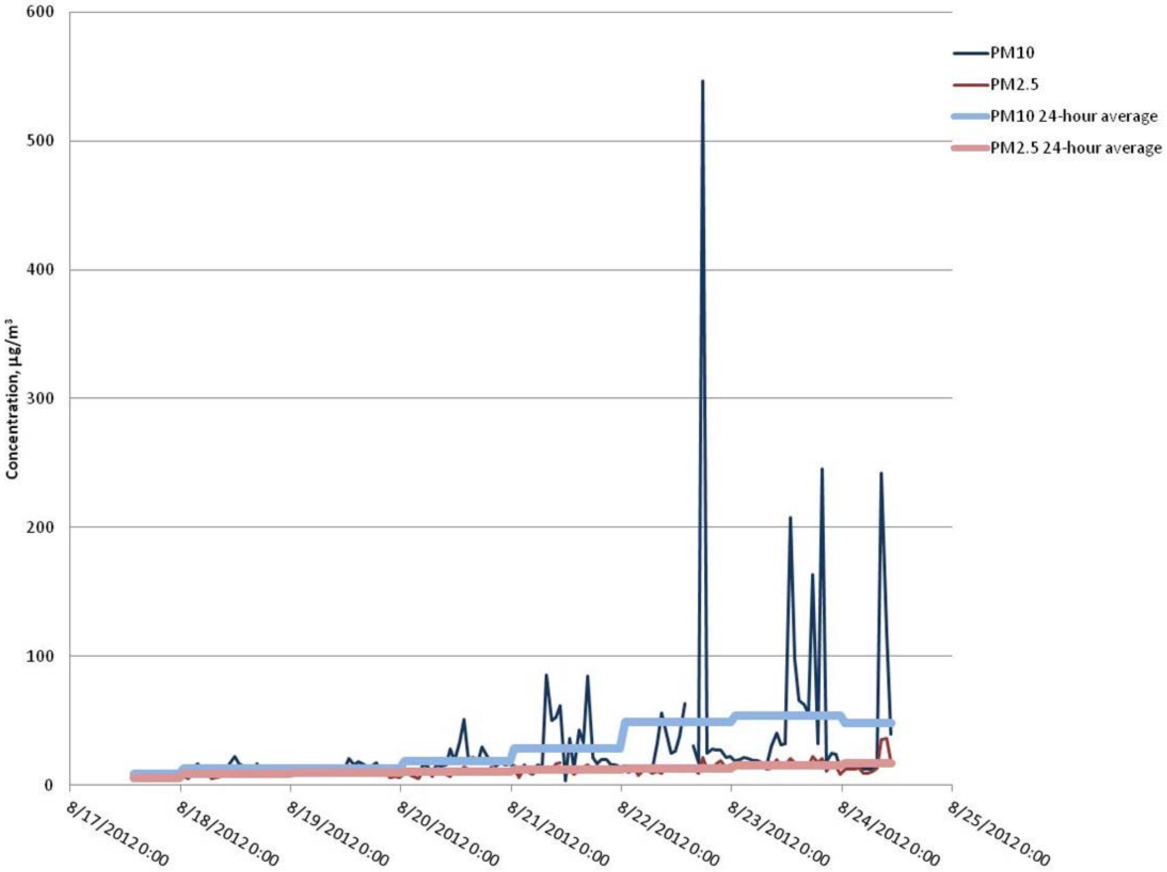


Figure 4.3i. One-hour average PM_{10} and $PM_{2.5}$ concentrations at the Mills-Wetzel pad #2.

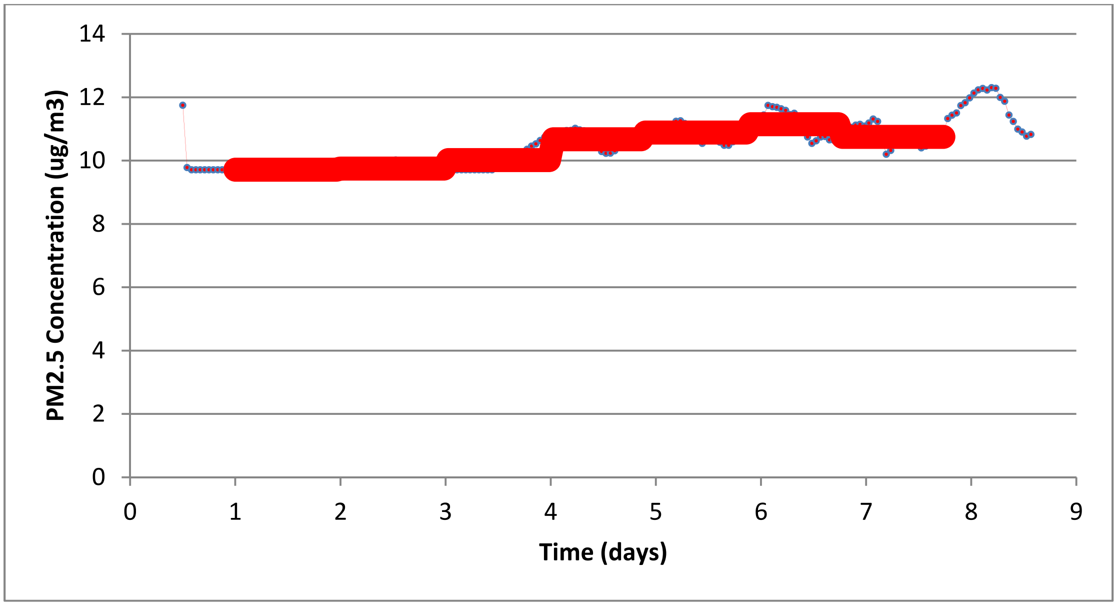


Figure 4.3j. MILLS-WETZEL PAD 2, PM 2.5 Dust Track 8/15-23/2012 data for Site A, with hourly data points and 24 hour averages represented as bar lines. (Note the small range of the vertical axis denoting a constant level being recorded by the device.)

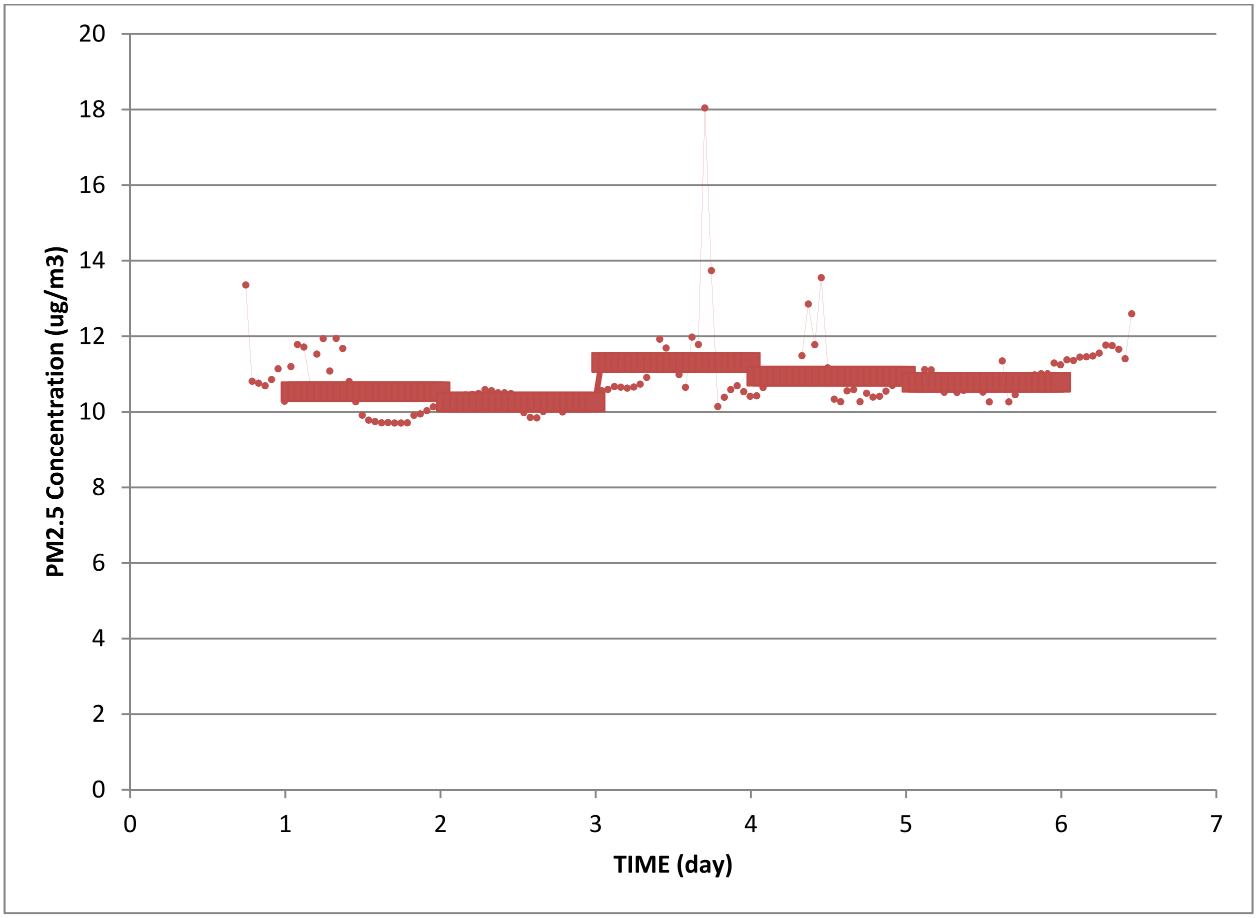
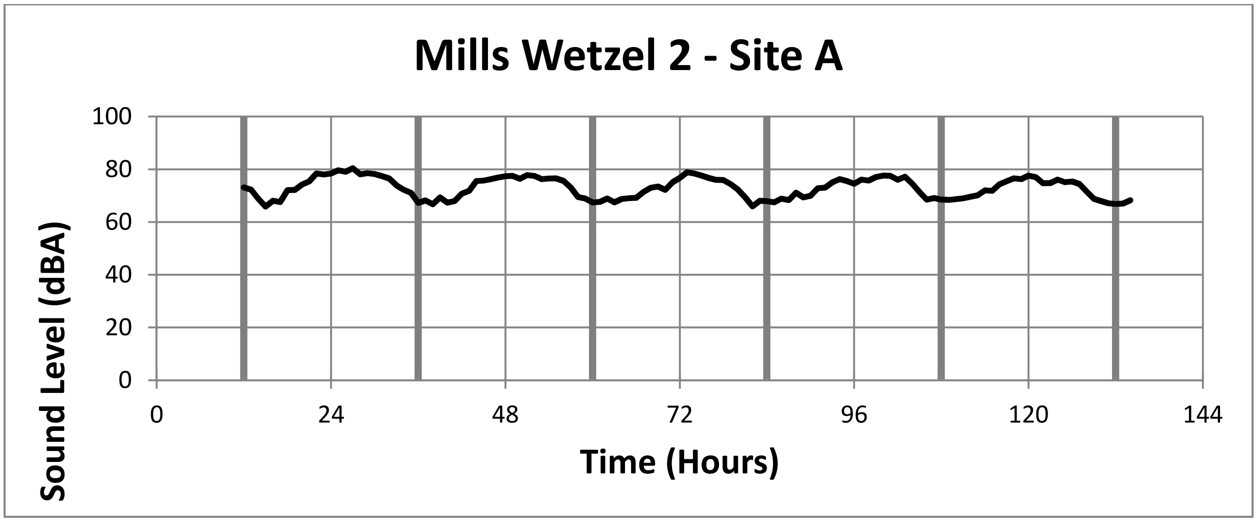


Figure 4.3k. MILLS-WETZEL PAD 2, PM 2.5 Dust Track 8/15-23/2012 data for Site C, with hourly data points and 24 hour averages represented as bar lines.

4.3.8 Noise Results



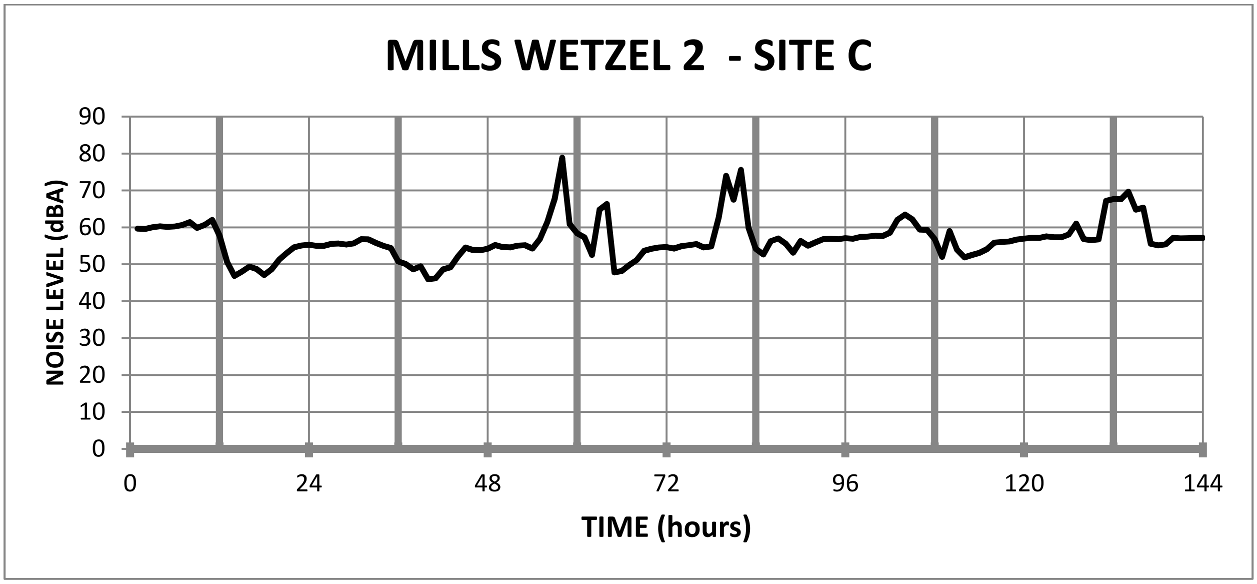


Figure 4.3l. Noise levels averaged 56 for site A and 73 for site C with an average level of 65 dBA with a standard deviation of 10 for the two sites together. Hours 0, 24, 48 etc. are midnight. Heavy, vertical lines are noon for each day.

4.3.9 SO2 Results

Data for SO_2 are available for the entire monitoring period, August 17-24 (Figure 4.3m). The average concentration of SO_2 at the Weekley pad was 3.0ppb, with peaks not exceeding 17ppb. Calculating 1-hour averages from the one-minute data for a more direct comparison with the NAAQS for SO_2 results in a range of 1-hour averages of 1.4ppb – 9.5ppb. Similarly, calculating 3-hour averages from the one-minute data results in a range of 1.6ppb –8.4ppb.

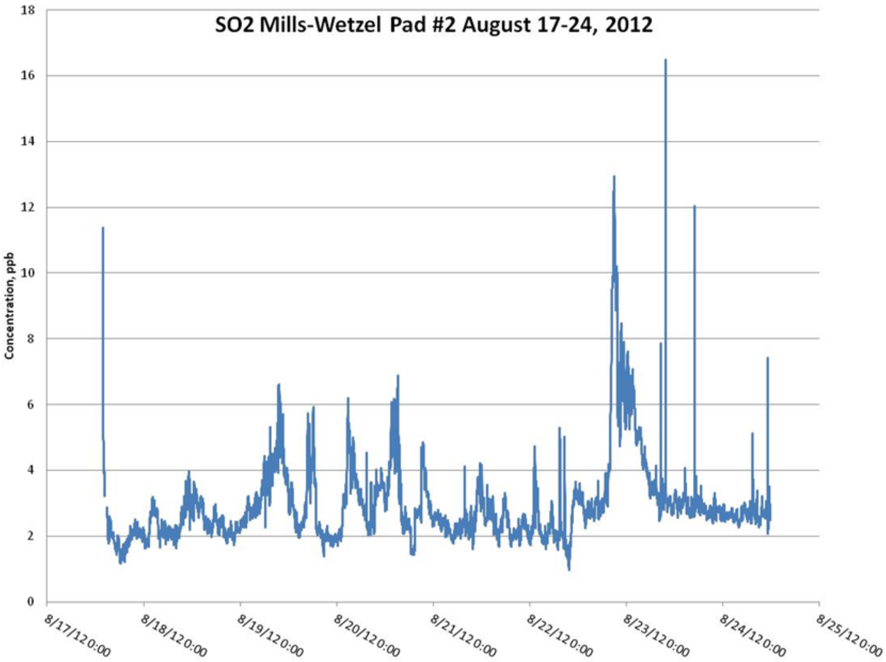


Figure 4.3m. One-minute average SO_2 concentrations

4.4 Mills Wetzel pad #3 (Site Preparation)

Sampling was conducted over an 8 day period from August 24-31, 2012 using a Dust Track direct reading dust monitor. The DOE trailer was not available to monitor this site. The monitors at Sites A and C were adjusted by the same density factor used for the Mills Wetzel pad #2 less than a mile away. No PID was used because of high dust levels potentially disabling the monitors.

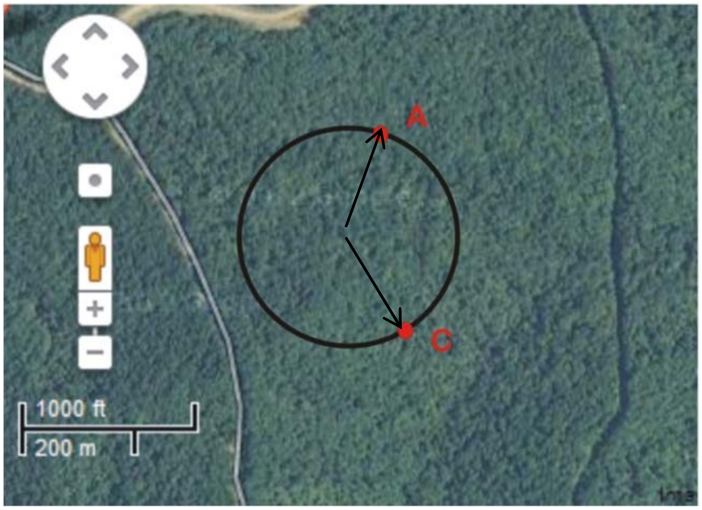


Fig 4.4a. Satellite photo of Mills Wetzel 3 pad showing sampling sites (A, C) as red dots. The DOE trailer was not placed at this location. Black circle is the 625 foot setback distance.

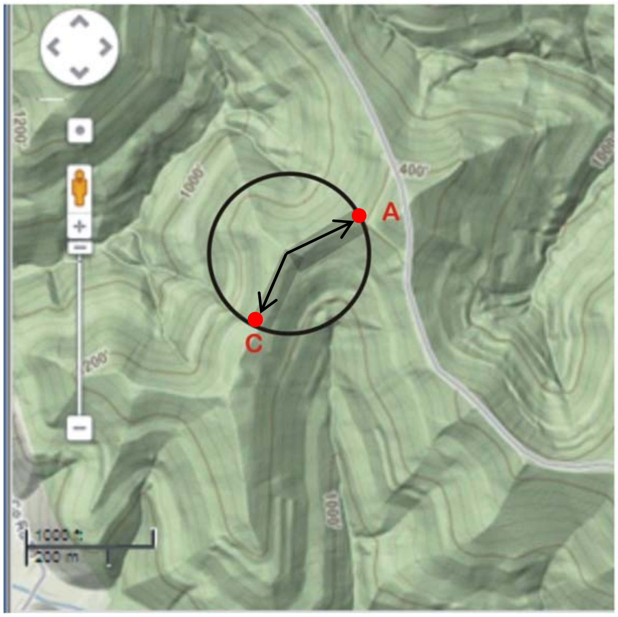


Fig 4.4b. Terrain map of Mills Wetzel 3 pad showing sampling sites (A, C) as red dots. The DOE trailer was not placed at this location. Black circle is the 625 foot setback distance. Shaded areas with the circle were areas being cleared for the pad site.

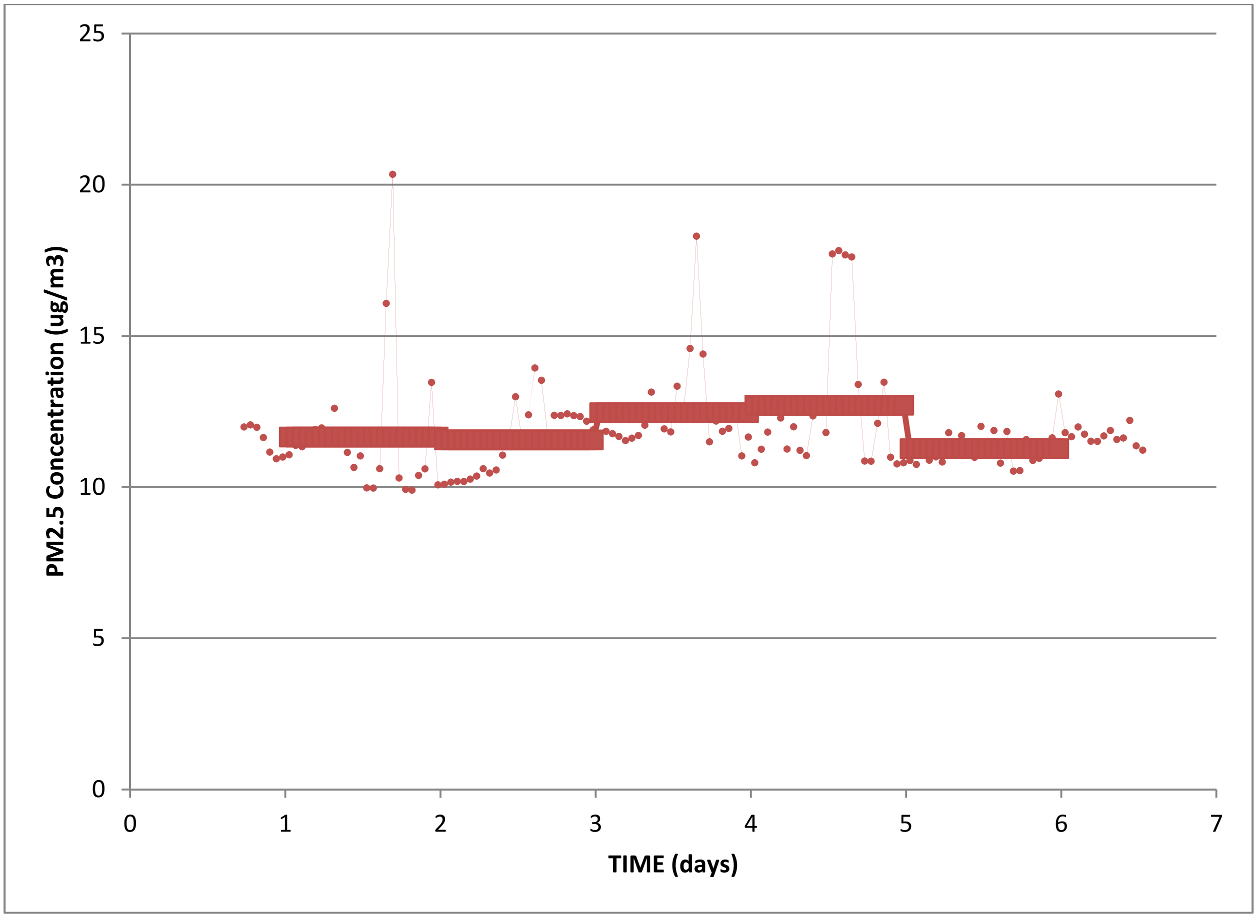


Figure 4.4c. MILLS-WETZEL PAD 3, PM 2.5 Dust Track 8/25-31/2012 data for Site A, with hourly data points and 24 hour averages represented as bar lines.

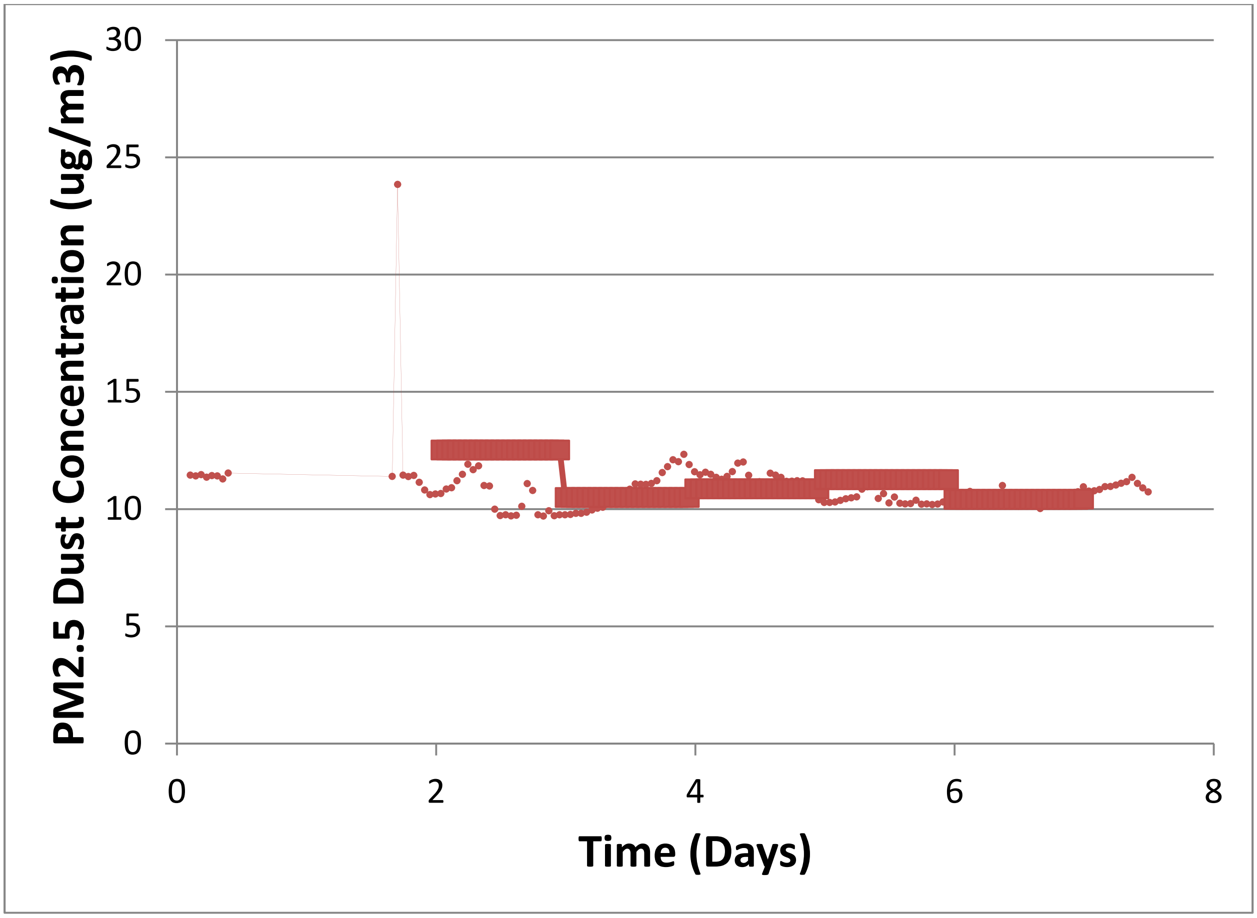
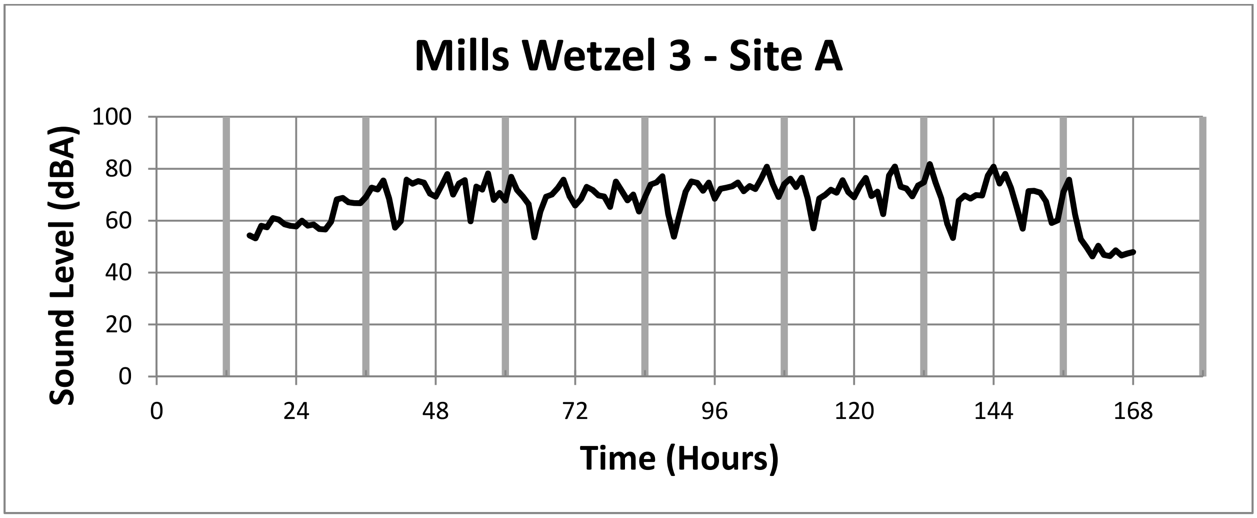


Figure 4.4d. MILLS-WETZEL PAD 3, PM 2.5 Dust Track 8/25-31/2012 data for Site C, with hourly data points and 24 hour averages represented as bar lines.

4.4.8 Noise Results



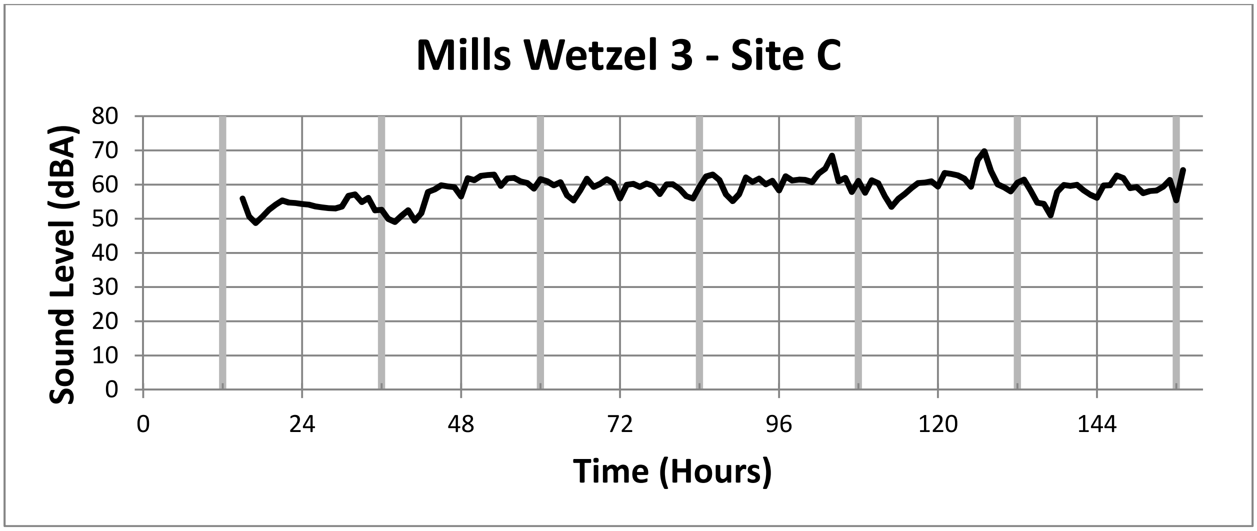


Figure 4.4e. Noise results for site A averaged 58 dBA and for Site C 69 dBA with an average between both sites of 64 dBA. Hours 0, 24, 48 etc. are midnight. Heavy, vertical lines are noon for each day.

4.5 Maury pad (Hydraulic Fracturing and Flowback)

4.5.1 HC Results

The laboratory was deployed to the Maury pad site near New Martinsville, WV in western Wetzel County on August 24, 2012. The laboratory was located approximately 190m northeast of the well pad on the side of a gravel well pad access road with coordinates of 39°37'5.48"N, 80°46'57.45"W. As there was no available electric service at this site, the laboratory was operated using a diesel fuel-powered generator provided by Stone Energy. The generator was approximately 5m from the laboratory in the opposite direction of the well pad. After unpacking, installing, and calibrating, some instruments were fully operational and collecting data on August 24. The remaining instruments were calibrated and began collecting data on August 29. Monitoring at this site ended on September 26, 2012. Figure 4.5a shows a wind rose and histogram for the wind direction and speed during monitoring at the Maury pad location. Wind speed was typically very low, with calm conditions 82% of the time. When there was wind, it was most frequently blowing from the south. At almost all times the laboratory was either monitoring during stagnant conditions or was almost directly downwind of the well pad. Figures for other measured meteorological parameters (temperature, relative humidity, rainfall, and solar intensity) are included in **Appendix C**.

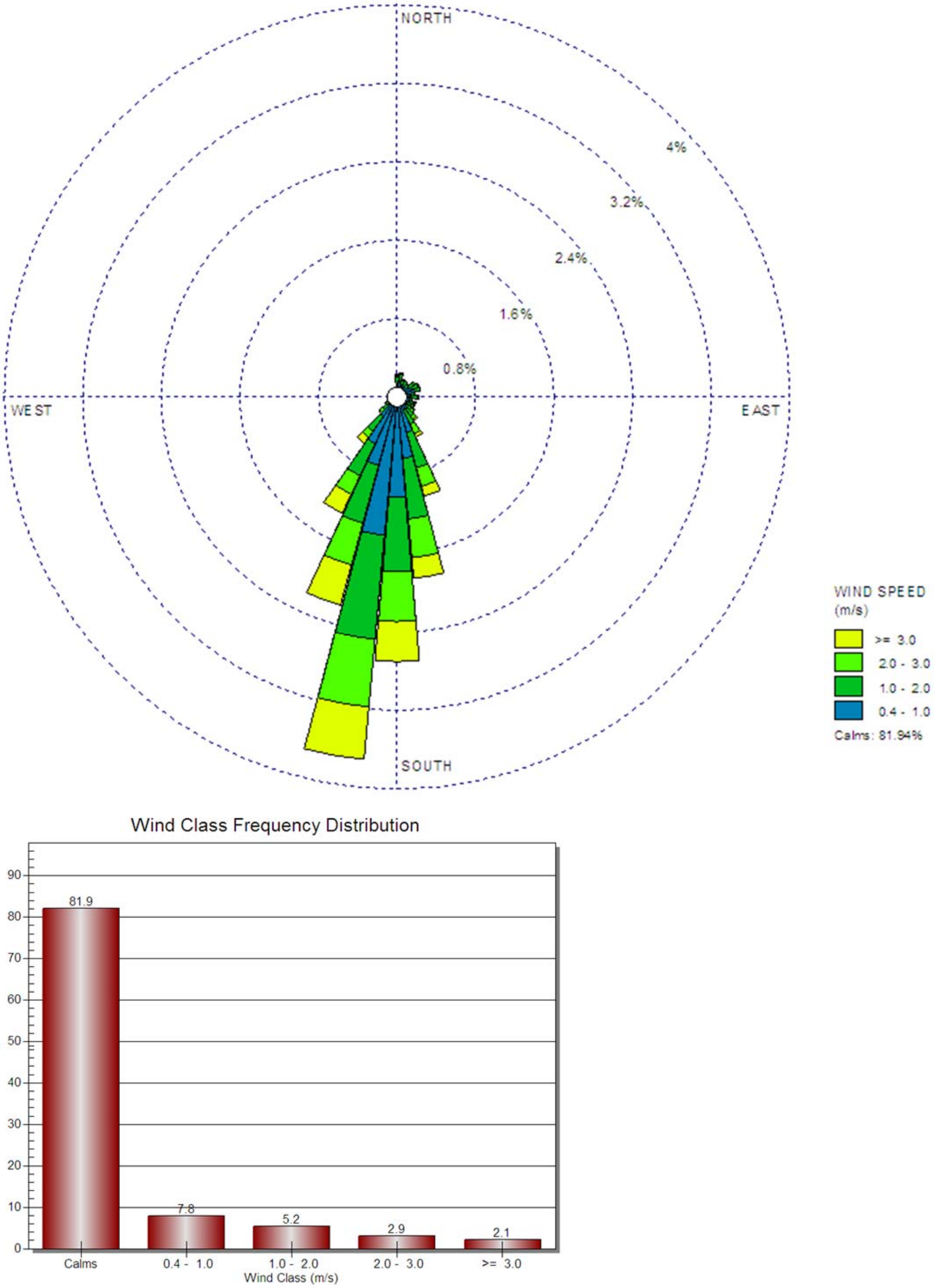


Figure 4.5a. Wind rose and histogram for wind direction and speed during monitoring at the Maury pad location.

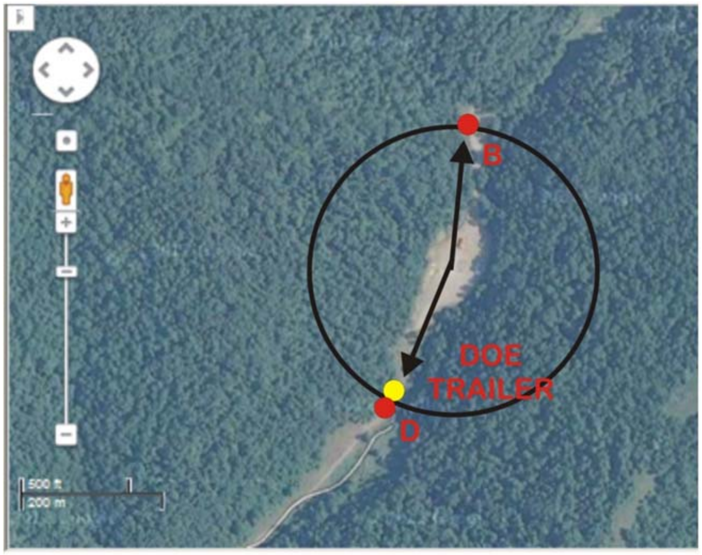


Figure 4.5b. Satellite photo of the Maury pad showing sampling sites (B, D) as red dots and location of DOE trailer as shown by the yellow dot. Black circle is the 625 foot setback distance.

At this site the analyzer ran continuously for the entire monitoring period from August 26-September 29. However, there were a large number of samples that had to be discarded due to moisture entering the gas chromatograph columns that caused an unstable baseline in the chromatograms, including all of the samples collected after the morning of September 23. The HCs analyzer has two columns; one is for the lighter hydrocarbons and one is for the heavier hydrocarbons. In table 4, for the lighter hydrocarbons ethane-isporene, there were a total of 535 samples with data for August 26-September 23. For the heavier compounds hexane-undecane, there were 353 samples, with intermittent periods of invalid data.

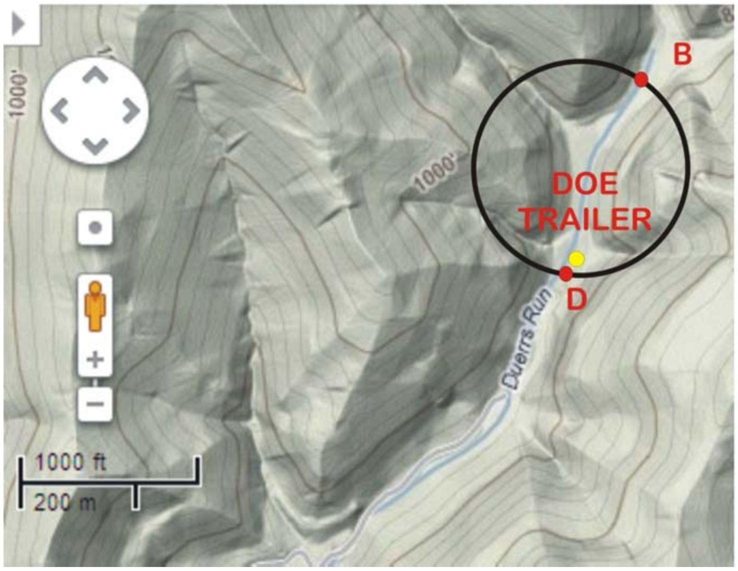


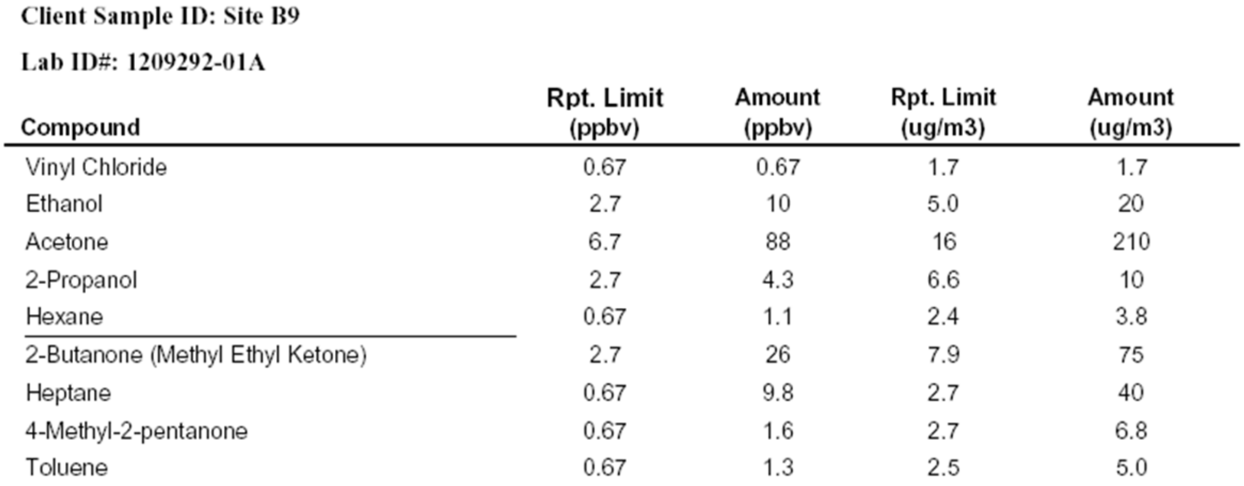
Fig. 4.5c. Terrain map of the Maury pad showing sampling sites (B, D) as red dots and location of DOE trailer as a yellow dot. Black circle is the 625 foot setback distance.

Table 4.5 GC-FID HC Results

Compound	Average (ppb)	Standard Deviation (ppb)	Minimum (ppb)	Maximum (ppb)	Frequency of Detection (%)
Hexane	1.2	2.9	0.0	28.2	37
n-heptane	0.3	1.2	0.0	14.2	11
Methylcyclohexane	0.2	0.8	0.0	7.0	10
Toluene	0.3	0.7	0.0	4.3	17
Nonane	0.2	0.7	0.0	3.8	12
Decane	0.4	1.0	0.0	6.9	16
Undecane	0.3	0.8	0.0	5.2	15
Ethane	40.2	62.1	3.3	840.5	100
Ethylene	1.7	1.4	0.0	8.7	74
Propane	24.1	31.3	0.0	453.3	100
Isobutane	6.4	6.5	0.0	72.0	96
n-butane	11.3	13.9	0.0	184.0	99
Isopentane	5.9	6.2	0.0	64.3	96
n-pentane	5.1	5.7	0.0	59.2	95
2-methylpentane	1.0	1.7	0.0	14.8	42
3-methylpentane	0.5	1.2	0.0	11.2	28
Isoprene	4.0	3.6	0.0	17.7	76

4.5.2 Summa Canister HC Results

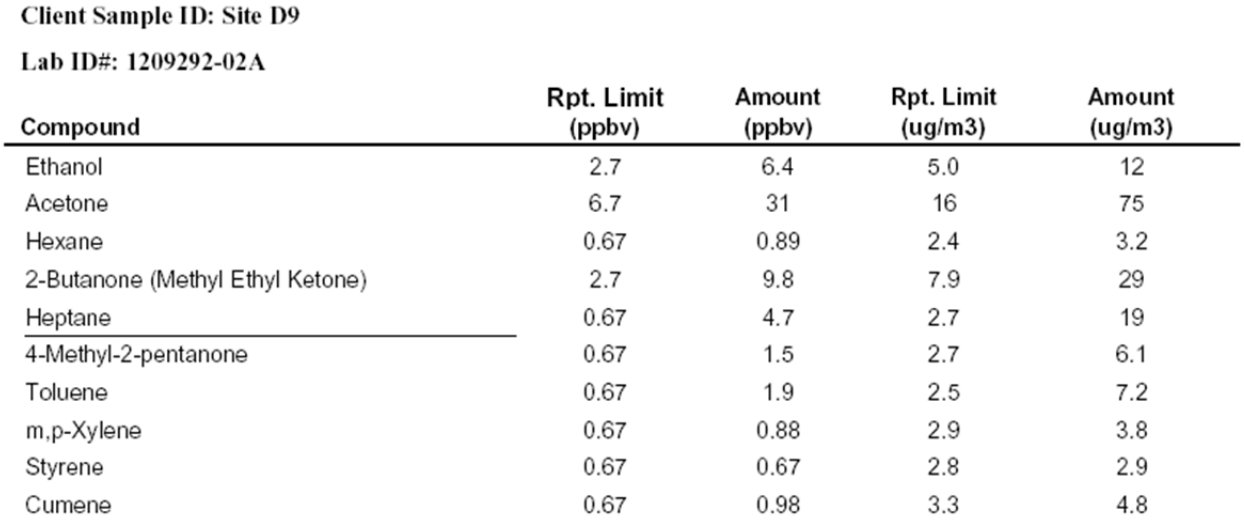
Only results above the reporting limit (Rpt Limit), that is, the concentration detectable with a statistical certainty are reported.



Client Sample ID: Site B9

Lab ID#: 1209292-01A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Vinyl Chloride	0.67	0.67	1.7	1.7
Ethanol	2.7	10	5.0	20
Acetone	6.7	88	16	210
2-Propanol	2.7	4.3	6.6	10
Hexane	0.67	1.1	2.4	3.8
2-Butanone (Methyl Ethyl Ketone)	2.7	26	7.9	75
Heptane	0.67	9.8	2.7	40
4-Methyl-2-pentanone	0.67	1.6	2.7	6.8
Toluene	0.67	1.3	2.5	5.0



Client Sample ID: Site D9

Lab ID#: 1209292-02A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethanol	2.7	6.4	5.0	12
Acetone	6.7	31	16	75
Hexane	0.67	0.89	2.4	3.2
2-Butanone (Methyl Ethyl Ketone)	2.7	9.8	7.9	29
Heptane	0.67	4.7	2.7	19
4-Methyl-2-pentanone	0.67	1.5	2.7	6.1
Toluene	0.67	1.9	2.5	7.2
m,p-Xylene	0.67	0.88	2.9	3.8
Styrene	0.67	0.67	2.8	2.9
Cumene	0.67	0.98	3.3	4.8

Client Sample ID: Site B10

Lab ID#: 1209293-01A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Vinyl Chloride	0.72	0.96	1.8	2.5
Ethanol	2.9	16	5.4	30
Acetone	7.2	160	17	380
2-Propanol	2.9	3.2	7.1	7.8
Hexane	0.72	1.6	2.5	5.8
2-Butanone (Methyl Ethyl Ketone)	2.9	49	8.5	140
Heptane	0.72	17	3.0	70
4-Methyl-2-pentanone	0.72	1.8	2.9	7.4
Toluene	0.72	1.6	2.7	5.9
m,p-Xylene	0.72	0.80	3.1	3.4

Client Sample ID: Site D10

Lab ID#: 1209293-02A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Acetone	6.8	14	16	34
Hexane	0.68	3.4	2.4	12
2-Butanone (Methyl Ethyl Ketone)	2.7	6.3	8.0	18
Heptane	0.68	4.3	2.8	18
Toluene	0.68	0.78	2.6	3.0

Client Sample ID: SITE B11

Lab ID#: 1209538-02A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethanol	3.3	20	6.2	38
Acetone	8.2	140	19	320
2-Propanol	3.3	12	8.1	29
2-Butanone (Methyl Ethyl Ketone)	3.3	8.9	9.7	26
Benzene	0.82	85	2.6	270
Heptane	0.82	1.0	3.4	4.2
4-Methyl-2-pentanone	0.82	2.7	3.4	11
Toluene	0.82	3.2	3.1	12
m,p-Xylene	0.82	0.90	3.6	3.9

Client Sample ID: SITE D11

Lab ID#: 1209539-01A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Acetone	6.8	59	16	140
2-Propanol	2.7	4.4	6.7	11
2-Butanone (Methyl Ethyl Ketone)	2.7	5.5	8.0	16
Benzene	0.68	12	2.2	39
4-Methyl-2-pentanone	0.68	3.3	2.8	14
Toluene	0.68	3.5	2.6	13
m,p-Xylene	0.68	0.94	3.0	4.1

Client Sample ID: Site B12

Lab ID#: 1209599-01A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethanol	2.7	4.9	5.1	9.2
Acetone	6.8	70	16	160
2-Propanol	2.7	3.0	6.7	7.4
2-Butanone (Methyl Ethyl Ketone)	2.7	4.6	8.0	13
Benzene	0.68	49	2.2	160
4-Methyl-2-pentanone	0.68	0.83	2.8	3.4
Toluene	0.68	1.2	2.6	4.6

Client Sample ID: Site D12

Lab ID#: 1209599-02A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Hexane	0.70	2.2	2.4	7.9
Heptane	0.70	1.0	2.8	4.1

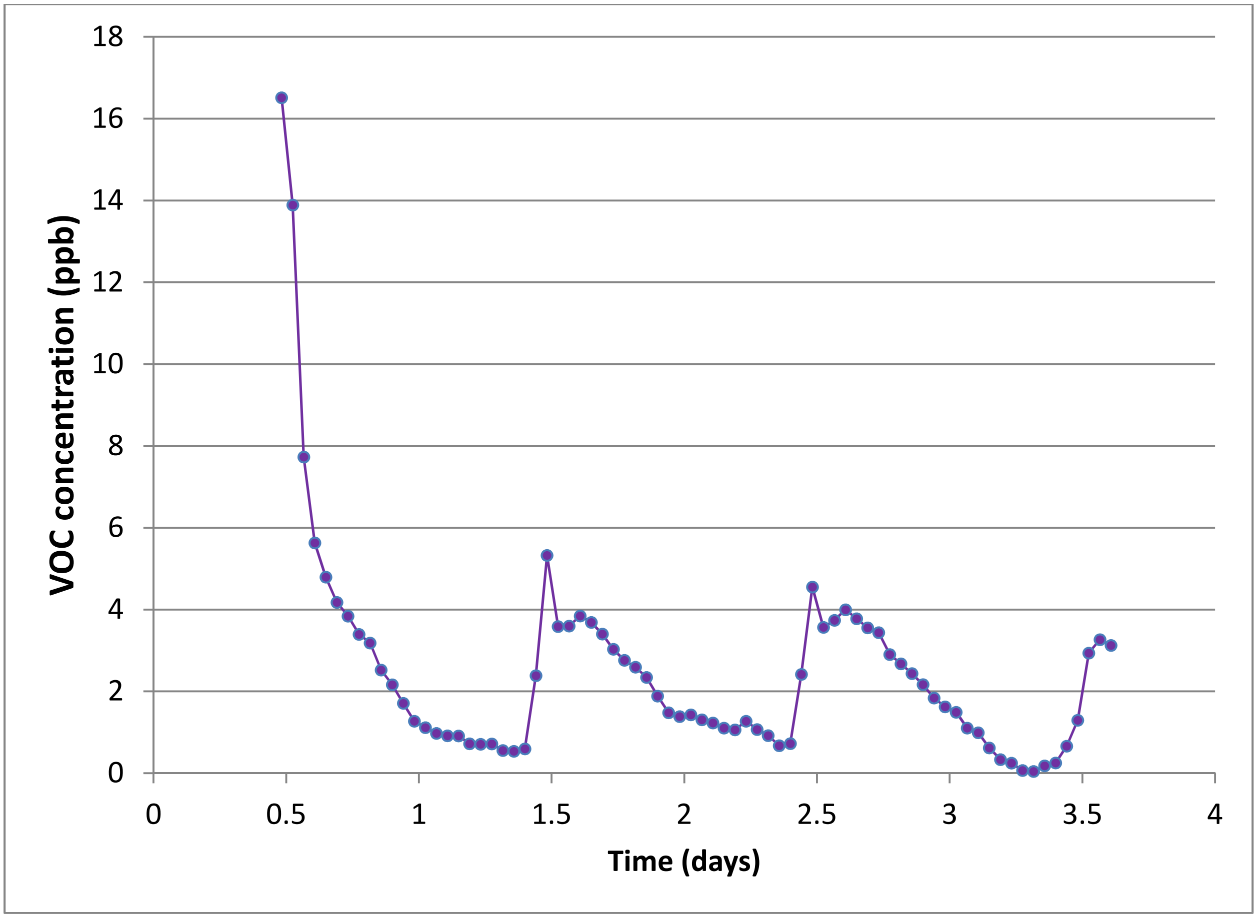


Figure 4.5.2a. PID data for 9/9-10/2012 at Site B.

PID malfunction at Site D resulted in loss of data for that location.

4.5.3 Ozone Results

Ozone data are available for most of the monitoring duration at this site, August 24-September 26, with a gap in the data from July 15-18 due to a power outage (Figures 4.5d-h). The average ozone concentration using one minute data at the Maury pad was 21ppb, and the maximum hourly average concentration was 76ppb. Day-to-night variations ranged from 30-70ppb. Calculating 8-hour averages to more directly compare to the NAAQS results in a range of 8-hour averages of 2ppb – 69ppb.

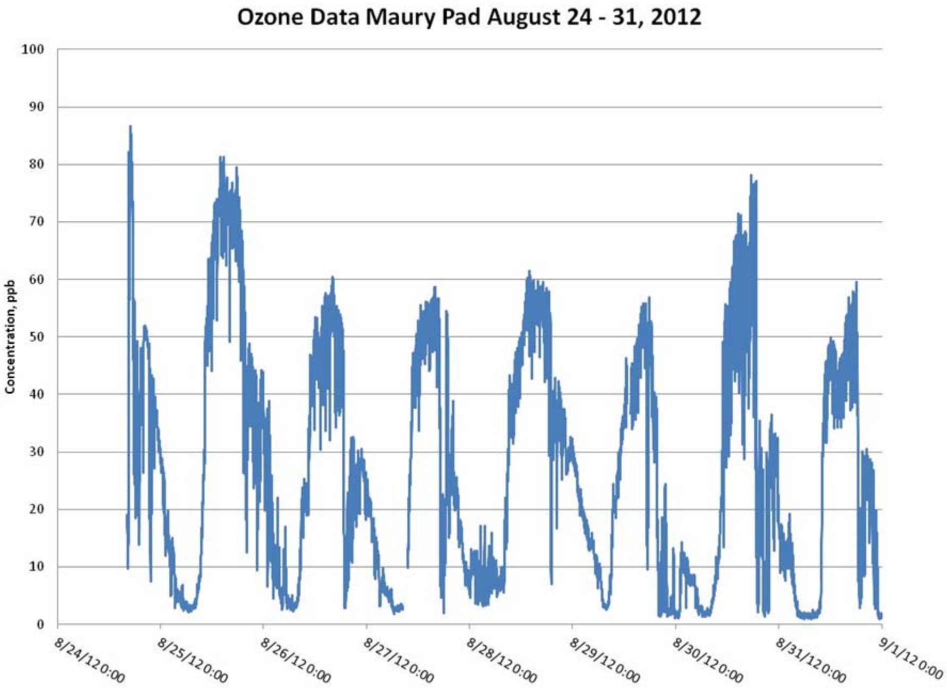


Figure 4.5d. One-minute average ozone concentrations for the first week at the Maury pad.

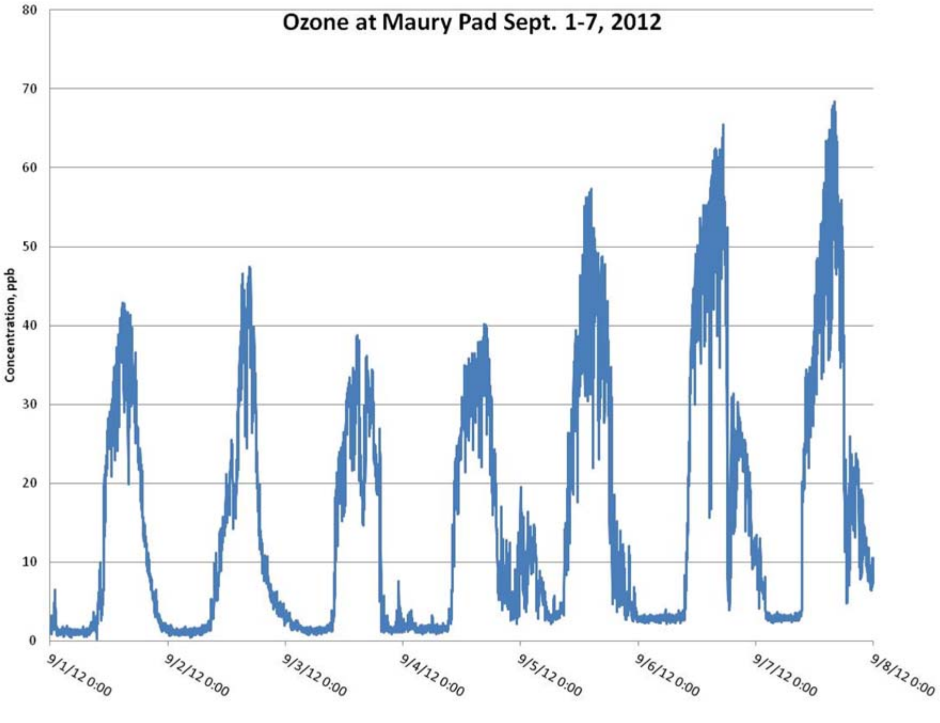


Figure 4.5e. One-minute average ozone concentrations for the second week at the Maury pad.

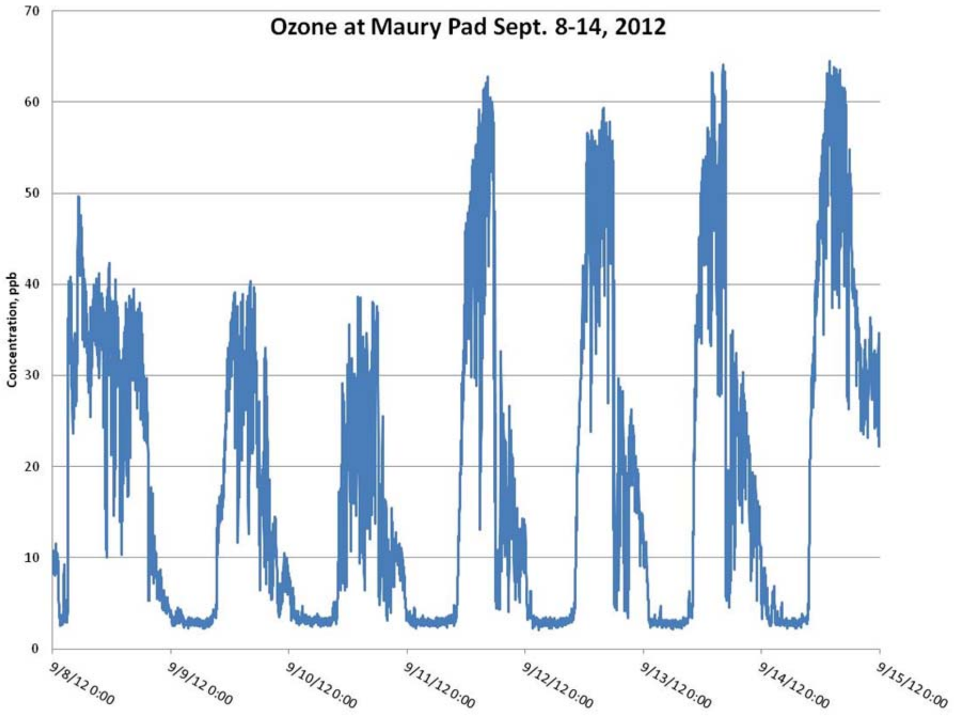


Figure 4.5f. One-minute average ozone concentrations for the third week at the Maury pad.

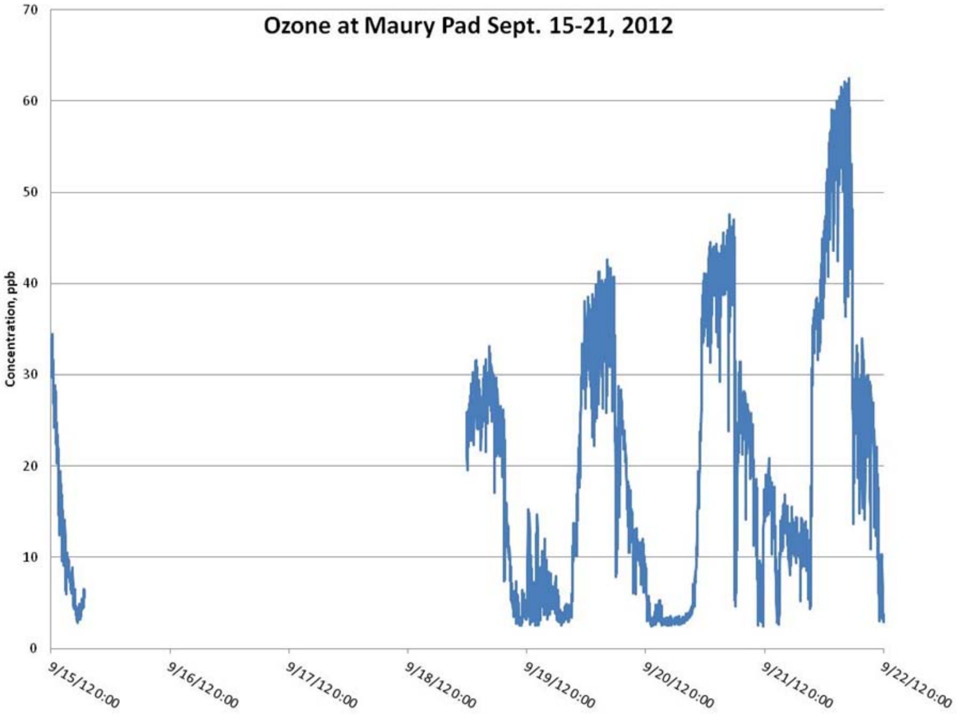


Figure 4.5g. One-minute average ozone concentrations for the fourth week at the Maury pad.

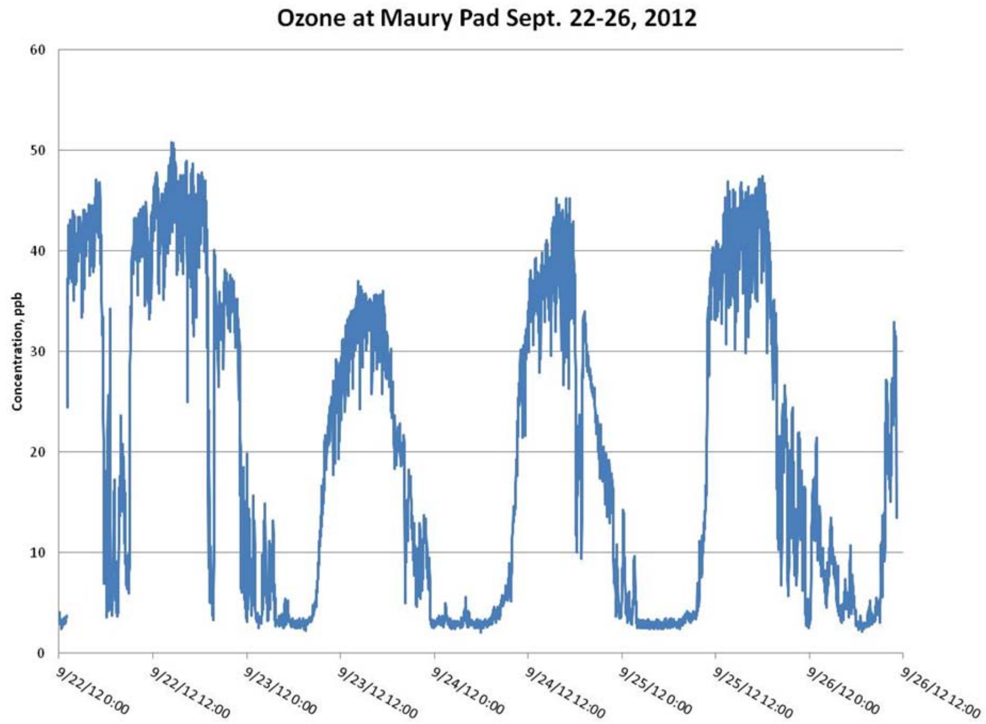


Figure 4.5h. One-minute average ozone concentrations for the fifth week at the Maury pad.

4.5.4 NOx Results

NO_x data for the Maury pad site are available for the entire monitoring duration, August 24-September 26, with the exception of a period from September 15-18 (Figures 4.5i-m). During this time a software glitch froze up the computer and prevented data from being recorded. The average of the one-minute measurements at the Maury pad site was 23ppb with an hourly average maximum of 138ppb.

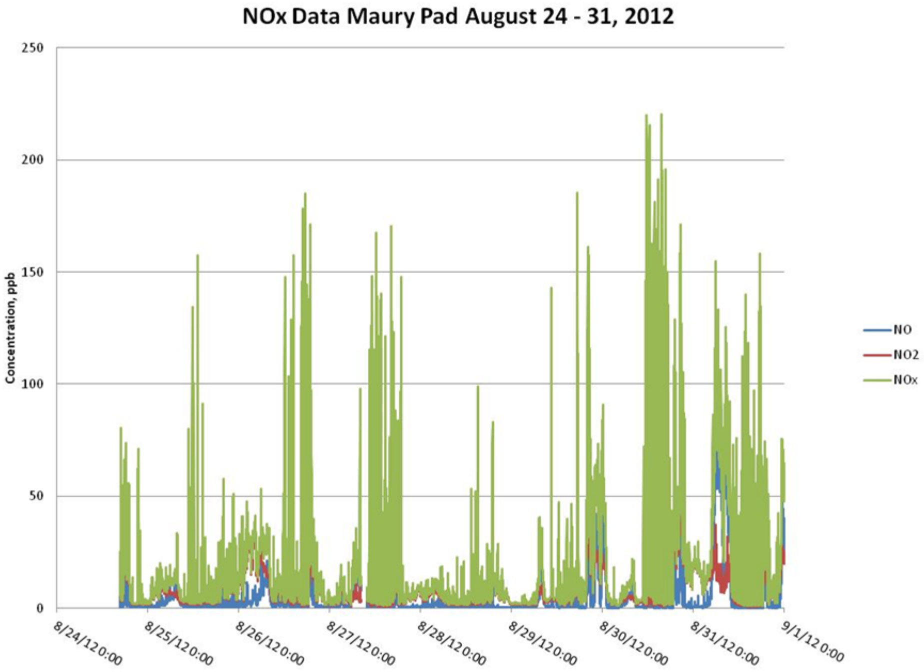


Figure 4.5i. One-minute average NO_x concentrations for the first week at the Maury pad.

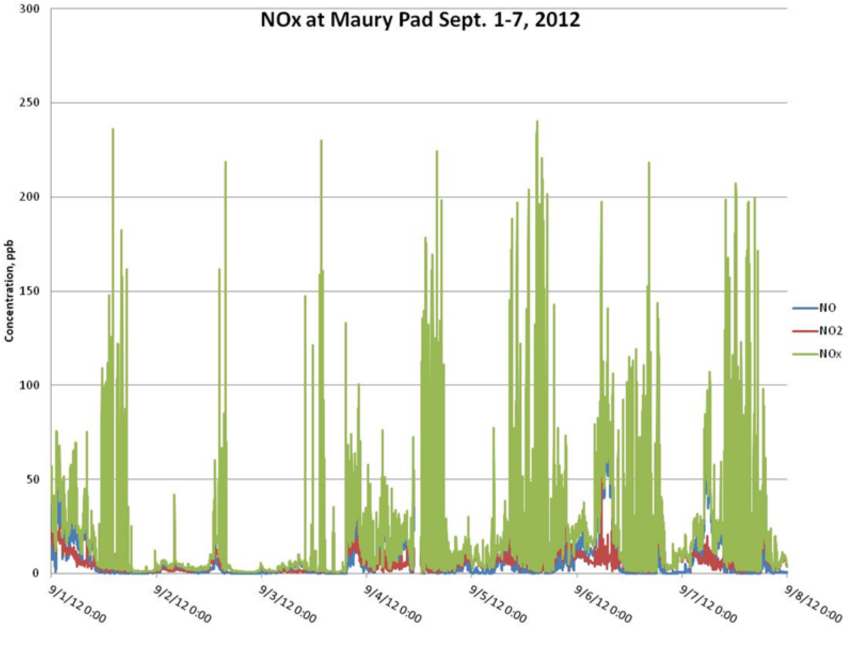


Figure 4.5j. One-minute average NO_x concentrations for the second week at the Maury pad.

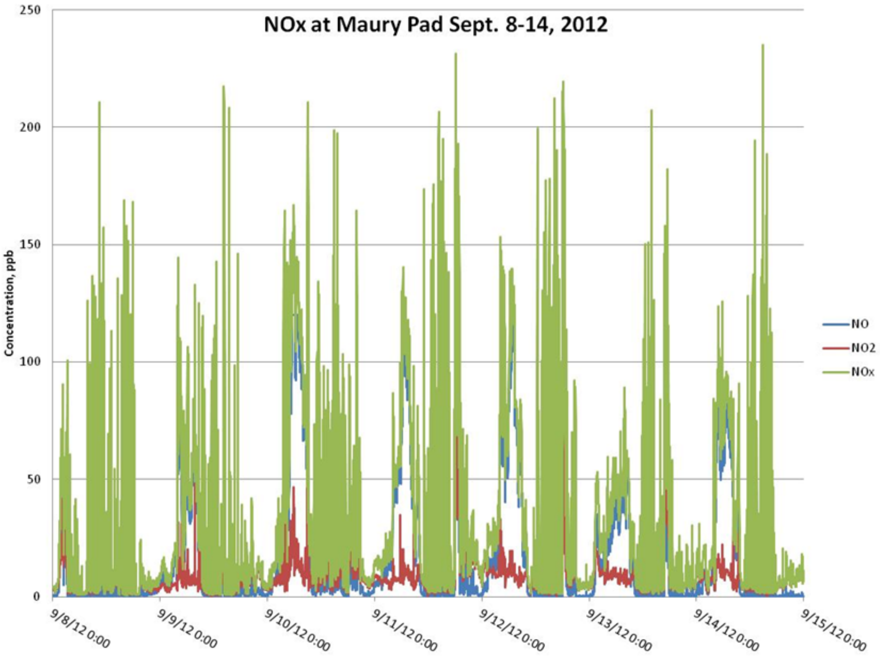


Figure 4.5k. One-minute average NO_x concentrations for the third week at the Maury pad.

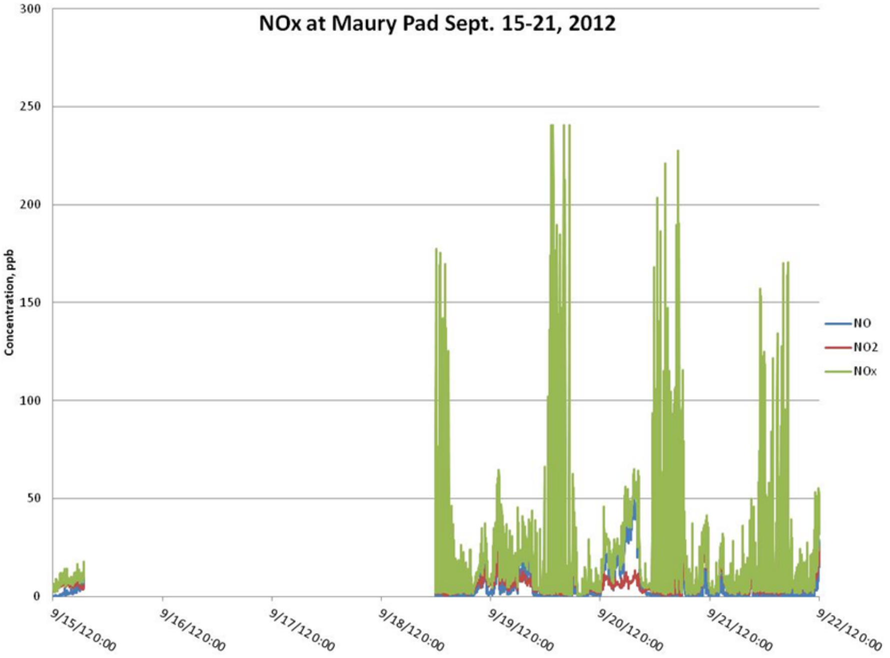


Figure 4.5l. One-minute average NO_x concentrations for the fourth week at the Maury pad.

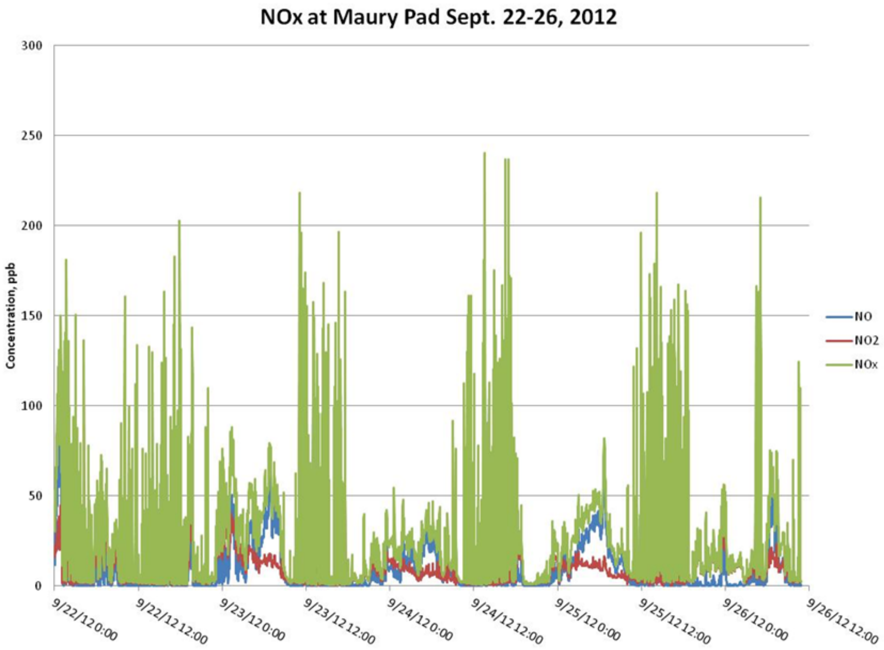


Figure 4.5m. One-minute average NO_x concentrations for the fifth week at the Maury pad.

4.5.5 Methane Results

The ambient methane concentration at the Maury pad averaged 2.0ppm (±0.1ppm) with an average isotopic composition of -49.4‰ (±1.7‰) which are typical background atmospheric values (Figures 4.5n-q). For the majority of the four week monitoring period at this site, the methane concentration was near ambient levels, exceeding 5ppm on only four occasions. The maximum observed methane concentration was 40.8ppm. Unfortunately, the corresponding δ^{13}C value is not available due to an instrument error. For concentrations greater than 5ppm (n=50), however, the δ^{13}C averaged -41.5‰ (±1.5‰) reflecting a significant contribution from a thermogenic source.

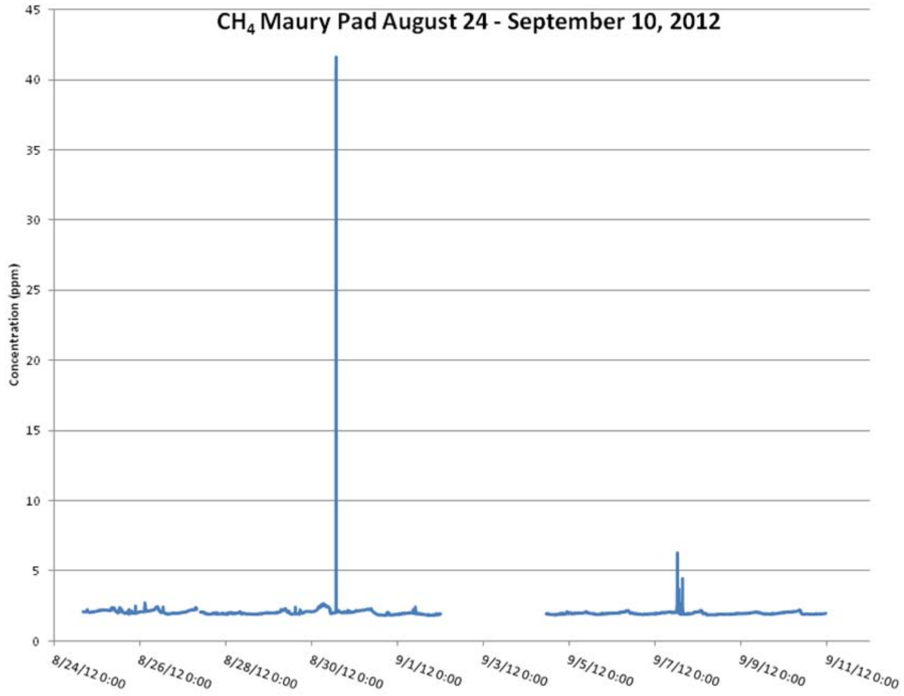


Figure 4.5n. One-minute average CH_4 concentrations at the Maury pad, 8/24/12 to 9/10/12.

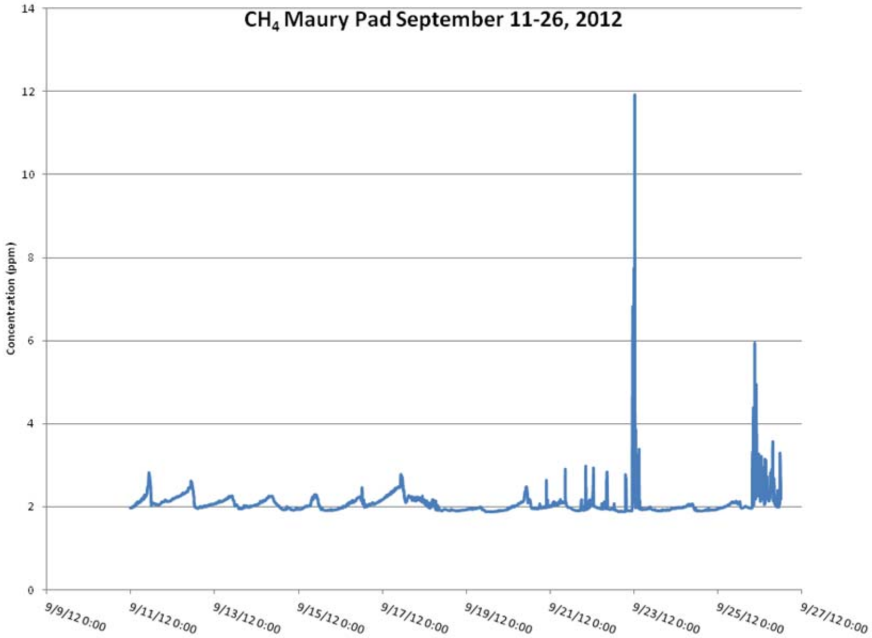


Figure 4.5o. One-minute average CH_4 concentrations at the Maury pad, 9/11/12 to 9/26/12.

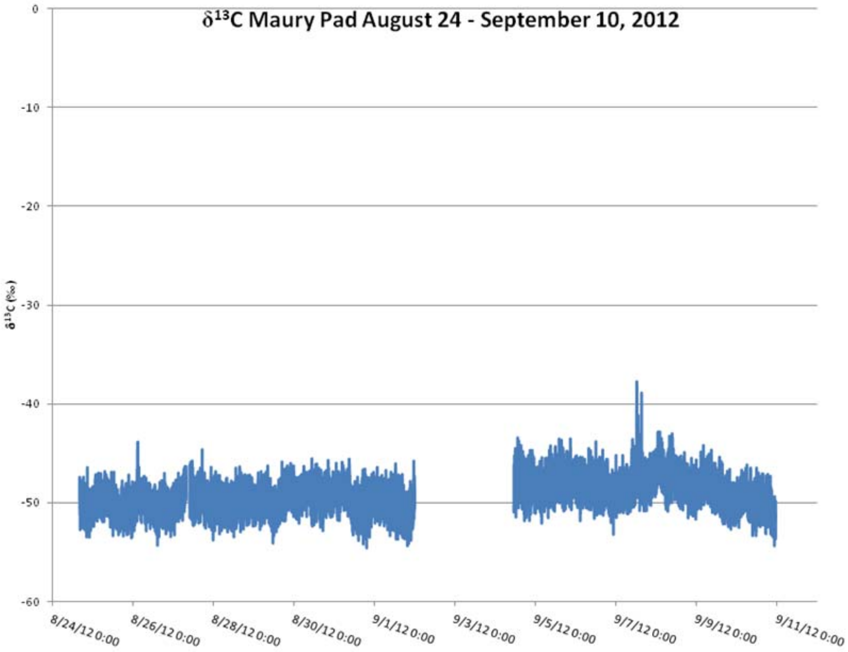


Figure 4.5p. One-minute average δ^{13}C of CH_4 at the Maury pad, 8/24/12 to 9/10/12.

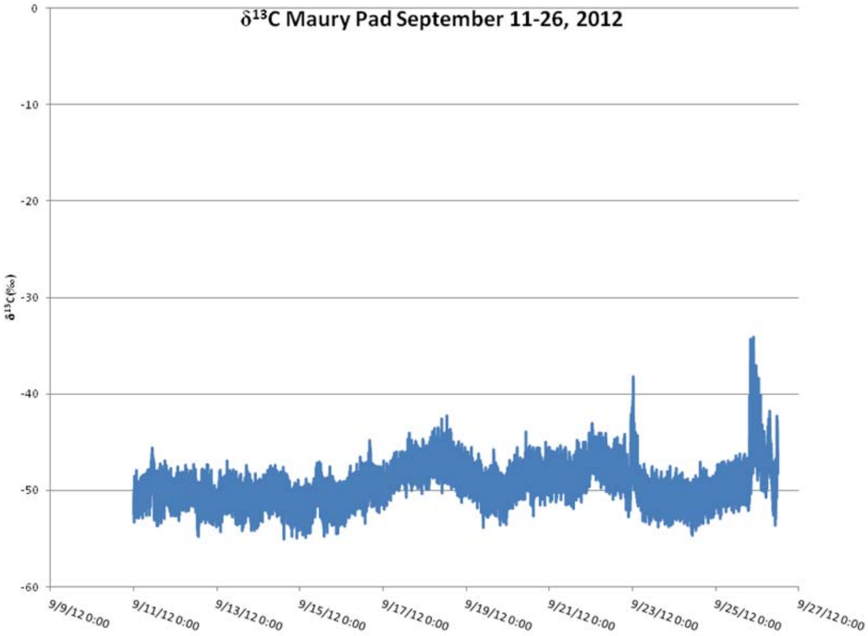


Figure 4.5q. One-minute average δ^{13}C of CH_4 at the Maury pad, 9/11/12 to 9/26/12.

4.5.6 CO2 Results

Over the four weeks of monitoring at the Maury pad site, the CO_2 concentration averaged 414ppm (±30ppm) with $\delta^{13}C$ averaging -12.6‰ (±1.5‰) (Figures 4.5r and s). The maximum CO_2 concentration at the site was 551ppm with a corresponding $\delta^{13}C$ value of -16.7‰. The CO_2 concentrations and $\delta^{13}C$ values at the site cycled daily. Starting at approximately 8pm, the CO_2 concentration increased gradually to values typically greater than 450ppm, and occasionally greater than 500ppm, before dropping back to near ambient levels by 7am. During these times, the corresponding $\delta^{13}C$ values become more depleted, approaching -14‰ and as occasionally as low as -16‰.

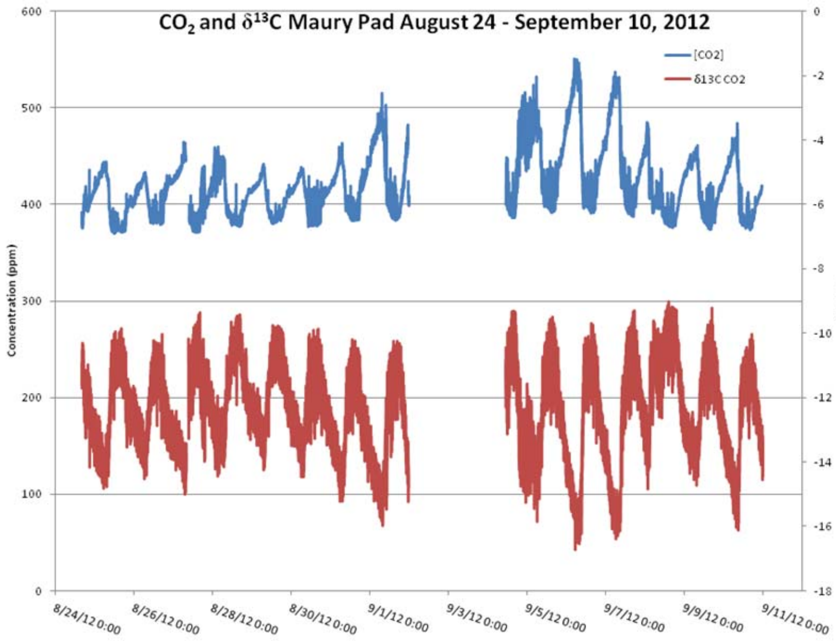


Figure 4.5r. One-minute average CO_2 concentrations and $\delta^{13}C$ of CO_2 at the Maury pad, 8/24/12 to 9/10/12.

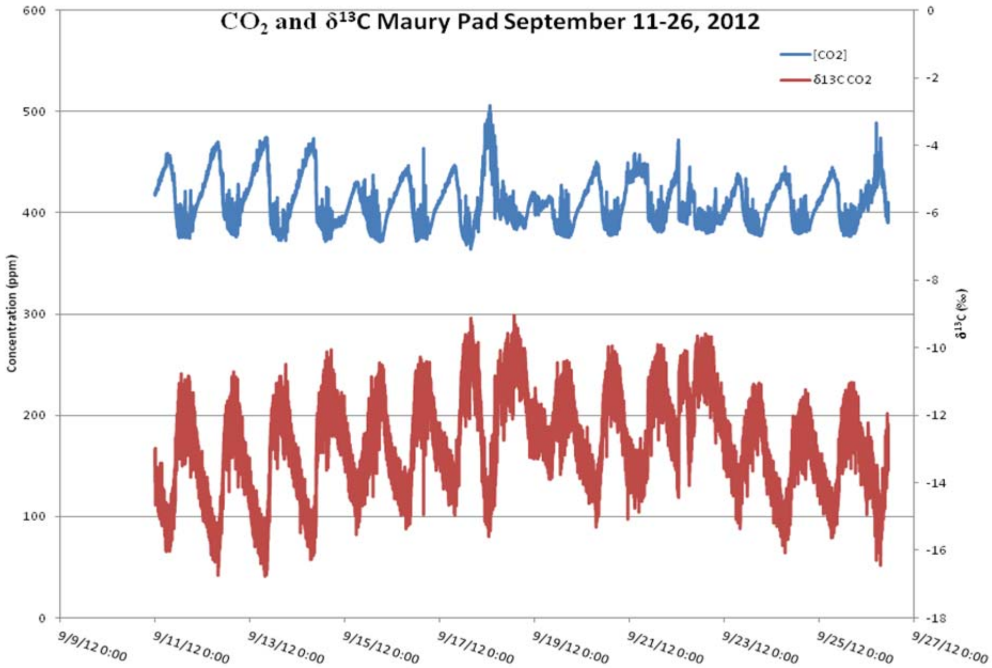


Figure 4.5s. One-minute average CO_2 concentrations and $\delta^{13}C$ of CO_2 at the Maury pad, 9/11/12 to 9/26/12.

4.5.7 Dust Results

Data are available for August 24-September 26 (Figure 4.5t). At the Maury pad, Average PM_{10} concentration was 30μg/m^3 and average $PM_{2.5}$ concentration was 12μg/m^3. Maximum one-hour average concentrations of PM_{10} and $PM_{2.5}$ were 768μg/m^3 and 129μg/m^3, respectively. The substantial peaks in PM_{10} concentration at this site were likely due to the mobile air monitoring laboratory's position by a frequently traveled gravel well pad access road.

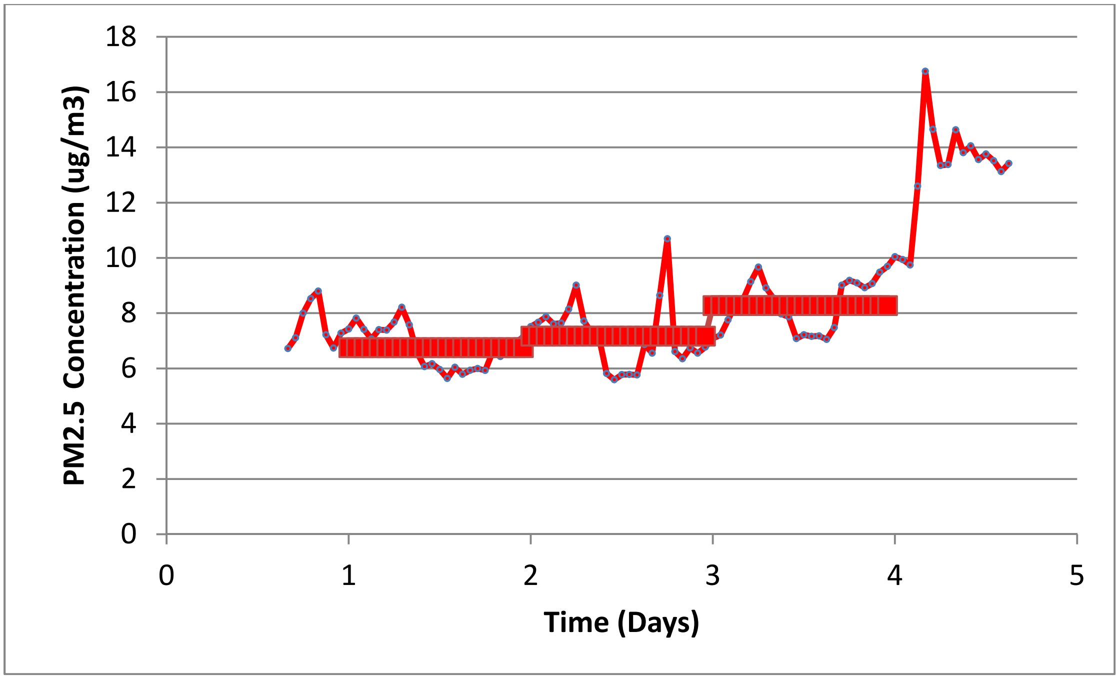


Figure 4.5t1. Dust Track results for Maury Site B. Data points are hourly averages, bars represent daily averages.

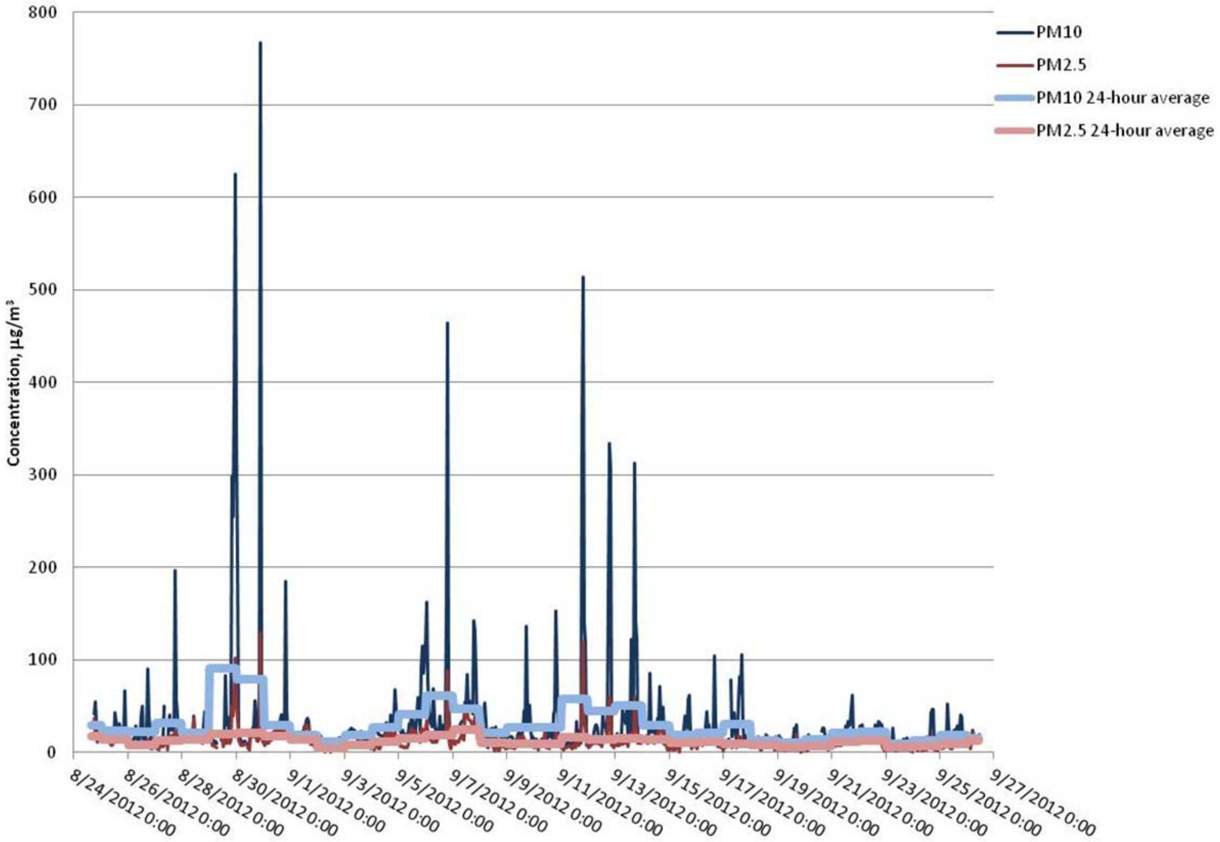
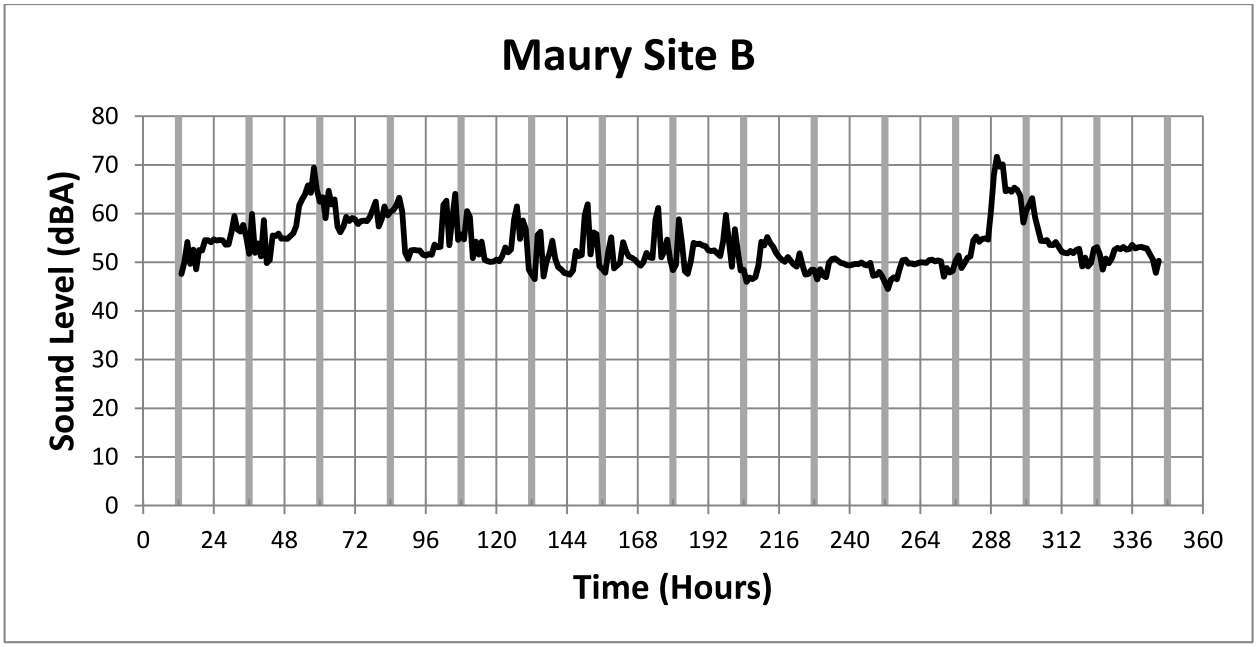


Figure 4.5t2. One-hour average PM_{10} and $PM_{2.5}$ concentrations at the Maury pad.

4.5.8 Noise Results



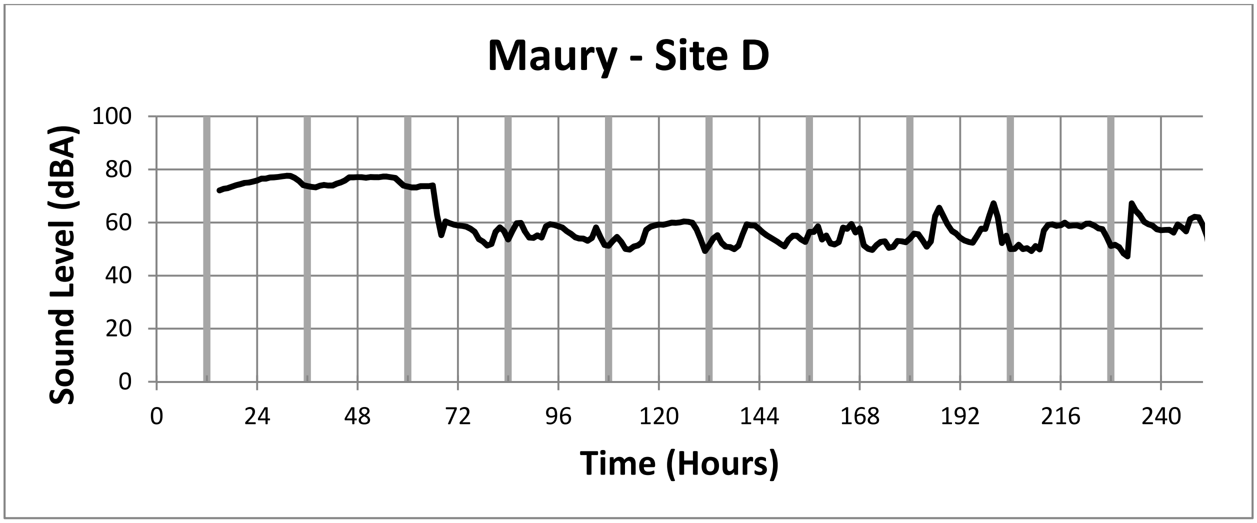


Figure 4.5u. Noise levels averaged 55 dBA for site B and 61 dBA for site D and 58 dBA overall. Hours 0, 24, 48 etc. are midnight. Heavy, vertical lines are noon for each day.

4.5.9 SO2 Results

Data for SO_2 are available for the entire monitoring period, August 24 – September 26 with the exception of a period from September 15-18 due to a computer software problem (Figures 4.5v-z). The average concentration of SO_2 at the Maury pad was 2.3ppb, with peaks not exceeding 13ppb. Calculating 1-hour averages from the one-minute data for a more direct comparison with the NAAQS for SO_2 results in a range of 1-hour averages of 0.9ppb – 12.2ppb. Similarly, calculating 3-hour averages from the one-minute data results in a range of 1.1ppb –9.6ppb.

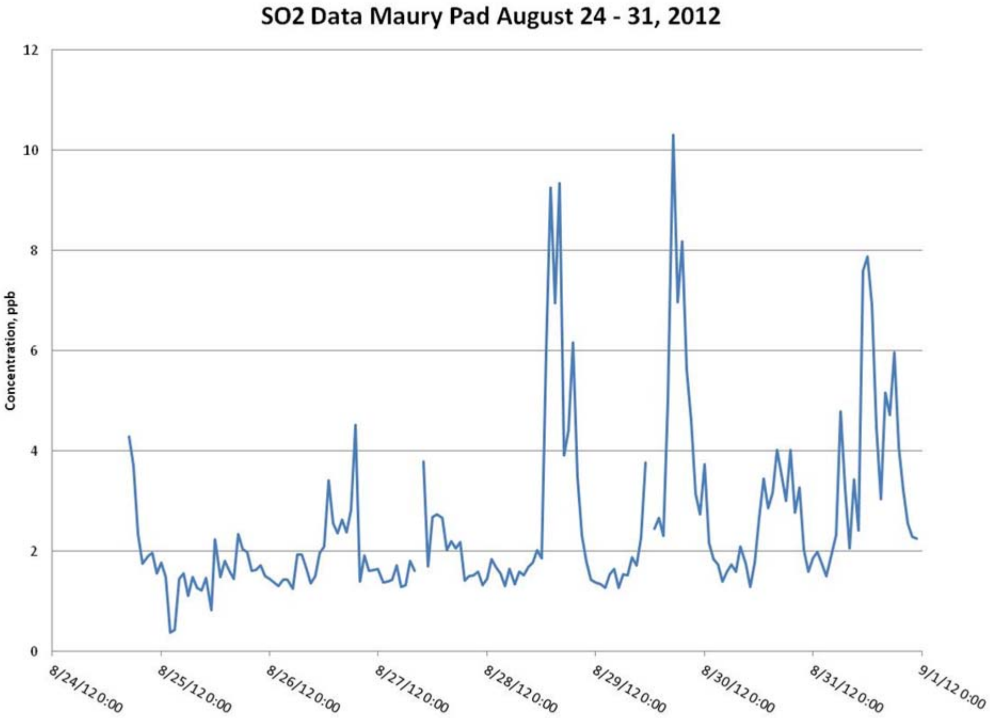


Figure 4.5v. One-minute average SO_2 concentrations for the Maury pad, August 24-31, 2012.

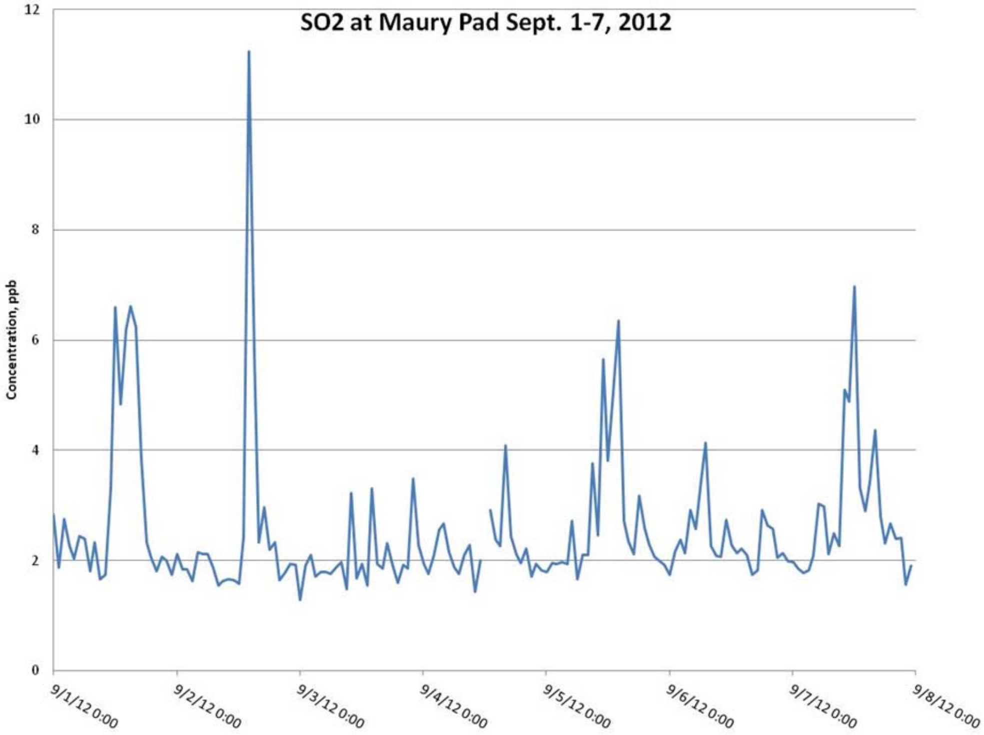


Figure 4.5w. One-minute average SO_2 concentrations for the Maury pad, September 1-7, 2012.

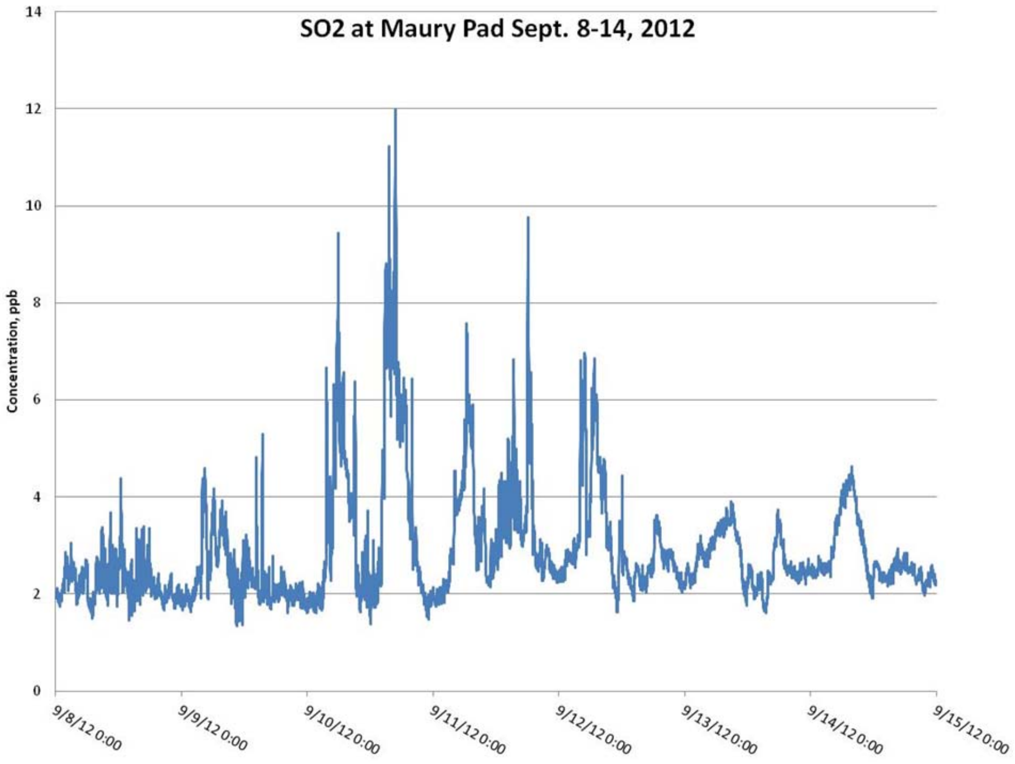


Figure 4.5x. One-minute average SO_2 concentrations for the Maury pad,September 8-14, 2012.

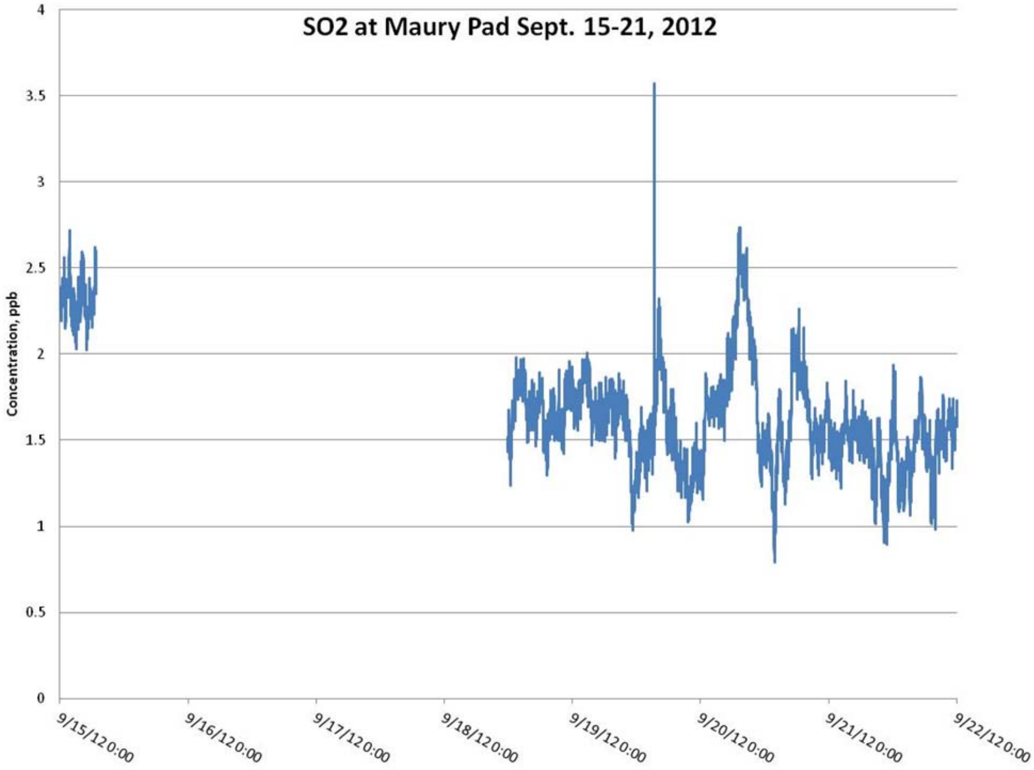


Figure 4.5y. One-minute average SO_2 concentrations for the Maury pad, September 15-21, 2012.

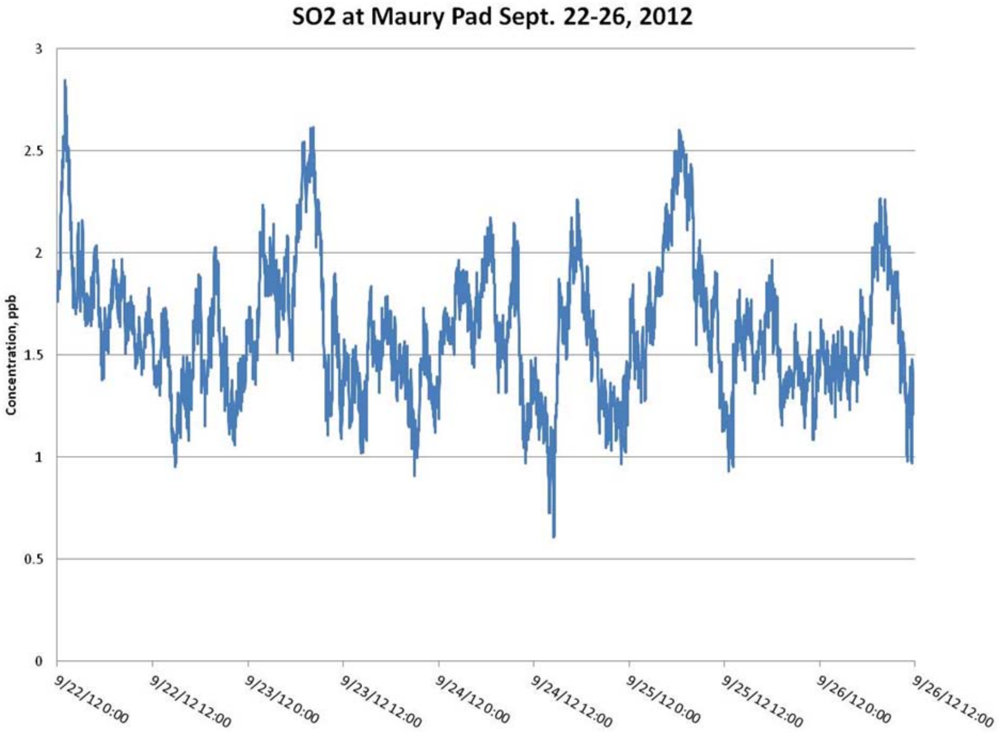


Figure 4.5z. One-minute average SO_2 concentrations for the Maury pad, September 22-26, 2012.

4.5.10 OC/EC Results

At the Maury pad, data are available for the entire monitoring period with the exception of September 15-18, when a software problem froze the computer and stopped the analysis. The data show high variability, with an average OC concentration of 2.7μgC/m^3, ranging from 1.3-6.7μgC/m^3, and an average EC concentration of 1.4μgC/m^3, ranging from >0.1-6.2μg/m^3.

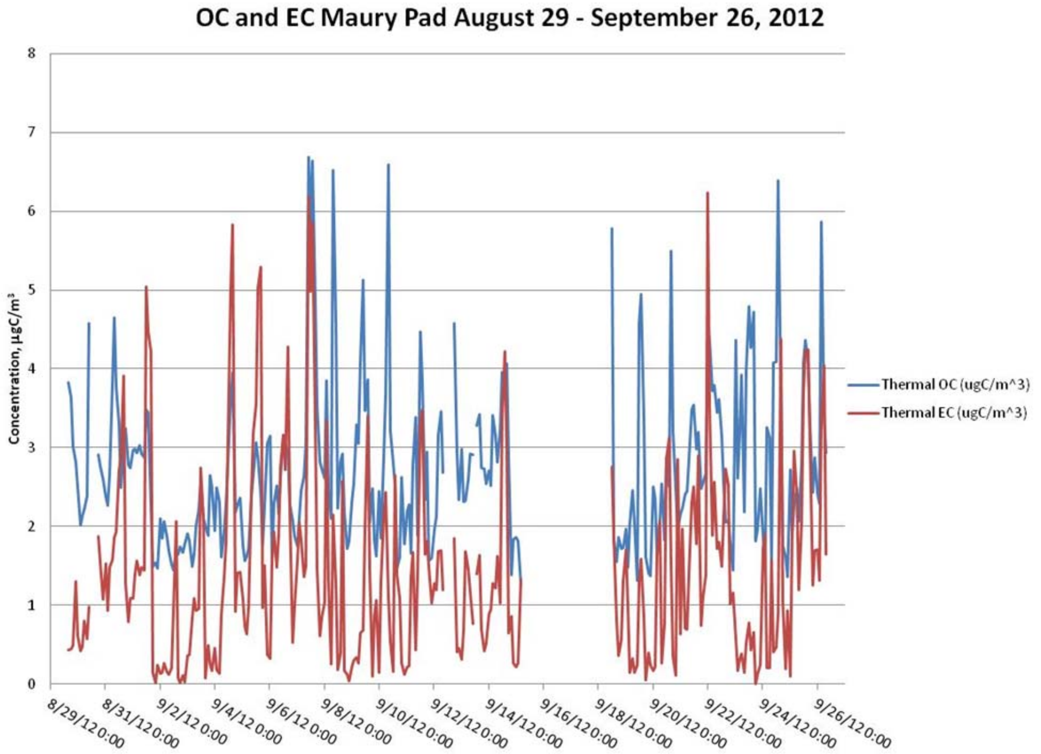


Figure 4.5aa. Two-hour average OC and EC concentrations for the Maury pad.

4.6 Lemons pad (Vertical Drill)

The laboratory was moved to the Lemons pad site, also near New Martinsville, WV in western Wetzel County, on September 27, 2012. The laboratory was located approximately 200m northwest of the well pad on a grassy knoll off the side of the main well pad access road with coordinates of 39°39'8.73"N, 80°47'44.69"W. As there was no available electric service at this site, the laboratory was operated using a diesel fuel-powered generator provided by Stone Energy. The generator was approximately 20m from the laboratory in the opposite direction of the well pad. After unpacking, installing, and calibrating, instruments were fully operational and collecting data on September 27. Monitoring at this site ended on October 15, 2012 due to power interruption. The laboratory was moved from the site on October 17, 2012. During this period, wind most frequently came from the southwest; winds from the southeast would likely have carried any plumes from the well pad toward the monitoring laboratory but the frequency of winds from the southeast was very low (less than 5%). Figure 4.6a shows a wind rose and histogram for the wind direction and speed during monitoring at the Lemons pad location. Figures for other measured meteorological parameters (temperature, relative humidity, rainfall, and solar intensity) are included in **Appendix C**.

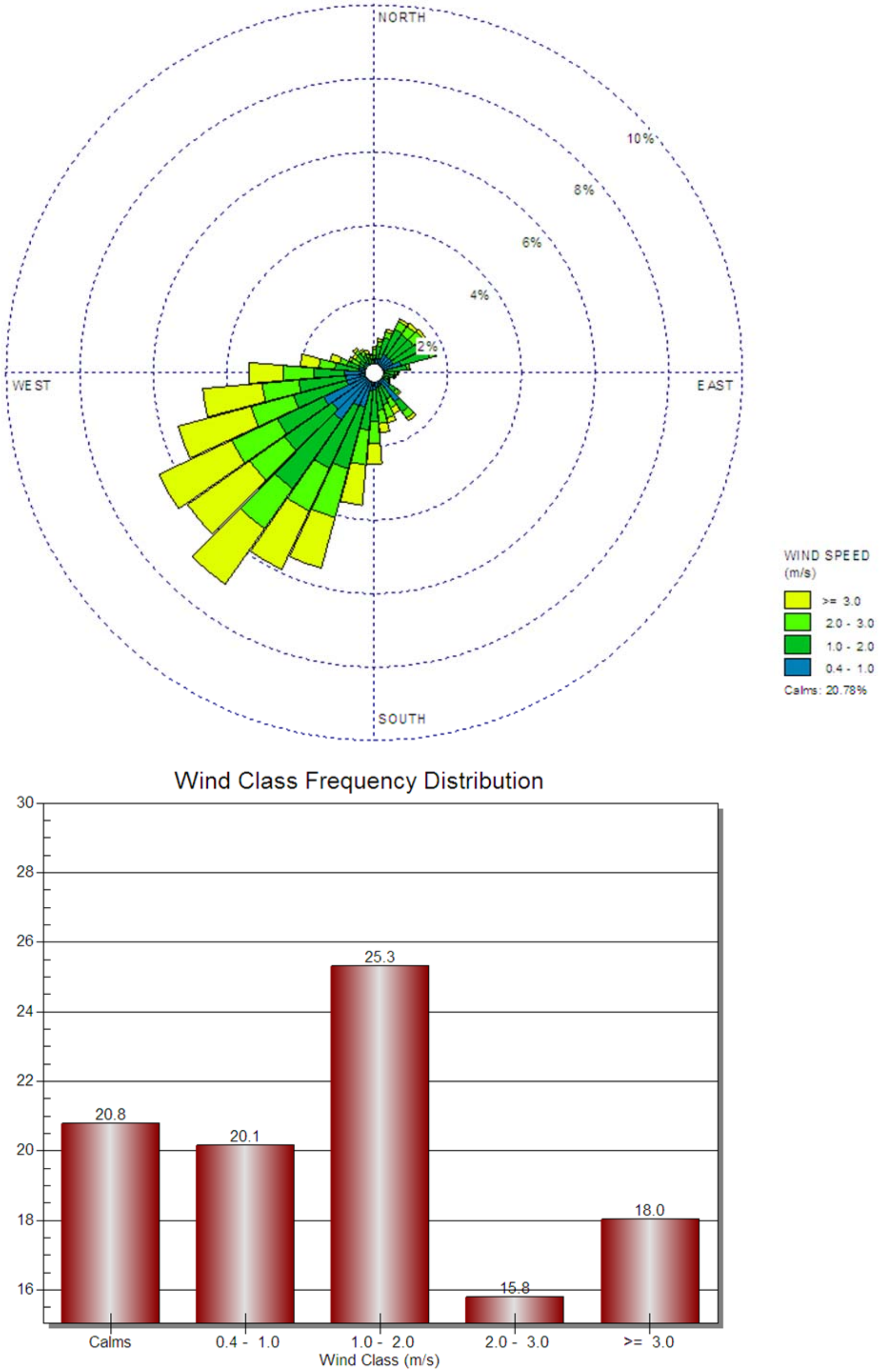


Figure 4.6a. Wind rose and histogram for wind direction and speed during monitoring at the Lemons pad location.

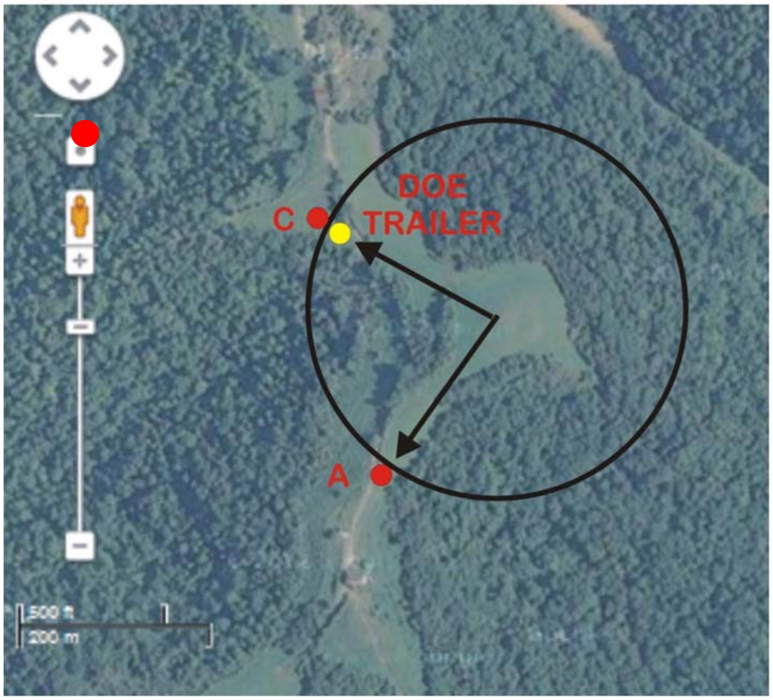


Figure 4.6b. Satellite photo of the Lemon pad showing sampling sites (A, C, E) as red dots and location of DOE trailer as shown by the yellow dot. Black circle is the 625 foot setback distance.

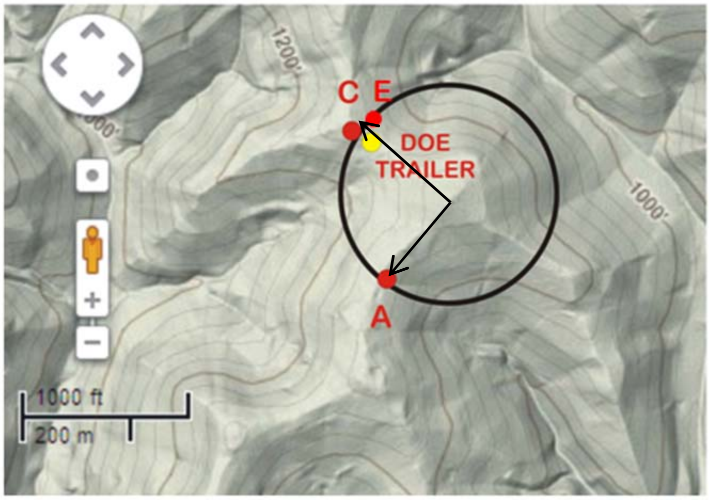


Figure 4.6c. Terrain map of the Lemons pad showing sampling sites (A,B,C, E) as red dots and location of DOE trailer as a yellow dot. Black circle is the 625 foot setback distance.

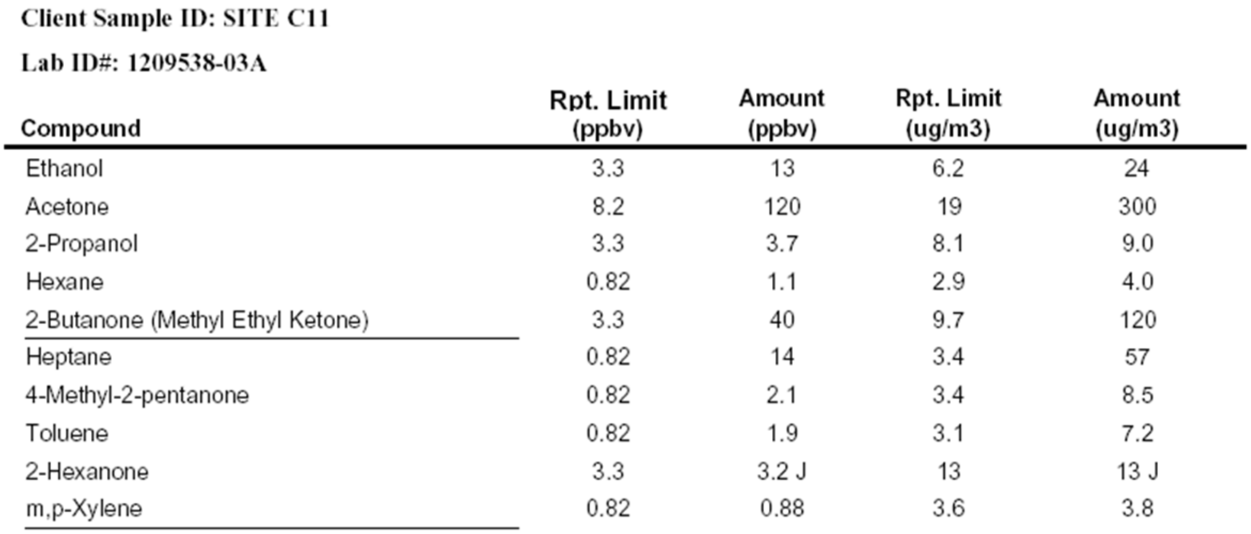
4.6.1 HC Results

HCs data are available from October 2-15 at this site for a total of 278 samples. The samples collected from September 27-October 2 had to be discarded due to excess moisture in the gas chromatograph columns that caused an unstable baseline in the chromatograms.

Table 4.6 GC-FID HC Results

Compound	Average (ppb)	Standard Deviation (ppb)	Minimum (ppb)	Maximum (ppb)	Frequency of Detection (%)
Ethane	30.4	49.9	4.7	638.6	100
Ethylene	0.8	1.2	0.0	6.8	43
Propane	25.1	65.8	0.6	860.0	100
Isobutane	5.7	10.0	0.0	122.7	95
n-butane	9.6	21.3	1.2	273.8	100
Isopentane	4.5	5.0	0.0	53	98
n-pentane	4.0	5.0	0.0	57.7	96
2-methylpentane	0.7	1.2	0.0	10.1	37
3-methylpentane	0.3	1.0	0.0	9.4	18

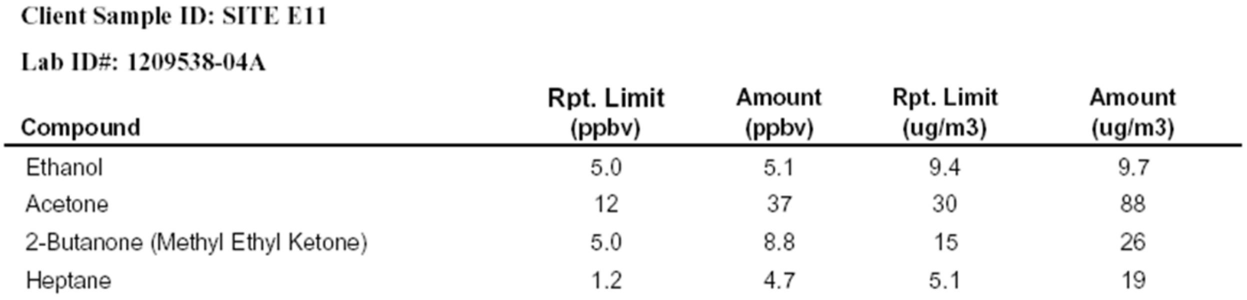
4.6.2 Summa Canister HC Results



Client Sample ID: SITE C11

Lab ID#: 1209538-03A

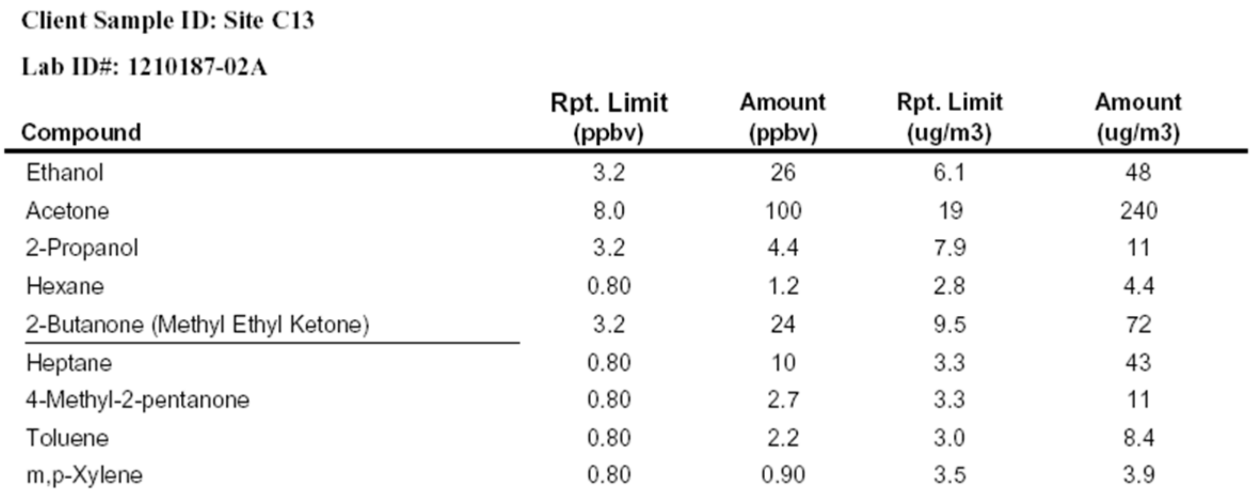
Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethanol	3.3	13	6.2	24
Acetone	8.2	120	19	300
2-Propanol	3.3	3.7	8.1	9.0
Hexane	0.82	1.1	2.9	4.0
2-Butanone (Methyl Ethyl Ketone)	3.3	40	9.7	120
Heptane	0.82	14	3.4	57
4-Methyl-2-pentanone	0.82	2.1	3.4	8.5
Toluene	0.82	1.9	3.1	7.2
2-Hexanone	3.3	3.2 J	13	13 J
m,p-Xylene	0.82	0.88	3.6	3.8



Client Sample ID: SITE E11

Lab ID#: 1209538-04A

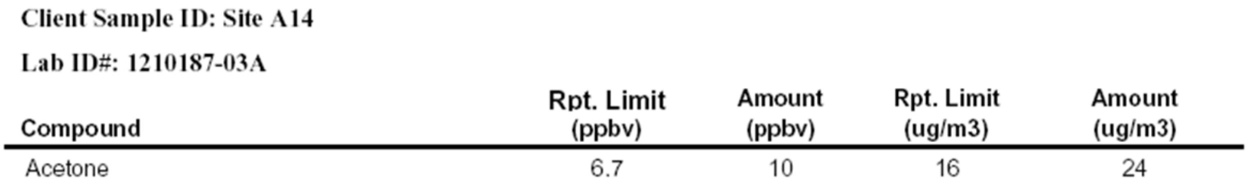
Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethanol	5.0	5.1	9.4	9.7
Acetone	12	37	30	88
2-Butanone (Methyl Ethyl Ketone)	5.0	8.8	15	26
Heptane	1.2	4.7	5.1	19



Client Sample ID: Site C13

Lab ID#: 1210187-02A

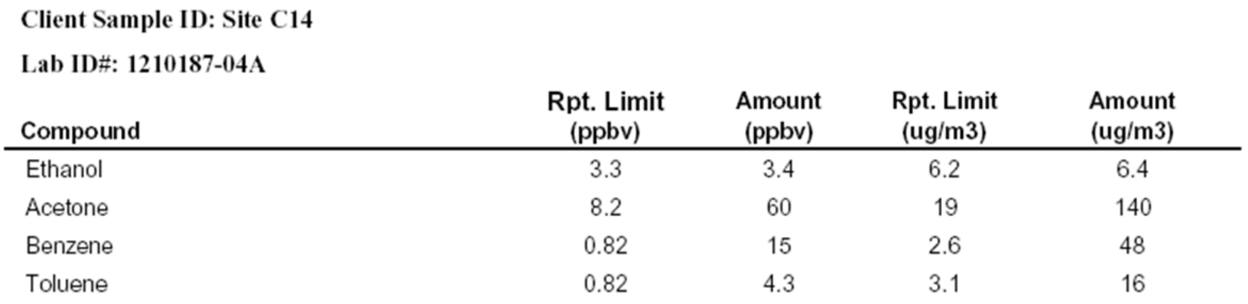
Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethanol	3.2	26	6.1	48
Acetone	8.0	100	19	240
2-Propanol	3.2	4.4	7.9	11
Hexane	0.80	1.2	2.8	4.4
2-Butanone (Methyl Ethyl Ketone)	3.2	24	9.5	72
Heptane	0.80	10	3.3	43
4-Methyl-2-pentanone	0.80	2.7	3.3	11
Toluene	0.80	2.2	3.0	8.4
m,p-Xylene	0.80	0.90	3.5	3.9



Client Sample ID: Site A14

Lab ID#: 1210187-03A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Acetone	6.7	10	16	24



Client Sample ID: Site C14

Lab ID#: 1210187-04A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethanol	3.3	3.4	6.2	6.4
Acetone	8.2	60	19	140
Benzene	0.82	15	2.6	48
Toluene	0.82	4.3	3.1	16

Samples A11 and A13 had no detectable organics.

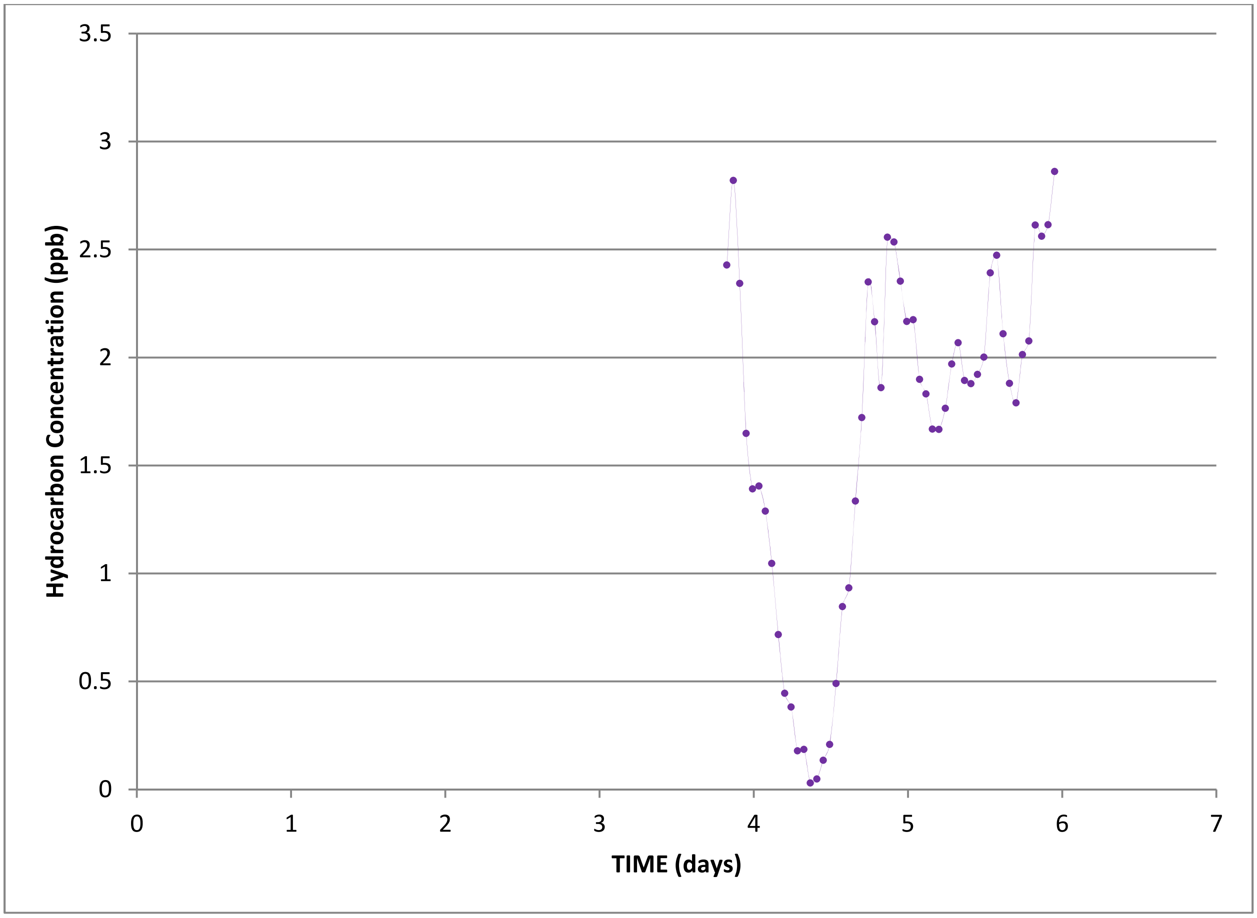


Figure 4.6.2a. PID results for 9/20-27/2012 at Site A.

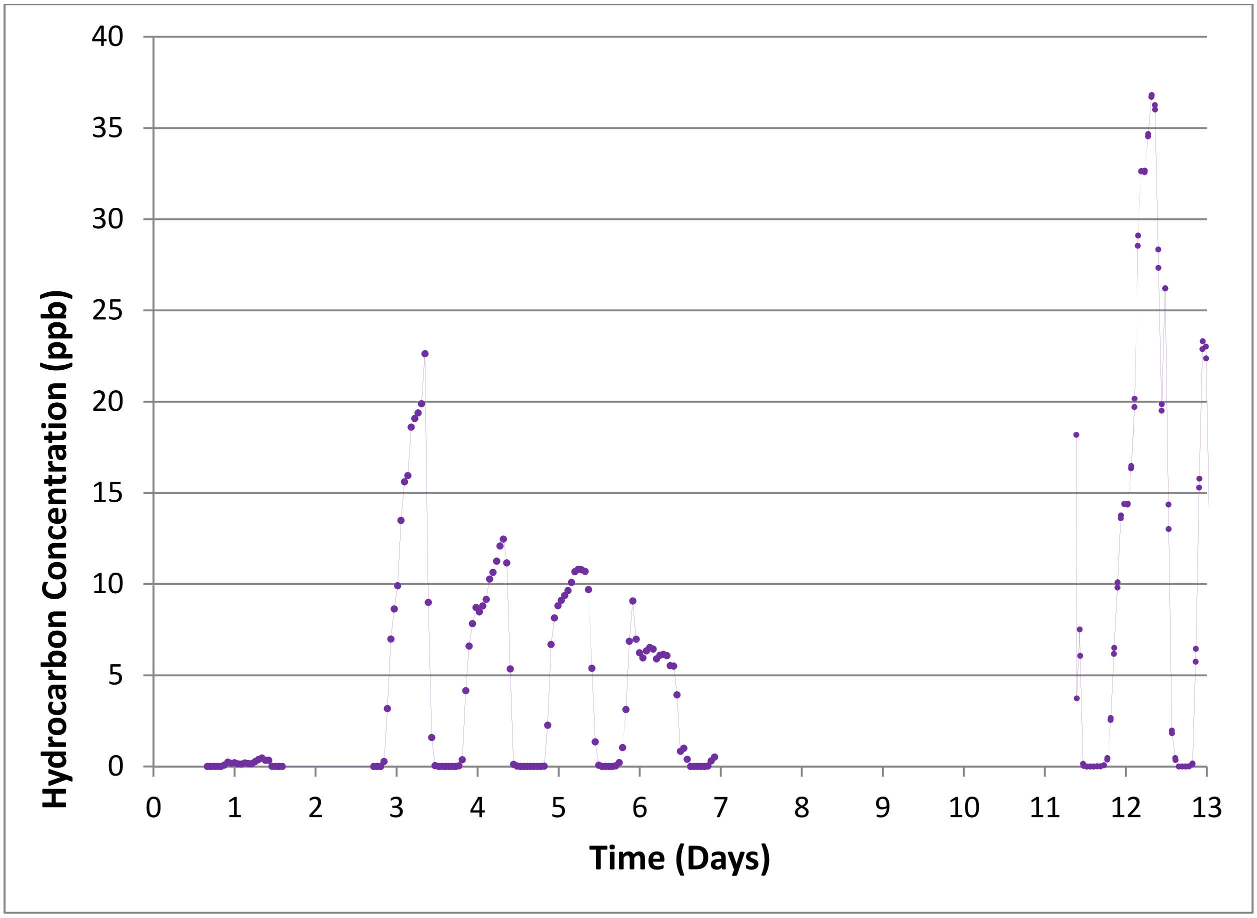


Figure 4.6.2b. PID results for 9/20-27/2012 and 10/1-3/2012 at Site C

4.6.3 Ozone Results

Ozone data are available for most of the monitoring duration at this site, September 26-October 15, with a gap in the data from September 28-October 2 due to a power outage (Figures 4.6d-f). The average ozone concentration using one minute data at the Donna pad was 33ppb, and the maximum hourly average concentration was 65ppb. Day-to-night variations were 20-40ppb. Calculating 8-hour averages to more directly compare to the NAAQS results in a range of 8-hour averages of 11ppb – 61ppb.

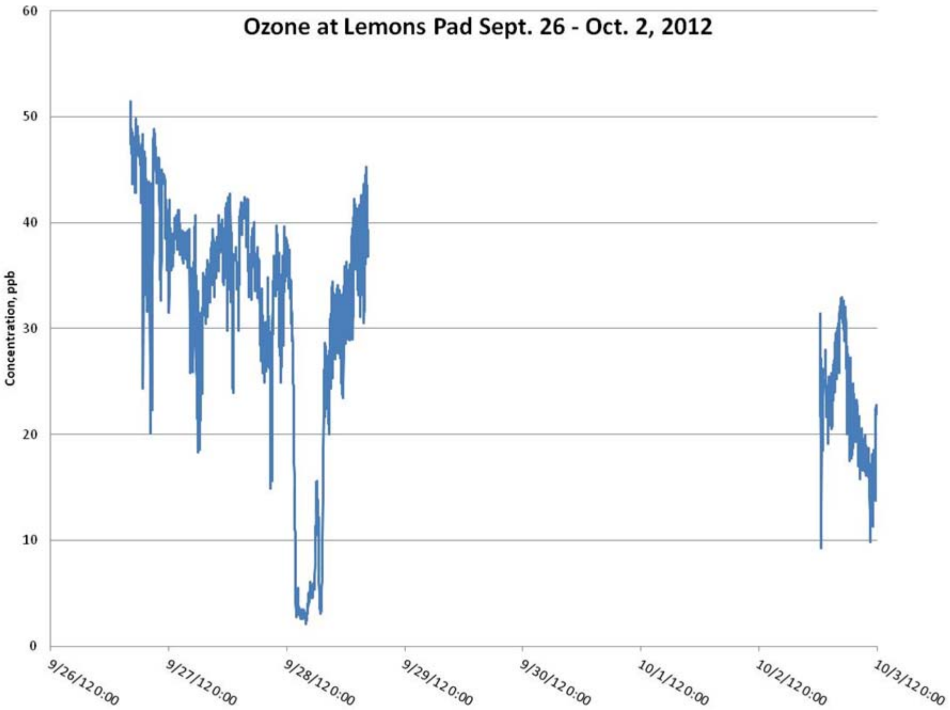


Figure 4.6d. One-minute average ozone concentrations for the first week at the Lemons pad.

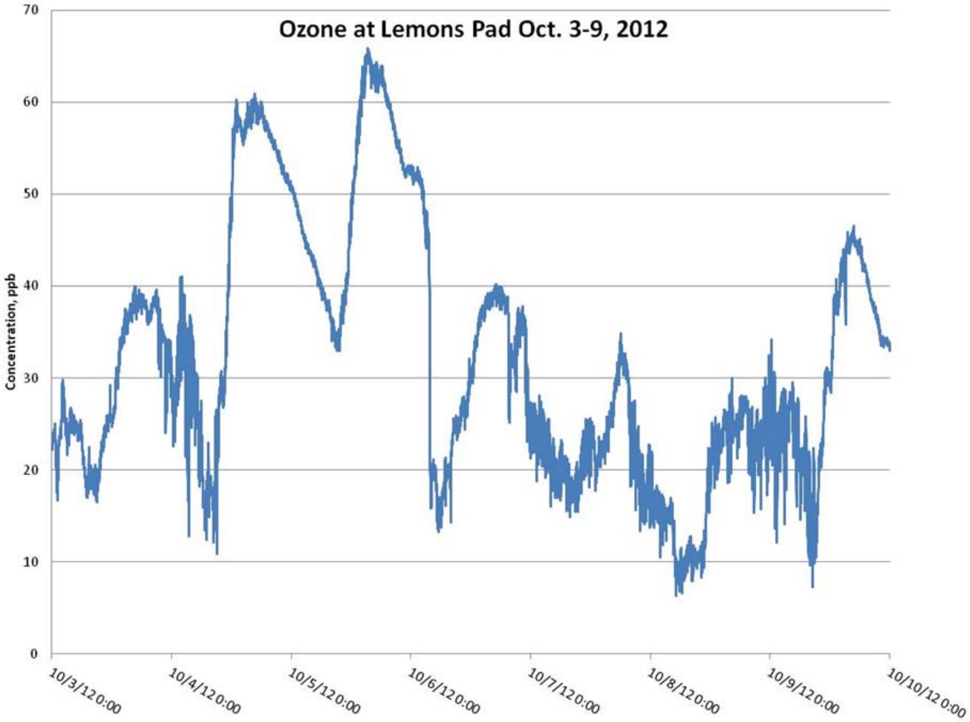


Figure 4.6e. One-minute average ozone concentrations for the second week at the Lemons pad.

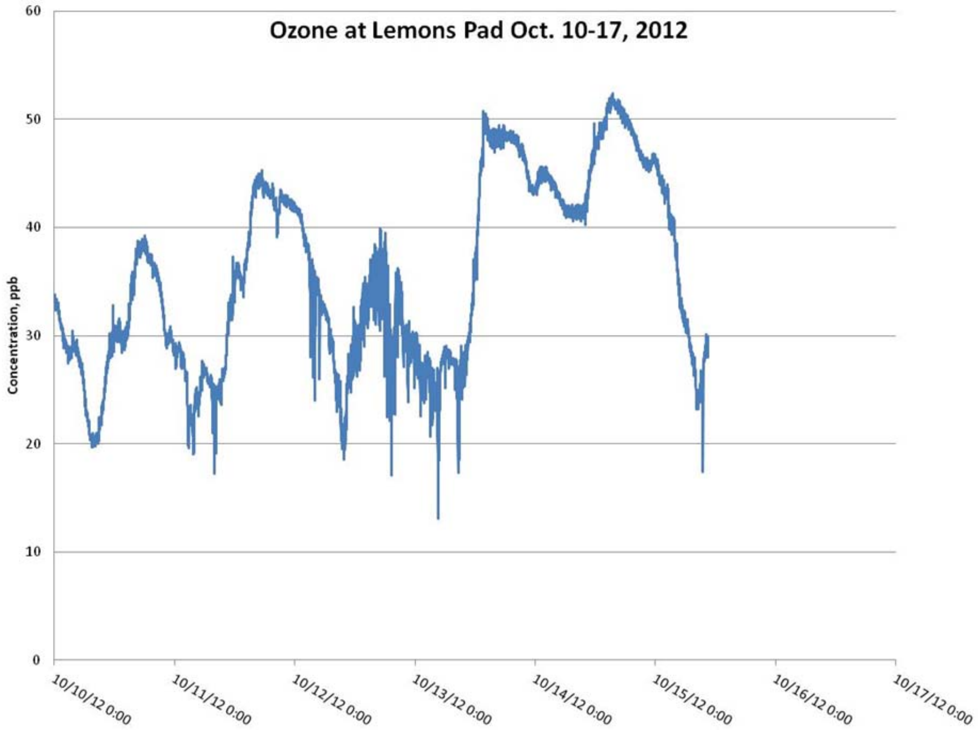


Figure 4.6f. One-minute average ozone concentrations for the third week at the Lemons pad.

4.6.4 NOx Results

NO_x data for the Lemons pad site are available for the entire monitoring duration, September 26-October 15, with a gap in the data from September 28-October 2 due to a power interruption caused by the diesel generator running out of fuel (Figures 4.6g-i). The average of the one-minute measurements at the Lemons pad site was 9ppb with an hourly average maximum of 151ppb.

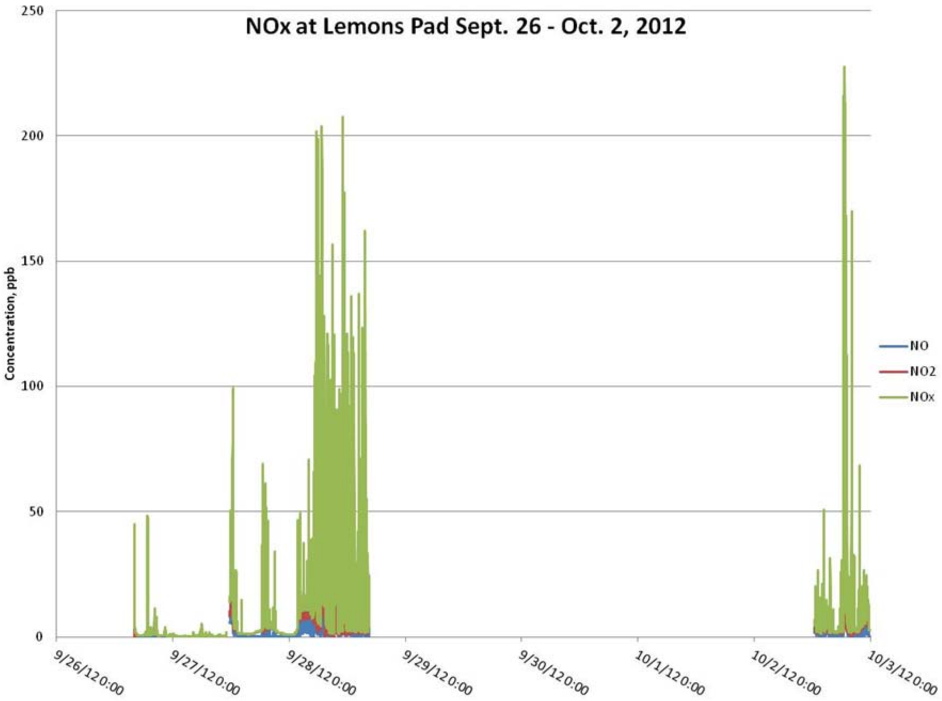


Figure 4.6g. One-minute average NO_x concentrations for the first week at the Lemons pad.

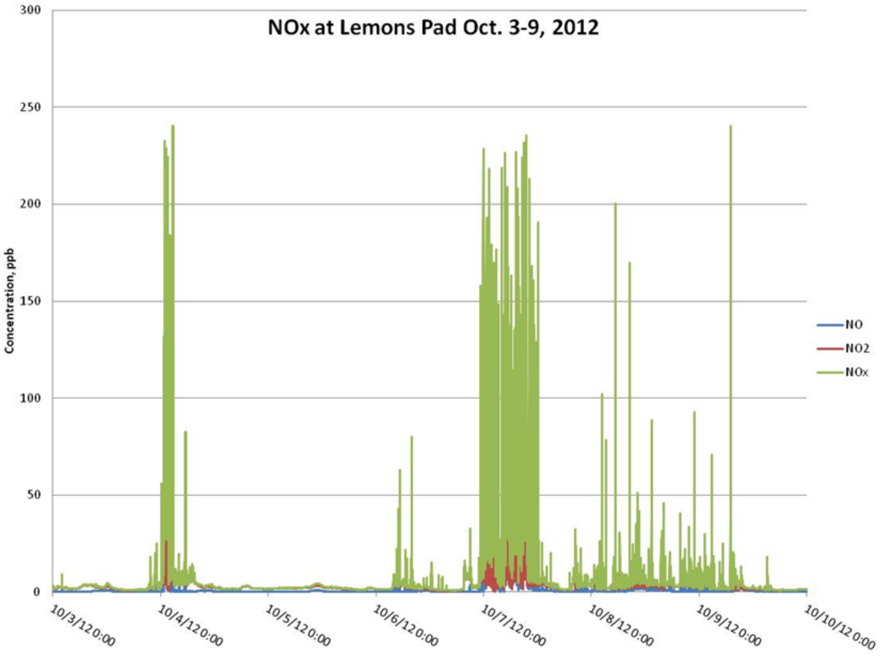


Figure 4.6h. One-minute average NO_x concentrations for the second week at the Lemons pad.

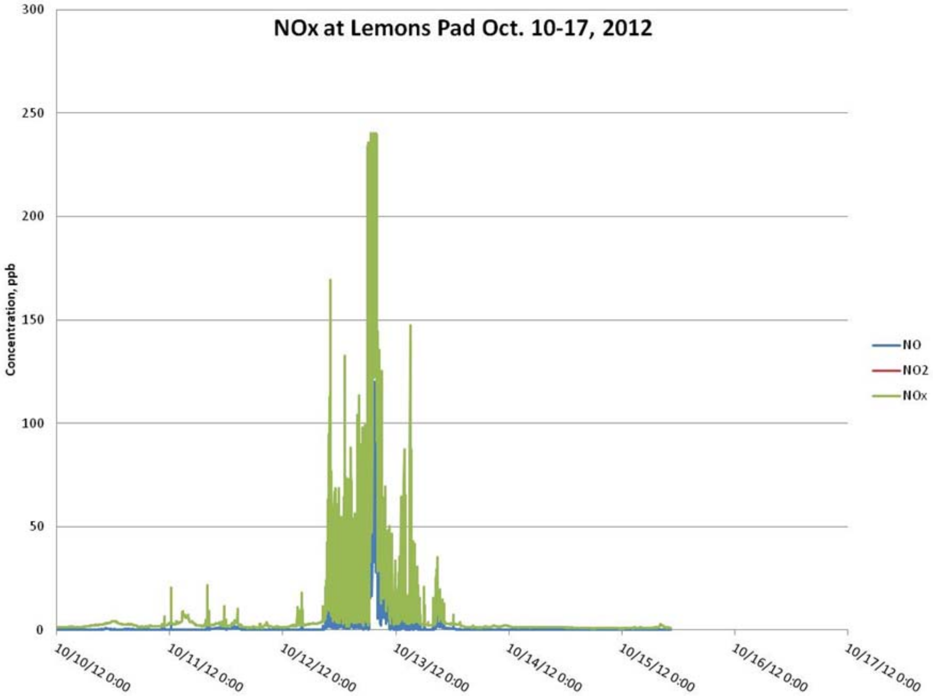


Figure 4.6i. One-minute average NO_x concentrations for the third week at the Lemons pad.

4.6.5 Methane Results

At this site there was a gap in the data due to a power interruption that started on 9/28 and ended on 10/2. The ambient methane concentration at the Lemons pad averaged 2.1ppm (±0.1) with an average isotopic composition of -46.7‰ (±1.8‰) which are typical background atmospheric values (Figures 4.6 j and k). For the duration of the three week monitoring period at this site, the methane concentration was near ambient levels. A maximum concentration of 2.9ppm was recorded a total of 41 times with an average $\delta^{13}C$ value of -45.7‰ (±0.7‰), indicating a very minor contribution from a thermogenic source.

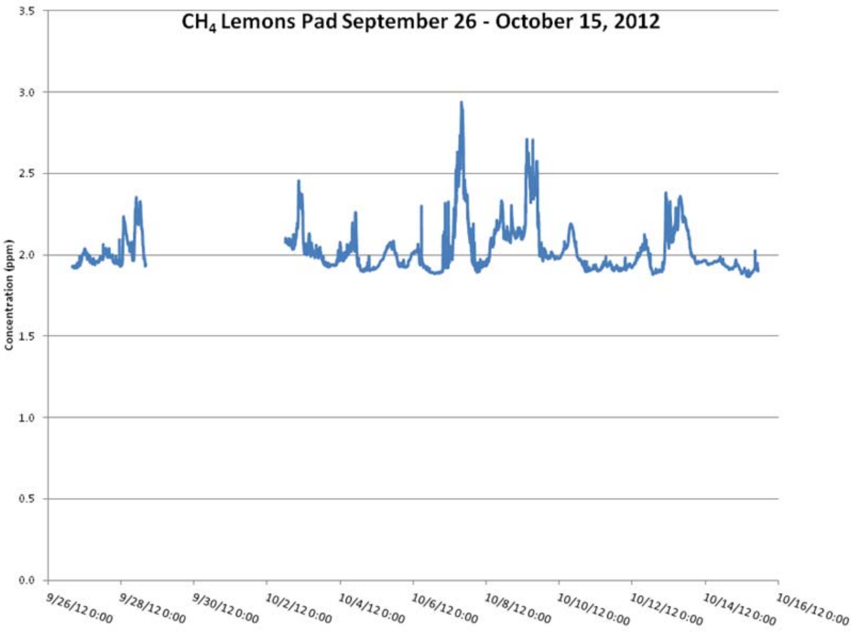


Figure 4.6j. One-minute average CH_4 concentrations at the Lemons pad.

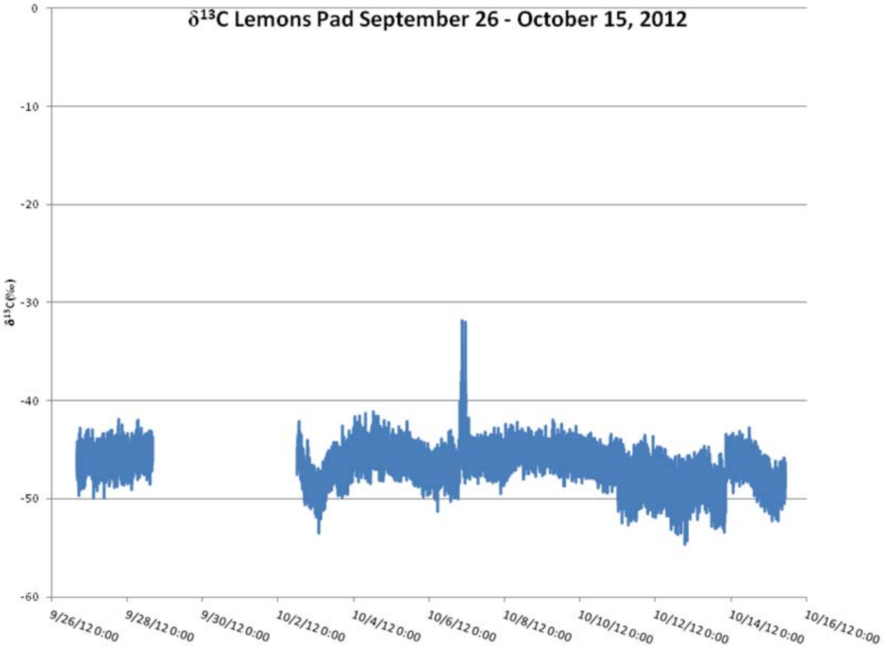


Figure 4.6k. One-minute average $\delta^{13}C$ of CH_4 at the Lemons pad.

4.6.6 CO2 Results

Over the three weeks of monitoring at the Lemons pad site, the CO$_2$ concentration averaged 395ppm (±9) with δ^{13}C averaging -11.7‰ (±0.8‰) (Figure 4.6l). The CO$_2$ concentrations and δ^{13}C values at the site cycled daily. Starting at approximately 8pm, the CO$_2$ concentration increased gradually to values typically greater than 415ppm and occasionally greater than 440ppm before dropping back to near ambient levels by 7am. During these times, the corresponding δ^{13}C values become more depleted, dropping to less than -13‰ and occasionally approaching -14‰. The maximum CO$_2$ concentration at the site was 446ppm with a corresponding δ^{13}C value of -13.6‰.

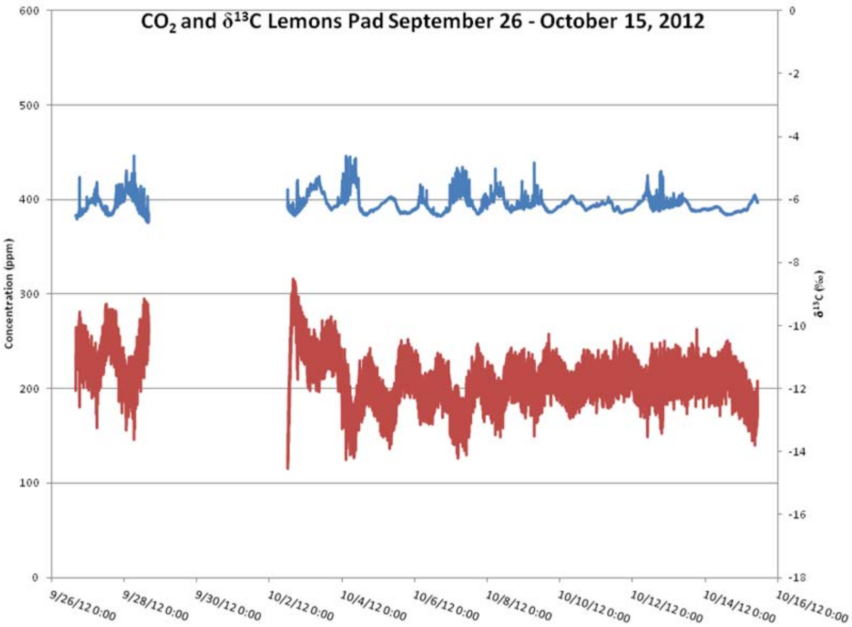


Figure 4.6l. One-minute average CO$_2$ concentrations and δ^{13}C of CO$_2$ at the Lemons pad.

4.6.7 Dust Results

Data are available for September 26-October 17 with gaps in the data from September 28-October 2 and October 15-16 due to power interruption (Figure 4.6 m1). At the Lemons pad, Average PM$_{10}$ concentration was 12µg/m^3 and average PM$_{2.5}$ concentration was 7µg/m^3. Maximum one-hour average concentrations of PM$_{10}$ and PM$_{2.5}$ were 188µg/m^3 and 25µg/m^3, respectively.

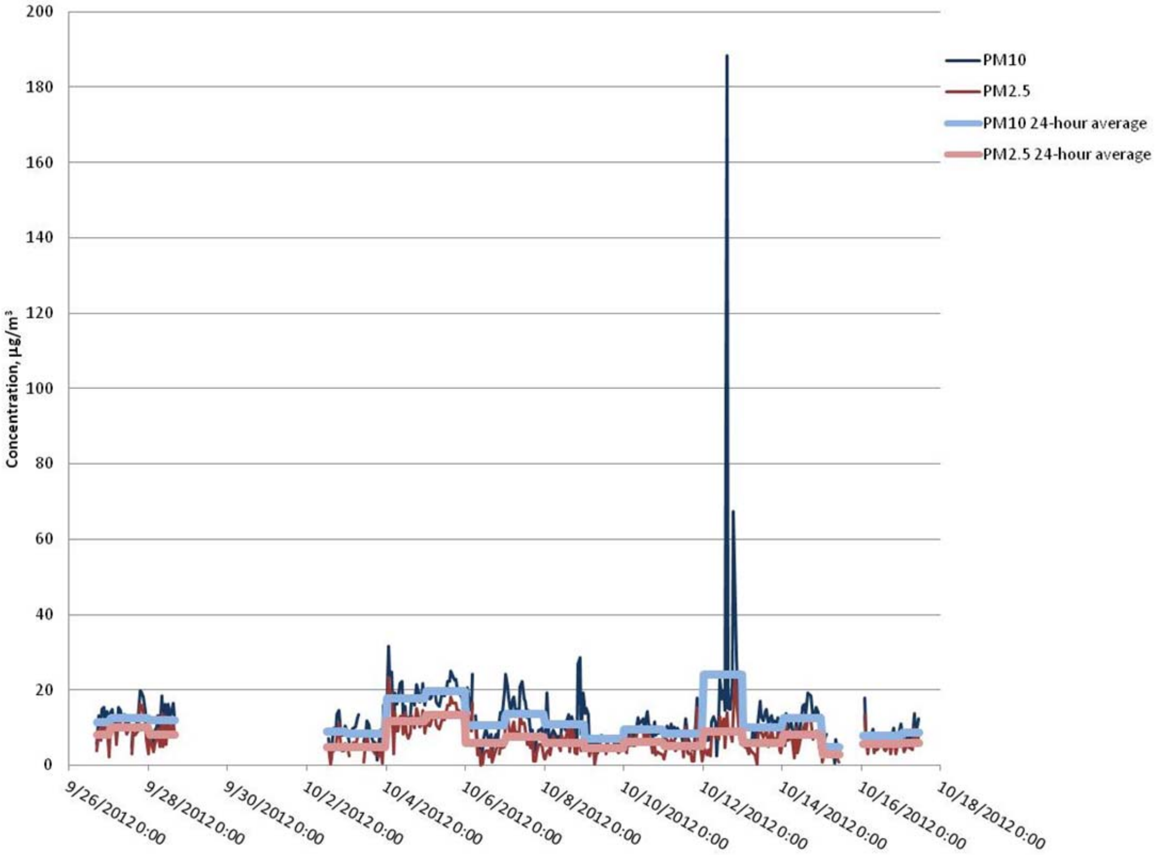


Figure 4.6m1. One-hour average PM_{10} and $PM_{2.5}$ concentrations at the Lemons pad.

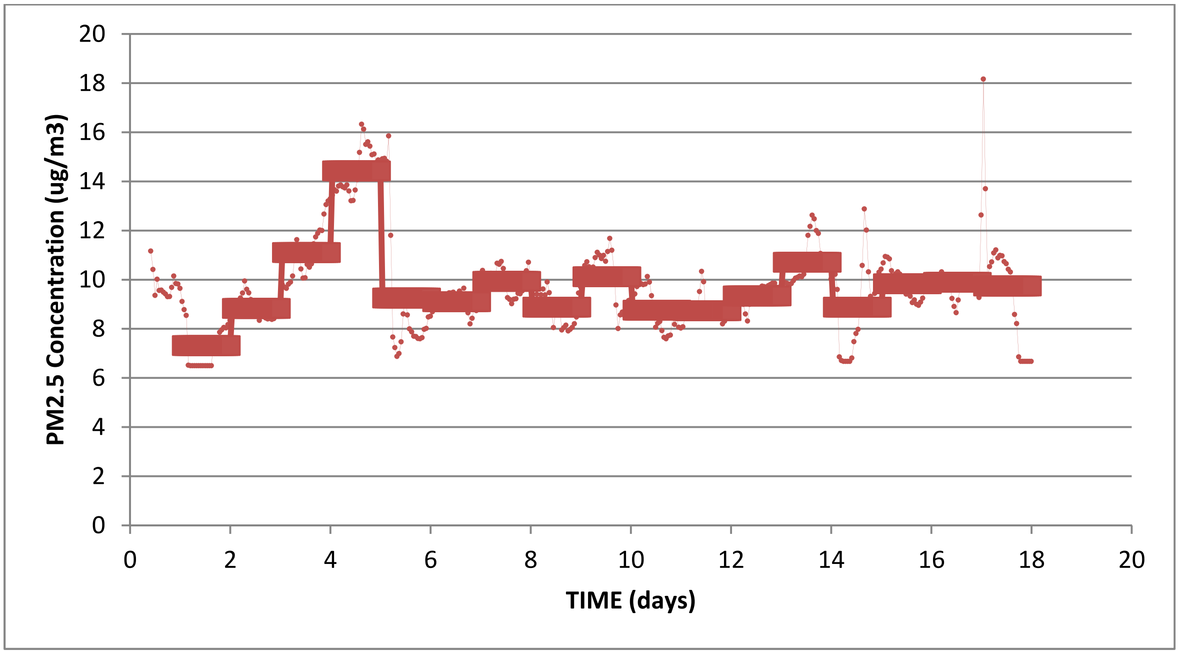


Figure4.6m2. One hour (points) and 24 hour (bars) Dust Track averages for Lemons pad site C.

4.6.8 Noise results

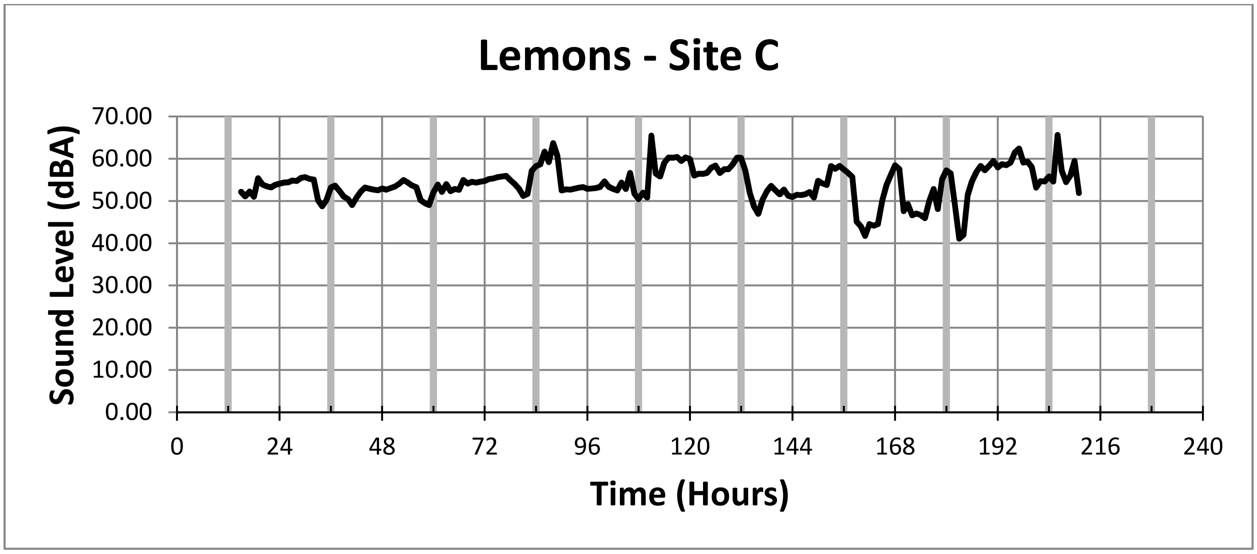


Figure 4.6n. Noise results for the period 9/20-30/12 for Site C averaged 54 dBA. Site A had battery problems. Hours 0, 24, 48 etc. are midnight. Heavy, vertical lines are noon for each day.

4.6.9 SO2 Results

Data for SO_2 are available for September 27 – October 15 with sections of data missing due to power interruptions (Figures 4.6o-q). The average concentration of SO_2 at the Lemons pad was 2.6ppb, with peaks not exceeding 4.5ppb. Calculating 1-hour averages from the one-minute data for a more direct comparison with the NAAQS for SO_2 results in a range of 1-hour averages of 1.6ppb – 3.8ppb. Similarly, calculating 3-hour averages from the one-minute data results in a range of 1.7ppb –3.7ppb.

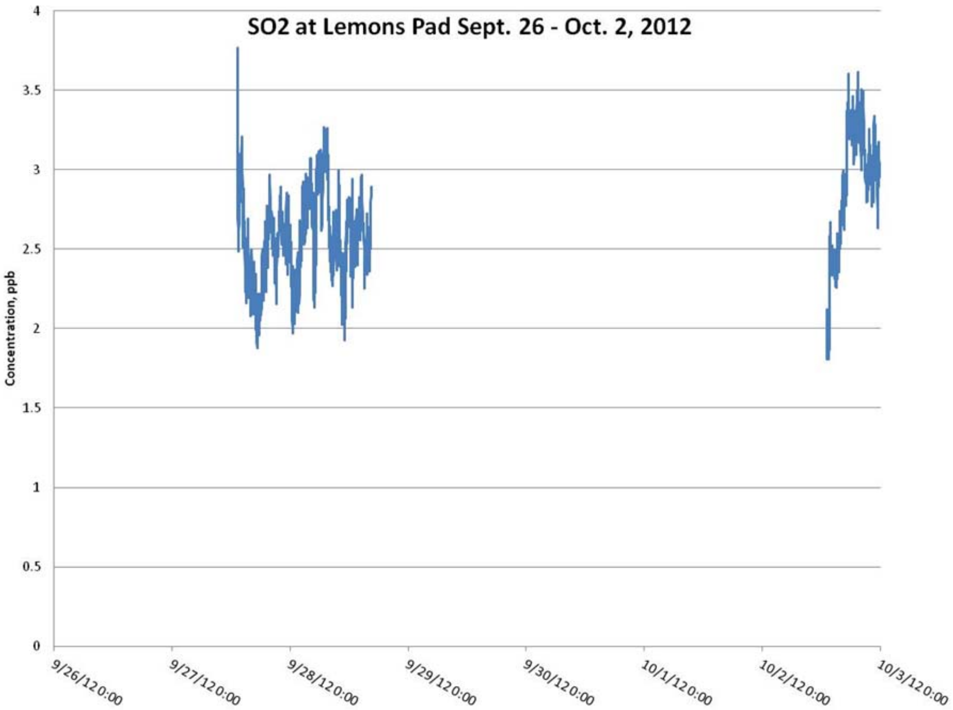


Figure 4.6o. One-minute average SO_2 concentrations for the Lemons pad, September 26 – October 2, 2012.

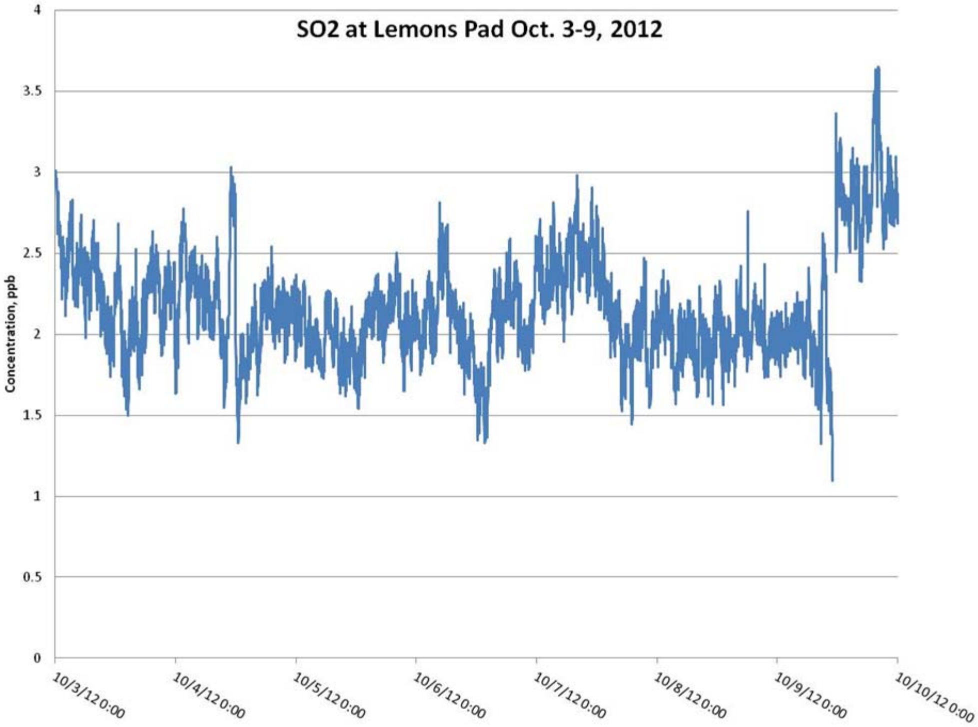


Figure 4.6p. One-minute average SO_2 concentrations for the Lemons pad, October 3-9, 2012.

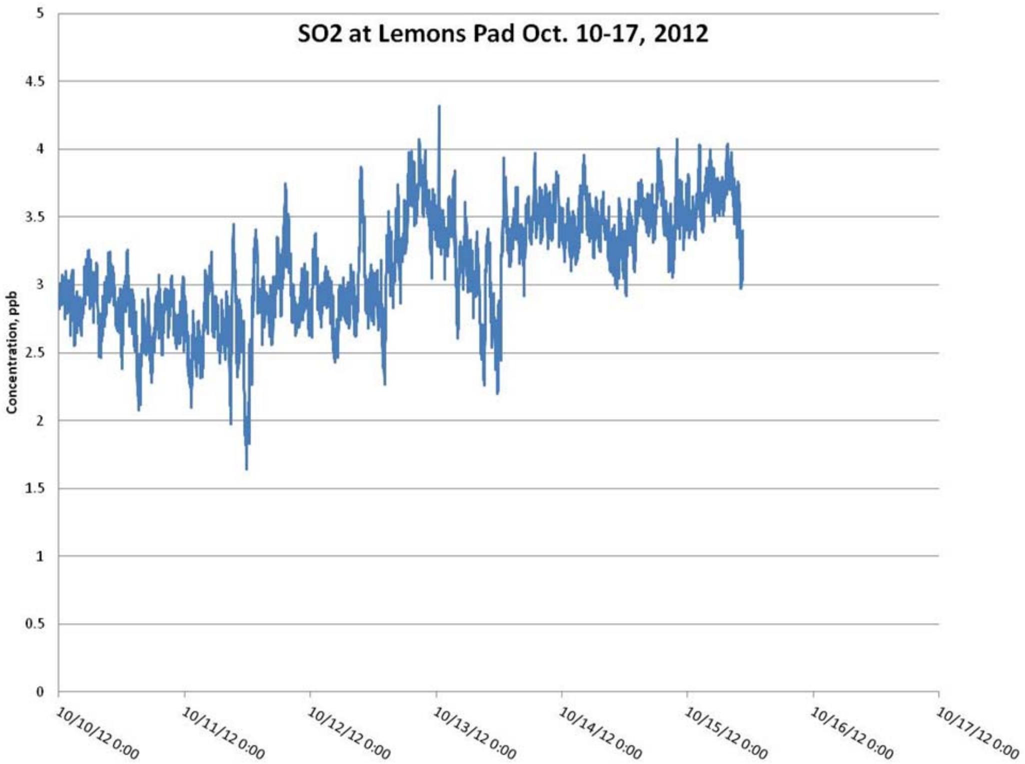


Figure 4.6q. One-minute average SO_2 concentrations for the Lemons pad, October 10-17, 2012.

4.6.10 OC/EC Results

At the Lemons pad, data are available for the entire monitoring period with the exception of September 28 – October 2 due to a loss of electric power. The data are less noisy and have more distinct peaks in concentration, with an average OC concentration of 2.4μgC/m^3, ranging from 1.2-17.7μgC/m^3, and an average EC concentration of 0.8μgC/m^3, ranging from >0.1-6.6μg/m^3.

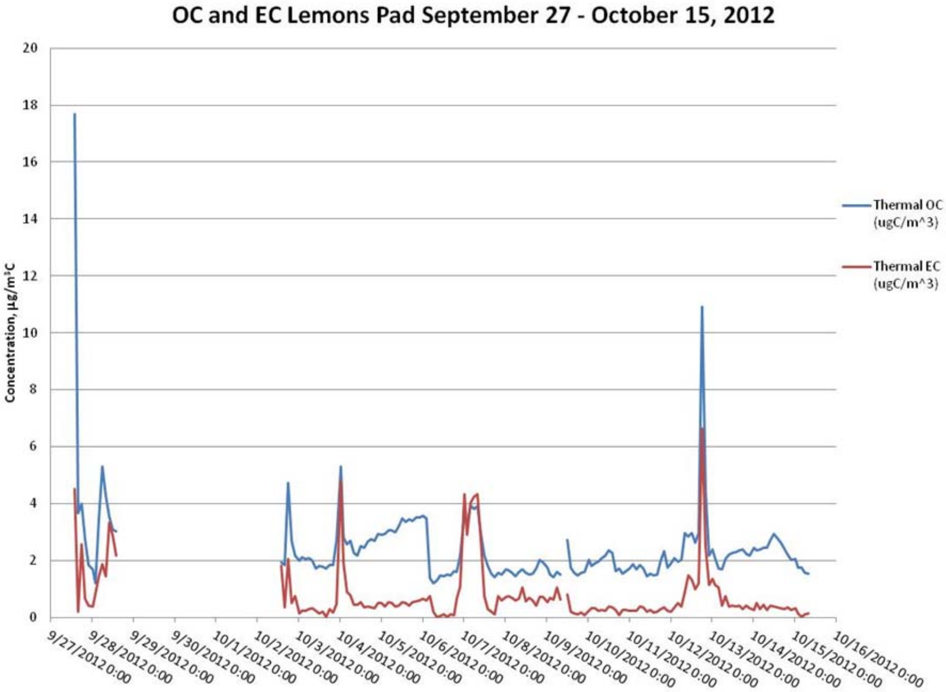


Figure 4.6r. Two-hour average OC and EC concentrations for the Lemons pad.

4.7 WVDNR A pad (Brooke County) (Horizontal Drilling)

The laboratory was moved to the WVDNR A pad site in Brooke County off of Putney Ridge Road on October 17, 2012. The laboratory was located approximately 200m southwest of the well pad off the side of the main well pad access road with coordinates of 40°19’15.5"N, 80°32'12.2"W. As there was no available electric service at this site, the laboratory was operated using a diesel fuel-powered generator provided by Chesapeake Energy. The generator was approximately 10m from the laboratory in the opposite direction of the well pad. After unpacking, installing, and calibrating, instruments were fully operational and collecting data on October 19. Monitoring at this site ended on November 2, 2012 due to Chesapeake Energy shutting down the generator. The laboratory was moved from the site on November 6, 2012. During this period, wind most frequently came from the southwest; winds from the northeast would likely have carried any plumes from the well pad toward the monitoring laboratory but there were no instances of winds from the northeast. Figure 4.7a shows a wind rose and histogram for the wind direction and speed during monitoring at the WVDNR A pad location. Figures for other measured meteorological parameters (temperature, relative humidity, rainfall, and solar intensity) are included in **Appendix C**.

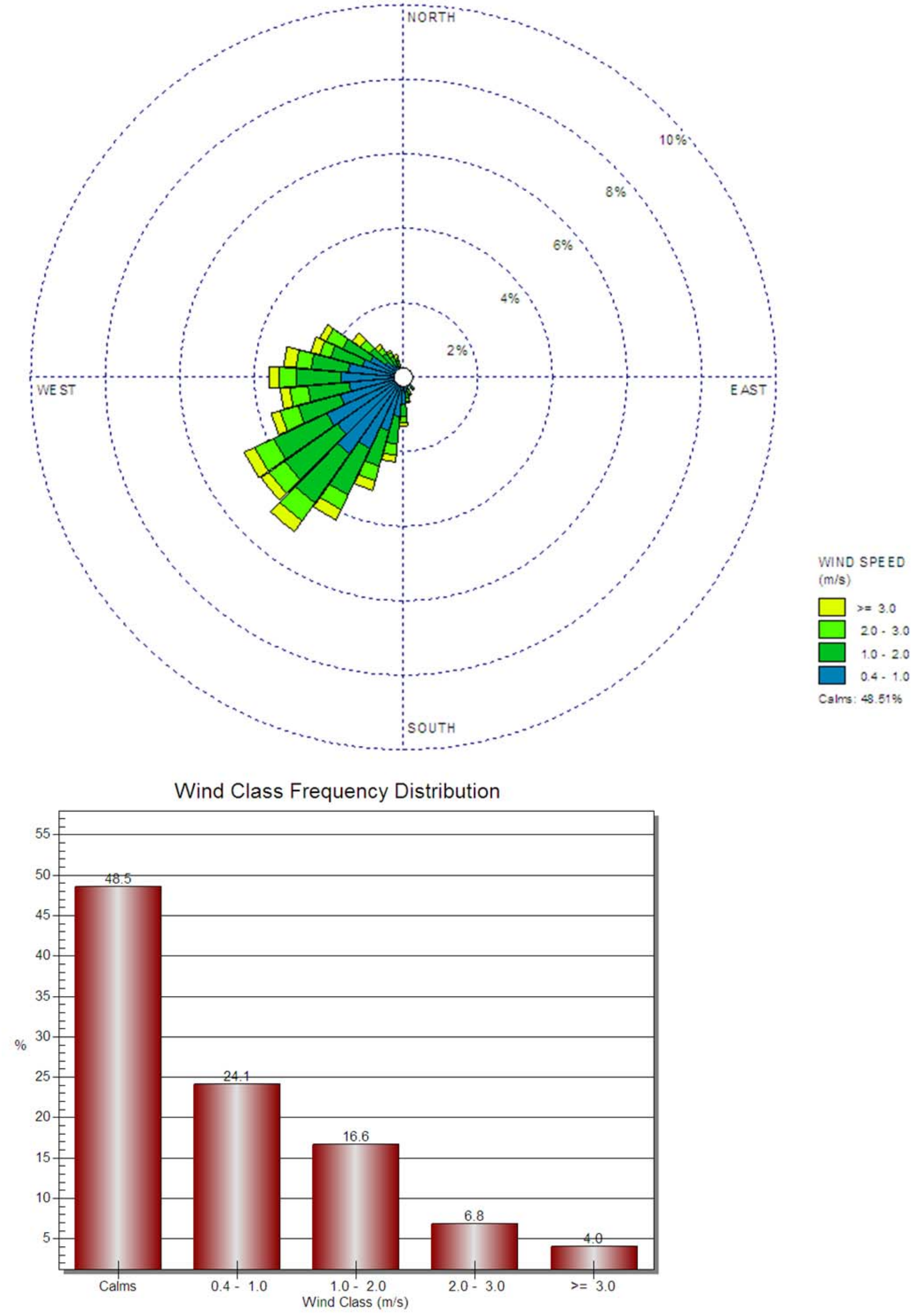


Figure 4.7a. Wind rose and histogram for wind direction and speed during monitoring at the WVDNR A Pad location.

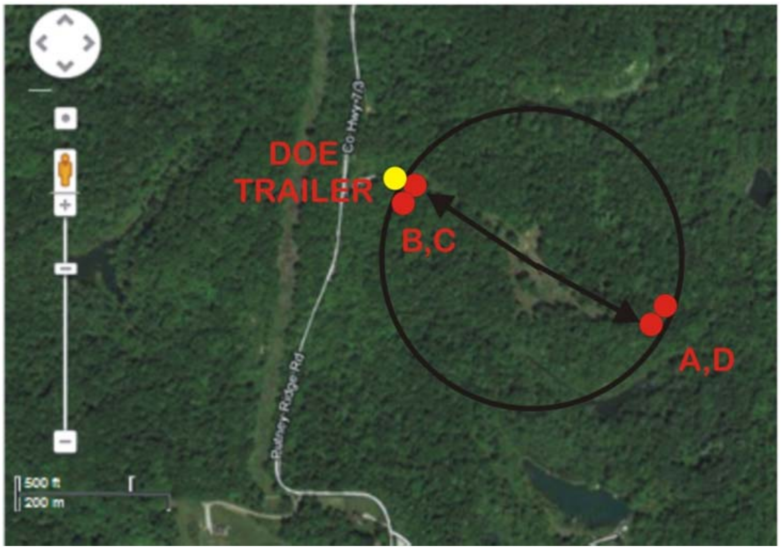


Figure 4.7b. Satellite photo of the WVDNR A pad showing sampling sites (A,B,C, D) as red dots and location of DOE trailer as shown by the yellow dot. Black circle is the 625 foot setback distance.

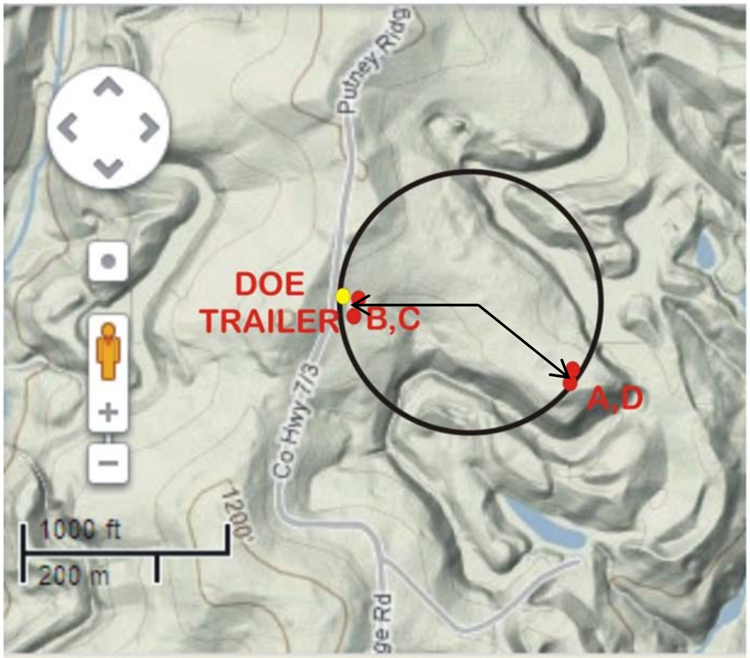


Figure 4.7c. Terrain map of the WVDNR pad showing sampling sites (A,B,C, D) as red dots and location of DOE trailer as a yellow dot. Black circle is the 625 foot setback distance.

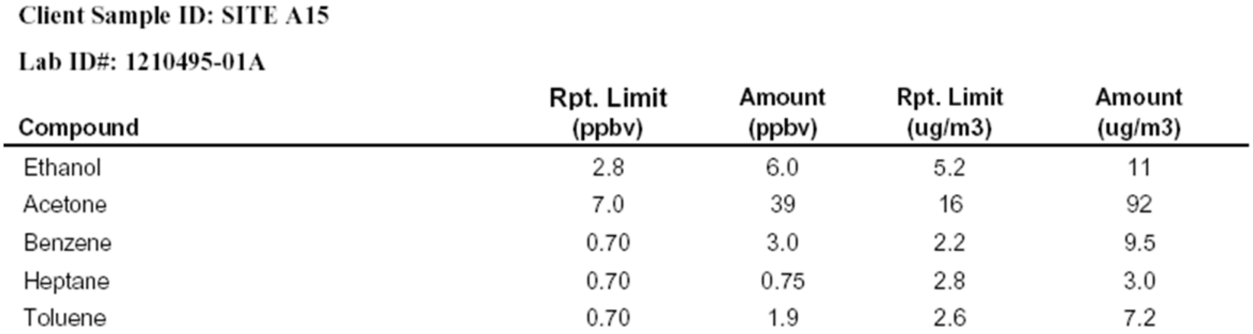
4.7.1 HC Results

The HCs analyzer was running continuously at this site from 10/19-11/2 with a gap in the data from 10/25-10/31 due to a power interruption. There were a total of 162 samples.

Table 4.7 GC-FID HC Results

Compound	Average (ppb)	Standard Deviation (ppb)	Minimum (ppb)	Maximum (ppb)	Frequency of Detection (%)
Hexane	0.4	1.3	0.0	8.7	13
Toluene	1.0	1.0	0.0	8.8	82
m-diethylbenzene	0.5	1.8	0.0	12.5	14
n-undecane	3.4	14.3	0.0	122.3	40
n-dodecane	3.6	12.7	0.0	95.8	43
Ethane	17.8	20.6	4.9	139.3	100
Ethylene	1.6	0.9	0.0	5.3	92
Propane	11.6	13.5	0.6	99.3	100
Propylene	0.2	0.5	0.0	3.7	20
Isobutane	2.5	3.1	0.0	22.2	86
n-butane	6.2	8.4	0.0	58.6	99
Acetylene	0.3	0.6	0.0	3.2	25
Isopentane	2.3	2.5	0.0	15.8	83
n-pentane	2.2	3.1	0.0	22.7	77
2-methylpentane	0.2	0.7	0.0	4.6	10

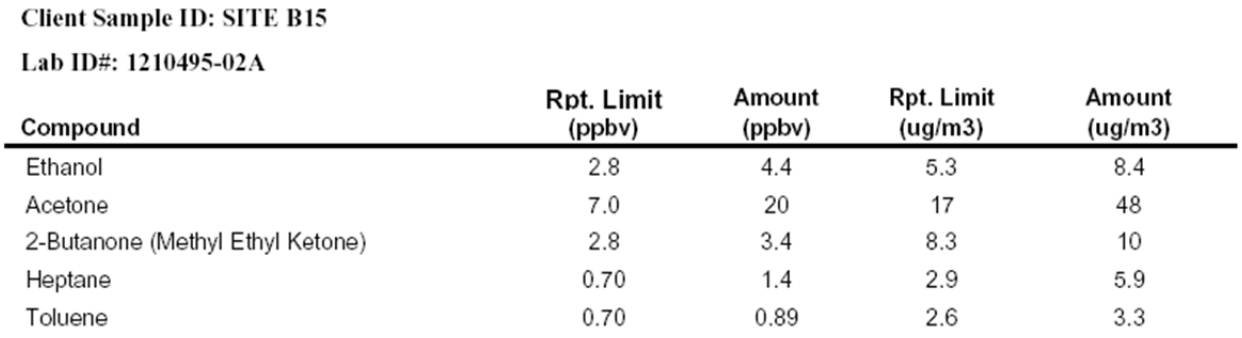
4.7.2 Summa Canister HC Results



Client Sample ID: SITE A15

Lab ID#: 1210495-01A

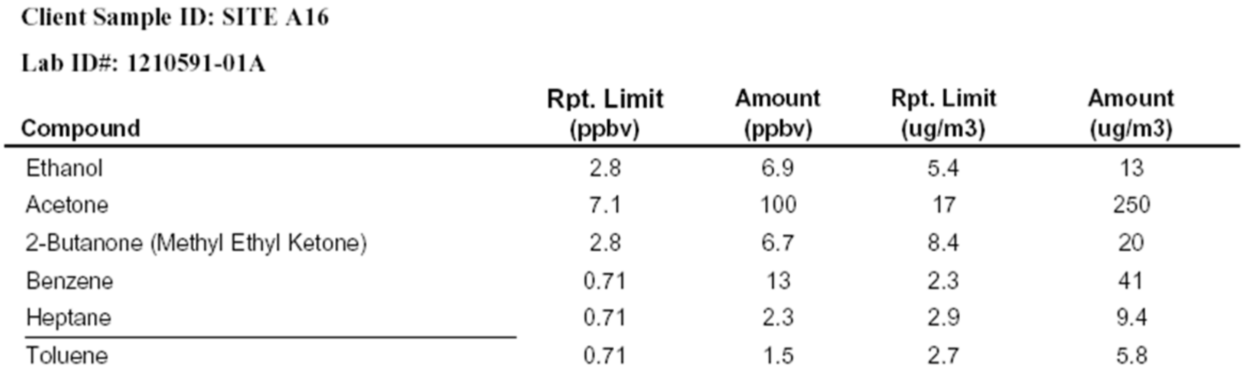
Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethanol	2.8	6.0	5.2	11
Acetone	7.0	39	16	92
Benzene	0.70	3.0	2.2	9.5
Heptane	0.70	0.75	2.8	3.0
Toluene	0.70	1.9	2.6	7.2



Client Sample ID: SITE B15

Lab ID#: 1210495-02A

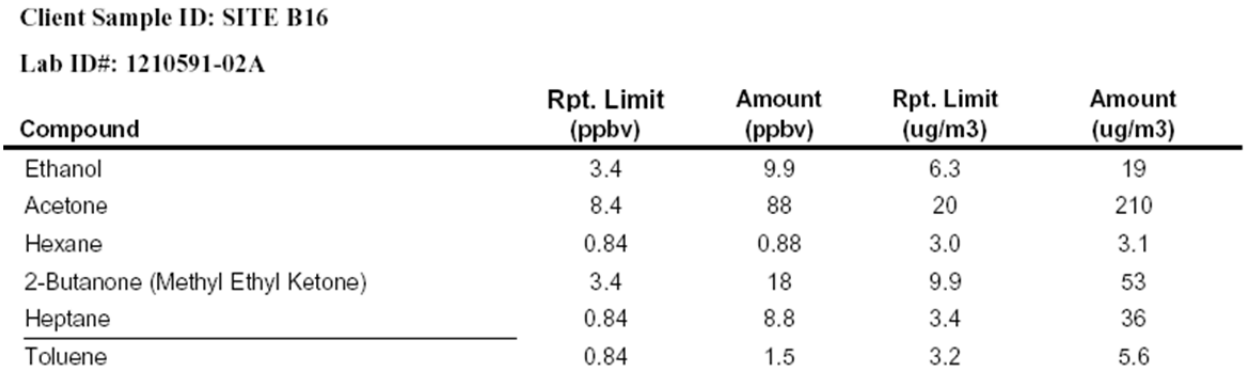
Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethanol	2.8	4.4	5.3	8.4
Acetone	7.0	20	17	48
2-Butanone (Methyl Ethyl Ketone)	2.8	3.4	8.3	10
Heptane	0.70	1.4	2.9	5.9
Toluene	0.70	0.89	2.6	3.3



Client Sample ID: SITE A16

Lab ID#: 1210591-01A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethanol	2.8	6.9	5.4	13
Acetone	7.1	100	17	250
2-Butanone (Methyl Ethyl Ketone)	2.8	6.7	8.4	20
Benzene	0.71	13	2.3	41
Heptane	0.71	2.3	2.9	9.4
Toluene	0.71	1.5	2.7	5.8



Client Sample ID: SITE B16

Lab ID#: 1210591-02A

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Ethanol	3.4	9.9	6.3	19
Acetone	8.4	88	20	210
Hexane	0.84	0.88	3.0	3.1
2-Butanone (Methyl Ethyl Ketone)	3.4	18	9.9	53
Heptane	0.84	8.8	3.4	36
Toluene	0.84	1.5	3.2	5.6

There were no samples for HCs taken at sites C or D because they were collocated with sites A and B.

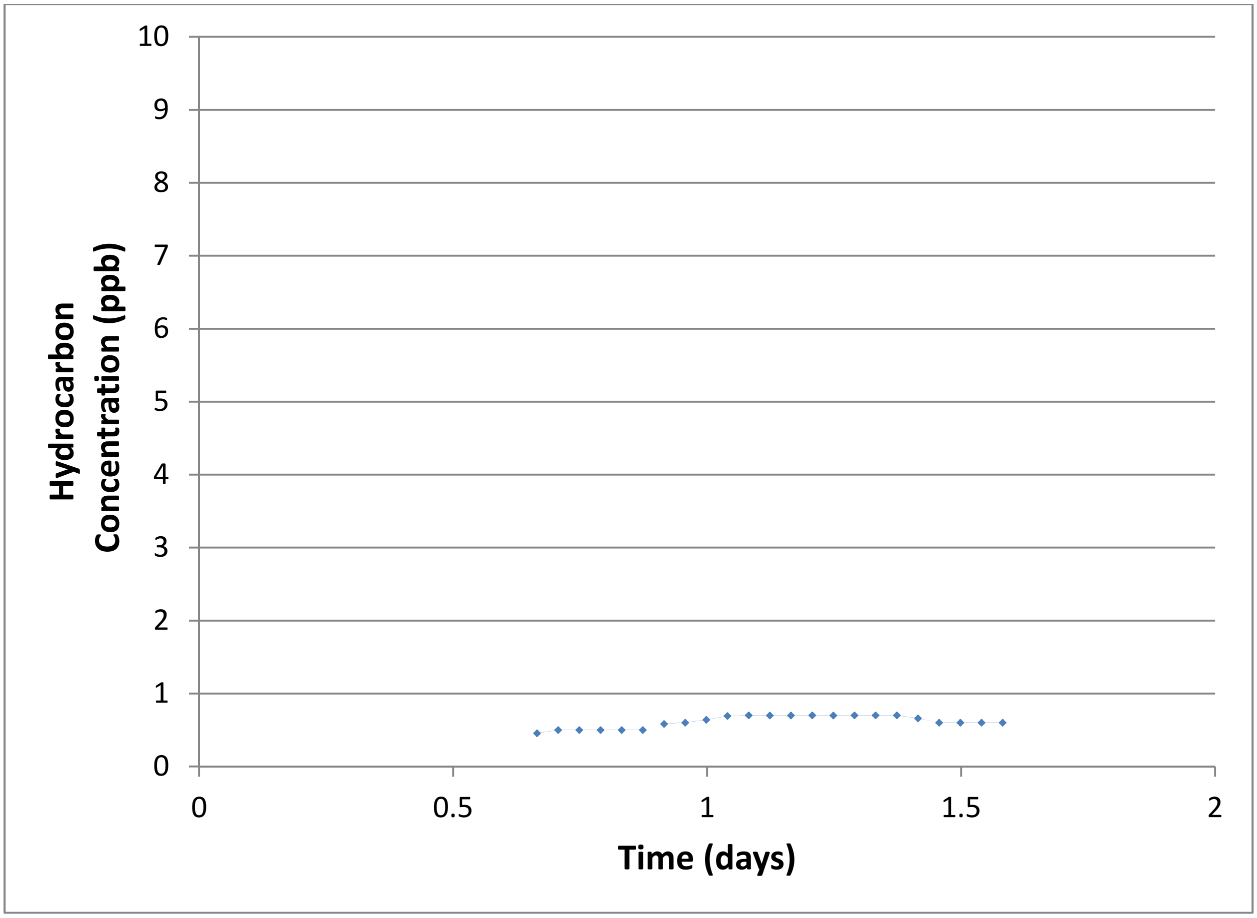


Figure 4.7.2a. PID data for 10/19-20/2012 at Site B. Instrument problems resulted in loss of data at other sites.

4.7.3 Ozone Results

Ozone data are available from October 19-November 2 (Figure 4.7d). The gap in the data from Oct. 25-31 is due to a generator switch that interrupted the power. The average ozone concentration using one minute data at the WVDNR A Pad was 31ppb, and the maximum hourly average concentration was 60ppb. Day-to-night variations typically around 20ppb. Calculating 8-hour averages to more directly compare to the NAAQS results in a range of 8-hour averages of 14ppb – 56ppb.

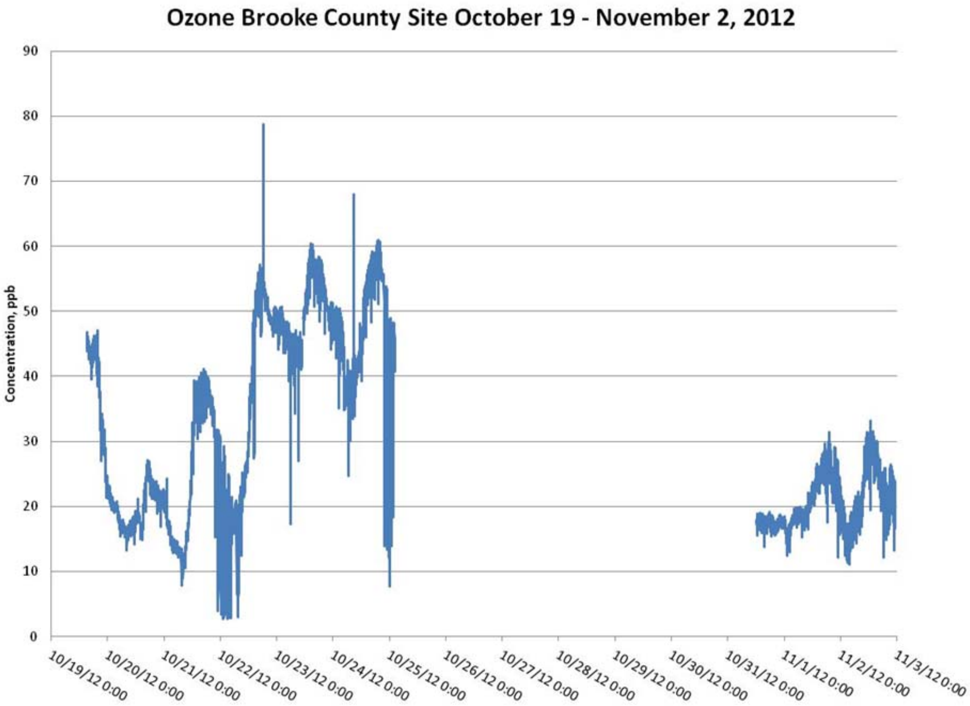


Figure 4.7d. One-minute average ozone concentrations at the WVDNR A pad.

4.7.4 NOx Results

NONE

4.7.5. Methane Results

There are limited data available for this site to due to multiple power interruptions. The concentration of methane at the WVDNR A pad averaged 1.9ppm (±0.1ppm) with an average isotopic composition of -50.1‰ (±1.5‰) over the course of the two week monitoring period (Figure 4.7e). A maximum concentration of 2.8ppm was recorded ($\delta^{13}C$ = -47.2‰) before an unexpected power failure.

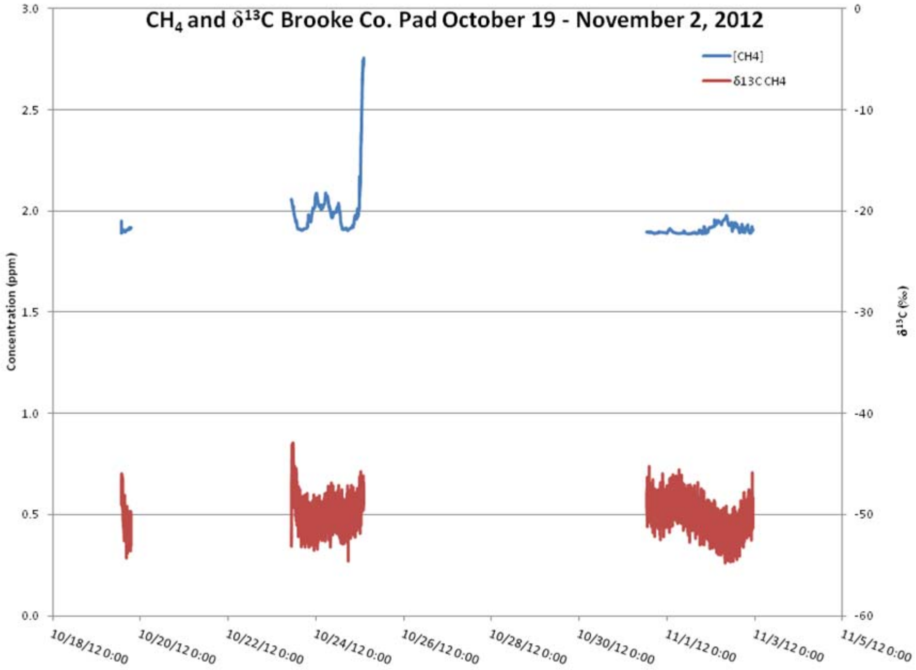


Figure 4.7e. One-minute average CH_4 concentrations and $\delta^{13}C$ of CH_4 at the WVDNR A pad.

4.7.6 CO2 Results

The concentration of carbon dioxide at the WVDNR A pad site averaged 405ppm (±7ppm) with an average isotopic composition of -12.5‰ (±0.9‰) over the course of the two week monitoring period (Figure 4.7f). The maximum CO_2 concentration at the site was 449ppm with a corresponding $\delta^{13}C$ value of -13.4‰.

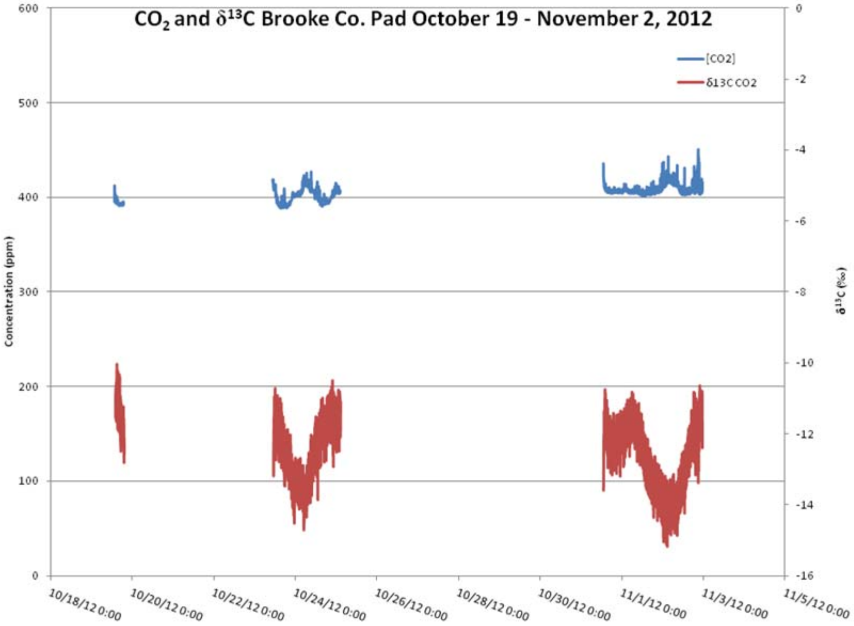


Figure 4.7f. One-minute average CO_2 concentrations and $\delta^{13}C$ of CO_2 at the Brooke Co. pad.

4.7.7 TEOM (Dust) Results

Data are available for October 19-November 2 with a 32-hour gap in the data starting on October 25 due to a power interruption (Figure 4.7g-i). Beginning on October 28, there were many samples that were discarded because they did not meet a data quality control objective; in all reported data, PM_{10} concentrations must be greater than $PM_{2.5}$ concentrations. Frequently the concentrations were near equal, with the slightly higher $PM_{2.5}$ concentrations attributed to instrument signal variability. At the WVDNR A pad, Average PM_{10} concentration was 15μg/m^3 and average $PM_{2.5}$ concentration was 8μg/m^3. Maximum one-hour average concentrations of PM_{10} and $PM_{2.5}$ were 129μg/m^3 and 24μg/m^3, respectively.

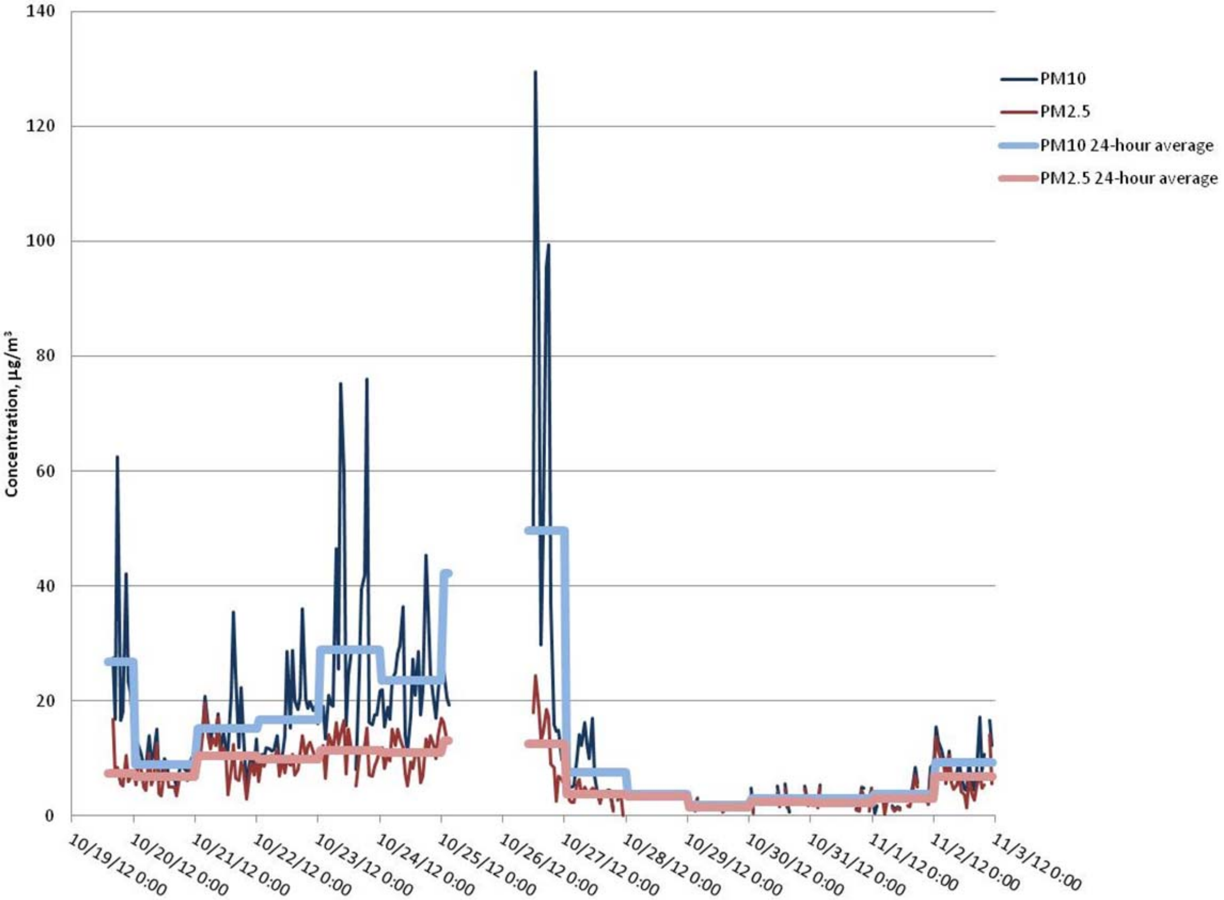


Figure 4.7g. One-hour average PM_{10} and $PM_{2.5}$ concentrations at the WVDNR Pad A.

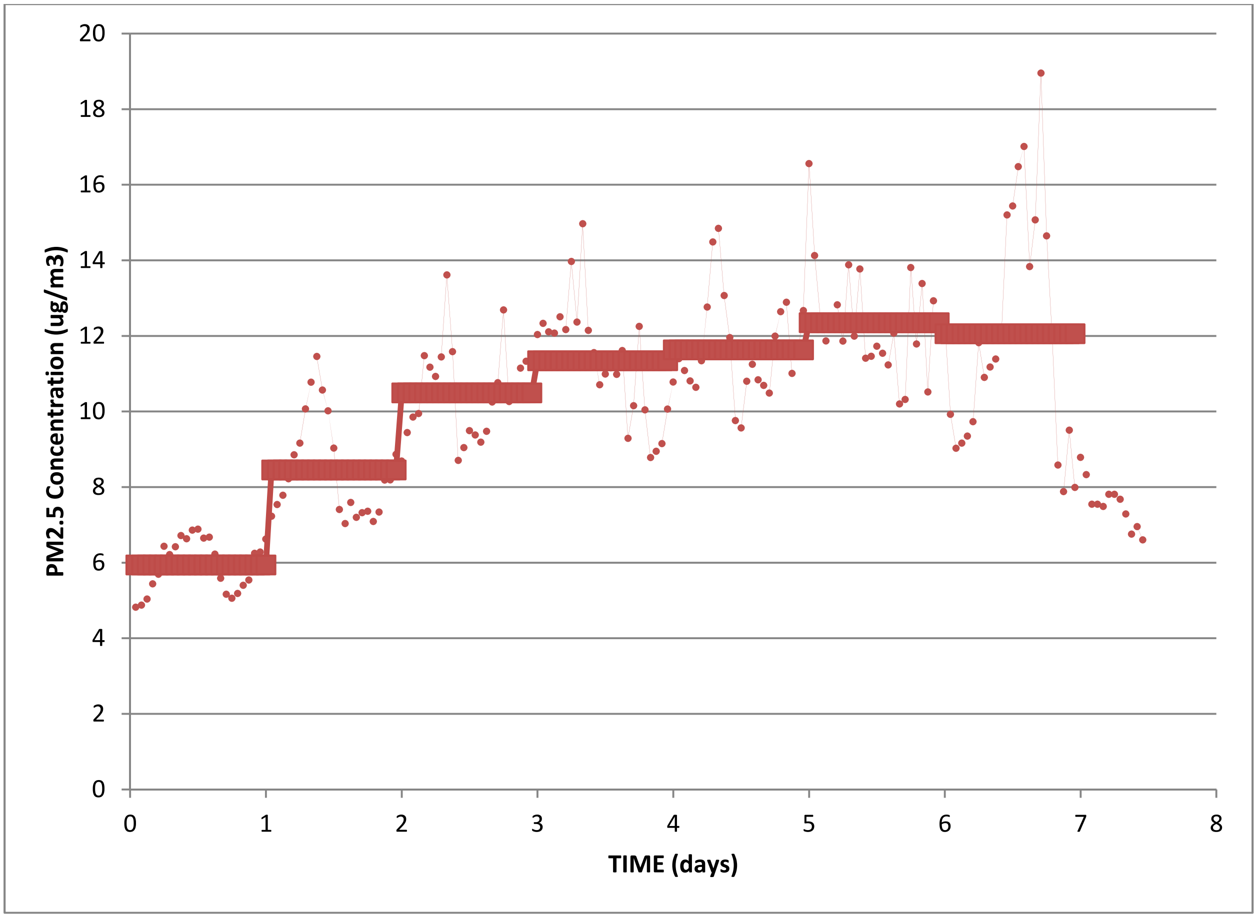


Figure 4.7h. PM 2.5 Dust Track 10/19-27/2012 data for Site A, with hourly data points and 24 hour averages represented as bar lines.

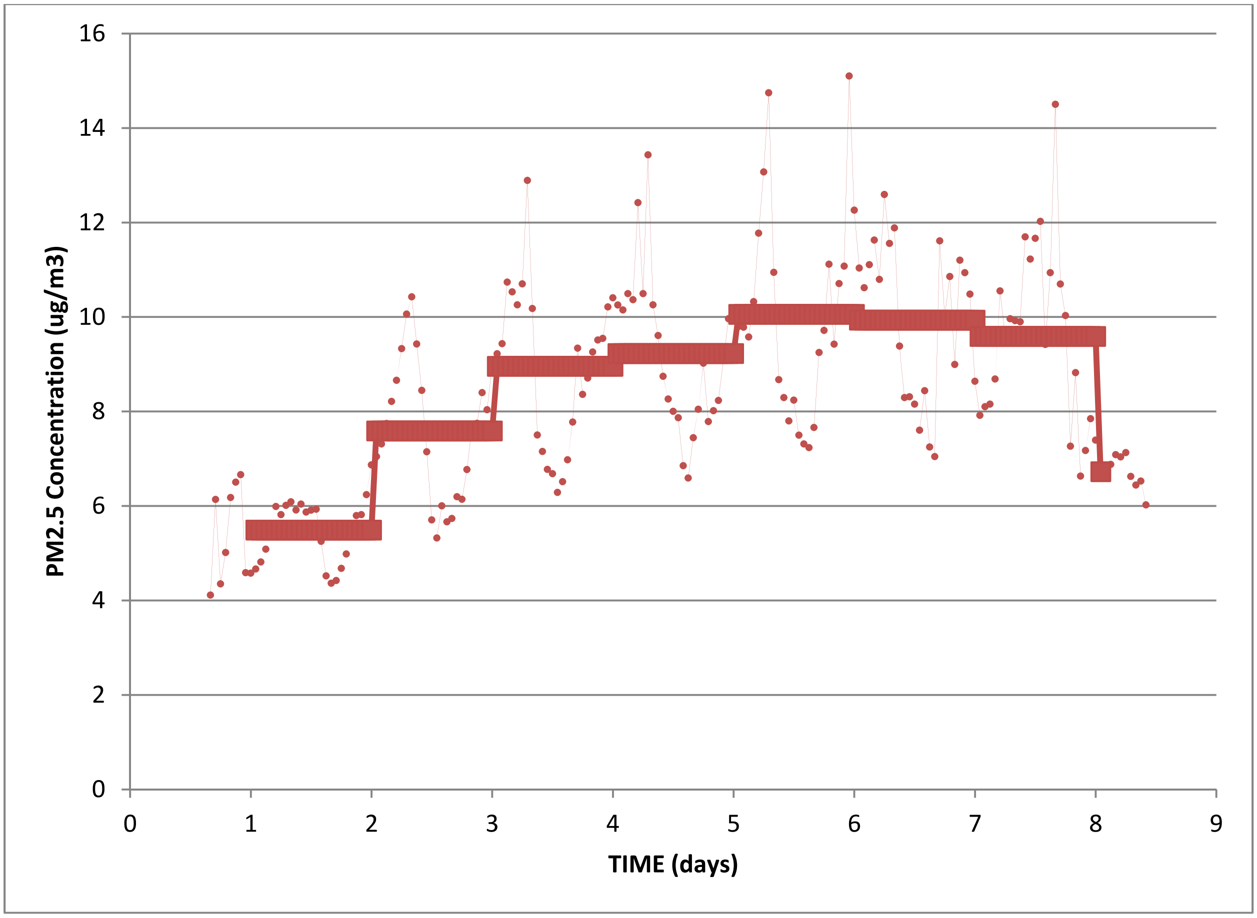


Figure 4.7i. PM 2.5 Dust Track 10/19-27/2012 data for Site C, with hourly data points and 24 hour averages represented as bar lines.

4.7.8 Noise

Instrument problems resulted in loss of noise data for this site.

4.7.9 SO2 Results

Data for SO_2 are available for October 19 – November 2 with a section of data from October 25-31 missing due to a power interruption (Figure 4.7j). The average concentration of SO_2 at the WVDNR A pad was 2.5ppb, with peaks not exceeding 9ppb. Calculating 1-hour averages from the one-minute data for a more direct comparison with the NAAQS for SO_2 results in a range of 1-hour averages of 1.9ppb – 7.0ppb. Similarly, calculating 3-hour averages from the one-minute data results in a range of 2.1ppb –5.3ppb.

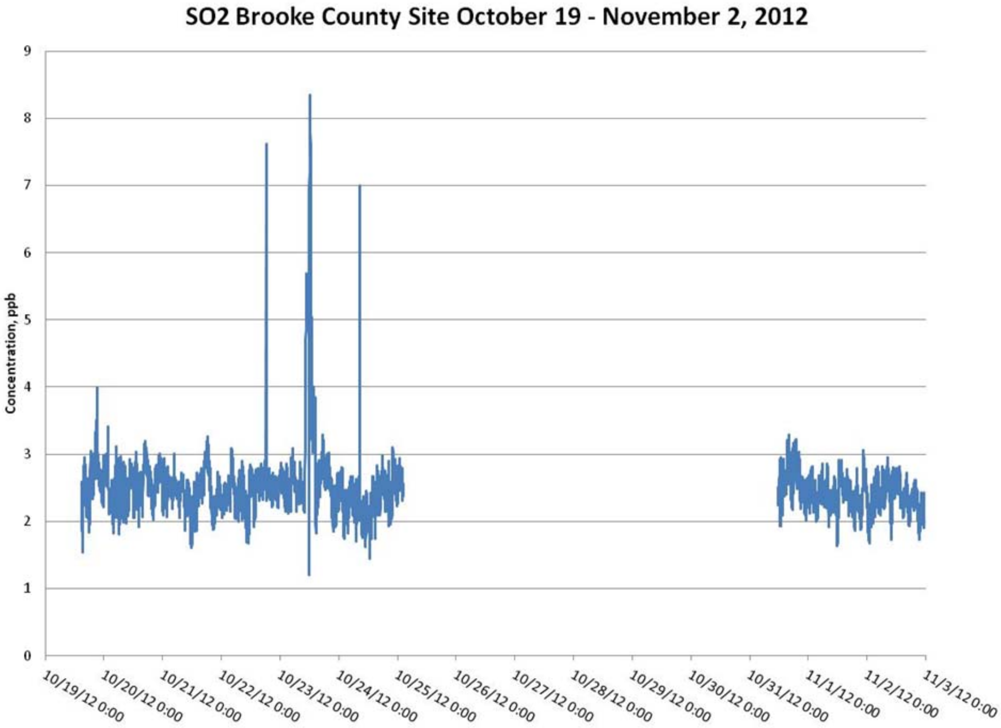


Figure 4.7j. One-minute average SO_2 concentrations for the WVDNR A pad.

4.8 Morgantown - Control

Three Summa Canisters were placed in residential areas in Morgantown, Monongalia County, West Virginia and used to sample for 72 hours (12/19-22/2012). Two of the canisters were placed, outside, side by side at a residence at the city limits. A third canister was placed, outside, at a residence near the downtown area. No detectable organic compounds were found in any of the canisters.

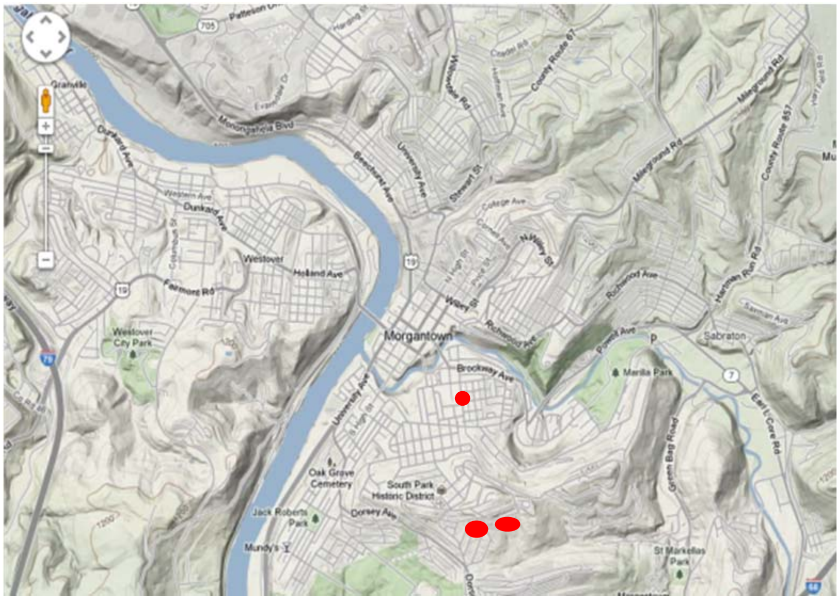


Figure 4.8a. Location of Control Summa Canister samples in Morgantown, WV.

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APPENDIX A

ATSDR MRL VALUES

Appendix A

Agency for Toxic Substances and Disease Registry

MINIMAL RISK LEVELS (MRLs)

February 2012

Name	Route	Duration	MRL	Uncertainty Factors	Endpoint	Status	Cover Date	CAS Number
ACENAPHTHENE	Oral	Int.	0.6 mg/kg/day	300	Hepatic	Final	08/95	83-32-9
ACETONE	Inh.	Acute	26 ppm	9	Neurol.	Final	05/94	67-64-1
		Int.	13 ppm	100	Neurol.			
		Chr.	13 ppm	100	Neurol.			
	Oral	Int.	2 mg/kg/day	100	Hemato.			
ACROLEIN	Inh.	Acute	0.003 ppm	100	Resp.	Final	08/07	107-02-8
		Int.	0.00004 ppm	300	Resp.			
	Oral	Int.	0.004 mg/kg/day	100	Gastro.			
ACRYLAMIDE	Oral	Acute	0.02 mg/kg/day	100	Repro.	Draft	09/09	79-06-1
		Int.	0.002 mg/kg/day	100	Neurol.			
ACRYLONITRILE	Inh.	Acute	0.1 ppm	10	Neurol.	Final	12/90	107-13-1
	Oral	Acute	0.1 mg/kg/day	100	Develop.			
		Int.	0.01 mg/kg/day	1000	Repro.			
		Chr.	0.04 mg/kg/day	100	Hemato.			
ALDRIN	Oral	Acute	0.002 mg/kg/day	1000	Develop.	Final	09/02	309-00-2
		Chr.	0.00003 mg/kg/day	1000	Hepatic			
ALUMINUM	Oral	Int.	1.0 mg/kg/day	30	Neurol.	Final	09/08	7429-90-5
		Chr.	1.0 mg/kg/day	90	Neurol.			
AMERICIUM	Rad.	Acute	4 mSv	3	Develop.	Final	10/04	7440-35-9
		Chr.	1 mSv/yr	3	Other			
AMMONIA	Inh.	Acute	1.7 ppm	30	Resp.	Final	10/04	7664-41-7
		Chr.	0.1 ppm	30	Resp.			
ANTHRACENE	Oral	Int.	10 mg/kg/day	100	Hepatic	Final	08/95	120-12-7

ARSENIC	Oral	Acute	0.005 mg/kg/day	10	Gastro.	Final	08/07	7440-38-2
		Chr.	0.0003 mg/kg/day	3	Dermal			
ATRAZINE	Oral	Acute	0.01 mg/kg/day	100	Body Wt.	Final	09/03	1912-24-9
		Int.	0.003 mg/kg/day	300	Repro.			
BARIUM, SOLUBLE SALTS	Oral	Int.	0.2 mg/kg/day	100	Renal	Final	08/07	7440-39-3
		Chr.	0.2 mg/kg/day	100	Renal			
BENZENE	Inh.	Acute	0.009 ppm	300	Immuno.	Final	08/07	71-43-2
		Int.	0.006 ppm	300	Immuno.			
		Chr.	0.003 ppm	10	Immuno.			
	Oral	Chr.	0.0005 mg/kg/day	30	Immuno.			
BERYLLIUM	Oral	Chr.	0.002 mg/kg/day	300	Gastro.	Final	09/02	7440-41-7
BIS(2-CHLOROETHYL) ETHER	Inh.	Int.	0.02 ppm	1000	Body Wt.	Final	12/89	111-44-4
BIS(CHLOROMETHYL) ETHER	Inh.	Int.	0.0003 ppm	100	Resp.	Final	12/89	542-88-1
BORON	Inh.	Acute	0.3 mg/m3	3	Resp.	Final	11/10	7440-42-8
	Oral	Acute	0.2 mg/kg/day	100	Develop.			
		Int.	0.2 mg/kg/day	66	Develop.			
BROMODICHLOROMETHANE	Oral	Acute	0.04 mg/kg/day	1000	Hepatic	Final	12/89	75-27-4
		Chr.	0.02 mg/kg/day	1000	Renal			
BROMOFORM	Oral	Acute	0.7 mg/kg/day	100	Hepatic	Final	09/05	75-25-2
		Int.	0.2 mg/kg/day	300	Hepatic			
		Chr.	0.02 mg/kg/day	3000	Hepatic			
BROMOMETHANE	Inh.	Acute	0.05 ppm	100	Neurol.	Final	09/92	74-83-9
		Int.	0.05 ppm	100	Neurol.			
		Chr.	0.005 ppm	100	Neurol.			
	Oral	Int.	0.003 mg/kg/day	100	Gastro.			
1,3-BUTADIENE	Inh.	Acute	0.1 ppm	90	Develop.	Draft	09/09	106-99-0
2-BUTOXYETHANOL (ETHYLENE GLYCOL MONOBUTYL ETHER)	Inh.	Acute	6 ppm	9	Hemato.	Final	10/98	111-76-2
		Int.	3 ppm	9	Hemato.			
		Chr.	0.2 ppm	3	Hemato.			
	Oral	Acute	0.4 mg/kg/day	90	Hemato.			
		Int.	0.07 mg/kg/day	1000	Hepatic			

CADMIUM	Inh.	Acute	0.00003 mg/m3	300	Resp.	Draft	09/08	7440-43-9
		Chr.	0.00001 mg/m3	9	Renal			
	Oral	Int.	0.0005 mg/kg/day	100	Musculo.			
		Chr.	0.0001 mg/kg/day	3	Renal			
CARBON DISULFIDE	Inh.	Chr.	0.3 ppm	30	Neurol.	Final	08/96	75-15-0
	Oral	Acute	0.01 mg/kg/day	300	Hepatic			
CARBON TETRACHLORIDE	Inh.	Int.	0.03 ppm	30	Hepatic	Final	09/05	56-23-5
		Chr.	0.03 ppm	30	Hepatic			
	Oral	Acute	0.02 mg/kg/day	300	Hepatic			
		Int.	0.007 mg/kg/day	100	Hepatic			
CESIUM	Rad.	Acute	4 mSv	3	Develop.	Final	10/04	7440-46-2
		Chr.	1 mSv/yr	3	Other			
CHLORDANE	Inh.	Int.	0.0002 mg/m3	100	Hepatic	Final	05/94	57-74-9
		Chr.	0.00002 mg/m3	1000	Hepatic			
	Oral	Acute	0.001 mg/kg/day	1000	Develop.			
		Int.	0.0006 mg/kg/day	100	Hepatic			
		Chr.	0.0006 mg/kg/day	100	Hepatic			
CHLORDECONE	Oral	Acute	0.01 mg/kg/day	100	Neurol.	Final	08/95	143-50-0
		Int.	0.0005 mg/kg/day	100	Renal			
		Chr.	0.0005 mg/kg/day	100	Renal			
CHLORFENVINPHOS	Oral	Acute	0.002 mg/kg/day	1000	Neurol.	Final	09/97	470-90-6
		Int.	0.002 mg/kg/day	1000	Immuno.			
		Chr.	0.0007 mg/kg/day	1000	Neurol.			
CHLORINE	Inh.	Acute	0.06 ppm	3	Resp.	Final	11/10	7782-50-5
		Int.	0.002 ppm	90	Resp.			
		Chr.	0.00005 ppm	30	Resp.			
CHLORINE DIOXIDE	Inh.	Int.	0.001 ppm	300	Resp.	Final	10/04	10049-04-4
CHLORITE	Oral	Int.	0.1 mg/kg/day	30	Neurol.	Final	10/04	7758-19-2
CHLOROBENZENE	Oral	Int.	0.4 mg/kg/day	100	Hepatic	Final	12/90	108-90-7
CHLORODIBROMOMETHANE	Oral	Acute	0.1 mg/kg/day	300	Hepatic	Final	09/05	124-48-1
		Chr.	0.09 mg/kg/day	300	Hepatic			
CHLOROETHANE	Inh.	Acute	15 ppm	100	Develop.	Final	12/98	75-00-3

CHLOROFORM	Inh.	Acute	0.1 ppm	30	Hepatic	Final	09/97	67-66-3
		Int.	0.05 ppm	300	Hepatic			
		Chr.	0.02 ppm	100	Hepatic			
	Oral	Acute	0.3 mg/kg/day	100	Hepatic			
		Int.	0.1 mg/kg/day	100	Hepatic			
		Chr.	0.01 mg/kg/day	1000	Hepatic			
CHLOROMETHANE	Inh.	Acute	0.5 ppm	100	Neurol.	Final	12/98	74-87-3
		Int.	0.2 ppm	300	Hepatic			
		Chr.	0.05 ppm	1000	Neurol.			
4-CHLOROPHENOL	Oral	Acute	0.01 mg/kg/day	100	Hepatic	Final	07/99	106-48-9
CHLORPYRIFOS	Oral	Acute	0.003 mg/kg/day	10	Neurol.	Final	09/97	2921-88-2
		Int.	0.003 mg/kg/day	10	Neurol.			
		Chr.	0.001 mg/kg/day	100	Neurol.			
CHROMIUM(III) SOLUBLE PARTICULATES	Inh.	Int.	0.0001 mg/m3	300	Resp.	Draft	09/08	16065-83-1
CHROMIUM(III) INSOL. PARTICULATES	Inh.	Int.	0.005 mg/m3	90	Resp.	Draft	09/08	16065-83-1
CHROMIUM(VI)	Oral	Int.	0.005 mg/kg/day	100	Hemato.	Draft	09/08	18540-29-9
		Chr.	0.001 mg/kg/day	100	Gastro.			
CHROMIUM(VI), AEROSOL MISTS	Inh.	Int.	0.000005 mg/m3	100	Resp.	Draft	09/08	18540-29-9
		Chr.	0.000005 mg/m3	100	Resp.			
CHROMIUM(VI), PARTICULATES	Inh.	Int.	0.0003 mg/m3	30	Resp.	Draft	09/08	18540-29-9
COBALT	Inh.	Chr.	0.0001 mg/m3	10	Resp.	Final	10/04	7440-48-4
	Oral	Int.	0.01 mg/kg/day	100	Hemato.			
	Rad.	Acute	4 mSv	3	Develop.			
		Chr.	1 mSv/yr	3	Other			
COPPER	Oral	Acute	0.01 mg/kg/day	3	Gastro.	Final	10/04	7440-50-8
		Int.	0.01 mg/kg/day	3	Gastro.			
CRESOLS	Oral	Int.	0.1 mg/kg/day	100	Resp.	Final	09/08	1319-77-3
		Chr.	0.1 mg/kg/day	1000	Resp.			
CYANIDE, SODIUM	Oral	Int.	0.05 mg/kg/day	100	Repro.	Final	07/06	143-33-9

CYHALOTHRIN	Oral	Acute	0.01 mg/kg/day	100	Gastro.	Final	09/03	68085-85-8
		Int.	0.01 mg/kg/day	100	Gastro.			
CYPERMETHRIN	Oral	Acute	0.02 mg/kg/day	100	Neurol.	Final	09/03	52315-07-8
DDT, P,P'-	Oral	Acute	0.0005 mg/kg/day	1000	Develop.	Final	09/02	50-29-3
		Int.	0.0005 mg/kg/day	100	Hepatic			
DIAZINON	Inh.	Int.	0.01 mg/m3	30	Neurol.	Final	09/08	333-41-5
	Oral	Acute	0.006 mg/kg/day	100	Neurol.			
		Int.	0.002 mg/kg/day	100	Neurol.			
		Chr.	0.0007 mg/kg/day	100	Neurol.			
1,2-DIBROMO-3-CHLOROPROPANE	Inh.	Int.	0.0002 ppm	100	Repro.	Final	09/92	96-12-8
	Oral	Int.	0.002 mg/kg/day	1000	Repro.			
DI-N-BUTYL PHTHALATE	Oral	Acute	0.5 mg/kg/day	100	Develop.	Final	09/01	84-74-2
1,2-DICHLOROBENZENE	Oral	Acute	0.7 mg/kg/day	100	Hepatic	Final	07/06	95-50-1
		Int.	0.6 mg/kg/day	100	Hepatic			
		Chr.	0.3 mg/kg/day	100	Renal			
1,3-DICHLOROBENZENE	Oral	Acute	0.4 mg/kg/day	100	Hepatic	Final	07/06	541-73-1
		Int.	0.02 mg/kg/day	100	Endocr.			
1,4-DICHLOROBENZENE	Inh.	Acute	2 ppm	10	Ocular	Final	07/06	106-46-7
		Int.	0.2 ppm	100	Hepatic			
		Chr.	0.01 ppm	30	Resp.			
	Oral	Int.	0.07 mg/kg/day	100	Hepatic			
		Chr.	0.07 mg/kg/day	100	Hepatic			
1,2-DICHLOROETHANE	Inh.	Chr.	0.6 ppm	90	Hepatic	Final	09/01	107-06-2
	Oral	Int.	0.2 mg/kg/day	300	Renal			
1,1-DICHLOROETHENE	Inh.	Int.	0.02 ppm	100	Hepatic	Final	05/94	75-35-4
	Oral	Chr.	0.009 mg/kg/day	1000	Hepatic			
1,2-DICHLOROETHENE, CIS-	Oral	Acute	1 mg/kg/day	100	Hemato.	Final	08/96	156-59-2
		Int.	0.3 mg/kg/day	100	Hemato.			
1,2-DICHLOROETHENE, TRANS-	Inh.	Acute	0.2 ppm	1000	Hepatic	Final	08/96	156-60-5
		Int.	0.2 ppm	1000	Hepatic			
	Oral	Int.	0.2 mg/kg/day	100	Hepatic			

2,4-DICHLOROPHENOL	Oral	Int.	0.003 mg/kg/day	100	Immuno.	Final	07/99	120-83-2
1,2-DICHLOROPROPANE	Inh.	Acute	0.05 ppm	1000	Resp.	Final	12/89	78-87-5
		Int.	0.007 ppm	1000	Resp.			
	Oral	Acute	0.1 mg/kg/day	1000	Neurol.			
		Int.	0.07 mg/kg/day	1000	Hemato.			
		Chr.	0.09 mg/kg/day	1000	Hepatic			
1,3-DICHLOROPROPENE	Inh.	Int.	0.008 ppm	30	Resp.	Final	09/08	542-75-6
		Chr.	0.007 ppm	30	Resp.			
	Oral	Int.	0.04 mg/kg/day	100	Gastro.			
		Chr.	0.03 mg/kg/day	100	Gastro.			
2,3-DICHLOROPROPENE	Inh.	Acute	0.002 ppm	90	Resp.	Final	09/08	78-88-6
DICHLORVOS	Inh.	Acute	0.002 ppm	100	Neurol.	Final	09/97	62-73-7
		Int.	0.0003 ppm	100	Neurol.			
		Chr.	0.00006 ppm	100	Neurol.			
	Oral	Acute	0.004 mg/kg/day	1000	Neurol.			
		Int.	0.003 mg/kg/day	10	Neurol.			
		Chr.	0.0005 mg/kg/day	100	Neurol.			
DIELDRIN	Oral	Int.	0.0001 mg/kg/day	100	Neurol.	Final	09/02	60-57-1
		Chr.	0.00005 mg/kg/day	100	Hepatic			
DI(2-ETHYLHEXYL)PHTHALATE	Oral	Int.	0.1 mg/kg/day	100	Repro.	Final	09/02	117-81-7
		Chr.	0.06 mg/kg/day	100	Repro.			
DIETHYL PHTHALATE	Oral	Acute	7 mg/kg/day	300	Repro.	Final	06/95	84-66-2
		Int.	6 mg/kg/day	300	Hepatic			
DIISOPROPYL METHYLPHOSPHONATE (DIMP)	Oral	Int.	0.8 mg/kg/day	100	Hemato.	Final	10/98	1445-75-6
		Chr.	0.6 mg/kg/day	100	Hemato.			
DIMETHYLARSINIC ACID (DMA)	Oral	Chr.	0.02 mg/kg/day	100	Renal	Final	08/07	75-60-5
1,1-DIMETHYLHYDRAZINE	Inh.	Int.	0.0002 ppm	300	Hepatic	Final	09/97	57-14-7
1,2-DIMETHYLHYDRAZINE	Oral	Int.	0.0008 mg/kg/day	1000	Hepatic	Final	09/97	540-73-8
1,3-DINITROBENZENE	Oral	Acute	0.008 mg/kg/day	100	Repro.	Final	06/95	99-65-0
		Int.	0.0005 mg/kg/day	1000	Hemato.			

4,6-DINITRO-O-CRESOL	Oral	Acute	0.004 mg/kg/day	100	Neurol.	Final	08/95	534-52-1
		Int.	0.004 mg/kg/day	100	Neurol.			
2,4-DINITROPHENOL	Oral	Acute	0.01 mg/kg/day	100	Body Wt.	Final	08/95	51-28-5
2,4-DINITROTOLUENE	Oral	Acute	0.05 mg/kg/day	100	Neurol.	Final	12/98	121-14-2
		Chr.	0.002 mg/kg/day	100	Hemato.			
2,6-DINITROTOLUENE	Oral	Int.	0.004 mg/kg/day	1000	Hemato.	Final	12/98	606-20-2
DI-N-OCTYL PHTHALATE	Oral	Acute	3 mg/kg/day	300	Hepatic	Final	09/97	117-84-0
		Int.	0.4 mg/kg/day	100	Hepatic			
1,4-DIOXANE	Inh.	Acute	2 ppm	30	Ocular	Draft	09/07	123-91-1
		Int.	1 ppm	30	Hepatic			
		Chr.	1 ppm	30	Hepatic			
	Oral	Acute	4 mg/kg/day	100	Resp.			
		Int.	0.6 mg/kg/day	100	Hepatic			
		Chr.	0.1 mg/kg/day	100	Hepatic			
DISULFOTON	Inh.	Acute	0.006 mg/m3	30	Neurol.	Final	08/95	298-04-4
		Int.	0.0002 mg/m3	30	Neurol.			
	Oral	Acute	0.001 mg/kg/day	100	Neurol.			
		Int.	0.00009 mg/kg/day	100	Develop.			
		Chr.	0.00006 mg/kg/day	1000	Neurol.			
ENDOSULFAN	Oral	Int.	0.005 mg/kg/day	100	Immuno.	Final	09/00	115-29-7
		Chr.	0.002 mg/kg/day	100	Hepatic			
ENDRIN	Oral	Int.	0.002 mg/kg/day	100	Neurol.	Final	08/96	72-20-8
		Chr.	0.0003 mg/kg/day	100	Neurol.			
ETHION	Oral	Acute	0.002 mg/kg/day	30	Neurol.	Final	09/00	563-12-2
		Int.	0.002 mg/kg/day	30	Neurol.			
		Chr.	0.0004 mg/kg/day	150	Neurol.			
ETHYLBENZENE	Inh.	Acute	5 ppm	30	Neurol.	Final	11/10	100-41-4
		Int.	2 ppm	30	Neurol.			
		Chr.	0.06 ppm	300	Renal			
	Oral	Int.	0.4 mg/kg/day	30	Hepatic			
ETHYLENE GLYCOL	Inh.	Acute	2 mg/m3	10	Resp.	Final	11/10	107-21-1
	Oral	Acute	0.8 mg/kg/day	100	Develop.			
		Int.	0.8 mg/kg/day	100	Develop.			

ETHYLENE OXIDE	Inh.	Int.	0.09 ppm	100	Renal	Final	12/90	75-21-8
FLUORANTHENE	Oral	Int.	0.4 mg/kg/day	300	Hepatic	Final	08/95	206-44-0
FLUORENE	Oral	Int.	0.4 mg/kg/day	300	Hepatic	Final	08/95	86-73-7
FLUORIDE, SODIUM	Oral	Chr.	0.05 mg/kg/day	3	Musculo.	Final	09/03	7681-49-4
FLUORINE	Inh.	Acute	0.01 ppm	10	Resp.	Final	09/03	7782-41-4
FORMALDEHYDE	Inh.	Acute	0.04 ppm	9	Resp.	Final	07/99	50-00-0
		Int.	0.03 ppm	30	Resp.			
		Chr.	0.008 ppm	30	Resp.			
	Oral	Int.	0.3 mg/kg/day	100	Gastro.			
		Chr.	0.2 mg/kg/day	100	Gastro.			
FUEL OIL NO.2	Inh.	Acute	0.02 mg/m3	1000	Neurol.	Final	06/95	68476-30-2
GUTHION (AZINPHOS-METHYL)	Inh.	Acute	0.02 mg/m3	30	Neurol.	Final	09/08	86-50-0
		Int.	0.01 mg/m3	30	Neurol.			
		Chr.	0.01 mg/m3	30	Neurol.			
	Oral	Acute	0.01 mg/kg/day	100	Neurol.			
		Int.	0.003 mg/kg/day	100	Neurol.			
		Chr.	0.003 mg/kg/day	100	Neurol.			
HEPTACHLOR	Oral	Acute	0.0006 mg/kg/day	3000	Repro.	Final	08/07	76-44-8
		Int.	0.0001 mg/kg/day	300	Immuno.			
HEXACHLOROBENZENE	Oral	Acute	0.008 mg/kg/day	300	Develop.	Final	09/02	118-74-1
		Int.	0.0001 mg/kg/day	90	Repro.			
		Chr.	0.00005 mg/kg/day	300	Develop.			
HEXACHLOROBUTADIENE	Oral	Int.	0.0002 mg/kg/day	1000	Renal	Final	05/94	87-68-3
ALPHA-HEXACHLOROCYCLOHEXANE	Oral	Chr.	0.008 mg/kg/day	100	Hepatic	Final	09/05	319-84-6
BETA-HEXACHLOROCYCLOHEXANE	Oral	Acute	0.05 mg/kg/day	100	Neurol.	Final	09/05	319-85-7
		Int.	0.0006 mg/kg/day	300	Hepatic			
GAMMA-HEXACHLOROCYCLOHEXANE	Oral	Acute	0.003 mg/kg/day	300	Develop.	Final	09/05	58-89-9
		Int.	0.00001 mg/kg/day	1000	Immuno.			

HEXACHLOROCYCLOPENTADIENE	Inh.	Int.	0.01 ppm	30	Resp.	Final	07/99	77-47-4
		Chr.	0.0002 ppm	90	Resp.			
	Oral	Int.	0.1 mg/kg/day	100	Renal			
HEXACHLOROETHANE	Inh.	Acute	6 ppm	30	Neurol.	Final	09/97	67-72-1
		Int.	6 ppm	30	Neurol.			
	Oral	Acute	1 mg/kg/day	100	Hepatic			
		Int.	0.01 mg/kg/day	100	Hepatic			
HEXAMETHYLENE DIISOCYANATE	Inh.	Int.	0.00003 ppm	30	Resp.	Final	10/98	822-06-0
		Chr.	0.00001 ppm	90	Resp.			
N-HEXANE	Inh.	Chr.	0.6 ppm	100	Neurol.	Final	07/99	110-54-3
HMX (CYCLOTETRAMETHYLENE TETRANITRAMINE)	Oral	Acute	0.1 mg/kg/day	1000	Neurol.	Final	09/97	2691-41-0
		Int.	0.05 mg/kg/day	1000	Hepatic			
HYDRAZINE	Inh.	Int.	0.004 ppm	300	Hepatic	Final	09/97	302-01-2
HYDROGEN FLUORIDE	Inh.	Acute	0.02 ppm	30	Resp.	Final	09/03	7664-39-3
HYDROGEN SULFIDE	Inh.	Acute	0.07 ppm	27	Resp.	Final	07/06	7783-06-4
		Int.	0.02 ppm	30	Resp.			
IODIDE	Oral	Acute	0.01 mg/kg/day	1	Endocr.	Final	10/04	7553-56-2
		Chr.	0.01 mg/kg/day	1	Endocr.			
IONIZING RADIATION, N.O.S.	Rad.	Acute	4 mSv	3	Neurol.	Final	09/99	HZ1800-45-T
		Chr.	1 mSv/yr	3	Other			
ISOPHORONE	Oral	Int.	3 mg/kg/day	100	Other	Final	12/89	78-59-1
		Chr.	0.2 mg/kg/day	1000	Hepatic			
JP-4	Inh.	Int.	9 mg/m3	300	Hepatic	Final	06/95	50815-00-4
JP-5/JP-8	Inh.	Int.	3 mg/m3	300	Hepatic	Final	10/98	HZ0600-26-T
JP-7	Inh.	Chr.	0.3 mg/m3	300	Hepatic	Final	06/95	HZ0600-22-T
KEROSENE	Inh.	Int.	0.01 mg/m3	1000	Hepatic	Final	06/95	8008-20-6

MALATHION	Inh.	Acute	0.2 mg/m3	100	Neurol.	Final	09/03	121-75-5
		Int.	0.02 mg/m3	1000	Resp.			
	Oral	Int.	0.02 mg/kg/day	10	Neurol.			
		Chr.	0.02 mg/kg/day	100	Neurol.			
MANGANESE, RESPIRABLE	Inh.	Chr.	0.04 ug/m3	500	Neurol.	Addendum	09/10	7439-96-5
MERCURIC CHLORIDE	Oral	Acute	0.007 mg/kg/day	100	Renal	Final	03/99	7487-94-7
		Int.	0.002 mg/kg/day	100	Renal			
MERCURY	Inh.	Chr.	0.0002 mg/m3	30	Neurol.	Final	03/99	7439-97-6
METHOXYCHLOR	Oral	Int.	0.005 mg/kg/day	1000	Repro.	Final	09/02	72-43-5
4,4'-METHYLENEBIS(2-CHLOROANILINE)	Oral	Chr.	0.003 mg/kg/day	3000	Hepatic	Final	05/94	101-14-4
METHYLENE CHLORIDE	Inh.	Acute	0.6 ppm	100	Neurol.	Final	09/00	75-09-2
		Int.	0.3 ppm	90	Hepatic			
		Chr.	0.3 ppm	30	Hepatic			
	Oral	Acute	0.2 mg/kg/day	100	Neurol.			
		Chr.	0.06 mg/kg/day	100	Hepatic			
4,4'-METHYLENEDIANILINE	Oral	Acute	0.2 mg/kg/day	300	Hepatic	Final	10/98	101-77-9
		Int.	0.08 mg/kg/day	100	Hepatic			
METHYLMERCURY	Oral	Chr.	0.0003 mg/kg/day	4.5	Develop.	Final	03/99	22967-92-6
1-METHYLNAPHTHALENE	Oral	Chr.	0.07 mg/kg/day	1000	Resp.	Final	09/05	90-12-0
2-METHYLNAPHTHALENE	Oral	Chr.	0.04 mg/kg/day	100	Resp.	Final	09/05	91-57-6
METHYL PARATHION	Oral	Int.	0.0007 mg/kg/day	300	Neurol.	Final	09/01	298-00-0
		Chr.	0.0003 mg/kg/day	100	Hemato.			
METHYL-T-BUTYL ETHER	Inh.	Acute	2 ppm	100	Neurol.	Final	08/96	1634-04-4
		Int.	0.7 ppm	100	Neurol.			
		Chr.	0.7 ppm	100	Renal			
	Oral	Acute	0.4 mg/kg/day	100	Neurol.			
		Int.	0.3 mg/kg/day	300	Hepatic			
MIREX	Oral	Chr.	0.0008 mg/kg/day	100	Hepatic	Final	08/95	2385-85-5
MONOMETHYLARSONIC ACID (MMA)	Oral	Int.	0.1 mg/kg/day	100	Gastro.	Final	08/07	124-58-3
		Chr.	0.01 mg/kg/day	100	Renal			

NAPHTHALENE	Inh.	Chr.	0.0007 ppm	300	Resp.	Final	09/05	91-20-3
	Oral	Acute	0.6 mg/kg/day	90	Neurol.			
		Int.	0.6 mg/kg/day	90	Neurol.			
N-NITROSODI-N-PROPYLAMINE	Oral	Acute	0.095 mg/kg/day	100	Hepatic	Final	12/89	621-64-7
NICKEL	Inh.	Int.	0.0002 mg/m3	30	Resp.	Final	09/05	7440-02-0
		Chr.	0.00009 mg/m3	30	Resp.			
2,3,4,7,8-PENTACHLORODIBENZOFURAN	Oral	Acute	0.001 ug/kg/day	3000	Immuno.	Final	05/94	57117-31-4
		Int.	0.00003 ug/kg/day	3000	Hepatic			
PENTACHLOROPHENOL	Oral	Acute	0.005 mg/kg/day	1000	Develop.	Final	09/01	87-86-5
		Int.	0.001 mg/kg/day	1000	Repro.			
		Chr.	0.001 mg/kg/day	1000	Endocr.			
PERCHLORATES	Oral	Chr.	0.0007 mg/kg/day	10	Endocr.	Final	08/08	7778-74-7
PERMETHRIN	Oral	Acute	0.3 mg/kg/day	100	Neurol.	Final	09/03	52645-53-1
		Int.	0.2 mg/kg/day	100	Neurol.			
PHENOL	Oral	Acute	1 mg/kg/day	100	Body Wt.	Final	09/08	108-95-2
PHOSPHORUS, WHITE	Inh.	Acute	0.02 mg/m3	30	Resp.	Final	09/97	7723-14-0
	Oral	Int.	0.0002 mg/kg/day	100	Repro.			
POLYBROMINATED BIPHENYLS (PBBs)	Oral	Acute	0.01 mg/kg/day	100	Endocr.	Final	10/04	36355-01-8
POLYBROMINATED DIPHENYL ETHERS (PBDEs), LOWER BROMINATED	Inh	Int.	0.006 mg/m3	90	Endocr.	Final	10/04	32534-81-9
	Oral	Acute	0.03 mg/kg/day	30	Endocr.			32536-52-0
		Int.	0.007 mg/kg/day	300	Hepatic			
PBDEs, DECABROMINATED	Oral	Int.	10 mg/kg/day	100	Develop.	Final	10/04	1163-19-5
POLYCHLORINATED BIPHENYLS (PCBs) (Aroclor 1254)	Oral	Int.	0.03 ug/kg/day	300	Neurol.	Final	11/00	11097-69-1
		Chr.	0.02 ug/kg/day	300	Immuno.			
PROPYLENE GLYCOL	Inh.	Int.	0.009 ppm	1000	Resp.	Final	09/97	57-55-6
PROPYLENE GLYCOL DINITRATE	Inh.	Acute	0.003 ppm	10	Neurol.	Final	06/95	6423-43-4
		Int.	0.00004 ppm	1000	Hemato.			
		Chr.	0.00004 ppm	1000	Hemato.			

RDX (Cyclonite)	**Oral**	**Acute**	**0.2 mg/kg/day**	**30**	**Neurol.**	**Final**	**01/12**	**121-82-4**
		Int.	**0.1 mg/kg/day**	**30**	**Neurol.**			
		Chr.	**0.1 mg/kg/day**	**30**	**Neurol.**			
REFRACTORY CERAMIC FIBERS	**Inh.**	**Chr.**	**0.03 fibers/cc**	**30**	**Resp.**	**Final**	**10/04**	**HZ0900-26-T**
SELENIUM	**Oral**	**Chr.**	**0.005 mg/kg/day**	**3**	**Dermal**	**Final**	**09/03**	**7782-49-2**
STRONTIUM	**Oral**	**Int.**	**2 mg/kg/day**	**30**	**Musculo.**	**Final**	**10/04**	**7440-24-6**
STYRENE	**Inh.**	**Acute**	**5 ppm**	**10**	**Neurol.**	**Final**	**11/10**	**100-42-5**
		Chr.	**0.2 ppm**	**30**	**Neurol.**			
	Oral	**Acute**	**0.1 mg/kg/day**	**1000**	**Neurol.**			
SULFUR DIOXIDE	**Inh.**	**Acute**	**0.01 ppm**	**9**	**Resp.**	**Final**	**12/98**	**7446-09-5**
SULFUR MUSTARD	**Inh.**	**Acute**	**0.0007 mg/m3**	**30**	**Ocular**	**Final**	**09/03**	**505-60-2**
		Int.	**0.00002 mg/m3**	**30**	**Ocular**			
	Oral	**Acute**	**0.5 ug/kg/day**	**1000**	**Develop.**			
		Int.	**0.07 ug/kg/day**	**300**	**Gastro.**			
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	**Oral**	**Acute**	**0.0002 ug/kg/day**	**21**	**Immuno.**	**Final**	**12/98**	**1746-01-6**
		Int.	**0.00002 ug/kg/day**	**30**	**Lymphor.**			
		Chr.	**0.000001 ug/kg/day**	**90**	**Develop.**			
1,1,2,2-TETRACHLOROETHANE	**Oral**	**Int.**	**0.5 mg/kg/day**	**100**	**Hepatic**	**Final**	**09/08**	**79-34-5**
TETRACHLOROETHYLENE	**Inh.**	**Acute**	**0.2 ppm**	**10**	**Neurol.**	**Final**	**09/97**	**127-18-4**
		Chr.	**0.04 ppm**	**100**	**Neurol.**			
	Oral	**Acute**	**0.05 mg/kg/day**	**100**	**Develop.**			
TIN, INORGANIC	**Oral**	**Int.**	**0.3 mg/kg/day**	**100**	**Hemato.**	**Final**	**09/05**	**7440-31-5**
TIN, DIBUTYL-, DICHLORIDE	**Oral**	**Int.**	**0.005 mg/kg/day**	**1000**	**Immuno.**	**Final**	**09/05**	**683-18-1**
TIN, TRIBUTYL-, OXIDE	**Oral**	**Int.**	**0.0003 mg/kg/day**	**100**	**Immuno.**	**Final**	**09/05**	**56-35-9**
		Chr.	**0.0003 mg/kg/day**	**100**	**Immuno.**			
TITANIUM TETRACHLORIDE	**Inh.**	**Int.**	**0.01 mg/m3**	**90**	**Resp.**	**Final**	**09/97**	**7550-45-0**
		Chr.	**0.0001 mg/m3**	**90**	**Resp.**			

TOLUENE	Inh.	Acute	1 ppm	10	Neurol.	Final	09/00	108-88-3
		Chr.	0.08 ppm	100	Neurol.			
	Oral	Acute	0.8 mg/kg/day	300	Neurol.			
		Int.	0.02 mg/kg/day	300	Neurol.			
TOXAPHENE	Oral	Acute	0.05 mg/kg/day	100	Neurol.	Draft	9/10	8001-35-2
		Int.	0.002 mg/kg/day	100	Immuno.			
TRIBUTYL PHOSPHATE (TnBP)	Oral	Acute	1.1 mg/kg/day	100	Body Wt.	Draft	09/09	126-73-8
		Int.	0.02 mg/kg/day	100	Renal			
		Chr.	0.02 mg/kg/day	100	Renal			
1,2,4-TRICHLOROBENZENE	Oral	Int.	0.1 mg/kg/day	100	Hepatic	Draft	9/10	120-82-1
		Chr.	0.1 mg/kg/day	100	Hepatic			
1,1,1-TRICHLOROETHANE	Inh.	Acute	2 ppm	100	Neurol.	Final	07/06	71-55-6
		Int.	0.7 ppm	100	Neurol.			
	Oral	Int.	20 mg/kg/day	100	Body Wt.			
1,1,2-TRICHLOROETHANE	Oral	Acute	0.3 mg/kg/day	100	Neurol.	Final	12/89	79-00-5
		Int.	0.04 mg/kg/day	100	Hepatic			
TRICHLOROETHYLENE	Inh.	Acute	2 ppm	30	Neurol.	Final	09/97	79-01-6
		Int.	0.1 ppm	300	Neurol.			
	Oral	Acute	0.2 mg/kg/day	300	Develop.			
1,2,3-TRICHLOROPROPANE	Inh.	Acute	0.0003 ppm	100	Resp.	Final	09/92	96-18-4
	Oral	Int.	0.08 mg/kg/day	100	Hepatic			
2,4,6-TRINITROTOLUENE	Oral	Int.	0.0005 mg/kg/day	1000	Hepatic	Final	06/95	118-96-7
TRIS(2-BUTOXYETHYL) PHOSPHATE (TBEP)	Oral	Acute	4.8 mg/kg/day	100	Body Wt.	Draft	09/09	78-51-3
		Int.	0.2 mg/kg/day	100	Hepatic			
TRIS(2-CHLOROETHYL) PHOSPHATE (TCEP)	Oral	Int.	0.6 mg/kg/day	100	Neurol.	Draft	09/09	115-96-8
		Chr.	0.3 mg/kg/day	100	Renal			
TRIS(1,3-DICHLORO-2-PROPYL) PHOSPHATE (TDCP)	Oral	Int.	0.05 mg/kg/day	100	Renal	Draft	09/09	13674-87-8
		Chr.	0.02 mg/kg/day	100	Renal			
URANIUM, SOLUBLE SALTS	Inh.	Int.	0.0001 mg/m3	300	Renal	Draft	05/11	7440-61-1
		Chr.	0.00004 mg/m3	100	Renal			
	Oral	Acute	0.002 mg/kg/day	100	Develop.			
		Int.	0.0002 mg/kg/day	300	Renal			

URANIUM, INSOLUBLE COMPOUNDS	Inh.	Int.	0.002 mg/m3	100	Renal	Draft	05/11	7440-61-1
		Chr.	0.0008 mg/m3	1000	Resp.			
VANADIUM	Inh.	Acute	0.0008 mg/m3	90	Resp.	Draft	09/09	7440-62-2
		Chr.	0.0001 mg/m3	30	Resp.			
	Oral	Int.	0.01 mg/kg/day	10	Hemato.			
VINYL ACETATE	Inh.	Int.	0.01 ppm	100	Resp.	Final	07/92	108-05-4
VINYL CHLORIDE	Inh.	Acute	0.5 ppm	30	Develop.	Final	07/06	75-01-4
		Int.	0.03 ppm	30	Hepatic			
	Oral	Chr.	0.003 mg/kg/day	30	Hepatic			
XYLENES, MIXED	Inh.	Acute	2 ppm	30	Neurol.	Final	08/07	1330-20-7
		Int.	0.6 ppm	90	Neurol.			
		Chr.	0.05 ppm	300	Neurol.			
	Oral	Acute	1 mg/kg/day	100	Neurol.			
		Int.	0.4 mg/kg/day	1000	Neurol.			
		Chr.	0.2 mg/kg/day	1000	Neurol.			
ZINC	Oral	Int.	0.3 mg/kg/day	3	Hemato.	Final	09/05	7440-66-6
		Chr.	0.3 mg/kg/day	3	Hemato.			

Total number of MRLs: 397

For Duration, Acute = 1 to 14 days, Intermediate = 15 to 364 days, and Chronic = 1 year or longer.

For general information on ATSDR Minimal Risk Levels, see www.atsdr.cdc.gov/mrls.

**For more information on a specific MRL, please refer to our Toxicological Profiles, particularly Appendix A of Profiles written after 1995.
The Profiles can be found online at www.astdr.cdc.gov or ordered via cdcinfo@cdc.gov or 1-800-CDC-INFO.**

APPENDIX B

SUMMA CANISTER RESULTS

WITH HQ AND HI VALUES

The following Tables are sorted by Compound Name. Pad Sites have been color coded for easier identification.

LABSAMPID	sample	Pad	site	RESULTS ppb(v)	RESULTS (ug/m3)	Hazard Quotient	COMPOUND NAME	CASNUM	MRL (ppbv)
1208560-04A	SITE A6	Lewis Wetzel Two	3	2.4	14	0.2	1,2-Dichlorobenzene	95-50-1	10
1207673-02A	SITE B2	DONNA	1	0.94	2.1	0.0	1,3-Butadiene	106-99-0	100
1210591-01A	SITE A16	BROOKE	7	6.7	20	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1210495-02A	SITE B15	BROOKE	7	3.4	10	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1210591-02A	SITE B16	BROOKE	7	18	53	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1207673-02A	SITE B2	DONNA	1	6.0	18	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1210187-02A	Site C13	LEMON	6	24	72	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209538-04A	SITE E11	LEMON	6	8.8	26	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1208683-01A	SITE A7	Lewis Wetzel Three	4	42	120	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209041-01A	Site A8	Lewis Wetzel Three	4	69	200	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1208683-02A	SITE C7	Lewis Wetzel Three	4	36	110	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209041-02A	Site C8	Lewis Wetzel Three	4	16	46	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1208560-02A	SITE A5	Lewis Wetzel Two	3	48	140	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1208560-04A	SITE A6	Lewis Wetzel Two	3	44	130	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1208560-01A	SITE C5	Lewis Wetzel Two	3	54	160	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1208560-03A	SITE C6	Lewis Wetzel Two	3	56	160	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209293-01A	Site B10	MAURY	5	49	140	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209538-02A	SITE B11	MAURY	5	8.9	26	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209599-01A	Site B12	MAURY	5	4.6	13	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209292-01A	Site B9	MAURY	5	26	75	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209538-03A	SITE C11	MAURY	5	40	120	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209293-02A	Site D10	MAURY	5	6.3	18	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209539-01A	SITE D11	MAURY	5	5.5	16	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209292-02A	Site D9	MAURY	5	9.8	29	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1208326-01A	SITE A4	WEEKLEY	2	48	140	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1208326-02A	SITE B4	WEEKLEY	2	47	140	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1208326-03A	SITE C4	WEEKLEY	2	33	98	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x

LABSAMPID	sample	Pad	site	RESULTS ppb(v)	RESULTS (ug/m3)	Hazard Quotient	COMPOUND NAME	CASNUM	MRL (ppbv)
1209538-03A	SITE C11	LEMON	6	3.2	13	NL*	2-Hexanone	591-78-6	x
1207673-02A	SITE B2	DONNA	1	13	32	NL*	2-Propanol	67-63-0	x
1209538-03A	SITE C11	LEMON	6	3.7	9.0	NL*	2-Propanol	67-63-0	x
1210187-02A	Site C13	LEMON	6	4.4	11	NL*	2-Propanol	67-63-0	x
1208683-01A	SITE A7	Lewis Wetzel Three	4	3.6	9.0	NL*	2-Propanol	67-63-0	x
1209041-01A	Site A8	Lewis Wetzel Three	4	4.8	12	NL*	2-Propanol	67-63-0	x
1208683-02A	SITE C7	Lewis Wetzel Three	4	5.5	13	NL*	2-Propanol	67-63-0	x
1208560-02A	SITE A5	Lewis Wetzel Two	3	4.4	11	NL*	2-Propanol	67-63-0	x
1208560-04A	SITE A6	Lewis Wetzel Two	3	27	67	NL*	2-Propanol	67-63-0	x
1208560-01A	SITE C5	Lewis Wetzel Two	3	5.1	12	NL*	2-Propanol	67-63-0	x
1209293-01A	Site B10	MAURY	5	3.2	7.8	NL*	2-Propanol	67-63-0	x
1209538-02A	SITE B11	MAURY	5	12	29	NL*	2-Propanol	67-63-0	x
1209599-01A	Site B12	MAURY	5	3.0	7.4	NL*	2-Propanol	67-63-0	x
1209292-01A	Site B9	MAURY	5	4.3	10	NL*	2-Propanol	67-63-0	x
1209539-01A	SITE D11	MAURY	5	4.4	11	NL*	2-Propanol	67-63-0	x
1208260-01A	SITE A3	WEEKLEY	2	4.5	11	NL*	2-Propanol	67-63-0	x
1208260-03A	SITE B3	WEEKLEY	2	5.9	14	NL*	2-Propanol	67-63-0	x
1208260-02A	SITE C3	WEEKLEY	2	4.4	11	NL*	2-Propanol	67-63-0	x
1207673-02A	SITE B2	DONNA	1	2.3	9.5	NL*	4-Methyl-2-pentanone	108-10-1	x
1209538-03A	SITE C11	LEMON	6	2.1	8.5	NL*	4-Methyl-2-pentanone	108-10-1	x
1210187-02A	Site C13	LEMON	6	2.7	11	NL*	4-Methyl-2-pentanone	108-10-1	x
1208683-01A	SITE A7	Lewis Wetzel Three	4	1.3	5.5	NL*	4-Methyl-2-pentanone	108-10-1	x
1209041-01A	Site A8	Lewis Wetzel Three	4	1.8	7.3	NL*	4-Methyl-2-pentanone	108-10-1	x
1208683-02A	SITE C7	Lewis Wetzel Three	4	2.3	9.4	NL*	4-Methyl-2-pentanone	108-10-1	x
1209041-02A	Site C8	Lewis Wetzel Three	4	0.80	3.3	NL*	4-Methyl-2-pentanone	108-10-1	x
1208560-02A	SITE A5	Lewis Wetzel Two	3	2.4	9.6	NL*	4-Methyl-2-pentanone	108-10-1	x
1208560-04A	SITE A6	Lewis Wetzel Two	3	2.9	12	NL*	4-Methyl-2-pentanone	108-10-1	x
1208560-01A	SITE C5	Lewis Wetzel Two	3	2.4	9.8	NL*	4-Methyl-2-pentanone	108-10-1	x
1208560-03A	SITE C6	Lewis Wetzel Two	3	2.0	8.3	NL*	4-Methyl-2-pentanone	108-10-1	x
1209293-01A	Site B10	MAURY	5	1.8	7.4	NL*	4-Methyl-2-pentanone	108-10-1	x
1209538-02A	SITE B11	MAURY	5	2.7	11	NL*	4-Methyl-2-pentanone	108-10-1	x
1209599-01A	Site B12	MAURY	5	0.83	3.4	NL*	4-Methyl-2-pentanone	108-10-1	x
1209292-01A	Site B9	MAURY	5	1.6	6.8	NL*	4-Methyl-2-pentanone	108-10-1	x
1209539-01A	SITE D11	MAURY	5	3.3	14	NL*	4-Methyl-2-pentanone	108-10-1	x
1209292-02A	Site D9	MAURY	5	1.5	6.1	NL*	4-Methyl-2-pentanone	108-10-1	x
1208260-01A	SITE A3	WEEKLEY	2	3.9	16	NL*	4-Methyl-2-pentanone	108-10-1	x
1208326-01A	SITE A4	WEEKLEY	2	2.6	11	NL*	4-Methyl-2-pentanone	108-10-1	x
1208260-03A	SITE B3	WEEKLEY	2	3.7	15	NL*	4-Methyl-2-pentanone	108-10-1	x
1208326-02A	SITE B4	WEEKLEY	2	2.0	8.3	NL*	4-Methyl-2-pentanone	108-10-1	x
1208260-02A	SITE C3	WEEKLEY	2	3.7	15	NL*	4-Methyl-2-pentanone	108-10-1	x
1208326-03A	SITE C4	WEEKLEY	2	1.3	5.2	NL*	4-Methyl-2-pentanone	108-10-1	x

LABSAMPID	sample	Pad	site	RESULTS ppb(v)	RESULTS (ug/m3)	Hazard Quotient	COMPOUND NAME	CASNUM	MRL (ppbv)
1209538-03A	SITE C11	LEMON	6	3.2	13	NL*	2-Hexanone	591-78-6	x
1207673-02A	SITE B2	DONNA	1	13	32	NL*	2-Propanol	67-63-0	x
1209538-03A	SITE C11	LEMON	6	3.7	9.0	NL*	2-Propanol	67-63-0	x
1210187-02A	Site C13	LEMON	6	4.4	11	NL*	2-Propanol	67-63-0	x
1208683-01A	SITE A7	Lewis Wetzel Three	4	3.6	9.0	NL*	2-Propanol	67-63-0	x
1209041-01A	Site A8	Lewis Wetzel Three	4	4.8	12	NL*	2-Propanol	67-63-0	x
1208683-02A	SITE C7	Lewis Wetzel Three	4	5.5	13	NL*	2-Propanol	67-63-0	x
1208560-02A	SITE A5	Lewis Wetzel Two	3	4.4	11	NL*	2-Propanol	67-63-0	x
1208560-04A	SITE A6	Lewis Wetzel Two	3	27	67	NL*	2-Propanol	67-63-0	x
1208560-01A	SITE C5	Lewis Wetzel Two	3	5.1	12	NL*	2-Propanol	67-63-0	x
1209293-01A	Site B10	MAURY	5	3.2	7.8	NL*	2-Propanol	67-63-0	x
1209538-02A	SITE B11	MAURY	5	12	29	NL*	2-Propanol	67-63-0	x
1209599-01A	Site B12	MAURY	5	3.0	7.4	NL*	2-Propanol	67-63-0	x
1209292-01A	Site B9	MAURY	5	4.3	10	NL*	2-Propanol	67-63-0	x
1209539-01A	SITE D11	MAURY	5	4.4	11	NL*	2-Propanol	67-63-0	x
1208260-01A	SITE A3	WEEKLEY	2	4.5	11	NL*	2-Propanol	67-63-0	x
1208260-03A	SITE B3	WEEKLEY	2	5.9	14	NL*	2-Propanol	67-63-0	x
1208260-02A	SITE C3	WEEKLEY	2	4.4	11	NL*	2-Propanol	67-63-0	x
1207673-02A	SITE B2	DONNA	1	2.3	9.5	NL*	4-Methyl-2-pentanone	108-10-1	x
1209538-03A	SITE C11	LEMON	6	2.1	8.5	NL*	4-Methyl-2-pentanone	108-10-1	x
1210187-02A	Site C13	LEMON	6	2.7	11	NL*	4-Methyl-2-pentanone	108-10-1	x
1208683-01A	SITE A7	Lewis Wetzel Three	4	1.3	5.5	NL*	4-Methyl-2-pentanone	108-10-1	x
1209041-01A	Site A8	Lewis Wetzel Three	4	1.8	7.3	NL*	4-Methyl-2-pentanone	108-10-1	x
1208683-02A	SITE C7	Lewis Wetzel Three	4	2.3	9.4	NL*	4-Methyl-2-pentanone	108-10-1	x
1209041-02A	Site C8	Lewis Wetzel Three	4	0.80	3.3	NL*	4-Methyl-2-pentanone	108-10-1	x
1208560-02A	SITE A5	Lewis Wetzel Two	3	2.4	9.6	NL*	4-Methyl-2-pentanone	108-10-1	x
1208560-04A	SITE A6	Lewis Wetzel Two	3	2.9	12	NL*	4-Methyl-2-pentanone	108-10-1	x
1208560-01A	SITE C5	Lewis Wetzel Two	3	2.4	9.8	NL*	4-Methyl-2-pentanone	108-10-1	x
1208560-03A	SITE C6	Lewis Wetzel Two	3	2.0	8.3	NL*	4-Methyl-2-pentanone	108-10-1	x
1209293-01A	Site B10	MAURY	5	1.8	7.4	NL*	4-Methyl-2-pentanone	108-10-1	x
1209538-02A	SITE B11	MAURY	5	2.7	11	NL*	4-Methyl-2-pentanone	108-10-1	x

LABSAMPID	sample	Pad	site	RESULTS ppb(v)	RESULTS (ug/m3)	Hazard Quotient	COMPOUND NAME	CASNUM	MRL (ppbv)
1209599-01A	Site B12	MAURY	5	0.83	3.4	NL*	4-Methyl-2-pentanone	108-10-1	x
1209292-01A	Site B9	MAURY	5	1.6	6.8	NL*	4-Methyl-2-pentanone	108-10-1	x
1209539-01A	SITE D11	MAURY	5	3.3	14	NL*	4-Methyl-2-pentanone	108-10-1	x
1209292-02A	Site D9	MAURY	5	1.5	6.1	NL*	4-Methyl-2-pentanone	108-10-1	x
1208260-01A	SITE A3	WEEKLEY	2	3.9	16	NL*	4-Methyl-2-pentanone	108-10-1	x
1208326-01A	SITE A4	WEEKLEY	2	2.6	11	NL*	4-Methyl-2-pentanone	108-10-1	x
1208260-03A	SITE B3	WEEKLEY	2	3.7	15	NL*	4-Methyl-2-pentanone	108-10-1	x
1208326-02A	SITE B4	WEEKLEY	2	2.0	8.3	NL*	4-Methyl-2-pentanone	108-10-1	x
1208260-02A	SITE C3	WEEKLEY	2	3.7	15	NL*	4-Methyl-2-pentanone	108-10-1	x
1208326-03A	SITE C4	WEEKLEY	2	1.3	5.2	NL*	4-Methyl-2-pentanone	108-10-1	x
1210495-01A	SITE A15	BROOKE	7	39	92	0.0	Acetone	67-64-1	13000
1210495-02A	SITE B15	BROOKE	7	20	48	0.0	Acetone	67-64-1	13000
1207673-04A	SITE D2	DONNA	1	29	70	0.0	Acetone	67-64-1	13000
1207673-03A	SITE C2	DONNA	1	22	52	0.0	Acetone	67-64-1	13000
1207673-02A	SITE B2	DONNA	1	14	34	0.0	Acetone	67-64-1	13000
1207576-01A	SITE A1	DONNA	1	8.3	20	0.0	Acetone	67-64-1	13000
1210187-04A	Site C14	LEMON	6	60	140	0.0	Acetone	67-64-1	13000
1209538-04A	SITE E11	LEMON	6	37	88	0.0	Acetone	67-64-1	13000
1210187-03A	Site A14	LEMON	6	10	24	0.0	Acetone	67-64-1	13000
1209041-02A	Site C8	Lewis Wetzel Three	4	56	130	0.0	Acetone	67-64-1	13000
1209292-01A	Site B9	MAURY	5	88	210	0.0	Acetone	67-64-1	13000
1209599-01A	Site B12	MAURY	5	70	160	0.0	Acetone	67-64-1	13000
1209539-01A	SITE D11	MAURY	5	59	140	0.0	Acetone	67-64-1	13000
1209292-02A	Site D9	MAURY	5	31	75	0.0	Acetone	67-64-1	13000
1209293-02A	Site D10	MAURY	5	14	34	0.0	Acetone	67-64-1	13000
1208326-02A	SITE B4	WEEKLEY	2	79	190	0.0	Acetone	67-64-1	13000
1208326-01A	SITE A4	WEEKLEY	2	67	160	0.0	Acetone	67-64-1	13000
1208326-03A	SITE C4	WEEKLEY	2	51	120	0.0	Acetone	67-64-1	13000
1210591-01A	SITE A16	BROOKE	7	13	41	4.3	Benzene	71-43-2	3
1210495-01A	SITE A15	BROOKE	7	3.0	9.5	1.0	Benzene	71-43-2	3
1207673-02A	SITE B2	DONNA	1	2.2	7.0	0.7	Benzene	71-43-2	3
1207673-04A	SITE D2	DONNA	1	2.1	6.8	0.7	Benzene	71-43-2	3
1207673-03A	SITE C2	DONNA	1	1.7	5.3	0.6	Benzene	71-43-2	3
1210187-04A	Site C14	LEMON	6	15	48	5.0	Benzene	71-43-2	3

LABSAMPID	sample	Pad	site	RESULTS ppb(v)	RESULTS (ug/m3)	Hazard Quotient	COMPOUND NAME	CASNUM	MRL (ppbv)
1209041-01A	Site A8	Lewis Wetzel Three	4	1.1	3.6	0.4	Benzene	71-43-2	3
1208683-02A	SITE C7	Lewis Wetzel Three	4	1.0	3.3	0.3	Benzene	71-43-2	3
1208683-01A	SITE A7	Lewis Wetzel Three	4	0.78	2.5	0.3	Benzene	71-43-2	3
1208560-01A	SITE C5	Lewis Wetzel Two	3	3.0	9.7	1.0	Benzene	71-43-2	3
1208560-02A	SITE A5	Lewis Wetzel Two	3	2.4	7.8	0.8	Benzene	71-43-2	3
1208560-03A	SITE C6	Lewis Wetzel Two	3	2.4	7.7	0.8	Benzene	71-43-2	3
1208560-04A	SITE A6	Lewis Wetzel Two	3	2.1	6.7	0.7	Benzene	71-43-2	3
1209538-02A	SITE B11	MAURY	5	85	270	28.3	Benzene	71-43-2	3
1209599-01A	Site B12	MAURY	5	49	160	16.3	Benzene	71-43-2	3
1209539-01A	SITE D11	MAURY	5	12	39	4.0	Benzene	71-43-2	3
1208260-03A	SITE B3	WEEKLEY	2	8.2	26	2.7	Benzene	71-43-2	3
1208260-02A	SITE C3	WEEKLEY	2	4.5	14	1.5	Benzene	71-43-2	3
1208260-01A	SITE A3	WEEKLEY	2	4.2	13	1.4	Benzene	71-43-2	3
1208326-02A	SITE B4	WEEKLEY	2	3.9	12	1.3	Benzene	71-43-2	3
1208326-01A	SITE A4	WEEKLEY	2	2.9	9.2	1.0	Benzene	71-43-2	3
1208326-03A	SITE C4	WEEKLEY	2	1.7	5.6	0.6	Benzene	71-43-2	3
1207576-01A	SITE A1	DONNA	1	5.1	16	0.0	Carbon Disulfide	75-15-0	300
1208683-01A	SITE A7	Lewis Wetzel Three	4	0.93	4.6	NL*	Cumene	98-82-8	x
1209041-01A	Site A8	Lewis Wetzel Three	4	1.1	5.4	NL*	Cumene	98-82-8	x
1208683-02A	SITE C7	Lewis Wetzel Three	4	1.2	5.8	NL*	Cumene	98-82-8	x
1208560-02A	SITE A5	Lewis Wetzel Two	3	1.8	8.8	NL*	Cumene	98-82-8	x
1208560-04A	SITE A6	Lewis Wetzel Two	3	2.9	14	NL*	Cumene	98-82-8	x
1208560-01A	SITE C5	Lewis Wetzel Two	3	1.4	6.7	NL*	Cumene	98-82-8	x
1208560-03A	SITE C6	Lewis Wetzel Two	3	1.4	7.0	NL*	Cumene	98-82-8	x
1209292-02A	Site D9	MAURY	5	0.98	4.8	NL*	Cumene	98-82-8	x
1208260-01A	SITE A3	WEEKLEY	2	3.4	17	NL*	Cumene	98-82-8	x
1208326-01A	SITE A4	WEEKLEY	2	2.4	12	NL*	Cumene	98-82-8	x
1208260-03A	SITE B3	WEEKLEY	2	2.8	14	NL*	Cumene	98-82-8	x
1208326-02A	SITE B4	WEEKLEY	2	1.8	8.8	NL*	Cumene	98-82-8	x
1208260-02A	SITE C3	WEEKLEY	2	3.3	16	NL*	Cumene	98-82-8	x
1208326-03A	SITE C4	WEEKLEY	2	1.3	6.4	NL*	Cumene	98-82-8	x
1207673-02A	SITE B2	DONNA	1	1.2	4.2	NL*	Cyclohexane	110-82-7	x
1210495-01A	SITE A15	BROOKE	7	6.0	11	NL*	Ethanol	64-17-5	x
1210591-01A	SITE A16	BROOKE	7	6.9	13	NL*	Ethanol	64-17-5	x
1210495-02A	SITE B15	BROOKE	7	4.4	8.4	NL*	Ethanol	64-17-5	x
1210591-02A	SITE B16	BROOKE	7	9.9	19	NL*	Ethanol	64-17-5	x
1207673-02A	SITE B2	DONNA	1	38	71	NL*	Ethanol	64-17-5	x
1209538-03A	SITE C11	LEMON	6	13	24	NL*	Ethanol	64-17-5	x
1210187-02A	Site C13	LEMON	6	26	48	NL*	Ethanol	64-17-5	x

LABSAMPID	sample	Pad	site	RESULTS ppb(v)	RESULTS (ug/m3)	Hazard Quotient	COMPOUND NAME	CASNUM	MRL (ppbv)
1210187-04A	Site C14	LEMON	6	3.4	6.4	NL*	Ethanol	64-17-5	x
1209538-04A	SITE E11	LEMON	6	5.1	9.7	NL*	Ethanol	64-17-5	x
1208683-01A	SITE A7	Lewis Wetzel Three	4	8.6	16	NL*	Ethanol	64-17-5	x
1209041-01A	Site A8	Lewis Wetzel Three	4	20	38	NL*	Ethanol	64-17-5	x
1208683-02A	SITE C7	Lewis Wetzel Three	4	10	19	NL*	Ethanol	64-17-5	x
1209041-02A	Site C8	Lewis Wetzel Three	4	5.3	9.9	NL*	Ethanol	64-17-5	x
1208560-02A	SITE A5	Lewis Wetzel Two	3	30	57	NL*	Ethanol	64-17-5	x
1208560-04A	SITE A6	Lewis Wetzel Two	3	42	80	NL*	Ethanol	64-17-5	x
1208560-01A	SITE C5	Lewis Wetzel Two	3	34	65	NL*	Ethanol	64-17-5	x
1208560-03A	SITE C6	Lewis Wetzel Two	3	26	49	NL*	Ethanol	64-17-5	x
1209293-01A	Site B10	MAURY	5	16	30	NL*	Ethanol	64-17-5	x
1209538-02A	SITE B11	MAURY	5	20	38	NL*	Ethanol	64-17-5	x
1209599-01A	Site B12	MAURY	5	4.9	9.2	NL*	Ethanol	64-17-5	x
1209292-01A	Site B9	MAURY	5	10	20	NL*	Ethanol	64-17-5	x
1209292-02A	Site D9	MAURY	5	6.4	12	NL*	Ethanol	64-17-5	x
1208260-01A	SITE A3	WEEKLEY	2	47	88	NL*	Ethanol	64-17-5	x
1208326-01A	SITE A4	WEEKLEY	2	19	36	NL*	Ethanol	64-17-5	x
1208260-03A	SITE B3	WEEKLEY	2	41	77	NL*	Ethanol	64-17-5	x
1208326-02A	SITE B4	WEEKLEY	2	19	36	NL*	Ethanol	64-17-5	x
1208260-02A	SITE C3	WEEKLEY	2	33	63	NL*	Ethanol	64-17-5	x
1208326-03A	SITE C4	WEEKLEY	2	13	25	NL*	Ethanol	64-17-5	x
1207673-02A	SITE B2	DONNA	1	1.2	5.1	0.0	Ethyl Benzene	100-41-4	60
1208560-04A	SITE A6	Lewis Wetzel Two	3	1.3	5.6	0.0	Ethyl Benzene	100-41-4	60
1208260-03A	SITE B3	WEEKLEY	2	1.2	5.3	0.0	Ethyl Benzene	100-41-4	60
1208260-01A	SITE A3	WEEKLEY	2	1.1	4.7	0.0	Ethyl Benzene	100-41-4	60
1208260-02A	SITE C3	WEEKLEY	2	1.0	4.3	0.0	Ethyl Benzene	100-41-4	60
1208326-01A	SITE A4	WEEKLEY	2	0.94	4.1	0.0	Ethyl Benzene	100-41-4	60
1210495-01A	SITE A15	BROOKE	7	0.75	3.0	NL*	Heptane	142-82-5	x
1210591-01A	SITE A16	BROOKE	7	2.3	9.4	NL*	Heptane	142-82-5	x
1210495-02A	SITE B15	BROOKE	7	1.4	5.9	NL*	Heptane	142-82-5	x
1210591-02A	SITE B16	BROOKE	7	8.8	36	NL*	Heptane	142-82-5	x
1207673-02A	SITE B2	DONNA	1	1.4	5.8	NL*	Heptane	142-82-5	x
1209538-03A	SITE C11	LEMON	6	14	57	NL*	Heptane	142-82-5	x
1210187-02A	Site C13	LEMON	6	10	43	NL*	Heptane	142-82-5	x
1209538-04A	SITE E11	LEMON	6	4.7	19	NL*	Heptane	142-82-5	x
1208683-01A	SITE A7	Lewis Wetzel Three	4	16	64	NL*	Heptane	142-82-5	x
1209041-01A	Site A8	Lewis Wetzel Three	4	32	130	NL*	Heptane	142-82-5	x
1208683-02A	SITE C7	Lewis Wetzel Three	4	15	63	NL*	Heptane	142-82-5	x
1209041-02A	Site C8	Lewis Wetzel Three	4	7.0	29	NL*	Heptane	142-82-5	x

LABSAMPID	sample	Pad	site	RESULTS ppb(v)	RESULTS (ug/m3)	Hazard Quotient	COMPOUND NAME	CASNUM	MRL (ppbv)
1208560-02A	SITE A5	Lewis Wetzel Two	3	15	62	NL*	Heptane	142-82-5	x
1208560-04A	SITE A6	Lewis Wetzel Two	3	16	65	NL*	Heptane	142-82-5	x
1208560-01A	SITE C5	Lewis Wetzel Two	3	20	80	NL*	Heptane	142-82-5	x
1208560-03A	SITE C6	Lewis Wetzel Two	3	22	88	NL*	Heptane	142-82-5	x
1209293-01A	Site B10	MAURY	5	17	70	NL*	Heptane	142-82-5	x
1209538-02A	SITE B11	MAURY	5	1.0	4.2	NL*	Heptane	142-82-5	x
1209292-01A	Site B9	MAURY	5	9.8	40	NL*	Heptane	142-82-5	x
1209293-02A	Site D10	MAURY	5	4.3	18	NL*	Heptane	142-82-5	x
1209599-02A	Site D12	MAURY	5	1.0	4.1	NL*	Heptane	142-82-5	x
1209292-02A	Site D9	MAURY	5	4.7	19	NL*	Heptane	142-82-5	x
1208260-01A	SITE A3	WEEKLEY	2	16	66	NL*	Heptane	142-82-5	x
1208326-01A	SITE A4	WEEKLEY	2	14	60	NL*	Heptane	142-82-5	x
1208260-03A	SITE B3	WEEKLEY	2	24	98	NL*	Heptane	142-82-5	x
1208326-02A	SITE B4	WEEKLEY	2	19	79	NL*	Heptane	142-82-5	x
1208260-02A	SITE C3	WEEKLEY	2	19	77	NL*	Heptane	142-82-5	x
1208326-03A	SITE C4	WEEKLEY	2	13	54	NL*	Heptane	142-82-5	x
1210591-02A	SITE B16	BROOKE	7	0.88	3.1	0.0	Hexane	110-54-3	600
1207673-02A	SITE B2	DONNA	1	1.0	3.6	0.0	Hexane	110-54-3	600
1210187-02A	Site C13	LEMON	6	1.2	4.4	0.0	Hexane	110-54-3	600
1209538-03A	SITE C11	LEMON	6	1.1	4.0	0.0	Hexane	110-54-3	600
1209041-01A	Site A8	Lewis Wetzel Three	4	3.8	13	0.0	Hexane	110-54-3	600
1208683-01A	SITE A7	Lewis Wetzel Three	4	2.1	7.5	0.0	Hexane	110-54-3	600
1208683-02A	SITE C7	Lewis Wetzel Three	4	2.1	7.6	0.0	Hexane	110-54-3	600
1209041-02A	Site C8	Lewis Wetzel Three	4	1.1	3.8	0.0	Hexane	110-54-3	600
1208560-03A	SITE C6	Lewis Wetzel Two	3	3.3	12	0.0	Hexane	110-54-3	600
1208560-04A	SITE A6	Lewis Wetzel Two	3	3.0	10	0.0	Hexane	110-54-3	600
1208560-01A	SITE C5	Lewis Wetzel Two	3	2.8	10	0.0	Hexane	110-54-3	600
1208560-02A	SITE A5	Lewis Wetzel Two	3	2.3	8.1	0.0	Hexane	110-54-3	600
1209293-02A	Site D10	MAURY	5	3.4	12	0.0	Hexane	110-54-3	600
1209599-02A	Site D12	MAURY	5	2.2	7.9	0.0	Hexane	110-54-3	600
1209293-01A	Site B10	MAURY	5	1.6	5.8	0.0	Hexane	110-54-3	600
1209292-01A	Site B9	MAURY	5	1.1	3.8	0.0	Hexane	110-54-3	600
1209292-02A	Site D9	MAURY	5	0.89	3.2	0.0	Hexane	110-54-3	600
1208260-03A	SITE B3	WEEKLEY	2	12	44	0.0	Hexane	110-54-3	600
1208326-02A	SITE B4	WEEKLEY	2	6.2	22	0.0	Hexane	110-54-3	600
1208260-02A	SITE C3	WEEKLEY	2	5.4	19	0.0	Hexane	110-54-3	600
1208260-01A	SITE A3	WEEKLEY	2	4.4	16	0.0	Hexane	110-54-3	600
1208326-01A	SITE A4	WEEKLEY	2	2.7	9.6	0.0	Hexane	110-54-3	600
1208326-03A	SITE C4	WEEKLEY	2	2.6	9.0	0.0	Hexane	110-54-3	600

LABSAMPID	sample	Pad	site	RESULTS ppb(v)	RESULTS (ug/m3)	Hazard Quotient	COMPOUND NAME	CASNUM	MRL (ppbv)
1207673-02A	SITE B2	DONNA	1	3.2	14	0.1	m,p-Xylene	108-38-3/106-42-3	50
1210187-02A	Site C13	LEMON	6	0.90	3.9	0.0	m,p-Xylene	108-38-3/106-42-3	50
1209538-03A	SITE C11	LEMON	6	0.88	3.8	0.0	m,p-Xylene	108-38-3/106-42-3	50
1209041-01A	Site A8	Lewis Wetzel Three	4	1.5	6.4	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208683-02A	SITE C7	Lewis Wetzel Three	4	1.3	5.7	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208683-01A	SITE A7	Lewis Wetzel Three	4	1.2	5.0	0.0	m,p-Xylene	108-38-3/106-42-3	50
1209041-02A	Site C8	Lewis Wetzel Three	4	0.72	3.1	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208560-04A	SITE A6	Lewis Wetzel Two	3	5.9	26	0.1	m,p-Xylene	108-38-3/106-42-3	50
1208560-03A	SITE C6	Lewis Wetzel Two	3	2.1	9.0	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208560-02A	SITE A5	Lewis Wetzel Two	3	1.9	8.4	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208560-01A	SITE C5	Lewis Wetzel Two	3	1.8	8.0	0.0	m,p-Xylene	108-38-3/106-42-3	50
1209539-01A	SITE D11	MAURY	5	0.94	4.1	0.0	m,p-Xylene	108-38-3/106-42-3	50
1209538-02A	SITE B11	MAURY	5	0.90	3.9	0.0	m,p-Xylene	108-38-3/106-42-3	50
1209292-02A	Site D9	MAURY	5	0.88	3.8	0.0	m,p-Xylene	108-38-3/106-42-3	50
1209293-01A	Site B10	MAURY	5	0.80	3.4	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208260-03A	SITE B3	WEEKLEY	2	2.8	12	0.1	m,p-Xylene	108-38-3/106-42-3	50
1208260-01A	SITE A3	WEEKLEY	2	2.2	9.7	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208260-02A	SITE C3	WEEKLEY	2	2.1	9.0	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208326-01A	SITE A4	WEEKLEY	2	2.0	8.7	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208326-02A	SITE B4	WEEKLEY	2	2.0	8.9	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208326-03A	SITE C4	WEEKLEY	2	0.99	4.3	0.0	m,p-Xylene	108-38-3/106-42-3	50
1207673-02A	SITE B2	DONNA	1	1.3	5.6	0.0	o-Xylene	95-47-6	50
1208560-04A	SITE A6	Lewis Wetzel Two	3	2.9	13	0.1	o-Xylene	95-47-6	50
1208560-04A	SITE A6	Lewis Wetzel Two	3	1.1	4.6	0.0	Styrene	100-42-5	200
1209292-02A	Site D9	MAURY	5	0.67	2.9	0.0	Styrene	100-42-5	200
1208260-03A	SITE B3	WEEKLEY	2	1.4	6.2	0.0	Styrene	100-42-5	200
1208260-02A	SITE C3	WEEKLEY	2	1.2	5.0	0.0	Styrene	100-42-5	200
1208260-01A	SITE A3	WEEKLEY	2	1.1	4.8	0.0	Styrene	100-42-5	200
1208260-01A	SITE A3	WEEKLEY	2	0.89	2.6	NL*	Tetrahydrofuran	109-99-9	x
1210495-01A	SITE A15	BROOKE	7	1.9	7.2	0.0	Toluene	108-88-3	80
1210591-01A	SITE A16	BROOKE	7	1.5	5.8	0.0	Toluene	108-88-3	80
1210591-02A	SITE B16	BROOKE	7	1.5	5.6	0.0	Toluene	108-88-3	80
1210495-02A	SITE B15	BROOKE	7	0.89	3.3	0.0	Toluene	108-88-3	80
1207673-02A	SITE B2	DONNA	1	62	230	0.8	Toluene	108-88-3	80
1207673-04A	SITE D2	DONNA	1	2.2	8.1	0.0	Toluene	108-88-3	80
1210187-04A	Site C14	LEMON	6	4.3	16	0.1	Toluene	108-88-3	80
1210187-02A	Site C13	LEMON	6	2.2	8.4	0.0	Toluene	108-88-3	80
1209538-03A	SITE C11	LEMON	6	1.9	7.2	0.0	Toluene	108-88-3	80
1209041-01A	Site A8	Lewis Wetzel Three	4	2.7	10	0.0	Toluene	108-88-3	80

LABSAMPID	sample	Pad	site	RESULTS ppb(v)	RESULTS (ug/m3)	Hazard Quotient	COMPOUND NAME	CASNUM	MRL (ppbv)
1208683-02A	SITE C7	Lewis Wetzel Three	4	1.9	7.3	0.0	Toluene	108-88-3	80
1208683-01A	SITE A7	Lewis Wetzel Three	4	1.4	5.3	0.0	Toluene	108-88-3	80
1209041-02A	Site C8	Lewis Wetzel Three	4	1.4	5.2	0.0	Toluene	108-88-3	80
1208560-04A	SITE A6	Lewis Wetzel Two	3	14	54	0.2	Toluene	108-88-3	80
1208560-01A	SITE C5	Lewis Wetzel Two	3	2.3	8.6	0.0	Toluene	108-88-3	80
1208560-02A	SITE A5	Lewis Wetzel Two	3	2.2	8.3	0.0	Toluene	108-88-3	80
1208560-03A	SITE C6	Lewis Wetzel Two	3	2.0	7.6	0.0	Toluene	108-88-3	80
1209539-01A	SITE D11	MAURY	5	3.5	13	0.0	Toluene	108-88-3	80
1209538-02A	SITE B11	MAURY	5	3.2	12	0.0	Toluene	108-88-3	80
1209292-02A	Site D9	MAURY	5	1.9	7.2	0.0	Toluene	108-88-3	80
1209293-01A	Site B10	MAURY	5	1.6	5.9	0.0	Toluene	108-88-3	80
1209292-01A	Site B9	MAURY	5	1.3	5.0	0.0	Toluene	108-88-3	80
1209599-01A	Site B12	MAURY	5	1.2	4.6	0.0	Toluene	108-88-3	80
1209293-02A	Site D10	MAURY	5	0.78	3.0	0.0	Toluene	108-88-3	80
1208260-03A	SITE B3	WEEKLEY	2	4.6	17	0.1	Toluene	108-88-3	80
1208260-01A	SITE A3	WEEKLEY	2	4.3	16	0.1	Toluene	108-88-3	80
1208260-02A	SITE C3	WEEKLEY	2	3.9	15	0.0	Toluene	108-88-3	80
1208326-01A	SITE A4	WEEKLEY	2	3.1	12	0.0	Toluene	108-88-3	80
1208326-02A	SITE B4	WEEKLEY	2	2.6	9.9	0.0	Toluene	108-88-3	80
1208326-03A	SITE C4	WEEKLEY	2	1.7	6.4	0.0	Toluene	108-88-3	80
1207673-02A	SITE B2	DONNA	1	0.94	5.1	NL*	Trichloroethene	79-01-6	x
1209041-01A	Site A8	Lewis Wetzel Three	4	1.4	3.5	0.0	Vinyl Chloride	75-01-4	30
1208560-03A	SITE C6	Lewis Wetzel Two	3	1.3	3.3	0.0	Vinyl Chloride	75-01-4	30
1208560-01A	SITE C5	Lewis Wetzel Two	3	0.93	2.4	0.0	Vinyl Chloride	75-01-4	30
1208560-02A	SITE A5	Lewis Wetzel Two	3	0.89	2.3	0.0	Vinyl Chloride	75-01-4	30
1209293-01A	Site B10	MAURY	5	0.96	2.5	0.0	Vinyl Chloride	75-01-4	30
1209292-01A	Site B9	MAURY	5	0.67	1.7	0.0	Vinyl Chloride	75-01-4	30
1208260-03A	SITE B3	WEEKLEY	2	1.2	3.0	0.0	Vinyl Chloride	75-01-4	30
1208326-02A	SITE B4	WEEKLEY	2	1.2	3.2	0.0	Vinyl Chloride	75-01-4	30
1208260-02A	SITE C3	WEEKLEY	2	0.98	2.5	0.0	Vinyl Chloride	75-01-4	30
1208326-03A	SITE C4	WEEKLEY	2	0.79	2.0	0.0	Vinyl Chloride	75-01-4	30

*NL - not listed by ATSDR

The following Tables have been sorted by Pad Site. Hazard quotients greater than 1.0 have been color coded yellow.

LABSAMPID	sample	Pad	site	RESULTS ppb(v)	RESULTS (ug/m3)	Hazard Quotient	COMPOUND NAME	CASNUM	MRL (ppbv)
1208260-01A	SITE A3	WEEKLEY	2	4.5	11	NL*	2-Propanol	67-63-0	x
1208260-01A	SITE A3	WEEKLEY	2	3.9	16	NL*	4-Methyl-2-pentanone	108-10-1	x
1208260-01A	SITE A3	WEEKLEY	2	3.4	17	NL*	Cumene	98-82-8	x
1208260-01A	SITE A3	WEEKLEY	2	47	88	NL*	Ethanol	64-17-5	x
1208260-01A	SITE A3	WEEKLEY	2	16	66	NL*	Heptane	142-82-5	x
1208260-01A	SITE A3	WEEKLEY	2	0.89	2.6	NL*	Tetrahydrofuran	109-99-9	x
1208326-01A	SITE A4	WEEKLEY	2	48	140	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1208326-01A	SITE A4	WEEKLEY	2	2.6	11	NL*	4-Methyl-2-pentanone	108-10-1	x
1208326-01A	SITE A4	WEEKLEY	2	2.4	12	NL*	Cumene	98-82-8	x
1208326-01A	SITE A4	WEEKLEY	2	19	36	NL*	Ethanol	64-17-5	x
1208326-01A	SITE A4	WEEKLEY	2	14	60	NL*	Heptane	142-82-5	x
1208260-03A	SITE B3	WEEKLEY	2	5.9	14	NL*	2-Propanol	67-63-0	x
1208260-03A	SITE B3	WEEKLEY	2	3.7	15	NL*	4-Methyl-2-pentanone	108-10-1	x
1208260-03A	SITE B3	WEEKLEY	2	2.8	14	NL*	Cumene	98-82-8	x
1208260-03A	SITE B3	WEEKLEY	2	41	77	NL*	Ethanol	64-17-5	x
1208260-03A	SITE B3	WEEKLEY	2	24	98	NL*	Heptane	142-82-5	x
1208326-02A	SITE B4	WEEKLEY	2	47	140	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1208326-02A	SITE B4	WEEKLEY	2	2.0	8.3	NL*	4-Methyl-2-pentanone	108-10-1	x
1208326-02A	SITE B4	WEEKLEY	2	1.8	8.8	NL*	Cumene	98-82-8	x
1208326-02A	SITE B4	WEEKLEY	2	19	36	NL*	Ethanol	64-17-5	x
1208326-02A	SITE B4	WEEKLEY	2	19	79	NL*	Heptane	142-82-5	x
1208260-02A	SITE C3	WEEKLEY	2	4.4	11	NL*	2-Propanol	67-63-0	x
1208260-02A	SITE C3	WEEKLEY	2	3.7	15	NL*	4-Methyl-2-pentanone	108-10-1	x
1208260-02A	SITE C3	WEEKLEY	2	3.3	16	NL*	Cumene	98-82-8	x
1208260-02A	SITE C3	WEEKLEY	2	33	63	NL*	Ethanol	64-17-5	x
1208260-02A	SITE C3	WEEKLEY	2	19	77	NL*	Heptane	142-82-5	x
1208326-03A	SITE C4	WEEKLEY	2	33	98	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1208326-03A	SITE C4	WEEKLEY	2	1.3	5.2	NL*	4-Methyl-2-pentanone	108-10-1	x
1208326-03A	SITE C4	WEEKLEY	2	1.3	6.4	NL*	Cumene	98-82-8	x
1208326-03A	SITE C4	WEEKLEY	2	13	25	NL*	Ethanol	64-17-5	x
1208326-03A	SITE C4	WEEKLEY	2	13	54	NL*	Heptane	142-82-5	x
1208260-03A	SITE B3	WEEKLEY	2	8.2	26	2.7	Benzene	71-43-2	3
1208260-02A	SITE C3	WEEKLEY	2	4.5	14	1.5	Benzene	71-43-2	3
1208260-01A	SITE A3	WEEKLEY	2	4.2	13	1.4	Benzene	71-43-2	3
1208326-02A	SITE B4	WEEKLEY	2	3.9	12	1.3	Benzene	71-43-2	3
1208326-01A	SITE A4	WEEKLEY	2	2.9	9.2	1.0	Benzene	71-43-2	3
1208326-03A	SITE C4	WEEKLEY	2	1.7	5.6	0.6	Benzene	71-43-2	3
1208260-03A	SITE B3	WEEKLEY	2	4.6	17	0.1	Toluene	108-88-3	80
1208260-03A	SITE B3	WEEKLEY	2	2.8	12	0.1	m,p-Xylene	108-38-3/106-42-3	50
1208260-01A	SITE A3	WEEKLEY	2	4.3	16	0.1	Toluene	108-88-3	80
1208260-02A	SITE C3	WEEKLEY	2	3.9	15	0.0	Toluene	108-88-3	80

LABSAMPID	sample	Pad	site	RESULTS ppb(v)	RESULTS (ug/m3)	Hazard Quotient	COMPOUND NAME	CASNUM	MRL (ppbv)
1208260-01A	SITE A3	WEEKLEY	2	2.2	9.7	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208260-02A	SITE C3	WEEKLEY	2	2.1	9.0	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208326-01A	SITE A4	WEEKLEY	2	2.0	8.7	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208260-03A	SITE B3	WEEKLEY	2	1.2	3.0	0.0	Vinyl Chloride	75-01-4	30
1208326-02A	SITE B4	WEEKLEY	2	2.0	8.9	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208326-02A	SITE B4	WEEKLEY	2	1.2	3.2	0.0	Vinyl Chloride	75-01-4	30
1208326-01A	SITE A4	WEEKLEY	2	3.1	12	0.0	Toluene	108-88-3	80
1208260-02A	SITE C3	WEEKLEY	2	0.98	2.5	0.0	Vinyl Chloride	75-01-4	30
1208326-02A	SITE B4	WEEKLEY	2	2.6	9.9	0.0	Toluene	108-88-3	80
1208326-03A	SITE C4	WEEKLEY	2	0.79	2.0	0.0	Vinyl Chloride	75-01-4	30
1208326-03A	SITE C4	WEEKLEY	2	1.7	6.4	0.0	Toluene	108-88-3	80
1208260-03A	SITE B3	WEEKLEY	2	1.2	5.3	0.0	Ethyl Benzene	100-41-4	60
1208260-03A	SITE B3	WEEKLEY	2	12	44	0.0	Hexane	110-54-3	600
1208326-03A	SITE C4	WEEKLEY	2	0.99	4.3	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208260-01A	SITE A3	WEEKLEY	2	1.1	4.7	0.0	Ethyl Benzene	100-41-4	60
1208260-02A	SITE C3	WEEKLEY	2	1.0	4.3	0.0	Ethyl Benzene	100-41-4	60
1208326-01A	SITE A4	WEEKLEY	2	0.94	4.1	0.0	Ethyl Benzene	100-41-4	60
1208326-02A	SITE B4	WEEKLEY	2	6.2	22	0.0	Hexane	110-54-3	600
1208260-02A	SITE C3	WEEKLEY	2	5.4	19	0.0	Hexane	110-54-3	600
1208260-01A	SITE A3	WEEKLEY	2	4.4	16	0.0	Hexane	110-54-3	600
1208260-03A	SITE B3	WEEKLEY	2	1.4	6.2	0.0	Styrene	100-42-5	200
1208326-02A	SITE B4	WEEKLEY	2	79	190	0.0	Acetone	67-64-1	13000
1208260-02A	SITE C3	WEEKLEY	2	1.2	5.0	0.0	Styrene	100-42-5	200
1208260-01A	SITE A3	WEEKLEY	2	1.1	4.8	0.0	Styrene	100-42-5	200
1208326-01A	SITE A4	WEEKLEY	2	67	160	0.0	Acetone	67-64-1	13000
1208326-01A	SITE A4	WEEKLEY	2	2.7	9.6	0.0	Hexane	110-54-3	600
1208326-03A	SITE C4	WEEKLEY	2	2.6	9.0	0.0	Hexane	110-54-3	600
1208326-03A	SITE C4	WEEKLEY	2	51	120	0.0	Acetone	67-64-1	13000
1209293-01A	Site B10	MAURY	5	49	140	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209293-01A	Site B10	MAURY	5	3.2	7.8	NL*	2-Propanol	67-63-0	x
1209293-01A	Site B10	MAURY	5	1.8	7.4	NL*	4-Methyl-2-pentanone	108-10-1	x
1209293-01A	Site B10	MAURY	5	16	30	NL*	Ethanol	64-17-5	x
1209293-01A	Site B10	MAURY	5	17	70	NL*	Heptane	142-82-5	x
1209538-02A	SITE B11	MAURY	5	8.9	26	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209538-02A	SITE B11	MAURY	5	12	29	NL*	2-Propanol	67-63-0	x
1209538-02A	SITE B11	MAURY	5	2.7	11	NL*	4-Methyl-2-pentanone	108-10-1	x
1209538-02A	SITE B11	MAURY	5	20	38	NL*	Ethanol	64-17-5	x
1209538-02A	SITE B11	MAURY	5	1.0	4.2	NL*	Heptane	142-82-5	x
1209599-01A	Site B12	MAURY	5	4.6	13	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209599-01A	Site B12	MAURY	5	3.0	7.4	NL*	2-Propanol	67-63-0	x
1209599-01A	Site B12	MAURY	5	0.83	3.4	NL*	4-Methyl-2-pentanone	108-10-1	x
1209599-01A	Site B12	MAURY	5	4.9	9.2	NL*	Ethanol	64-17-5	x

LABSAMPID	sample	Pad	site	RESULTS ppb(v)	RESULTS (ug/m3)	Hazard Quotient	COMPOUND NAME	CASNUM	MRL(ppb v)
1209292-01A	Site B9	MAURY	5	26	75	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209292-01A	Site B9	MAURY	5	4.3	10	NL*	2-Propanol	67-63-0	x
1209292-01A	Site B9	MAURY	5	1.6	6.8	NL*	4-Methyl-2-pentanone	108-10-1	x
1209292-01A	Site B9	MAURY	5	10	20	NL*	Ethanol	64-17-5	x
1209292-01A	Site B9	MAURY	5	9.8	40	NL*	Heptane	142-82-5	x
1209538-03A	SITE C11	MAURY	5	40	120	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209293-02A	Site D10	MAURY	5	6.3	18	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209293-02A	Site D10	MAURY	5	4.3	18	NL*	Heptane	142-82-5	x
1209539-01A	SITE D11	MAURY	5	5.5	16	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209539-01A	SITE D11	MAURY	5	4.4	11	NL*	2-Propanol	67-63-0	x
1209539-01A	SITE D11	MAURY	5	3.3	14	NL*	4-Methyl-2-pentanone	108-10-1	x
1209599-02A	Site D12	MAURY	5	1.0	4.1	NL*	Heptane	142-82-5	x
1209292-02A	Site D9	MAURY	5	9.8	29	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209292-02A	Site D9	MAURY	5	1.5	6.1	NL*	4-Methyl-2-pentanone	108-10-1	x
1209292-02A	Site D9	MAURY	5	0.98	4.8	NL*	Cumene	98-82-8	x
1209292-02A	Site D9	MAURY	5	6.4	12	NL*	Ethanol	64-17-5	x
1209292-02A	Site D9	MAURY	5	4.7	19	NL*	Heptane	142-82-5	x
1209538-02A	SITE B11	MAURY	5	85	270	28.3	Benzene	71-43-2	3
1209599-01A	Site B12	MAURY	5	49	160	16.3	Benzene	71-43-2	3
1209539-01A	SITE D11	MAURY	5	12	39	4.0	Benzene	71-43-2	3
1209539-01A	SITE D11	MAURY	5	3.5	13	0.0	Toluene	108-88-3	80
1209538-02A	SITE B11	MAURY	5	3.2	12	0.0	Toluene	108-88-3	80
1209293-01A	Site B10	MAURY	5	0.96	2.5	0.0	Vinyl Chloride	75-01-4	30
1209292-02A	Site D9	MAURY	5	1.9	7.2	0.0	Toluene	108-88-3	80
1209292-01A	Site B9	MAURY	5	0.67	1.7	0.0	Vinyl Chloride	75-01-4	30
1209293-01A	Site B10	MAURY	5	1.6	5.9	0.0	Toluene	108-88-3	80
1209539-01A	SITE D11	MAURY	5	0.94	4.1	0.0	m,p-Xylene	108-38-3/106-42-3	50
1209538-02A	SITE B11	MAURY	5	0.90	3.9	0.0	m,p-Xylene	108-38-3/106-42-3	50
1209292-02A	Site D9	MAURY	5	0.88	3.8	0.0	m,p-Xylene	108-38-3/106-42-3	50
1209292-01A	Site B9	MAURY	5	1.3	5.0	0.0	Toluene	108-88-3	80
1209293-01A	Site B10	MAURY	5	0.80	3.4	0.0	m,p-Xylene	108-38-3/106-42-3	50
1209599-01A	Site B12	MAURY	5	1.2	4.6	0.0	Toluene	108-88-3	80
1209293-02A	Site D10	MAURY	5	0.78	3.0	0.0	Toluene	108-88-3	80
1209292-01A	Site B9	MAURY	5	88	210	0.0	Acetone	67-64-1	13000
1209293-02A	Site D10	MAURY	5	3.4	12	0.0	Hexane	110-54-3	600
1209599-01A	Site B12	MAURY	5	70	160	0.0	Acetone	67-64-1	13000
1209539-01A	SITE D11	MAURY	5	59	140	0.0	Acetone	67-64-1	13000
1209599-02A	Site D12	MAURY	5	2.2	7.9	0.0	Hexane	110-54-3	600
1209292-02A	Site D9	MAURY	5	0.67	2.9	0.0	Styrene	100-42-5	200
1209293-01A	Site B10	MAURY	5	1.6	5.8	0	Hexane	110-54-3	600

LABSAMPID	sample	Pad	site	RESULTS ppb(v)	RESULTS (ug/m3)	Hazard Quotient	COMPOUND NAME	CASNUM	MRL (ppbv)
1209292-02A	Site D9	MAURY	5	31	75	0	Acetone	67-64-1	13000
1209292-01A	Site B9	MAURY	5	1.1	3.8	0	Hexane	110-54-3	600
1209599-01A	Site B12	MAURY	5	0.83	3.4	NL*	4-Methyl-2-pentanone	108-10-1	x
1209599-01A	Site B12	MAURY	5	4.9	9.2	NL*	Ethanol	64-17-5	x
1209292-01A	Site B9	MAURY	5	26	75	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209292-01A	Site B9	MAURY	5	4.3	10	NL*	2-Propanol	67-63-0	x
1209292-01A	Site B9	MAURY	5	1.6	6.8	NL*	4-Methyl-2-pentanone	108-10-1	x
1209292-01A	Site B9	MAURY	5	10	20	NL*	Ethanol	64-17-5	x
1209292-01A	Site B9	MAURY	5	9.8	40	NL*	Heptane	142-82-5	x
1209538-03A	SITE C11	MAURY	5	40	120	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209293-02A	Site D10	MAURY	5	6.3	18	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209293-02A	Site D10	MAURY	5	4.3	18	NL*	Heptane	142-82-5	x
1209539-01A	SITE D11	MAURY	5	5.5	16	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209539-01A	SITE D11	MAURY	5	4.4	11	NL*	2-Propanol	67-63-0	x
1209539-01A	SITE D11	MAURY	5	3.3	14	NL*	4-Methyl-2-pentanone	108-10-1	x
1209599-02A	Site D12	MAURY	5	1	4.1	NL*	Heptane	142-82-5	x
1209292-02A	Site D9	MAURY	5	9.8	29	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209292-02A	Site D9	MAURY	5	1.5	6.1	NL*	4-Methyl-2-pentanone	108-10-1	x
1209292-02A	Site D9	MAURY	5	0.98	4.8	NL*	Cumene	98-82-8	x
1209292-02A	Site D9	MAURY	5	6.4	12	NL*	Ethanol	64-17-5	x
1209292-02A	Site D9	MAURY	5	4.7	19	NL*	Heptane	142-82-5	x
1209538-02A	SITE B11	MAURY	5	85	270	28.3	Benzene	71-43-2	3
1209599-01A	Site B12	MAURY	5	49	160	16.3	Benzene	71-43-2	3
1209539-01A	SITE D11	MAURY	5	12	39	4	Benzene	71-43-2	3
1209539-01A	SITE D11	MAURY	5	3.5	13	0	Toluene	108-88-3	80
1209538-02A	SITE B11	MAURY	5	3.2	12	0	Toluene	108-88-3	80
1209293-01A	Site B10	MAURY	5	0.96	2.5	0	Vinyl Chloride	75-01-4	30
1209292-02A	Site D9	MAURY	5	1.9	7.2	0	Toluene	108-88-3	80
1209292-01A	Site B9	MAURY	5	0.67	1.7	0	Vinyl Chloride	75-01-4	30
1209293-01A	Site B10	MAURY	5	1.6	5.9	0	Toluene	108-88-3	80
1209539-01A	SITE D11	MAURY	5	0.94	4.1	0	m,p-Xylene	108-38-3/106-42-3	50
1209538-02A	SITE B11	MAURY	5	0.9	3.9	0	m,p-Xylene	108-38-3/106-42-3	50
1209292-02A	Site D9	MAURY	5	0.88	3.8	0	m,p-Xylene	108-38-3/106-42-3	50
1209292-01A	Site B9	MAURY	5	1.3	5	0	Toluene	108-88-3	80

LABSAMPID	sample	Pad	site	RESULTS ppb(v)	RESULTS (ug/m3)	Hazard Quotient	COMPOUND NAME	CASNUM	MRL (ppbv)
1209293-01A	Site B10	MAURY	5	0.80	3.4	0.0	m,p-Xylene	108-38-3/106-42-3	50
1209599-01A	Site B12	MAURY	5	1.2	4.6	0.0	Toluene	108-88-3	80
1209293-02A	Site D10	MAURY	5	0.78	3.0	0.0	Toluene	108-88-3	80
1209292-01A	Site B9	MAURY	5	88	210	0.0	Acetone	67-64-1	13000
1209293-02A	Site D10	MAURY	5	3.4	12	0.0	Hexane	110-54-3	600
1209599-01A	Site B12	MAURY	5	70	160	0.0	Acetone	67-64-1	13000
1209539-01A	SITE D11	MAURY	5	59	140	0.0	Acetone	67-64-1	13000
1209599-02A	Site D12	MAURY	5	2.2	7.9	0.0	Hexane	110-54-3	600
1209292-02A	Site D9	MAURY	5	0.67	2.9	0.0	Styrene	100-42-5	200
1209293-01A	Site B10	MAURY	5	1.6	5.8	0.0	Hexane	110-54-3	600
1209292-02A	Site D9	MAURY	5	31	75	0.0	Acetone	67-64-1	13000
1209292-01A	Site B9	MAURY	5	1.1	3.8	0.0	Hexane	110-54-3	600
1209292-02A	Site D9	MAURY	5	0.89	3.2	0.0	Hexane	110-54-3	600
1209293-02A	Site D10	MAURY	5	14	34	0.0	Acetone	67-64-1	13000
1208560-02A	SITE A5	Lewis Wetzel Two	3	48	140	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1208560-02A	SITE A5	Lewis Wetzel Two	3	4.4	11	NL*	2-Propanol	67-63-0	x
1208560-02A	SITE A5	Lewis Wetzel Two	3	2.4	9.6	NL*	4-Methyl-2-pentanone	108-10-1	x
1208560-02A	SITE A5	Lewis Wetzel Two	3	1.8	8.8	NL*	Cumene	98-82-8	x
1208560-02A	SITE A5	Lewis Wetzel Two	3	30	57	NL*	Ethanol	64-17-5	x
1208560-02A	SITE A5	Lewis Wetzel Two	3	15	62	NL*	Heptane	142-82-5	x
1208560-04A	SITE A6	Lewis Wetzel Two	3	44	130	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1208560-04A	SITE A6	Lewis Wetzel Two	3	27	67	NL*	2-Propanol	67-63-0	x
1208560-04A	SITE A6	Lewis Wetzel Two	3	2.9	12	NL*	4-Methyl-2-pentanone	108-10-1	x
1208560-04A	SITE A6	Lewis Wetzel Two	3	2.9	14	NL*	Cumene	98-82-8	x
1208560-04A	SITE A6	Lewis Wetzel Two	3	42	80	NL*	Ethanol	64-17-5	x
1208560-04A	SITE A6	Lewis Wetzel Two	3	16	65	NL*	Heptane	142-82-5	x
1208560-01A	SITE C5	Lewis Wetzel Two	3	54	160	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1208560-01A	SITE C5	Lewis Wetzel Two	3	5.1	12	NL*	2-Propanol	67-63-0	x
1208560-01A	SITE C5	Lewis Wetzel Two	3	2.4	9.8	NL*	4-Methyl-2-pentanone	108-10-1	x
1208560-01A	SITE C5	Lewis Wetzel Two	3	1.4	6.7	NL*	Cumene	98-82-8	x
1208560-01A	SITE C5	Lewis Wetzel Two	3	34	65	NL*	Ethanol	64-17-5	x
1208560-01A	SITE C5	Lewis Wetzel Two	3	20	80	NL*	Heptane	142-82-5	x
1208560-03A	SITE C6	Lewis Wetzel Two	3	56	160	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1208560-03A	SITE C6	Lewis Wetzel Two	3	2.0	8.3	NL*	4-Methyl-2-pentanone	108-10-1	x
1208560-03A	SITE C6	Lewis Wetzel Two	3	1.4	7.0	NL*	Cumene	98-82-8	x
1208560-03A	SITE C6	Lewis Wetzel Two	3	26	49	NL*	Ethanol	64-17-5	x

LABSAMPID	sample	Pad	site	RESULTS ppb(v)	RESULTS (ug/m3)	Hazard Quotient	COMPOUND NAME	CASNUM	MRL(ppbv)
1208560-03A	SITE C6	Lewis Wetzel Two	3	22	88	NL*	Heptane	142-82-5	x
1208560-01A	SITE C5	Lewis Wetzel Two	3	3.0	9.7	1.0	Benzene	71-43-2	3
1208560-02A	SITE A5	Lewis Wetzel Two	3	2.4	7.8	0.8	Benzene	71-43-2	3
1208560-03A	SITE C6	Lewis Wetzel Two	3	2.4	7.7	0.8	Benzene	71-43-2	3
1208560-04A	SITE A6	Lewis Wetzel Two	3	2.1	6.7	0.7	Benzene	71-43-2	3
1208560-04A	SITE A6	Lewis Wetzel Two	3	2.4	14	0.2	1,2-Dichlorobenzene	95-50-1	10
1208560-04A	SITE A6	Lewis Wetzel Two	3	14	54	0.2	Toluene	108-88-3	80
1208560-04A	SITE A6	Lewis Wetzel Two	3	5.9	26	0.1	m,p-Xylene	108-38-3/106-42-3	50
1208560-04A	SITE A6	Lewis Wetzel Two	3	2.9	13	0.1	o-Xylene	95-47-6	50
1208560-03A	SITE C6	Lewis Wetzel Two	3	1.3	3.3	0.0	Vinyl Chloride	75-01-4	30
1208560-03A	SITE C6	Lewis Wetzel Two	3	2.1	9.0	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208560-02A	SITE A5	Lewis Wetzel Two	3	1.9	8.4	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208560-01A	SITE C5	Lewis Wetzel Two	3	1.8	8.0	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208560-01A	SITE C5	Lewis Wetzel Two	3	0.93	2.4	0.0	Vinyl Chloride	75-01-4	30
1208560-02A	SITE A5	Lewis Wetzel Two	3	0.89	2.3	0.0	Vinyl Chloride	75-01-4	30
1208560-01A	SITE C5	Lewis Wetzel Two	3	2.3	8.6	0.0	Toluene	108-88-3	80
1208560-02A	SITE A5	Lewis Wetzel Two	3	2.2	8.3	0.0	Toluene	108-88-3	80
1208560-03A	SITE C6	Lewis Wetzel Two	3	2.0	7.6	0.0	Toluene	108-88-3	80
1208560-04A	SITE A6	Lewis Wetzel Two	3	1.3	5.6	0.0	Ethyl Benzene	100-41-4	60
1208560-04A	SITE A6	Lewis Wetzel Two	3	1.1	4.6	0.0	Styrene	100-42-5	200
LABSAMPID	sample	Pad	site	RESULTS ppb(v)	RESULTS (ug/m3)	Hazard Quotient	COMPOUND NAME	CASNUM	MRL(ppbv)
1208560-03A	SITE C6	Lewis Wetzel Two	3	3.3	12	0.0	Hexane	110-54-3	600
1208560-04A	SITE A6	Lewis Wetzel Two	3	3.0	10	0.0	Hexane	110-54-3	600
1208683-01A	SITE A7	Lewis Wetzel Three	4	42	120	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1208683-01A	SITE A7	Lewis Wetzel Three	4	3.6	9	NL*	2-Propanol	67-63-0	x
1208683-01A	SITE A7	Lewis Wetzel Three	4	1.3	5.5	NL*	4-Methyl-2-pentanone	108-10-1	x
1208683-01A	SITE A7	Lewis Wetzel Three	4	0.93	4.6	NL*	Cumene	98-82-8	x
1208683-01A	SITE A7	Lewis Wetzel Three	4	8.6	16	NL*	Ethanol	64-17-5	x
1208683-01A	SITE A7	Lewis Wetzel Three	4	16	64	NL*	Heptane	142-82-5	x
1209041-01A	Site A8	Lewis Wetzel Three	4	69	200	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x

LABSAMPID	sample	Pad	site	RESULTS ppb(v)	RESULTS (ug/m3)	Hazard Quotient	COMPOUND NAME	CASNUM	MRL(ppbv)
1209041-01A	Site A8	Lewis Wetzel Three	4	4.8	12	NL*	2-Propanol	67-63-0	x
1209041-01A	Site A8	Lewis Wetzel Three	4	1.8	7.3	NL*	4-Methyl-2-pentanone	108-10-1	x
1209041-01A	Site A8	Lewis Wetzel Three	4	1.1	5.4	NL*	Cumene	98-82-8	x
1209041-01A	Site A8	Lewis Wetzel Three	4	20	38	NL*	Ethanol	64-17-5	x
1209041-01A	Site A8	Lewis Wetzel Three	4	32	130	NL*	Heptane	142-82-5	x
1208683-02A	SITE C7	Lewis Wetzel Three	4	36	110	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1208683-02A	SITE C7	Lewis Wetzel Three	4	5.5	13	NL*	2-Propanol	67-63-0	x
1208683-02A	SITE C7	Lewis Wetzel Three	4	2.3	9.4	NL*	4-Methyl-2-pentanone	108-10-1	x
1208683-02A	SITE C7	Lewis Wetzel Three	4	1.2	5.8	NL*	Cumene	98-82-8	x
1208683-02A	SITE C7	Lewis Wetzel Three	4	10	19	NL*	Ethanol	64-17-5	x
1208683-02A	SITE C7	Lewis Wetzel Three	4	15	63	NL*	Heptane	142-82-5	x
1209041-02A	Site C8	Lewis Wetzel Three	4	16	46	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209041-02A	Site C8	Lewis Wetzel Three	4	0.80	3.3	NL*	4-Methyl-2-pentanone	108-10-1	x
1209041-02A	Site C8	Lewis Wetzel Three	4	5.3	9.9	NL*	Ethanol	64-17-5	x
1209041-02A	Site C8	Lewis Wetzel Three	4	7.0	29	NL*	Heptane	142-82-5	x
1209041-01A	Site A8	Lewis Wetzel Three	4	1.1	3.6	0.4	Benzene	71-43-2	3
1208683-02A	SITE C7	Lewis Wetzel Three	4	1.0	3.3	0.3	Benzene	71-43-2	3
1208683-01A	SITE A7	Lewis Wetzel Three	4	0.78	2.5	0.3	Benzene	71-43-2	3
1209041-01A	Site A8	Lewis Wetzel Three	4	1.4	3.5	0.0	Vinyl Chloride	75-01-4	30
1209041-01A	Site A8	Lewis Wetzel Three	4	2.7	10	0.0	Toluene	108-88-3	80
1209041-01A	Site A8	Lewis Wetzel Three	4	1.5	6.4	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208683-02A	SITE C7	Lewis Wetzel Three	4	1.3	5.7	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208683-01A	SITE A7	Lewis Wetzel Three	4	1.2	5.0	0.0	m,p-Xylene	108-38-3/106-42-3	50
1208683-02A	SITE C7	Lewis Wetzel Three	4	1.9	7.3	0.0	Toluene	108-88-3	80
1208683-01A	SITE A7	Lewis Wetzel Three	4	1.4	5.3	0.0	Toluene	108-88-3	80
1209041-02A	Site C8	Lewis Wetzel Three	4	1.4	5.2	0.0	Toluene	108-88-3	80
1209041-02A	Site C8	Lewis Wetzel Three	4	0.72	3.1	0.0	m,p-Xylene	108-38-3/106-42-3	50
1209041-01A	Site A8	Lewis Wetzel Three	4	3.8	13	0	Hexane	110-54-3	600
1209041-02A	Site C8	Lewis Wetzel Three	4	56	130	0	Acetone	67-64-1	13000
1208683-01A	SITE A7	Lewis Wetzel Three	4	2.1	7.5	0	Hexane	110-54-3	600
1208683-02A	SITE C7	Lewis Wetzel Three	4	2.1	7.6	0	Hexane	110-54-3	600
1209041-02A	Site C8	Lewis Wetzel Three	4	1.1	3.8	0	Hexane	110-54-3	600

LABSAMPID	sample	Pad	site	RESULTS ppb(v)	RESULTS (ug/m3)	Hazard Quotient	COMPOUND NAME	CASNUM	MRL (ppbv)
1209538-03A	SITE C11	LEMON	6	3.2	13	NL*	2-Hexanone	591-78-6	x
1209538-03A	SITE C11	LEMON	6	3.7	9.0	NL*	2-Propanol	67-63-0	x
1209538-03A	SITE C11	LEMON	6	2.1	8.5	NL*	4-Methyl-2-pentanone	108-10-1	x
1209538-03A	SITE C11	LEMON	6	13	24	NL*	Ethanol	64-17-5	x
1209538-03A	SITE C11	LEMON	6	14	57	NL*	Heptane	142-82-5	x
1210187-02A	Site C13	LEMON	6	24	72	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1210187-02A	Site C13	LEMON	6	4.4	11	NL*	2-Propanol	67-63-0	x
1210187-02A	Site C13	LEMON	6	2.7	11	NL*	4-Methyl-2-pentanone	108-10-1	x
1210187-02A	Site C13	LEMON	6	26	48	NL*	Ethanol	64-17-5	x
1210187-02A	Site C13	LEMON	6	10	43	NL*	Heptane	142-82-5	x
1210187-04A	Site C14	LEMON	6	3.4	6.4	NL*	Ethanol	64-17-5	x
1209538-04A	SITE E11	LEMON	6	8.8	26	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1209538-04A	SITE E11	LEMON	6	5.1	9.7	NL*	Ethanol	64-17-5	x
1209538-04A	SITE E11	LEMON	6	4.7	19	NL*	Heptane	142-82-5	x
1210187-04A	Site C14	LEMON	6	15	48	5.0	Benzene	71-43-2	3
1210187-04A	Site C14	LEMON	6	4.3	16	0.1	Toluene	108-88-3	80
1210187-02A	Site C13	LEMON	6	2.2	8.4	0.0	Toluene	108-88-3	80
1209538-03A	SITE C11	LEMON	6	1.9	7.2	0.0	Toluene	108-88-3	80
1210187-02A	Site C13	LEMON	6	0.90	3.9	0.0	m,p-Xylene	108-38-3/106-42-3	50
1209538-03A	SITE C11	LEMON	6	0.88	3.8	0.0	m,p-Xylene	108-38-3/106-42-3	50
1210187-04A	Site C14	LEMON	6	60	140	0.0	Acetone	67-64-1	13000
1209538-04A	SITE E11	LEMON	6	37	88	0.0	Acetone	67-64-1	13000
1210187-02A	Site C13	LEMON	6	1.2	4.4	0.0	Hexane	110-54-3	600
1209538-03A	SITE C11	LEMON	6	1.1	4.0	0.0	Hexane	110-54-3	600
1210187-03A	Site A14	LEMON	6	10	24	0.0	Acetone	67-64-1	13000
1207673-02A	SITE B2	DONNA	1	6	18	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1207673-02A	SITE B2	DONNA	1	13	32	NL*	2-Propanol	67-63-0	x
1207673-02A	SITE B2	DONNA	1	2.3	9.5	NL*	4-Methyl-2-pentanone	108-10-1	x
1207673-02A	SITE B2	DONNA	1	1.2	4.2	NL*	Cyclohexane	110-82-7	x
1207673-02A	SITE B2	DONNA	1	38	71	NL*	Ethanol	64-17-5	x
1207673-02A	SITE B2	DONNA	1	1.4	5.8	NL*	Heptane	142-82-5	x
1207673-02A	SITE B2	DONNA	1	0.94	5.1	NL*	Trichloroethene	79-01-6	x
1207673-02A	SITE B2	DONNA	1	62	230	0.8	Toluene	108-88-3	80
1207673-02A	SITE B2	DONNA	1	2.2	7	0.7	Benzene	71-43-2	3
1207673-04A	SITE D2	DONNA	1	2.1	6.8	0.7	Benzene	71-43-2	3
1207673-03A	SITE C2	DONNA	1	1.7	5.3	0.6	Benzene	71-43-2	3
1207673-02A	SITE B2	DONNA	1	3.2	14	0.1	m,p-Xylene	108-38-3/106-42-3	50
1207673-04A	SITE D2	DONNA	1	2.2	8.1	0	Toluene	108-88-3	80
1207673-02A	SITE B2	DONNA	1	1.3	5.6	0	o-Xylene	95-47-6	50
1207673-02A	SITE B2	DONNA	1	1.2	5.1	0	Ethyl Benzene	100-41-4	60

LABSAMPID	sample	Pad	site	RESULTS ppb(v)	RESULTS (ug/m3)	Hazard Quotient	COMPOUND NAME	CASNUM	MRL (ppbv)
1207576-01A	SITE A1	DONNA	1	5.1	16	0.0	Carbon Disulfide	75-15-0	300
1207673-02A	SITE B2	DONNA	1	0.94	2.1	0.0	1,3-Butadiene	106-99-0	100
1207673-04A	SITE D2	DONNA	1	29	70	0.0	Acetone	67-64-1	13000
1207673-03A	SITE C2	DONNA	1	22	52	0.0	Acetone	67-64-1	13000
1207673-02A	SITE B2	DONNA	1	1.0	3.6	0.0	Hexane	110-54-3	600
1207673-02A	SITE B2	DONNA	1	14	34	0.0	Acetone	67-64-1	13000
1207576-01A	SITE A1	DONNA	1	8.3	20	0.0	Acetone	67-64-1	13000
1210495-01A	SITE A15	BROOKE	7	6.0	11	NL*	Ethanol	64-17-5	x
1210495-01A	SITE A15	BROOKE	7	0.75	3.0	NL*	Heptane	142-82-5	x
1210591-01A	SITE A16	BROOKE	7	6.7	20	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1210591-01A	SITE A16	BROOKE	7	6.9	13	NL*	Ethanol	64-17-5	x
1210591-01A	SITE A16	BROOKE	7	2.3	9.4	NL*	Heptane	142-82-5	x
1210495-02A	SITE B15	BROOKE	7	3.4	10	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1210495-02A	SITE B15	BROOKE	7	4.4	8.4	NL*	Ethanol	64-17-5	x
1210495-02A	SITE B15	BROOKE	7	1.4	5.9	NL*	Heptane	142-82-5	x
1210591-02A	SITE B16	BROOKE	7	18	53	NL*	2-Butanone (Methyl Ethyl Ketone)	78-93-3	x
1210591-02A	SITE B16	BROOKE	7	9.9	19	NL*	Ethanol	64-17-5	x
1210591-02A	SITE B16	BROOKE	7	8.8	36	NL*	Heptane	142-82-5	x
1210591-01A	SITE A16	BROOKE	7	13	41	4.3	Benzene	71-43-2	3
1210495-01A	SITE A15	BROOKE	7	3.0	9.5	1.0	Benzene	71-43-2	3
1210495-01A	SITE A15	BROOKE	7	1.9	7.2	0.0	Toluene	108-88-3	80
1210591-01A	SITE A16	BROOKE	7	1.5	5.8	0.0	Toluene	108-88-3	80
1210591-02A	SITE B16	BROOKE	7	1.5	5.6	0.0	Toluene	108-88-3	80
1210495-02A	SITE B15	BROOKE	7	0.89	3.3	0.0	Toluene	108-88-3	80
1210495-01A	SITE A15	BROOKE	7	39	92	0.0	Acetone	67-64-1	13000
1210495-02A	SITE B15	BROOKE	7	20	48	0.0	Acetone	67-64-1	13000
1210591-02A	SITE B16	BROOKE	7	0.88	3.1	0.0	Hexane	110-54-3	600

*NL - not listed by ATSDR

APPENDIX C

METEOROLOGY DATA

Appendix C: Meteorological Data

Meteorological data (temperature, relative humidity, barometric pressure, wind speed and direction, rainfall, and solar intensity) were collected using a Davis Instruments Vantage Pro2 Plus meteorological station. One-minute averaged values were obtained. Results for temperature, relative humidity, rainfall, and solar intensity (measured in watts per square meter – a software difficulty results in the "2" for "squared" meters not showing on the vertical axis label for the DOE Trailer results) for each of the six monitoring locations are shown in figures A1-A28.

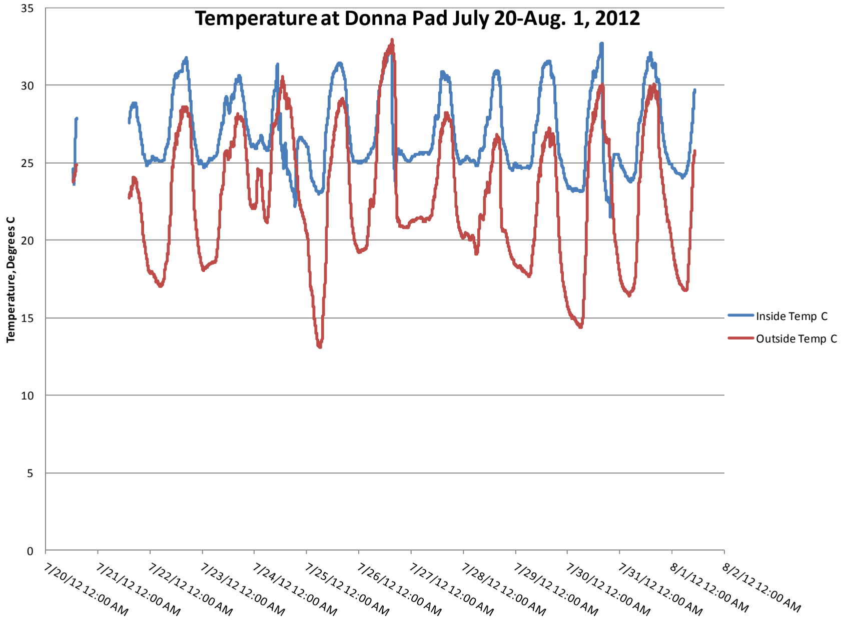

Figure A1. Air temperature inside and outside of the air monitoring laboratory at the Donna pad.

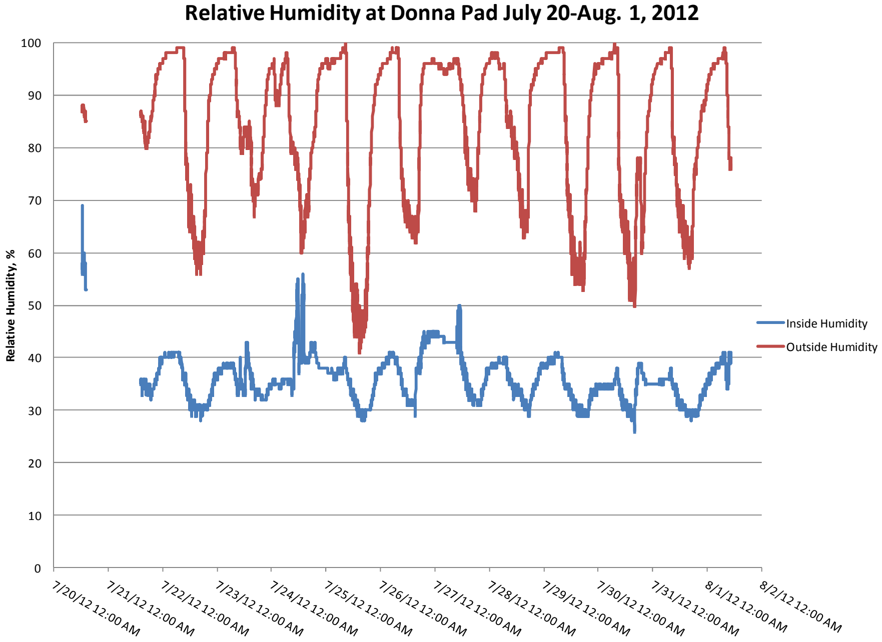

Figure A2. Relative humidity inside and outside of the air monitoring laboratory at the Donna pad.

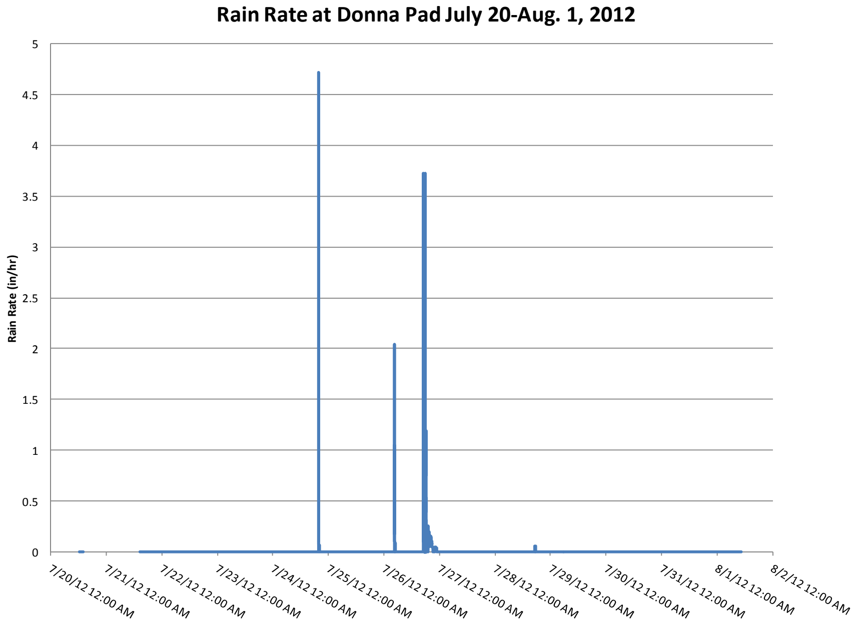

Figure A3. Rainfall events at the Donna pad.

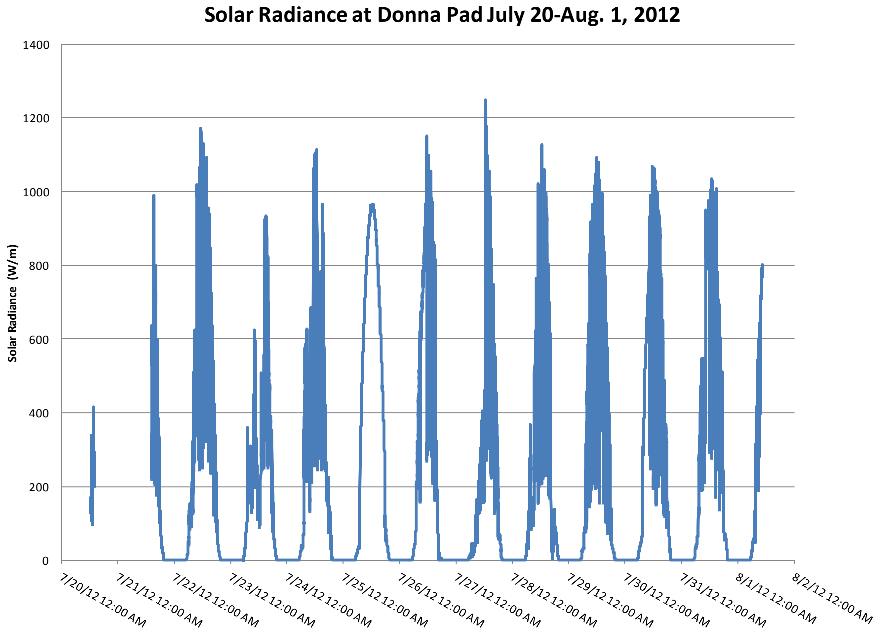

Figure A4a. Solar radiance at the Donna pad (units are Watts per square meter).

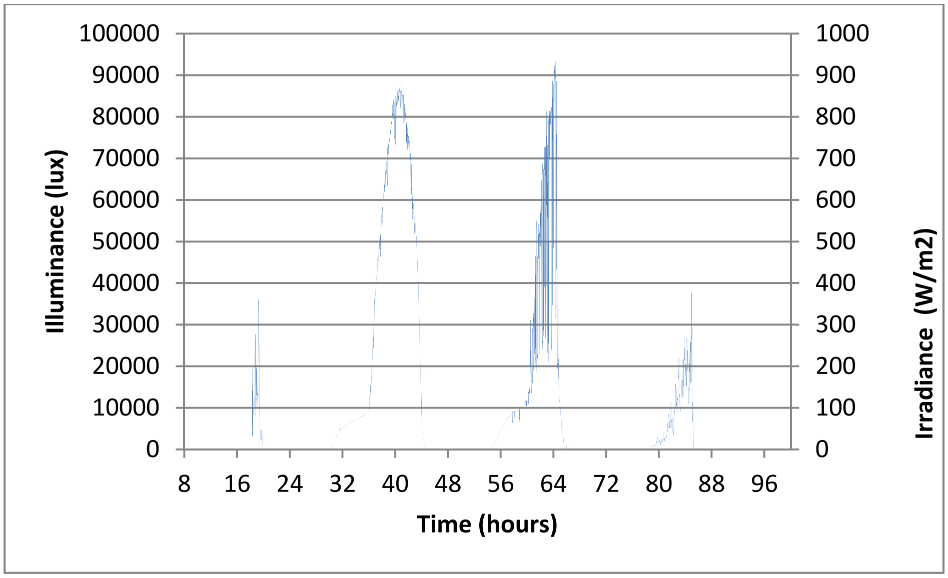

Figure A4b.Solar radiance at Site A on the Donna Pad from 7/24 to 7/27

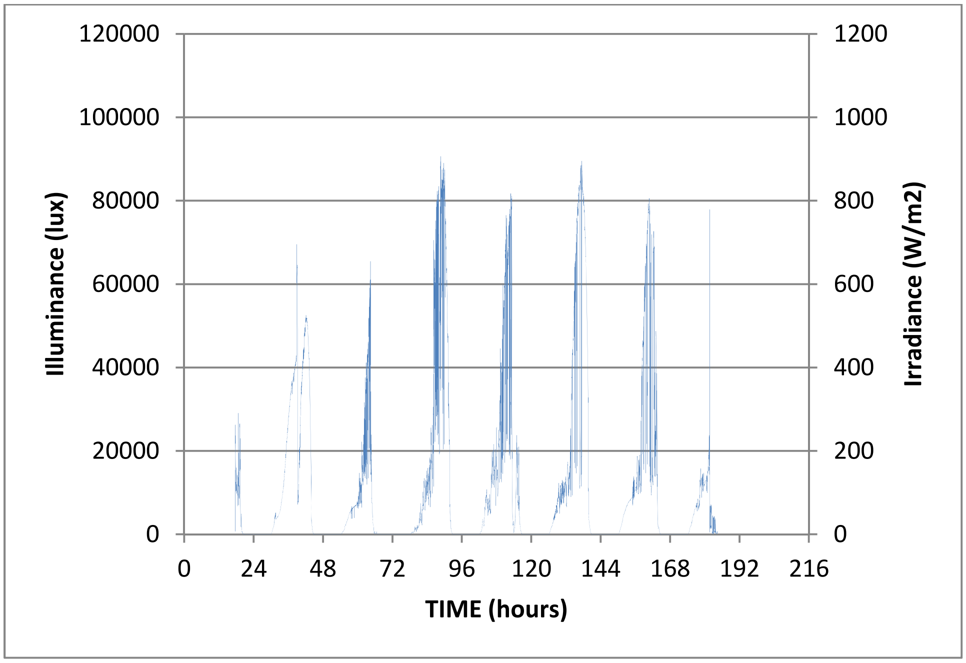

Figure A4 c. Solar radiance at Donna Pad Site C from 7/24 to 7/31.

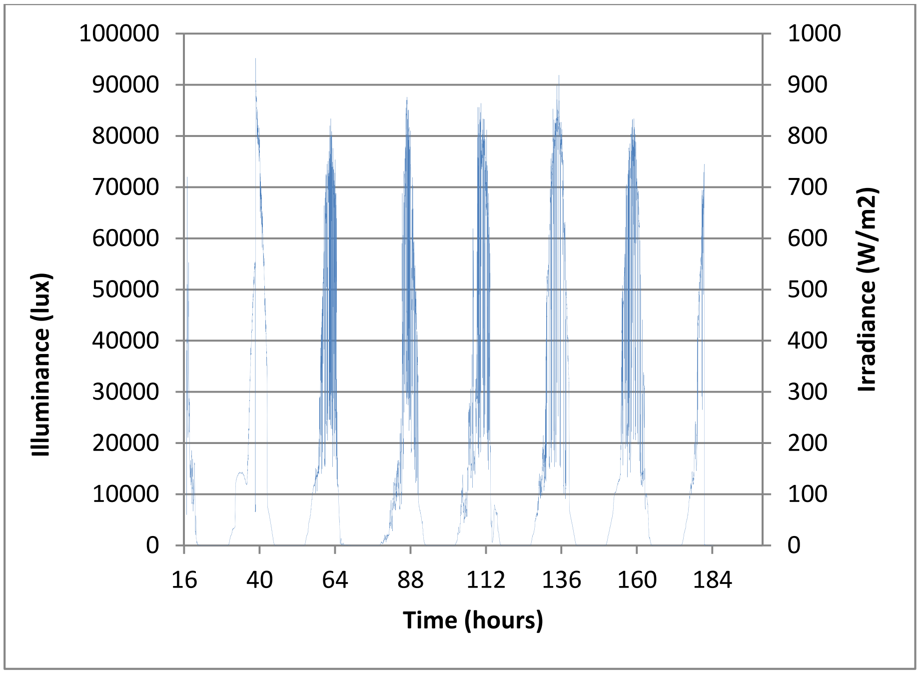

Figure A4d. Solar radiance at Donna Pad Site D

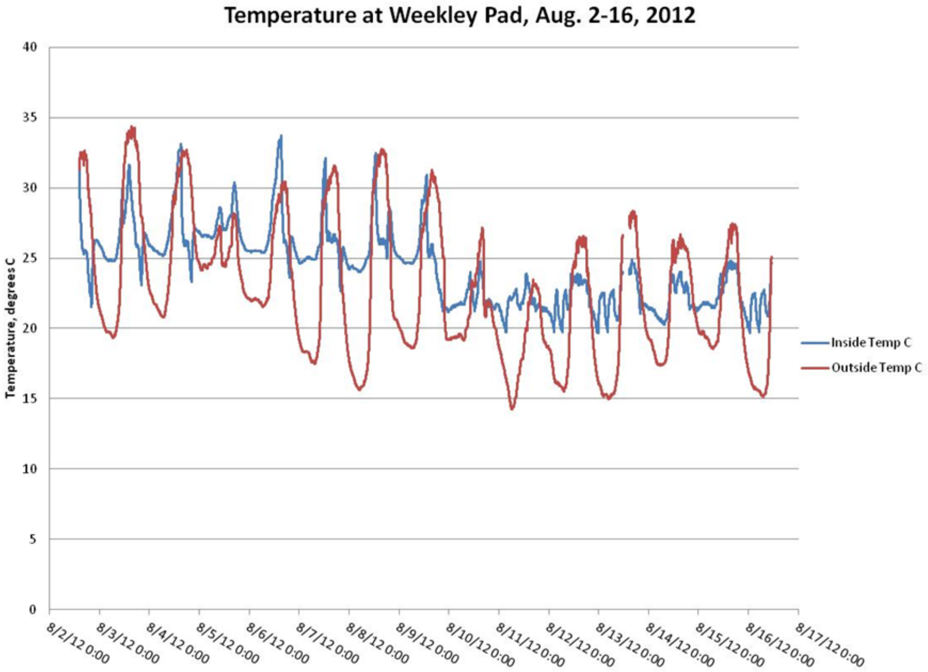

Figure A5. Air temperature inside and outside of the air monitoring laboratory at the Weekley pad.

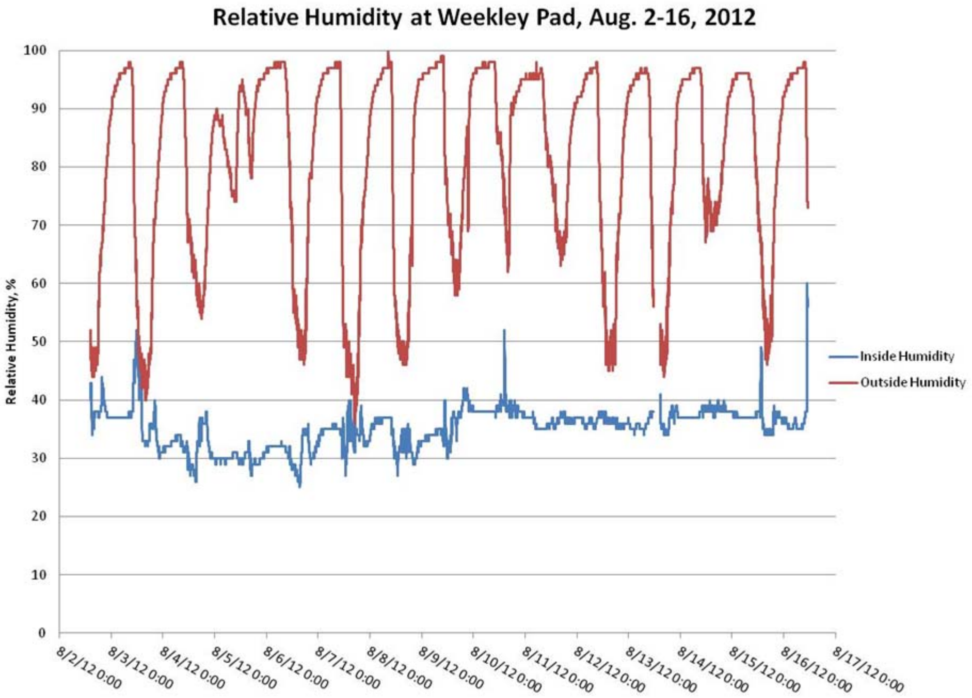

Figure A6. Relative Humidity inside and outside of the air monitoring laboratory at the Weekley pad.

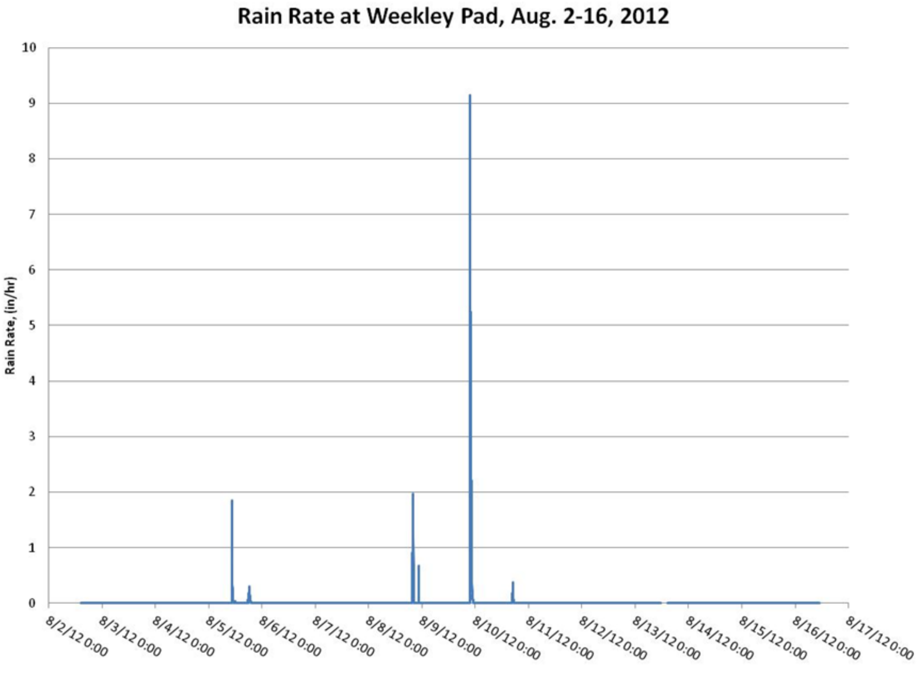

Figure A7. Rainfall events at the Weekley pad.

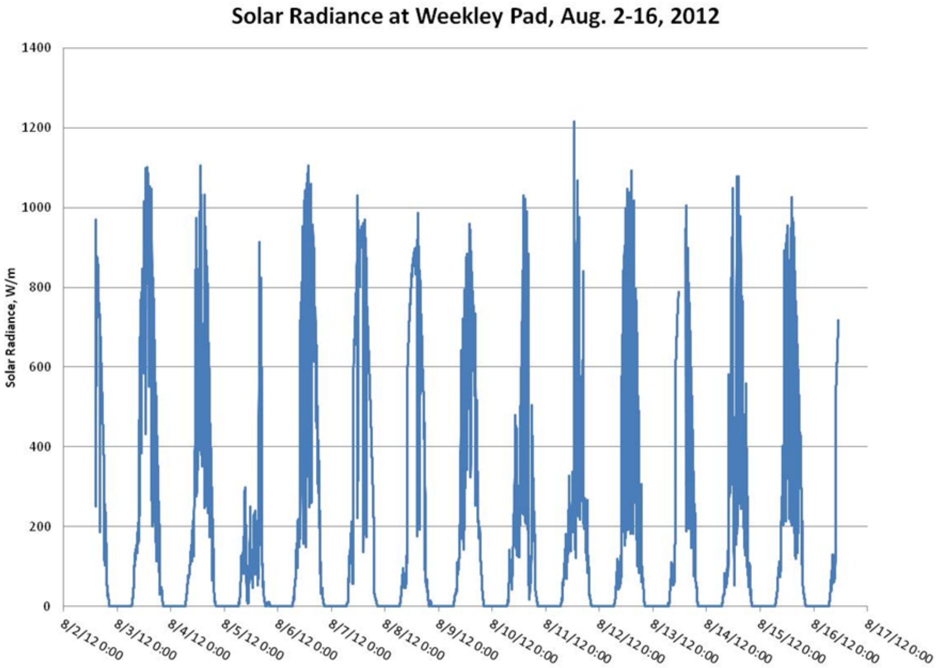

Figure A8a. Solar radiance at the Weekley pad at DOE Trailer.

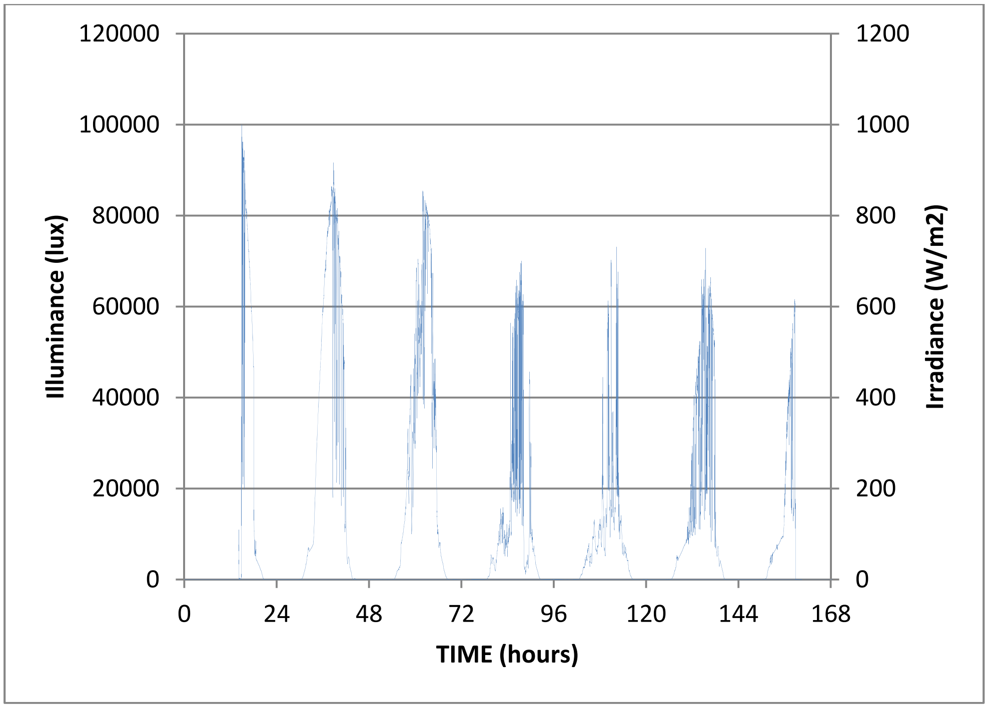

Figure A8b. Solar radiance at the Weekley pad at Site A for 8/6 to 8/12.

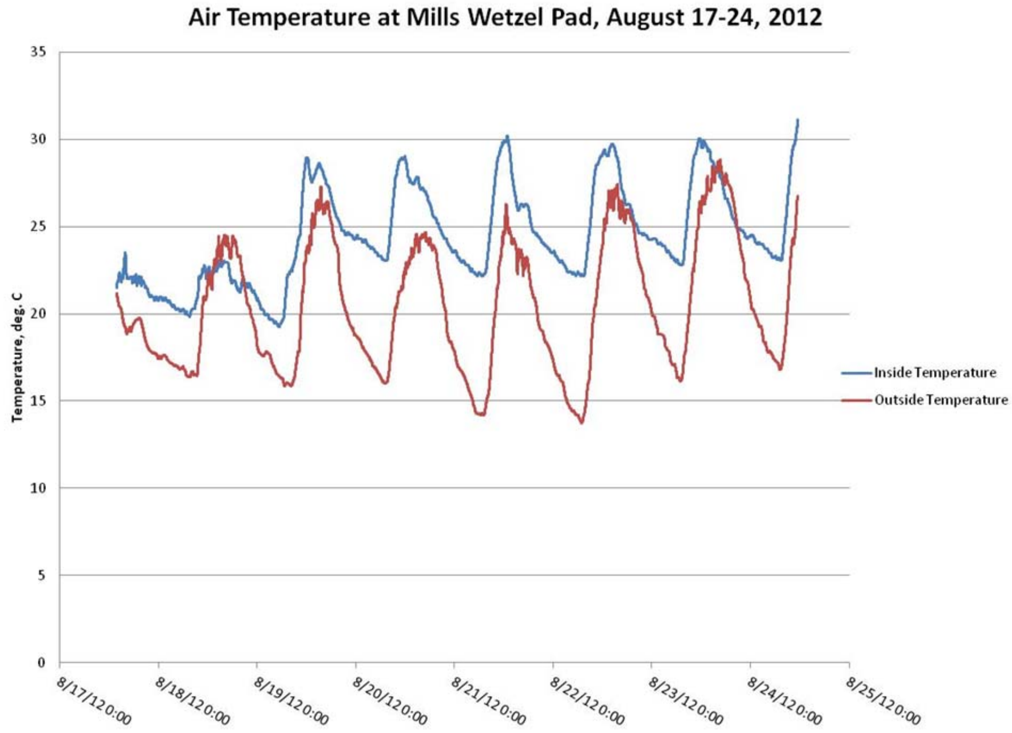

Figure A9. Air temperature inside and outside of the air monitoring laboratory at the Mills-Wetzel pad.

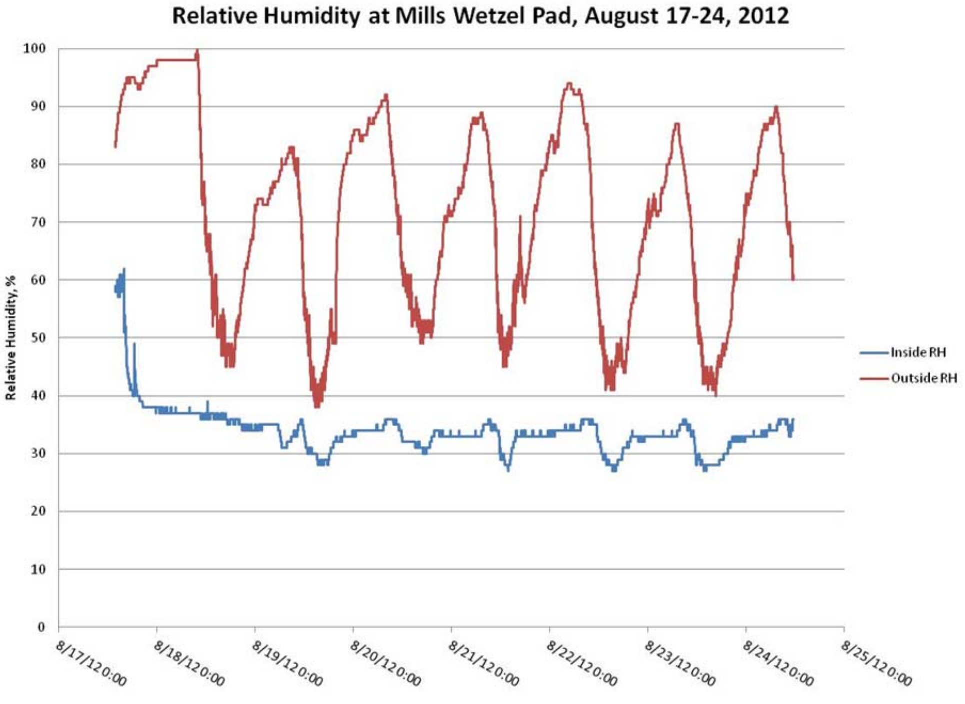

Figure A10. Relative humidity inside and outside of the air monitoring laboratory at the Mills-Wetzel pad.

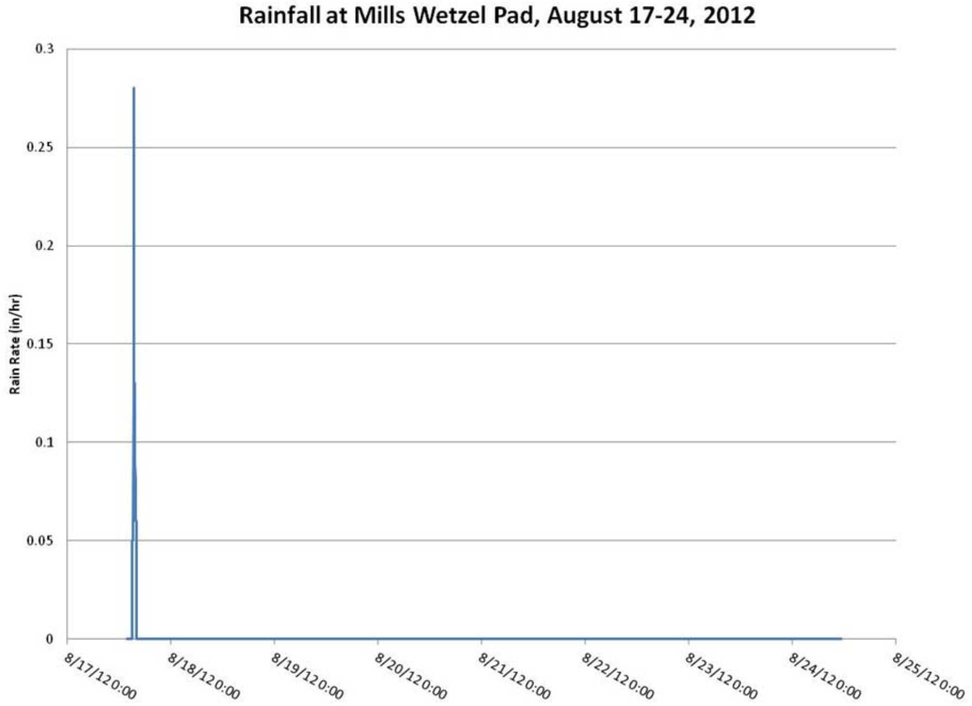

Figure A11. Rainfall events at the Mills-Wetzel pad.

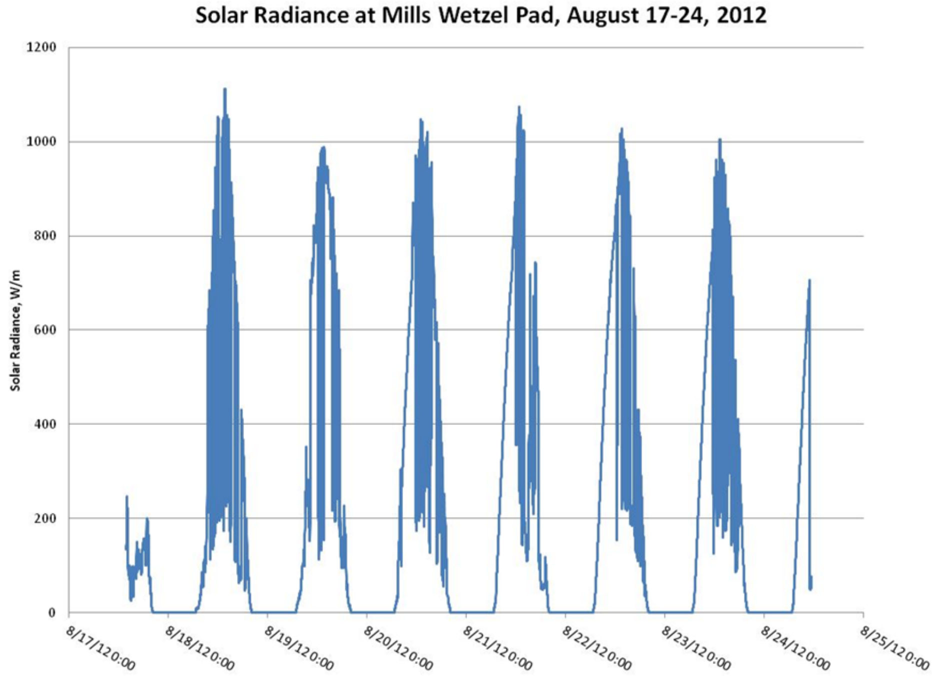

Figure A12. Solar radiance at the Mills-Wetzel pad.

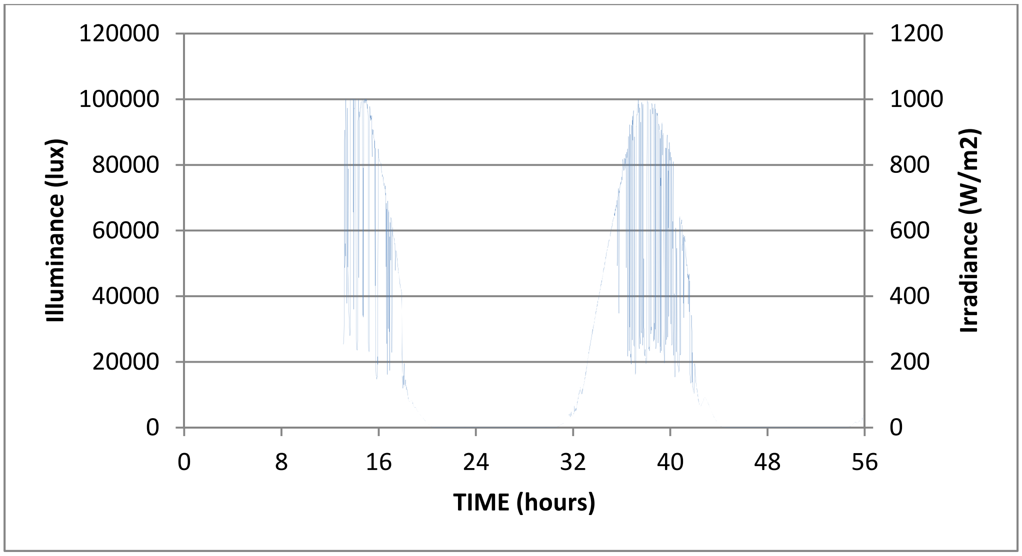

Figure A12b. Solar radiance at the Mills-Wetzel pad 2 site C for 8/15 to 8/17.

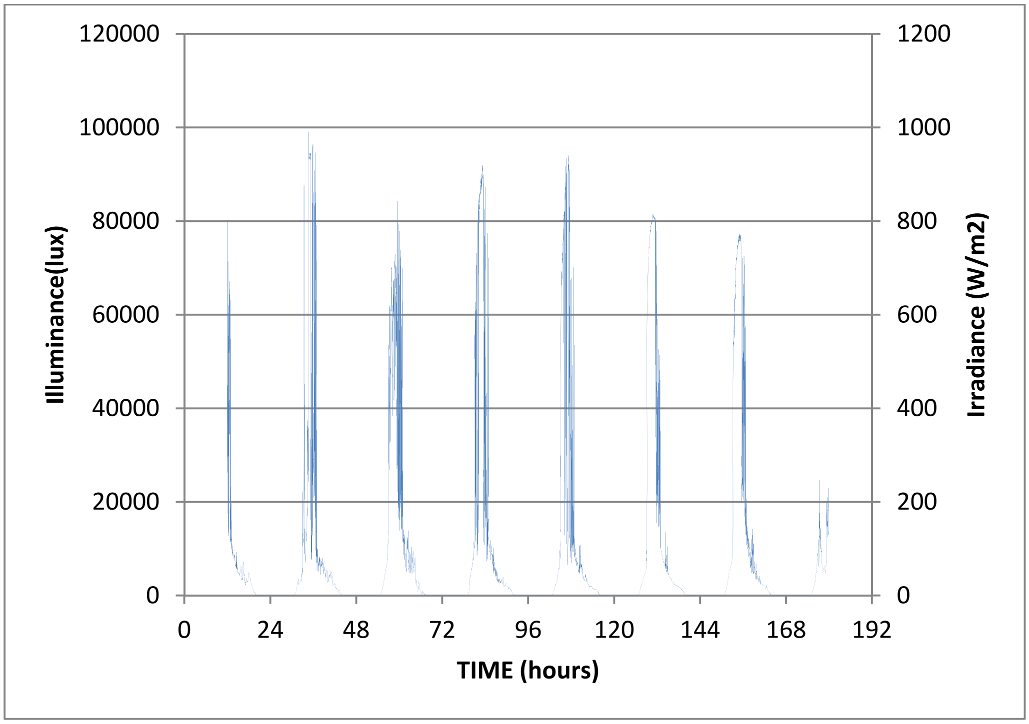

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Figure A12c. Solar radiance at the Mills-Wetzel pad 3 site C for 8/25 to 8/31.

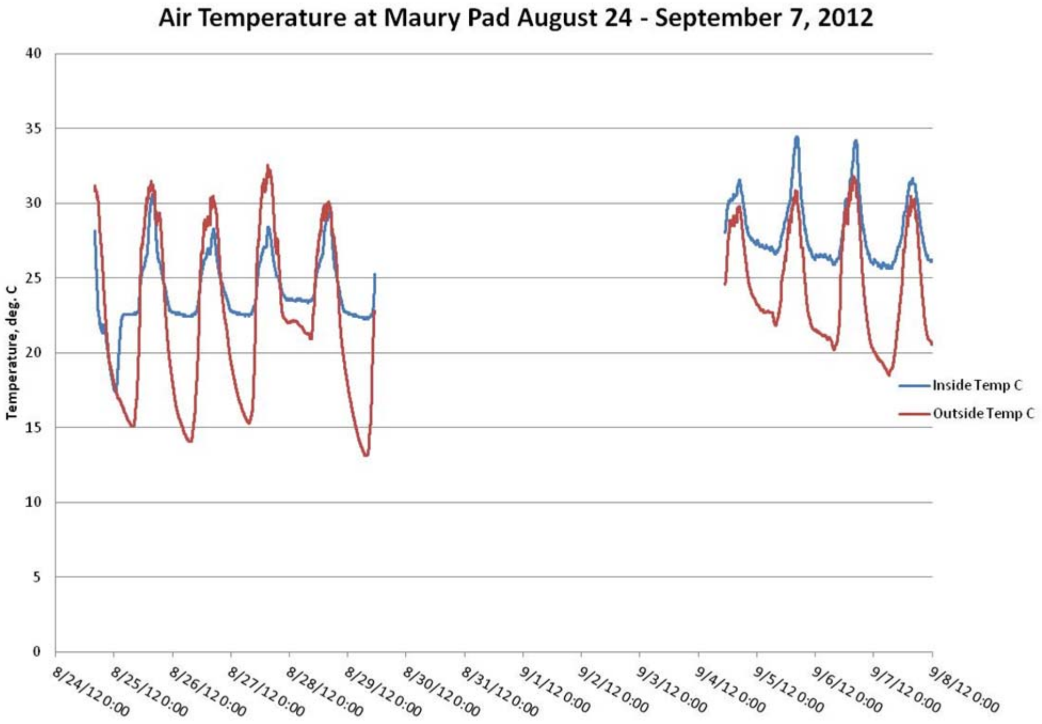


Figure A13. Air temperature inside and outside of the air monitoring laboratory for the first two weeks of monitoring at the Maury pad. The gap in the data was due to a software error.

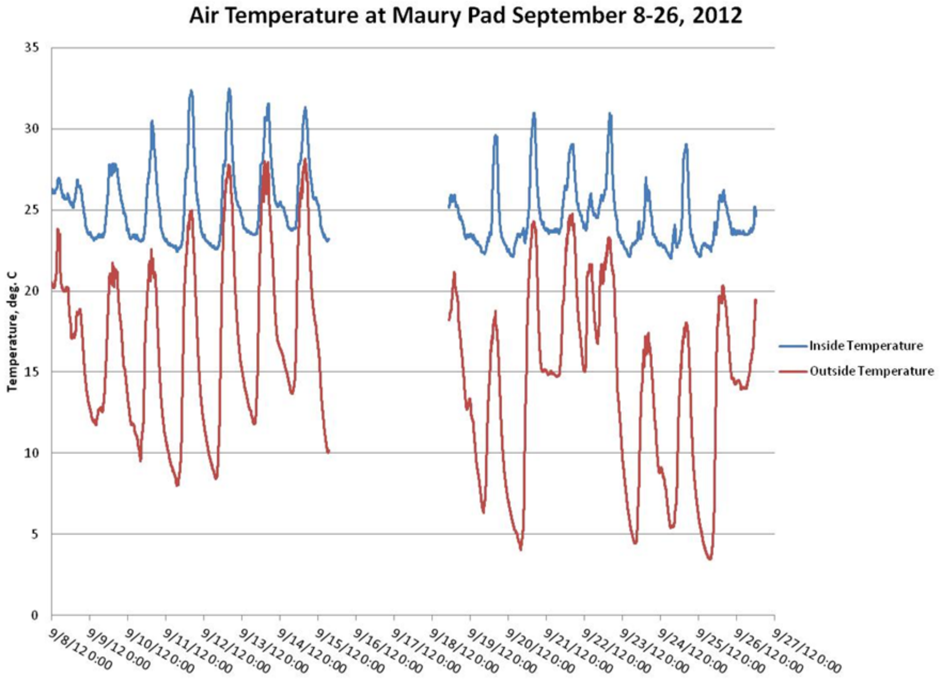


Figure A14. Air temperature inside and outside of the air monitoring laboratory for the second two weeks of monitoring at the Maury pad. The gap in the data was due to a software error.

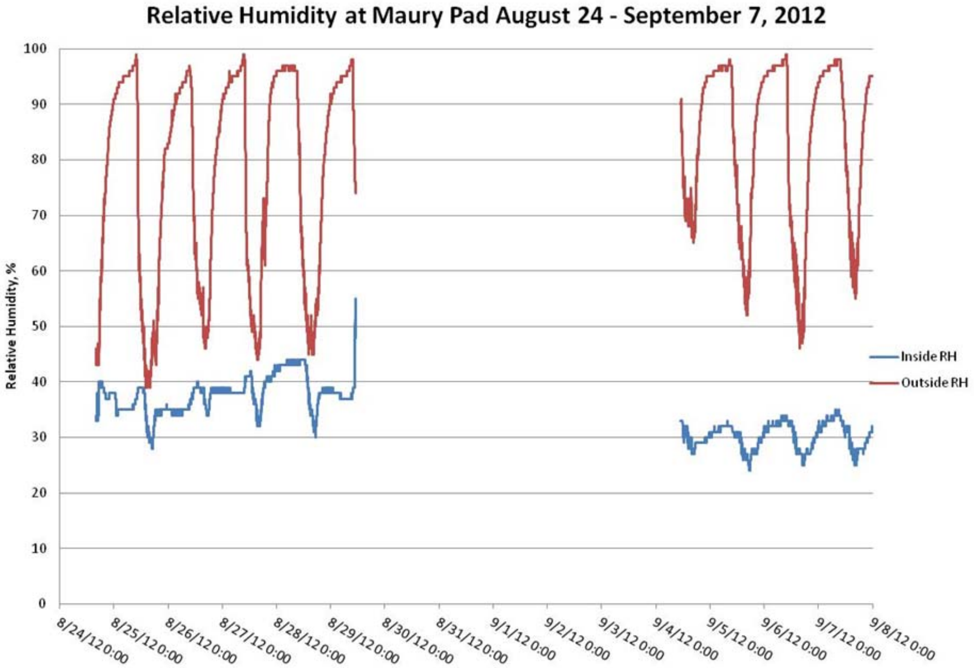


Figure A15. Relative humidity inside and outside of the air monitoring laboratory for the first two weeks of monitoring at the Maury pad. The gap in the data was due to a software error.

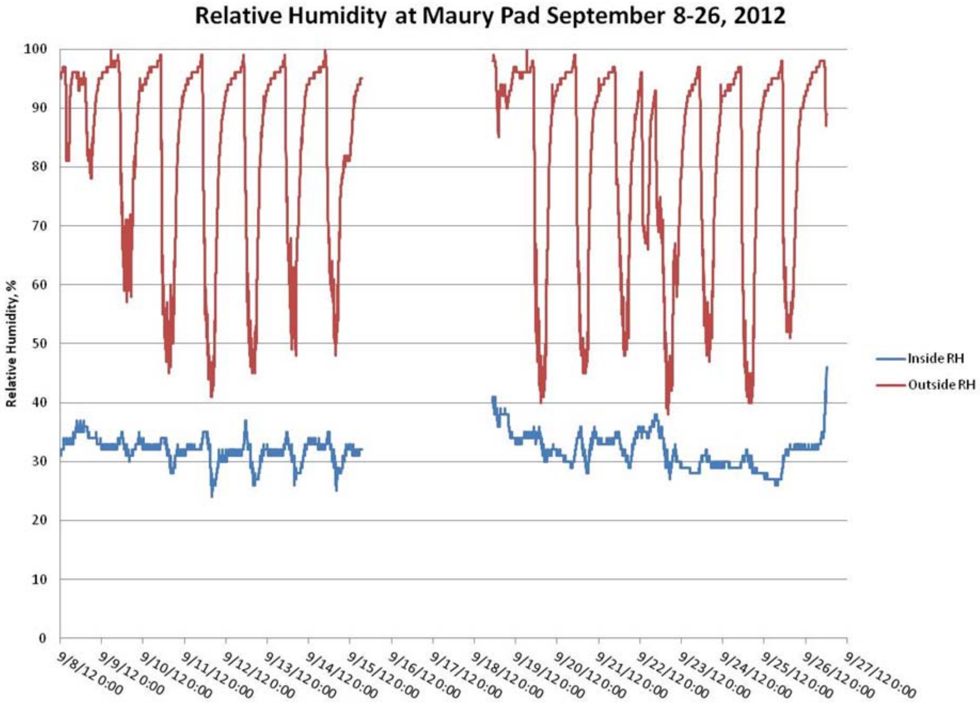


Figure A16. Relative humidity inside and outside of the air monitoring laboratory for the second two weeks of monitoring at the Maury pad. The gap in the data was due to a software error.

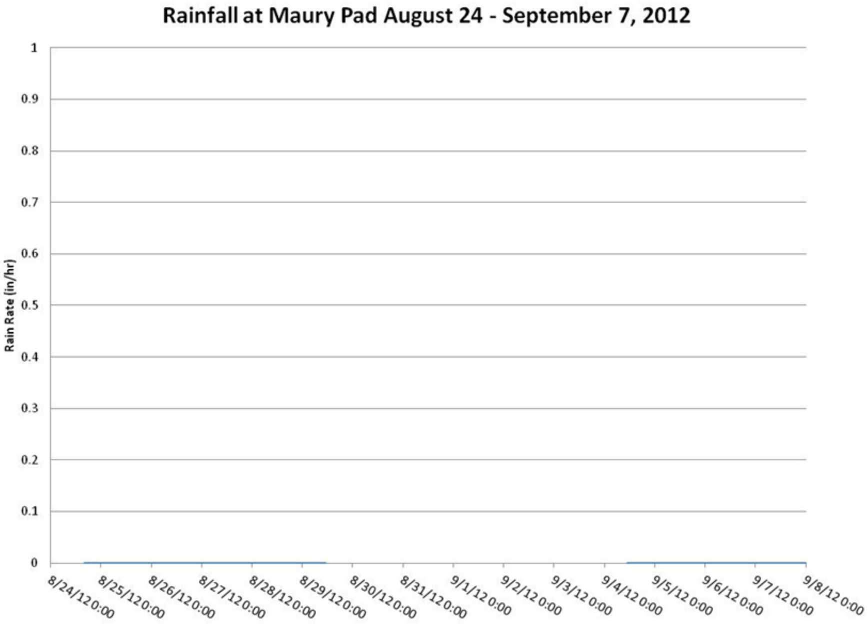


Figure A17. Rainfall events for the first two weeks of monitoring at the Maury pad. The gap in the data was due to a software error.

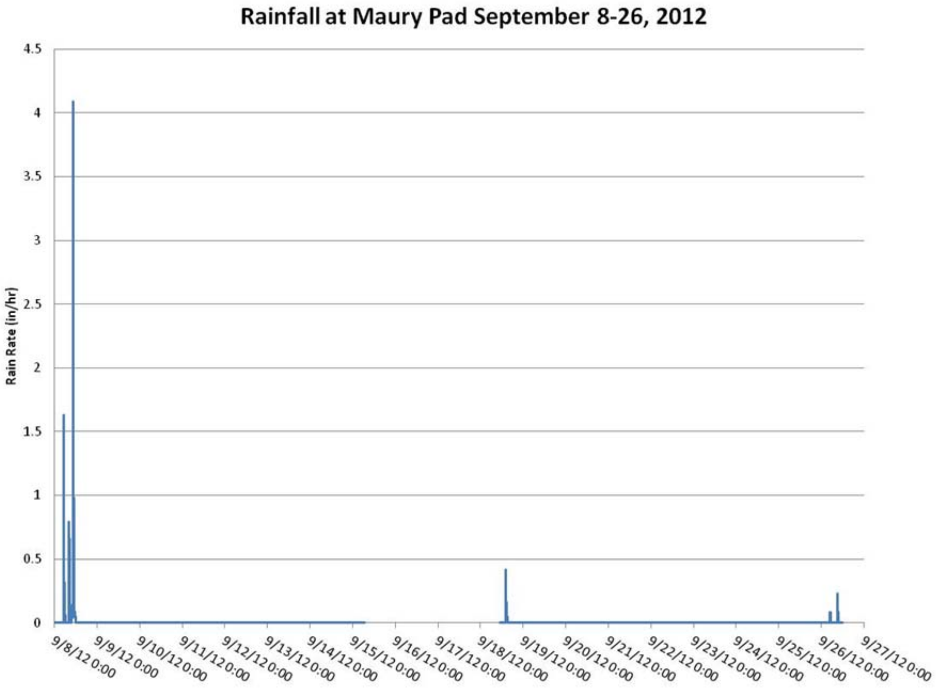


Figure A18. Rainfall events for the second two weeks of monitoring at the Maury pad. The gap in the data was due to a software error.

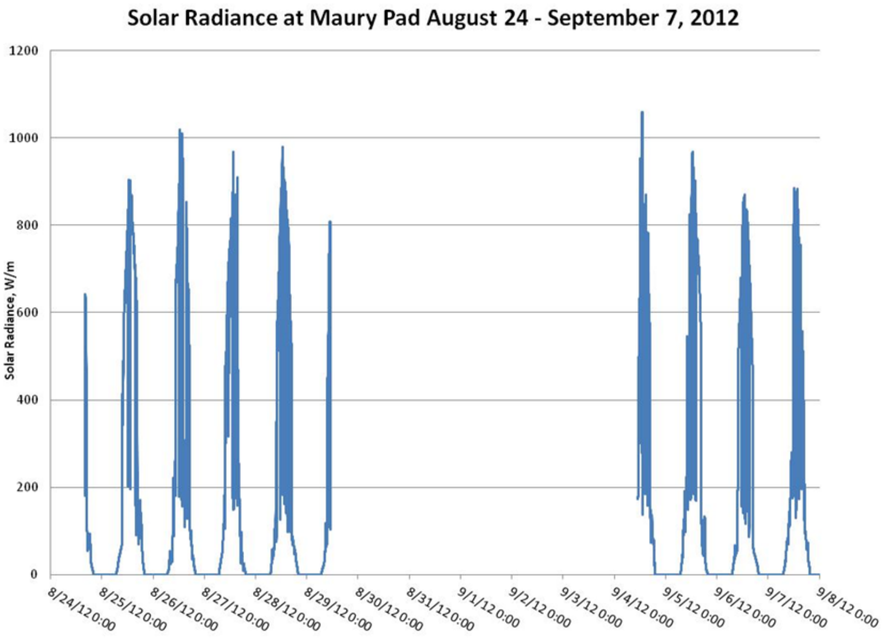


Figure A19. Solar radiance for the first two weeks of monitoring at the DOE trailer at the Maury pad. The gap in the data was due to a software error.

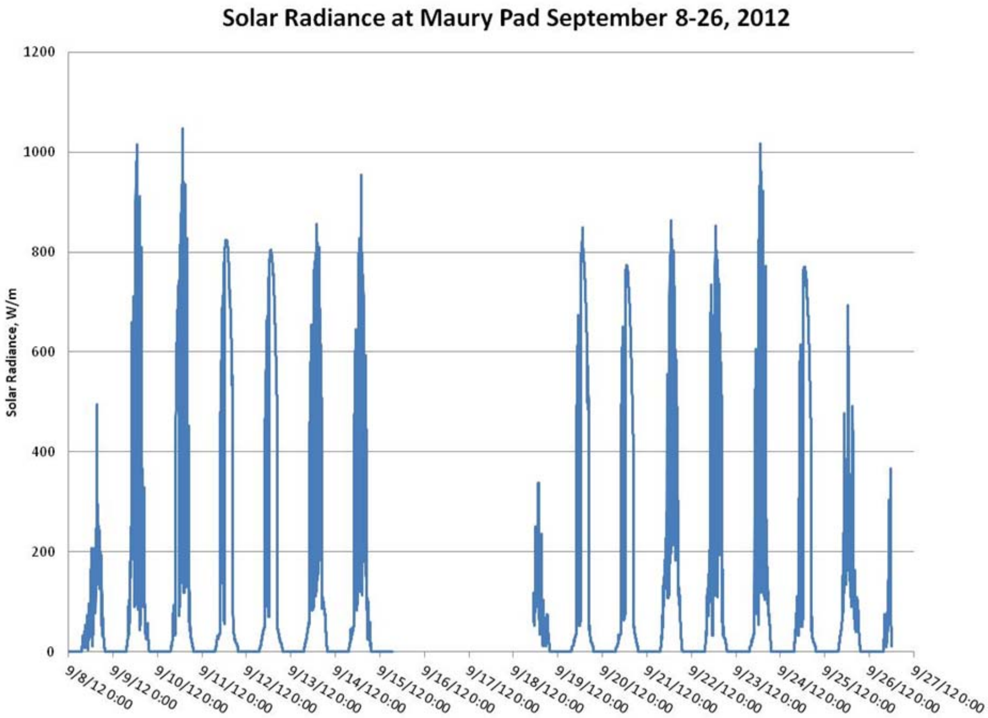


Figure A20a. Solar radiance for the second two weeks of monitoring at the DOE Trailer at the Maury pad. The gap in the data was due to a software error.

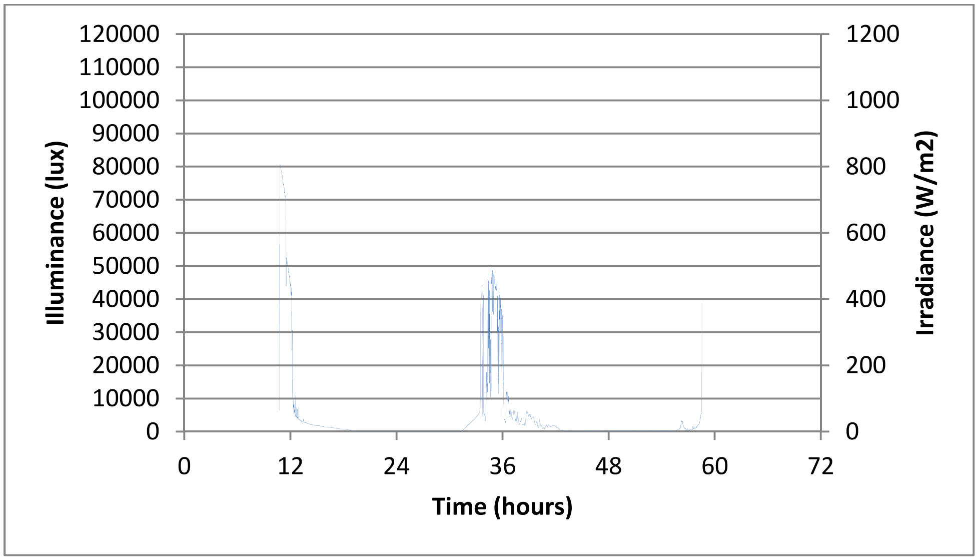


Figure A20b. Solar radiance at site D at the Maury Pad for 9/23 to 9/25.

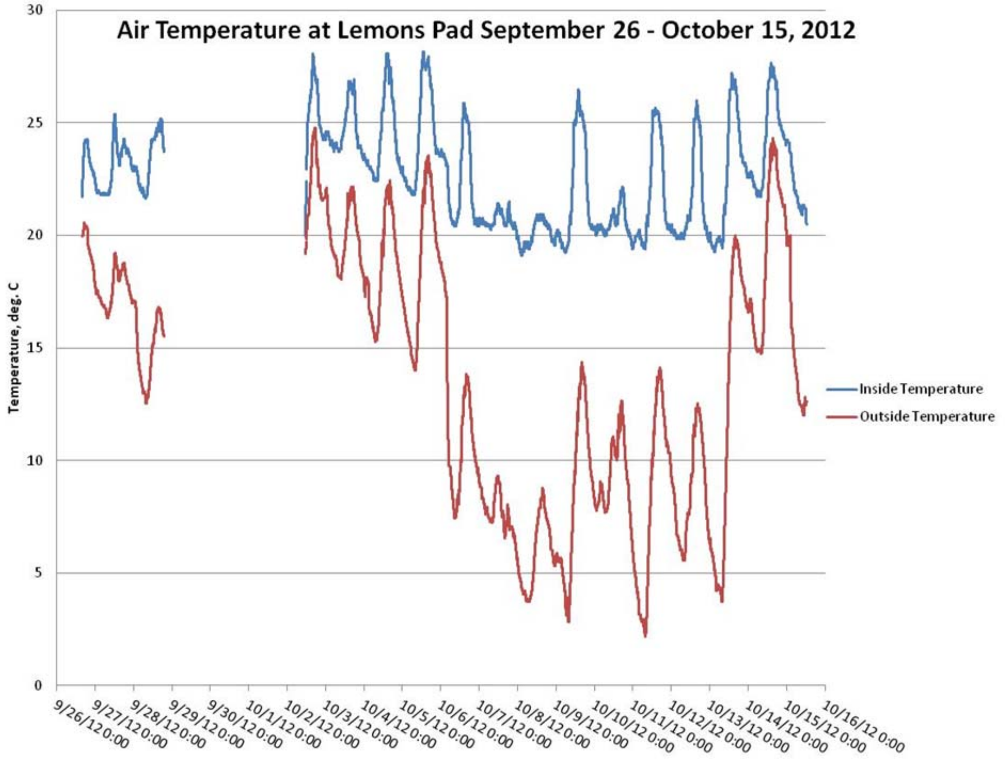


Figure A21. Air temperature inside and outside of the air monitoring laboratory at the Lemons pad. The gap in the data was due to a power interruption.

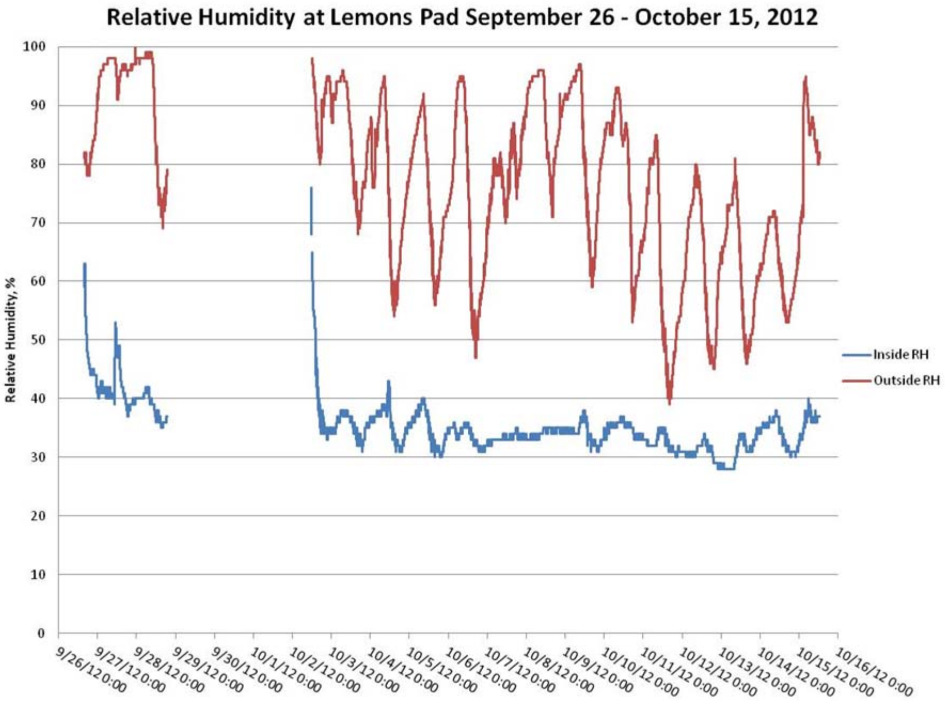


Figure A22. Relative Humidity inside and outside of the air monitoring laboratory at the Lemons pad. The gap in the data was due to a power interruption.

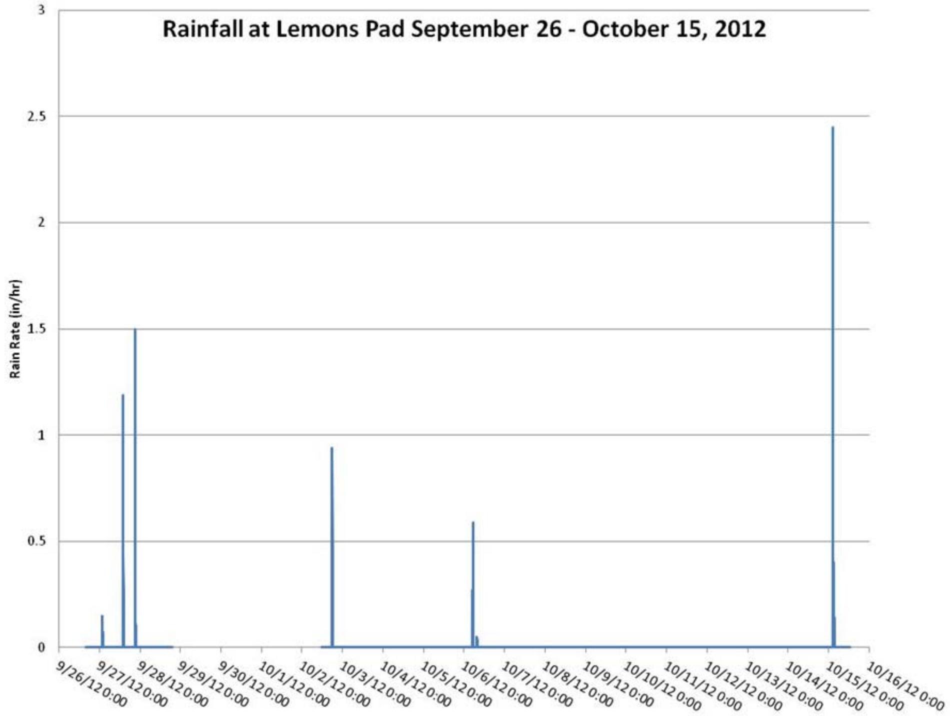


Figure A23. Rainfall events at the Lemons pad. The gap in the data was due to a power interruption.

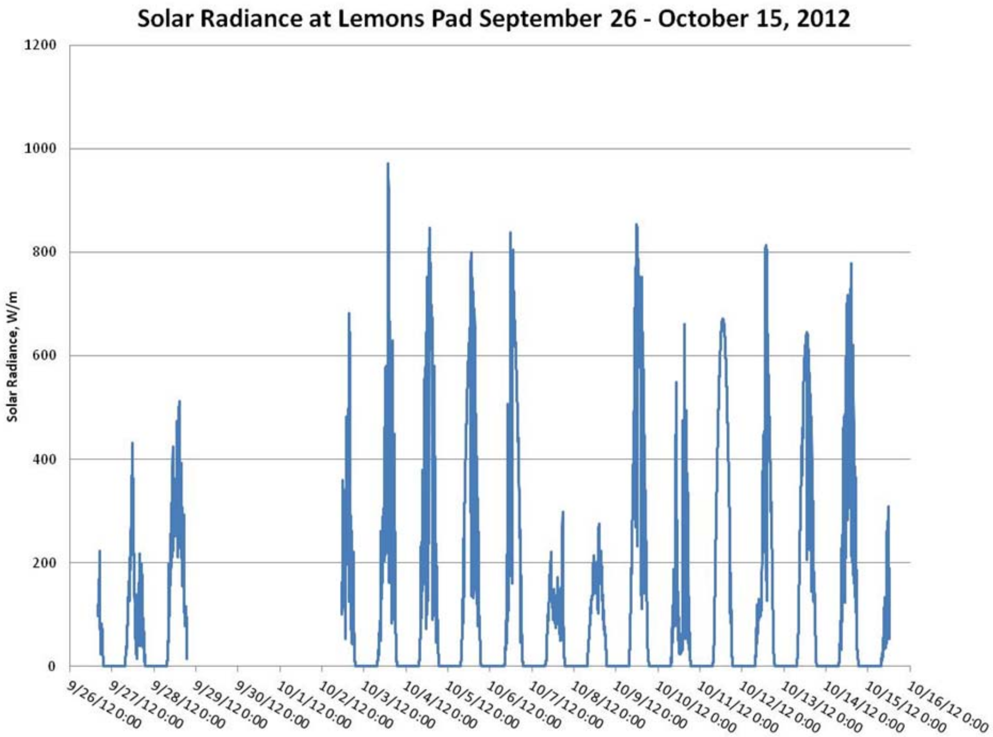


Figure A24a. Solar radiance at the Lemons pad. The gap in the data was due to a power interruption.

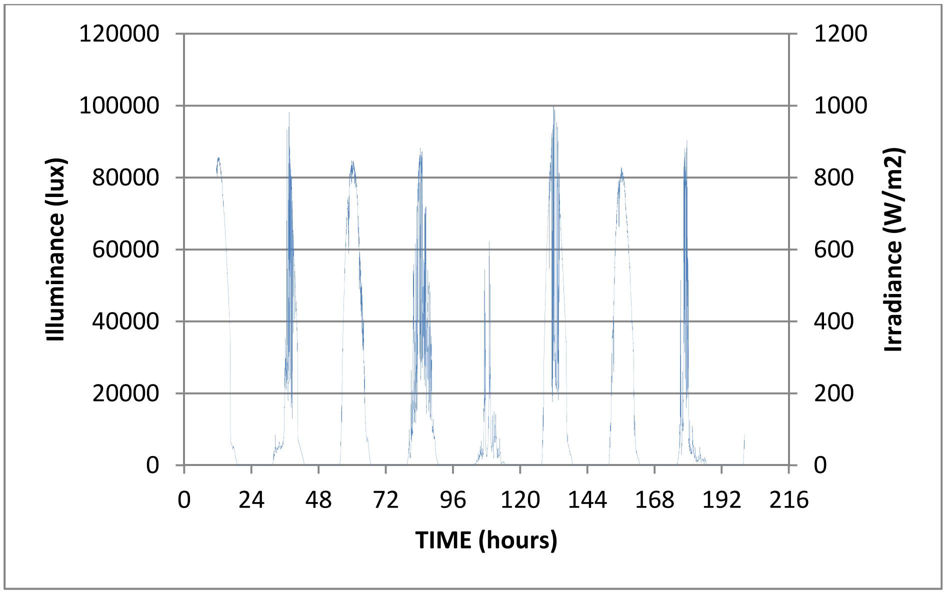


Figure A24b. Solar radiance at the Lemons Pad site A for 10/11 to 10/19.

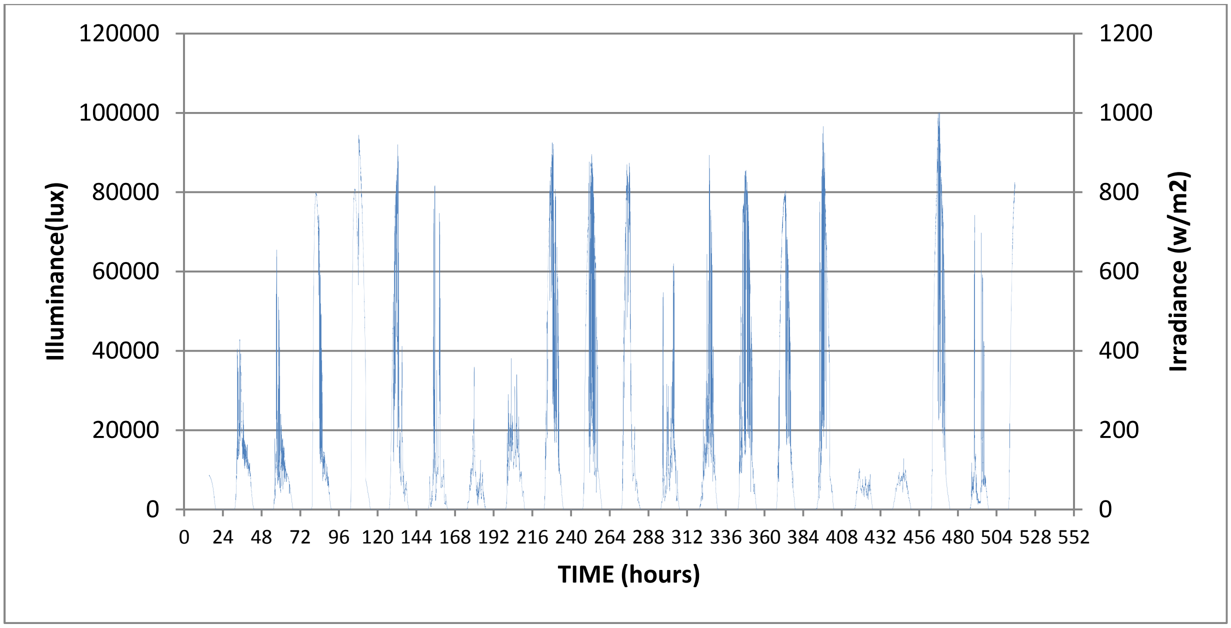


Figure A20c. Solar radiance at the Lemons Pad Site C from 9/20 to 10/11.

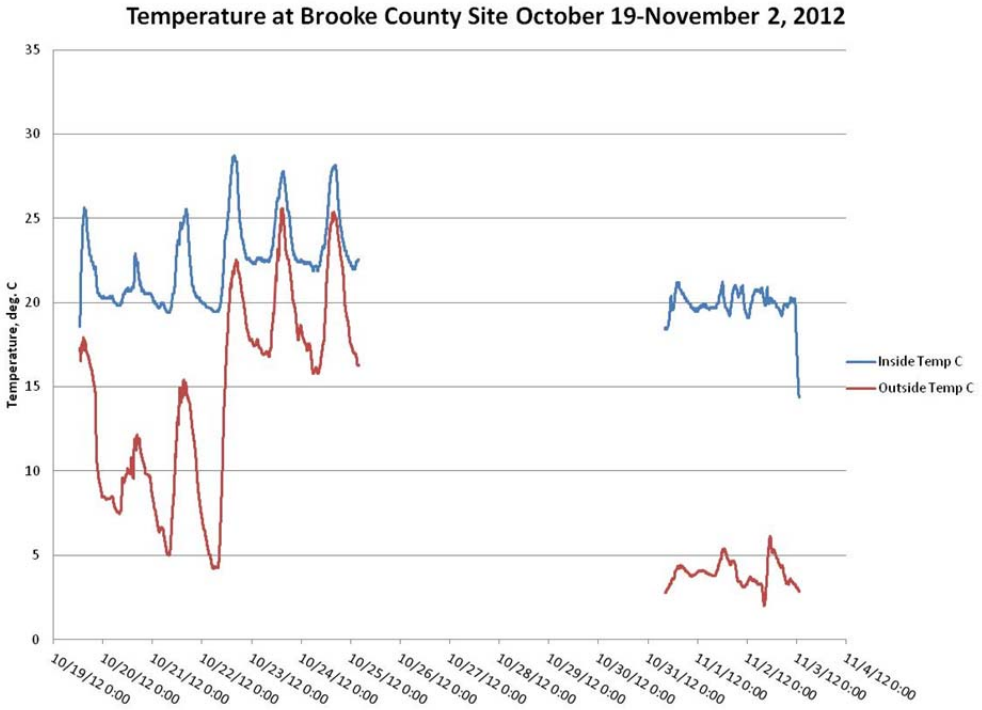


Figure A25. Air temperature inside and outside of the air monitoring laboratory at the WVDNR A pad. The gap in the data was due to a power interruption.

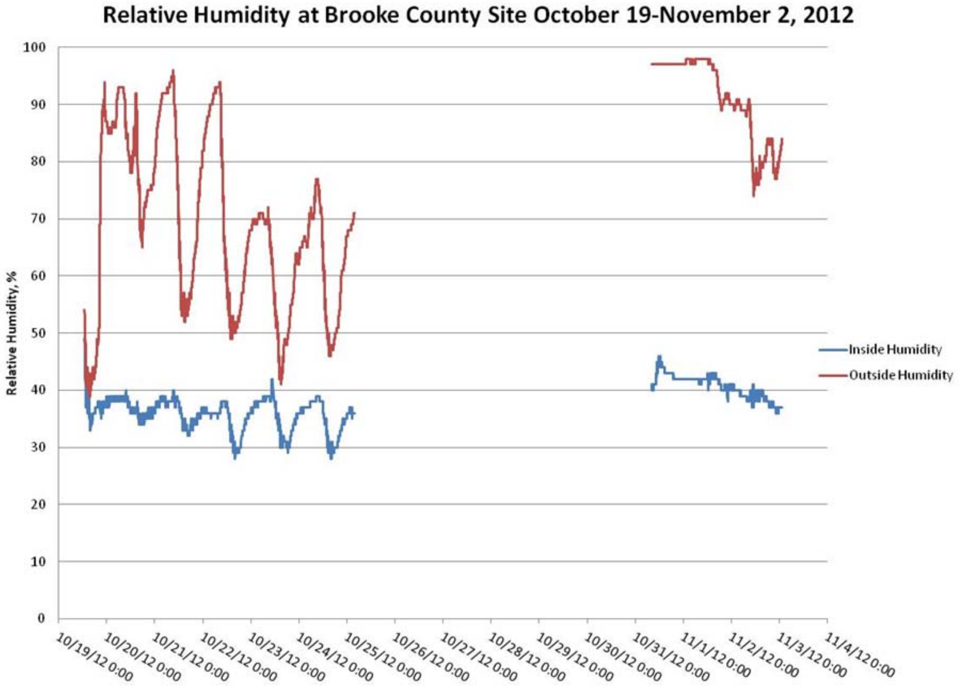


Figure A26. Relative humidity inside and outside of the air monitoring laboratory at the WVDNR A pad. The gap in the data was due to a power interruption.

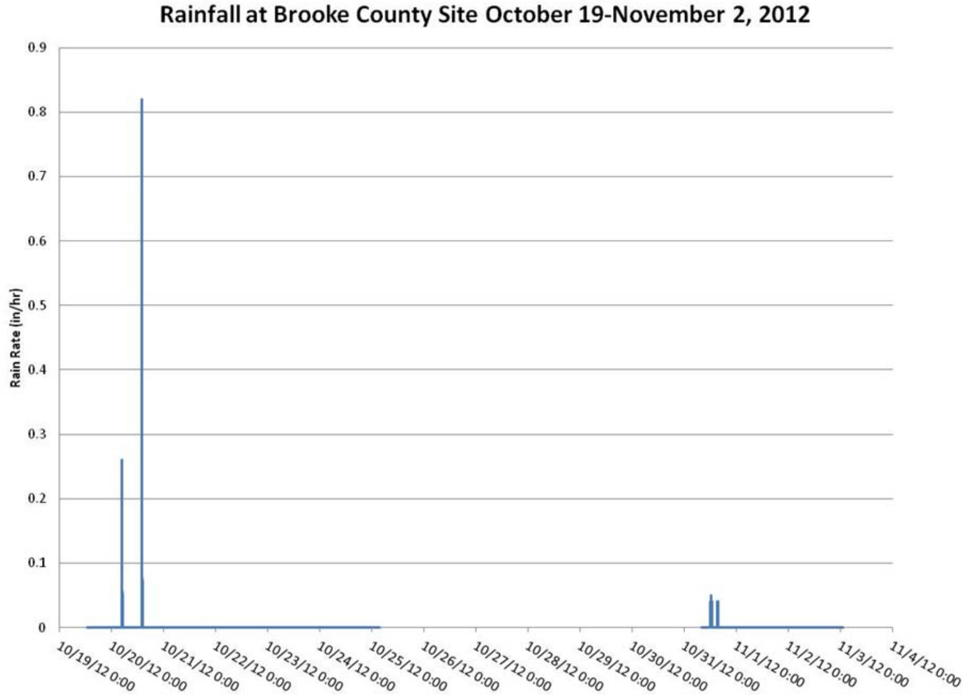


Figure A27. Rainfall events at the WVDNR A pad. The gap in the data was due to a power interruption.

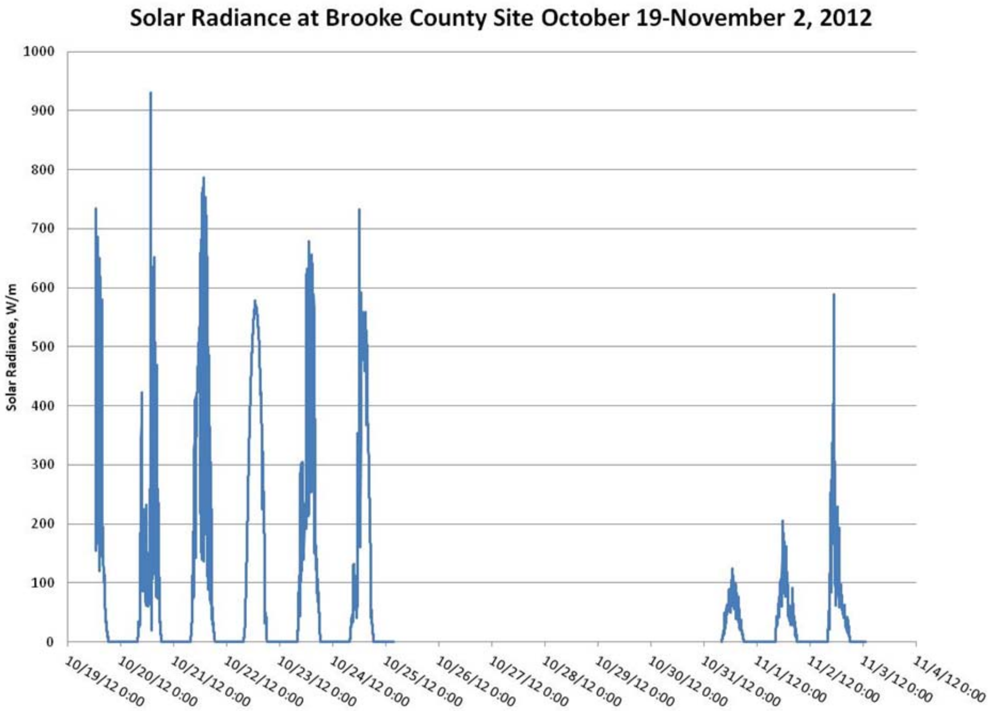


Figure A28a. Solar radiance at the WVDNR A pad at the DOE Trailer. The gap in the data was due to a power interruption.

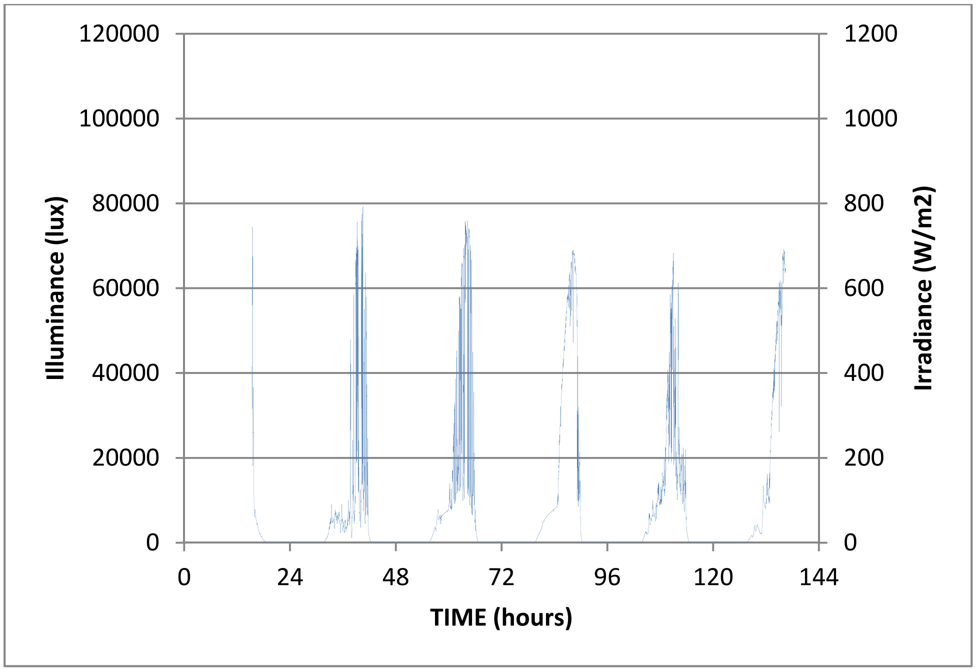


Figure A28b. Solar radiance at the WV DNR A pad at site A for 10/19 to 10/26.

APPENDIX D

Results From Other Studies

D1. Health Effects Study of Drilling Operations in Colorado

One point of comparison is a study of actual health effects around drilling operations and their concomitant measured exposures. To date there has only been one study with sufficient data against which to compare. The study by McKenzie et al., 2012(14) in Colorado, claims there is a significant increase in disease risk for populations living within a half mile of a drilling operation compared to those living farther away. Cumulative cancer risks were 10 in a million and 6 in a million for residents living less than a half mile and greater than a half mile from wells, respectively, with benzene as the major contributor to the risk. The population, however had a 30 year exposure period compared to the relatively short time frame over which increased drilling has occurred by hydrofracturing techniques. Lacking any other health study that could be applied to Unconventional Gas Drilling Operations the most prudent course of action for Public Health would appear to be adoption of the setback limit based upon the health study cited above. There are, however, difficulties with the determination of the actual setback distances cited by the study. Sampling was done between 100 and 500 feet from adjoining wells and at some central location an unspecified distance from any given well. There was no explanation offered as to how the half mile distance was arrived at.

D2. Noise Control Recommendations of the WHO - Europe

In the past, EPA coordinated all federal noise control activities through its Office of Noise Abatement and Control. In 1981, the Administration at that time concluded that noise issues were best handled at the state or local government level. As a result, the EPA phased out the office's funding in 1982 as part of a shift in federal noise control policy to transfer the primary responsibility of regulating noise to state and local governments. The Noise Control Act of 1972 and the Quiet Communities Act of 1978, however, were not rescinded by Congress and remain in effect today, although essentially unfunded.

Alternatively, the World Health Organization (WHO) - Europe has continued to be instrumental in driving the environmental health agenda in Europe and published the Night Noise Guidelines for Europe which summarize the deliberations of many experts and provide a clear and simple guide for planners and regulators.(12) The NNG summarize the relationship between night noise and health effects into four ranges of continuous outside sound level at night (L_{Night}):

<30 dB - Although individual sensitivities and circumstances differ, it appears that up to this level no substantial biological effects are observed.

30-40 dB - A number of effects on sleep are observed from this range: Body movements, awakening, self-reported sleep disturbance, and arousals. The intensity of the effect depends on the nature of the source and the number of events. Vulnerable groups (e.g., children, the chronically ill and the elderly) are more susceptible. However, even in the worst cases the effects seem modest.

40-55 dB - Adverse health effects are observed among the exposed population. Many people have to adapt their lives to cope with the noise at night. Vulnerable groups are more severely affected.

>55 dB - The situation is considered increasingly dangerous for public health. Adverse health effects occur frequently, a sizeable proportion of the population is highly annoyed and sleep disturbed. There is evidence that the risk of cardiovascular disease increases.

More recently, WHO - Europe (2011) has reported on the burden of disease as a result of the growing concern of the public, environmental health agencies, and policy makers in Europe, in terms of disability-adjusted life-years (DALYs) lost due to environmental noise.(13) The findings suggest that sleep disturbance, due mainly to road traffic noise, constitutes the heaviest burden followed by annoyance which account for 903 000 and 587 000 DALYs, respectively. The other factors associated with environmental noise are ischemic heart disease (61 000 DALYs), cognitive impairment in children (45 000 DALYs) and tinnitus (22 000 DALYs). The report concludes with the estimate that at least one million healthy life years are lost every year from traffic related noise in Western Europe.

D3. Disturbance of Sleep Patterns by Light

Light disturbance of sleep may have similar effects to noise. Individual-specific doses of light delivered through closed eyelids have been shown suppress melatonin and phase shift dim light melatonin onset and may be related to sleep disorders.(16) Melatonin production in humans decreases when people are exposed to light at night. Since melatonin shows potential oncostatic action in a variety of tumours, it is possible that lowered serum melatonin levels caused by exposure to light at night enhance the general tumour development.(17)

4. PA DEP Table of HC's for Drill Sites

The Pennsylvania Department of Environmental Protection reported on VOC concentrations from SUMMA canister sampling. (5) The compounds that were detected that the PA DEP believed were most likely related to the Marcellus Shale drilling activities were acetone, benzene, n-heptane, propene and toluene. Concentrations of these pollutants were at, or slightly higher than, levels detected in the PA DEP monitoring network sites. However, none were detected at levels of concern. The table below shows the results of that study.

Pennsylvania DEP Analysis of VOC Levels at Pennsylvania Drilling Sites

		Concentration (ug/m3)																
Compounds	MDL	Florence 001	Florence 002	Florence 003	Stewart 001	Stewart 002	Stewart 003	CrossCreek 001	CrossCreek 002	CrossCreek 003	EnergyCorp 001	EnergyCorp 002	EnergyCorp 003	Yeager 001	Yeager 002	Yeager 003	Arendtsville	Marcus Hook
1,1,1-Trichloroethane	0.23	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,1,2,2-Tetrachloroethane	0.462	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,1,2-Trichloro-1,2,2-trifluoroethane	0.194	0.64	0.76	0.72	--	0.56	0.75	0.67	0.62	0.64	0.62	0.59	0.69	0.66	0.72	0.77	0.64	0.62
1,1,2-Trichloroethane	0.132	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,1-Dichloroethane	0.142	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,1-Dichloroethene	0.091	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,4-Trichlorobenzene	0.274	1.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.31	0.46
1,2,4-Trimethylbenzene	0.175	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.14	0.44
1,2-Dibromoethane	0.198	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichloro-1,1,2,2-tetrafluoroethane	0.184	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	0.301	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethane	0.101	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.054	--
1,2-Dichloropropane	0.11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.076	0.067
1,3,5-Trimethylbenzene	0.316	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.16
1,3-Butadiene	0.362	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	0.302	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,4-Dichlorobenzene	0.297	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.15
1-Bromopropane	0.108	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1-Ethyl-4-methylbenzene	0.238	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.18	0.17
2-Butanone (MEK)	0.473	0.83	1.7	1.2	0.91	1.5	1.2	2.8	2	4.1	1.8	--	2.2	2.3	2.6	2.1	2.6	2.3
2-Hexanone	0.606	2.6	--	--	--	--	--	0.7	--	--	1	--	--	1.1	--	--	0.51	0.33
2-Methoxy-2-methylpropane (MTBE)	0.148	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Methyl-2-pentanone (MIBK)	0.606	3.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acetone	0.419	24	17	17	8.8	24	13	--	18	11	16	11	40	24	18	31	19	18
Acrolein	0.122	0.41	0.71	0.94	--	1.2	--	--	1.5	0.92	0.76	3.7	0.78	1.3	--	2.2	2	1.2
Benzene	0.071	0.29	0.3	0.8	0.51	0.35	0.42	0.7	0.64	1.3	0.45	0.35	0.3	0.32	0.48	0.35	0.52	1.7

APPENDIX E

SUMMARY OF SETBACK REGULATIONS

E. Review of Setback Distance Rules

There does not appear to be a simple solution to specifying a setback distance. There is no single geometry to which all drill site activities conform. The activities follow the terrain of the site and the needs of the process. There was activity associated with the drilling site and the source of air contaminants and noise at 625 feet and farther from the center of the pad.

This difficulty is somewhat reflected by the variety of state regulations for which a review found the following requirements that were applicable in defining a setback distances:

E.1 Colorado Setback Rule 604 draft proposal

> (1)At the time of initial drilling, a well shall be located not less than two hundred (200) feet from buildings, public roads, major above ground utility lines, or railroads. Building Units and Designated Outside Activity Areas are subject to Rule 604. (2)A well shall be a minimum distance of located not less than one hundred fifty (150) feet from a surface property line. The Director may grant an exception if it is not feasible for the operator to meet this minimum distance requirement and a waiver is obtained from the offset surface owner(s). An exception request letter stating the reasons for the exception shall be submitted to the Director and accompanied by a signed waiver(s) from the offset surface owner(s). Such waiver shall be written and filed in the county clerk and recorder's office and with the Director.

604. LOCATION REQUIREMENTS FOR OIL AND GAS FACILITIES, DRILLING, AND WELL SERVICING OPERATIONS IN DESIGNATED BUFFER ZONESOIL AND GAS FACILITIES

a. Designated Buffer Zones

(1) Exception Zone. Any proposed Oil and Gas Location with a wellhead or production facility located 350 feet or less from a Building Unit shall constitute an Exception Zone location. Except as provided in subsection (3), below, the Director shall not approve a Form 2 or Form 2A proposing to locate a wellhead or a production facility within the Exception Zone unless all Building Unit owners within the Exception Zone consent in writing to the proposed locations of any wellhead(s) and production facility(ies) within the Exception Zone and the Applicant certifies it has complied with Rule 306.e.

(2) Buffer Zone. Any proposed Oil and Gas Location with a wellhead or production facility located 1000 feet or less from a Building Unit shall constitute a Buffer Zone Location. The Director shall not approve a Form 2 or Form 2A proposing to locate a wellhead or a production facility within the Buffer Zone until the Applicant certifies it has complied with Rule 306.e.

(3) High Occupancy Building Unit Zone. Commission approval is required for any Form 2 or Form 2A proposing to locate a wellhead or production facility within seven hundred

fifty (750) feet of High Occupancy Building Unit. The Director may approve a Form 2 or Form 2A proposing to locate a wellhead or production facility more than seven hundred fifty (750) feet from a High Occupancy Building Unit, provided the Applicant certifies it has complied with Rule 306.e., if applicable.

(4) Designated Outside Activity Area Zone. The minimum setback from the boundary of a Designated Outside Activity area shall be three hundred fifty (350) feet. The Commission, in its discretion, may establish a setback of greater than three hundred fifty (350) feet based on the totality of circumstances.

(Colorado Oil and Gas Conservation Commission Cause 1-R, Docket No. 1211-RM-04 Regulatory Analysis pursuant to §24-4-103(4.5), C.R.S.)

E.2. Kentucky Oil and Gas Conservation Commission Setback rules

> Section 4. Spacing of Deep Oil and Gas Wells…2) Except as provided in subsections (4) and (5) of this section no deep gas well drilled to a depth less than 7,000 feet shall be located within 1,072 feet of the boundary of the proposed unit, and no deep gas well drilled to a depth of 7,000 feet or more shall be drilled within 1,532 feet of the boundary of the proposed unit.
>
> (3) Except as provided in subsections (4) and (5) of this section no deep oil well drilled to a depth less than 7,000 feet shall be located within 536 feet of the boundary of the proposed unit, and no deep oil well drilled to a depth of 7,000 feet or more shall be drilled within 766 feet of the boundary of the proposed unit.
>
> (4)(a) Upon receiving evidence showing a necessity therefor, the director may in his discretion grant permits with the following limitation on well location:
>
> 1. A deep oil well at a depth less than 7,000 feet may be located no closer than 438 feet to the boundary of the proposed unit.
>
> 2. A deep oil well at a depth of 7,000 feet or more may be located no closer than 625 feet to the boundary of the proposed unit.
>
> 3. A deep gas well at a depth of less than 7,000 feet may be located no closer than 875 feet to the boundary of the proposed unit.
>
> 4. A deep gas well at a depth of 7,000 feet or more may be located no closer than 1,250 feet to the boundary of the proposed unit.

(805 KAR 1:100. Commission's rules of procedure; spacing of deep well drilling; wildcat wells and pooling of interests.RELATES TO: KRS 353.651, 353.652

STATUTORY AUTHORITY: KRS 13A.100, 353.565 NECESSITY, FUNCTION, AND CONFORMITY: KRS 353.565 requires the Kentucky Oil and Gas Conservation Commission to administer and enforce the provisions of KRS 353.651 and 353.652 by regulating the spacing of deep well drilling, drilling units and pooling of interests.)

E.3 Ohio Setback rules

D. Spacing of wells (1509:021 ORC):

1. Set back requirements: The surface location of a new well may be no closer than 150 feet to any property line not within drilling unit without the landowner's written approval if directional drilling is to be used. This setback distance may be reduced to no less than 100 feet upon approval of the Chief.

2. The surface location of a new well or a tank battery may be no closer than 150 feet to an occupied dwelling without the written consent of the owner of the land on which the dwelling is located. This setback distance may be reduced to no less than 100 feet upon approval of the Chief.

3. The surface location of a new well may be no closer than 200 feet to an occupied dwelling that has become part of a unit as a result of mandatory pooling unless the owner of the land on which the dwelling is located gives written consent in which case the well may not be closer than 100 feet to the dwelling.

4. The surface location of a new well may be no closer than 150 feet to a property that has become part of a unit as a result of mandatory pooling unless the owner of the land gives written consent in which case the well may not be closer than 75 feet to the property.

5. The location of a tank battery may be no closer than 150 feet to an occupied dwelling located on a property that has become part of a unit as a result of mandatory pooling unless the owner of the land gives written consent in which case the tank battery may not be closer than 100 feet to the dwelling.

6. The location of a new tank battery may be no closer than 75 feet to a property that has become part of a unit as a result of mandatory pooling unless the owner of the land gives written consent in which case the tank battery may not be located on the property.

7. The surface location of a new well may be no closer than 100 feet to an occupied private dwelling or public building, no closer than 50 feet to a public road or railroad track, no closer than 50 feet to a tank battery or 100 feet to another well. The Chief may

authorize a well to be located closer than 100 feet to another well if the applicant provides a written statement that by locating the wells closer than 100 feet it will reduce impact to the landowner or to the immediate surface environment.

(Chapter 1509 Ohio Revised Code (ORC) Chapter 1501 Ohio Administrative Code (OAC))

E.4 Oklahoma Setback rule

Any well drilled for oil or gas to an unspaced common source of supply 2,500 feet or more in depth shall be located not less than 330 feet from any property line or lease line, and shall be located not less than 600 feet from any other producible or drilling oil or gas well when drilling to the same common source of supply; provided and except that in drilling to an unspaced common source of supply that is less than 2,500 feet in depth, the well shall be located not less than 165 feet from any property line or lease line and not less than 300 feet from any other producible or drilling oil or gas well in the same common source of supply; provided, however, that the completed depth of the discovery well shall be recognized as the depth of the common source of supply for the purpose of this Section; provided further, when an exception to this Section is granted, the Commission may adjust the allowable or take such other action as it deems necessary for the prevention of waste and protection of correlative rights.

(Source: Oklahoma Title 165 Ch. 10-1-21. General well spacing requirements)

E.5 Pennsylvania Act 13 Setback rules

(5.1) Notwithstanding section 3215 (relating to well location restrictions), may prohibit, or permit only as a conditional use, wells or well sites otherwise permitted under paragraph (5) within a residential district if the well site cannot be placed so that the wellhead is at least 500 feet from any existing building. In a residential district, all of the following apply:

(i) A well site may not be located so that the outer edge of the well pad is closer than 300 feet from an existing building.

(Title 58 Chapter 33 Section 5.1 of the Pennsylvania Consolidated Statutes)

E.6 Texas Setback rule

(a) Distance requirements.

> (1) No well for oil, gas, or geothermal resource shall hereafter be drilled nearer than 1,200 feet to any well completed in or drilling to the same horizon on the same tract or farm, and no well shall be drilled nearer than 467 feet to any property line, lease line, or subdivision line; provided the commission, in order to prevent waste or to prevent the confiscation of property, may grant exceptions to permit drilling within shorter distances than prescribed in this paragraph when the commission shall determine that such exceptions are necessary either to prevent waste or to prevent the confiscation of property.
>
> (Texas Administrative Code TITLE 16 ECONOMIC REGULATION PART 1 RAILROAD COMMISSION OF TEXAS CHAPTER 3 OIL AND GAS DIVISION RULE §3.37 Statewide Spacing Rule)

E.7 Wyoming Setback rule

> Before drilling commences, approval to construct proper and adequate reserve pits for the reception and confinement of mud and cuttings and to facilitate the drilling operation shall be applied for and received in accordance with Chapter 4, Section 1 of these rules. Special precautions including, but not limited to, an impermeable liner and/or membrane, monitoring systems, or closed systems, shall be taken, if necessary, to prevent contamination of streams and potable water and to provide additional protection to human health and safety in instances where drilling operations are conducted in close proximity to water supplies, residences, schools, hospitals, or other structures where people are known to congregate. Pits, wellheads, pumping units, tanks, and treaters shall be located no closer than three hundred fifty feet (350') from any of the aforementioned items. The Supervisor may impose greater distances for good cause and likewise grant exceptions to the 350-foot rule.

(Wyoming Oil and Gas Conservation Comm’n, Rules and Regulations Ch. 3 § 22(b))

E.8 Other states:

Michigan 300 ft. (well, assoc. surface facilities) Mich. Admin. Code R. 324.502 (2011)

Maryland 1,000 ft. (well). Code Md. Reg. 26.19.01.09 (2011)

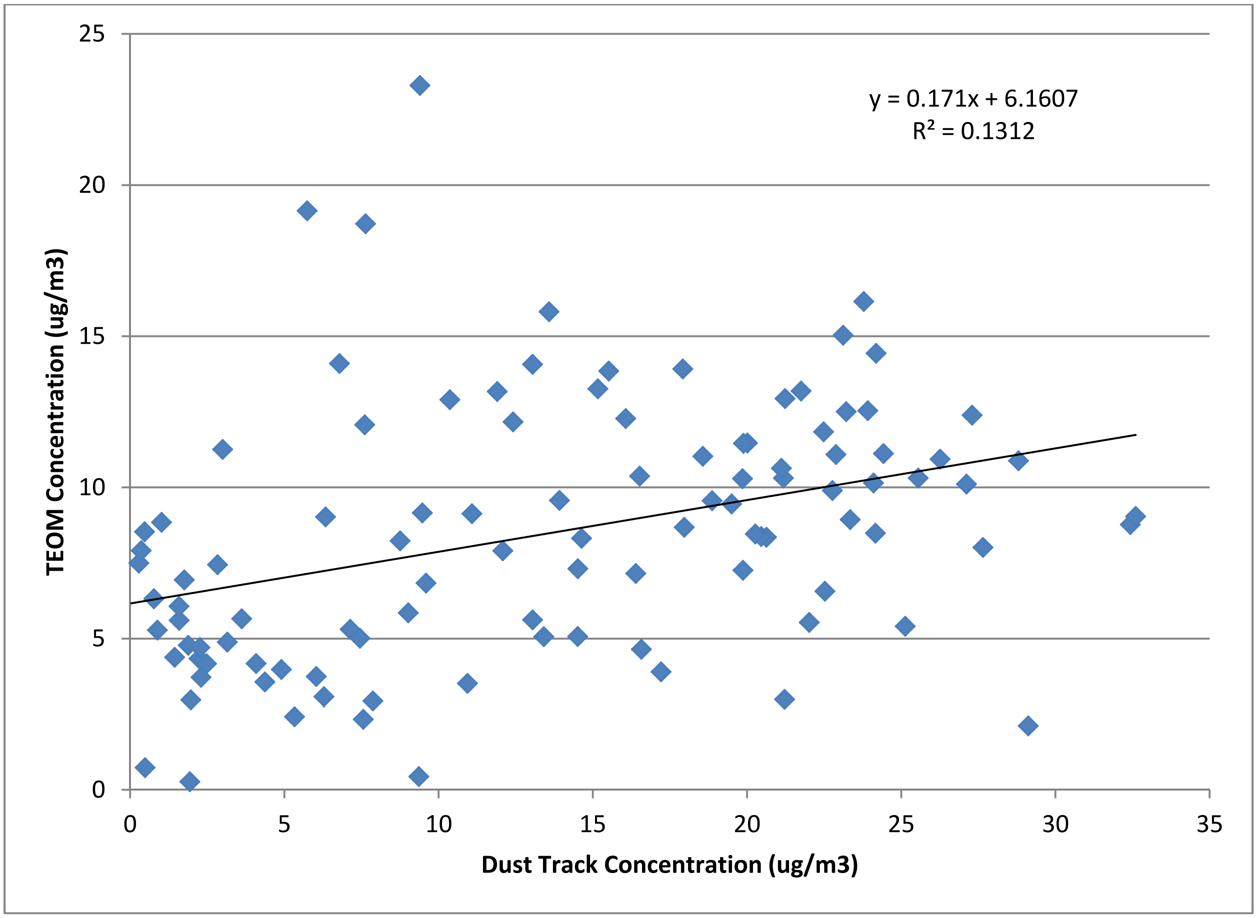
New Mexico 500 ft. (temp. pit or below-grade tank); 500 ft. (permanent pit). 19.15.17.10 NMAC (2011)

New York 500 ft. (well pad). R SGEIS 7.1.11.1 (2011)

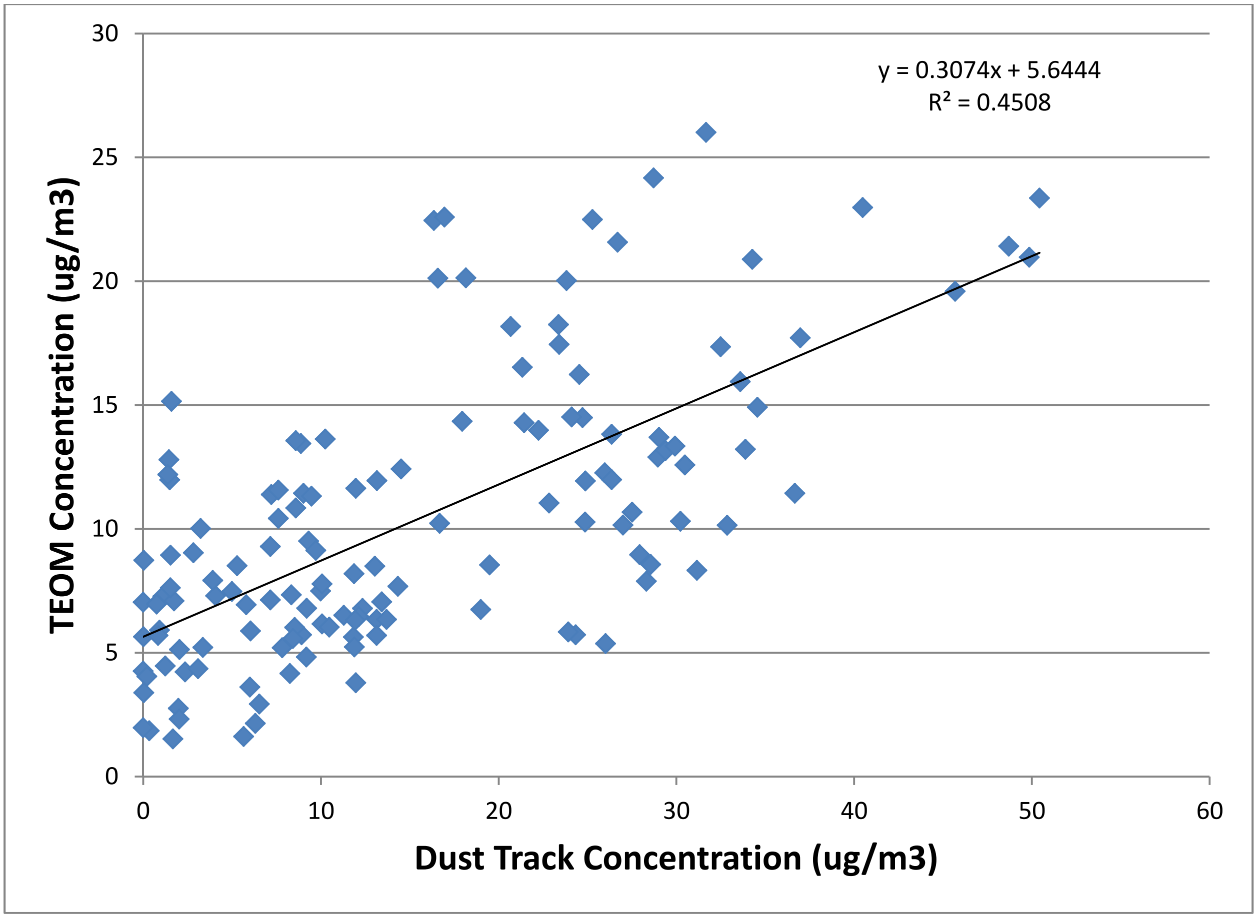
APPENDIX F

DUST TRACK CORRECTION FACTORS

Dust Track readings were post-corrected by applying a correction factor to the average six day mass value to account for the density of the dust. The concentration from the TEOM (which measures actual mass) was compared with the Dust Track reading in µg/m^3 from the WAMS site co-located with the trailer, a linear regression equation derived and the Dust Track readings corrected using that linear regression equation to give a density corrected value to all of the Dust Tracks at that drill site. This density correction procedure was repeated with the data from each specific drill sites. Data for Mills Wetzel 2 and Mills Wetzel 3 used the same density correction factor, derived from the Mills Wetzel 2 data comparison since they were so closely located to one another and the TEOM was not available for the Mills Wetzel 3 site. The data used for all the corrections are shown below. The linear regression equation used as the correction factor is displayed in the upper right hand corner of each graph. The variable "x" in the equation represents the Dust Track concentration and the variable "y" represents the calculated value for the accompanying TEOM dust concentration predicted by the linear regression equation.

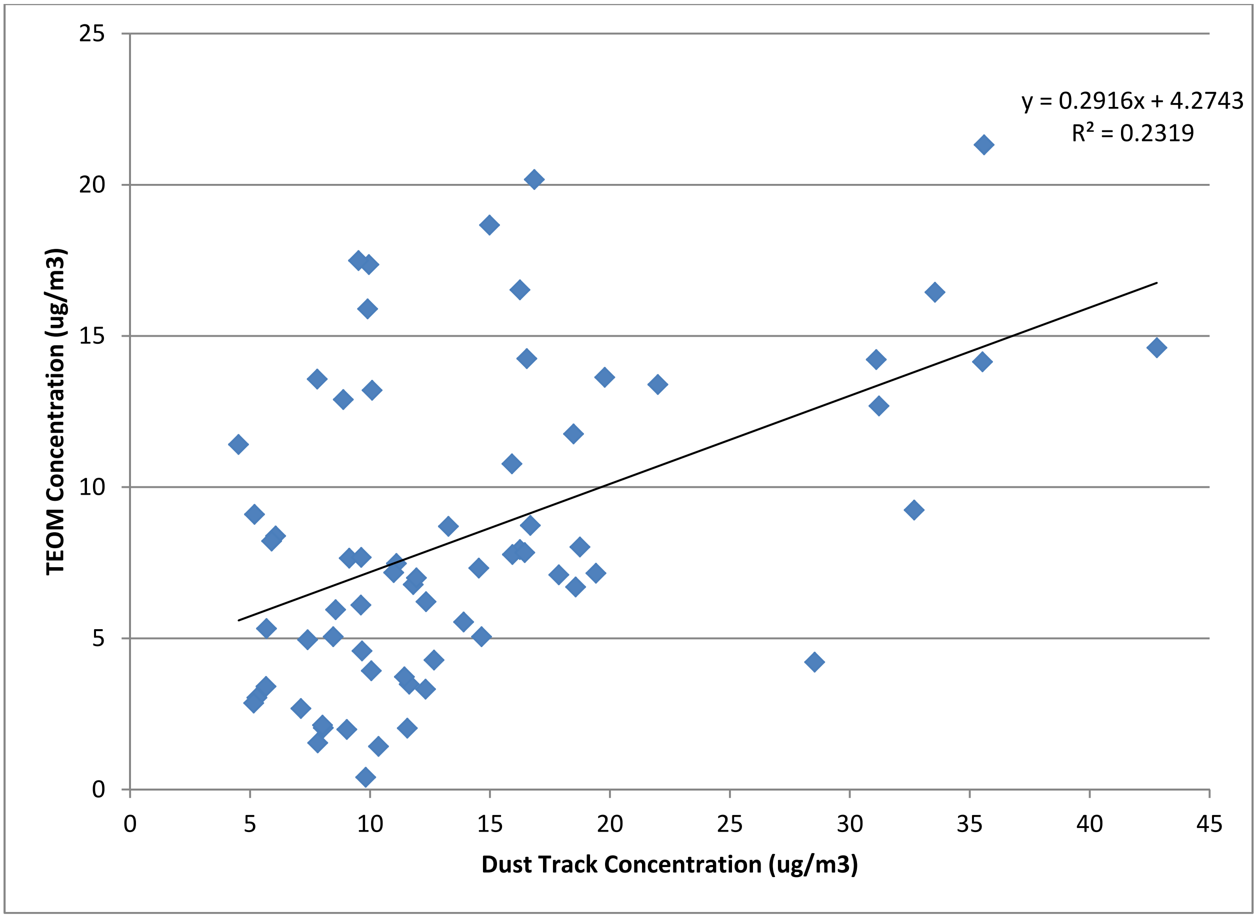


LEMONS PAD

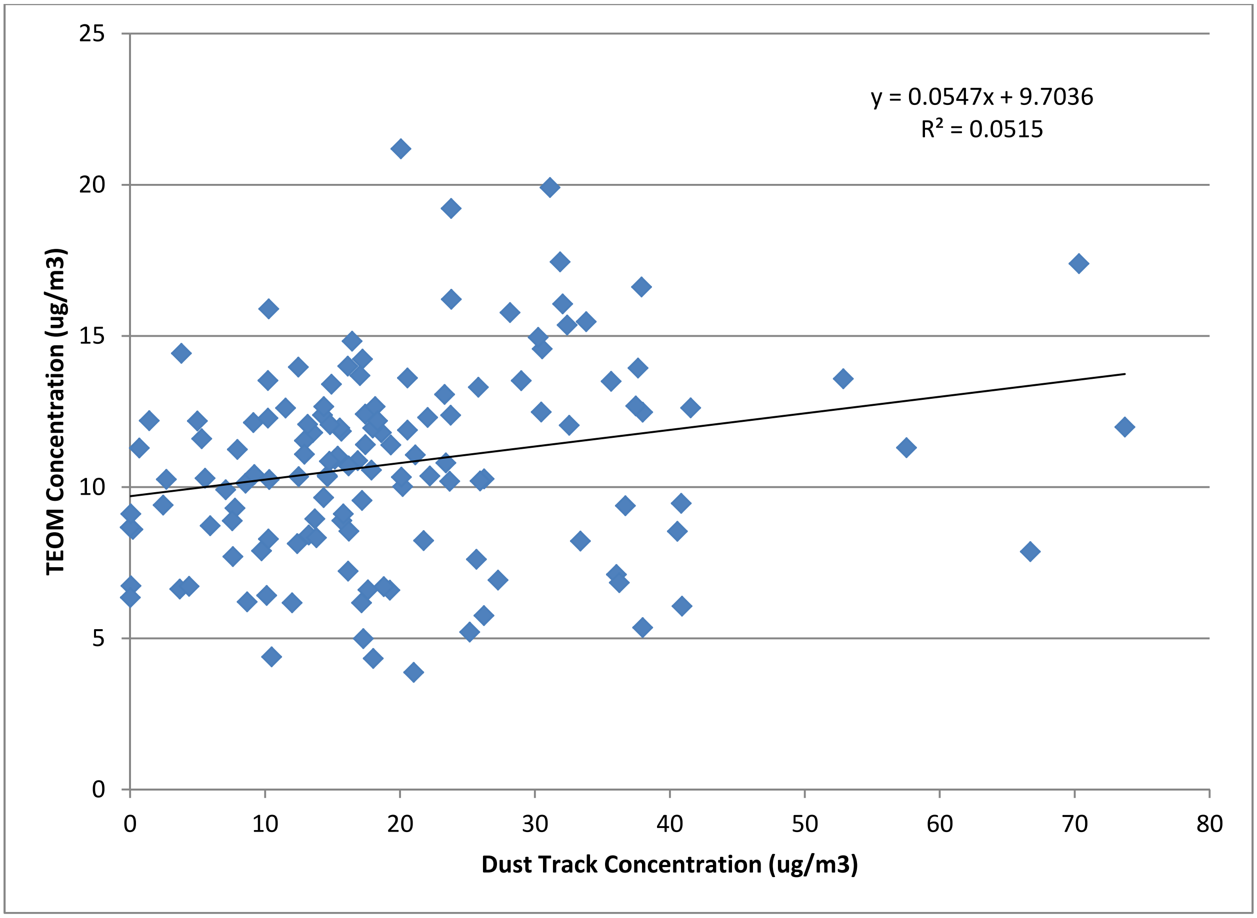


y = 0.3074x + 5.6444
R² = 0.4508
TEOM Concentration (ug/m3)
Dust Track Concentration (ug/m3)
0
5
10
15
20
25
30
0
10
20
30
40
50
60

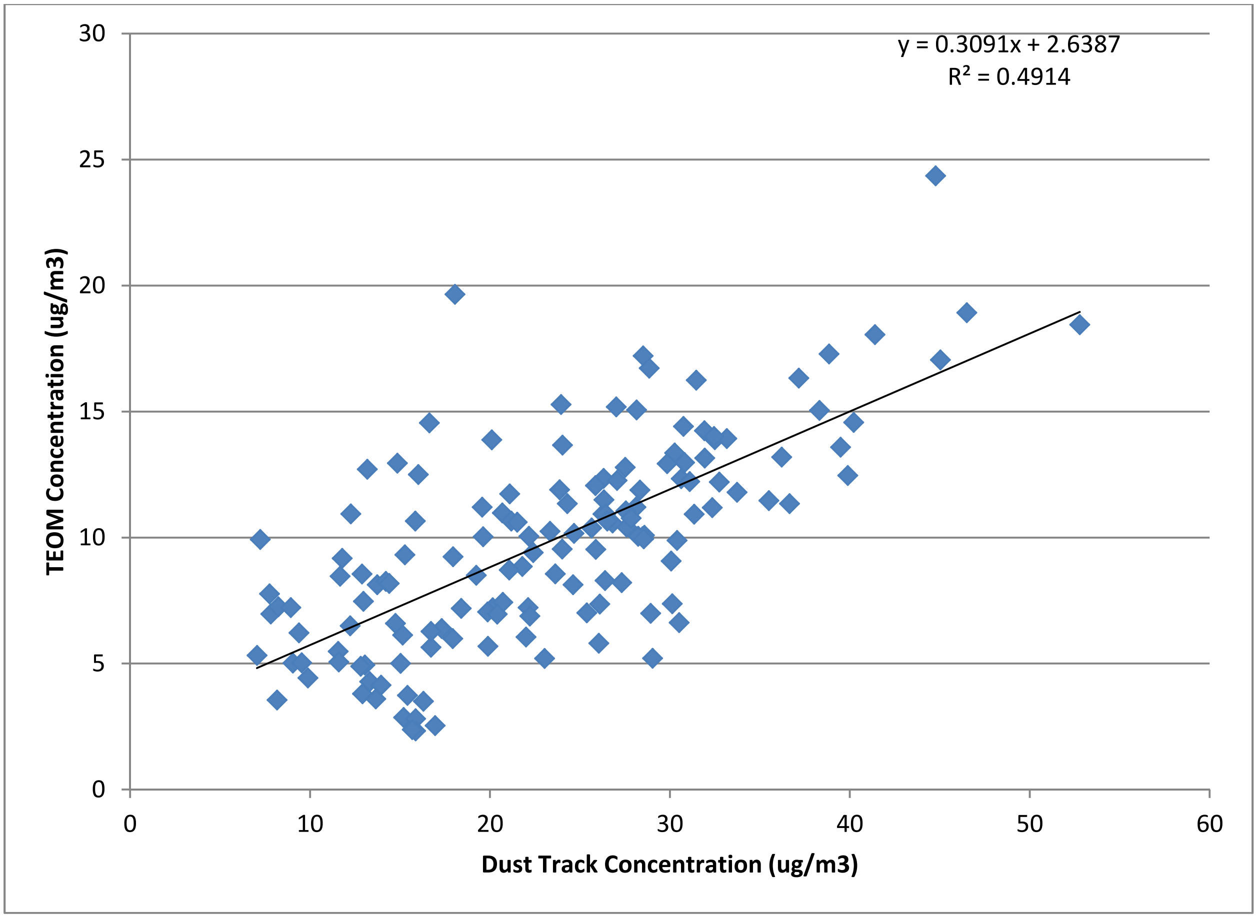
Weekley Pad


y = 0.2916x + 4.2743
R² = 0.2319
TEOM Concentration (ug/m3)
Dust Track Concentration (ug/m3)
0
5
10
15
20
25
0
5
10
15
20
25
30
35
40
45

Maury Pad



Mills Wetzel


y = 0.3091x + 2.6387
R² = 0.4914
TEOM Concentration (ug/m3)
Dust Track Concentration (ug/m3)
0
5
10
15
20
25
30
0
10
20
30
40
50
60

WV DNR A Pad

Air, Noise, and Light Monitoring Plan

For

Assessing Environmental Impacts of Horizontal Gas Well Drilling Operations
(ETD-10 Project)

Prepared for:

West Virginia Department of Environmental Protection
Divisions of Air Quality
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July 1, 2012

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Disclaimer

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented. The contents DO NOT necessarily reflect the official views or policies of the State. These reports do not constitute a standard, specification, or regulation. Trade or manufacturers' names which may appear herein are cited only because they are considered essential to the objectives of these reports. The State of West Virginia does not endorse products or manufacturers. This report was prepared for the West Virginia Department of Environmental Protection.

1 Background

Horizontal drilling and hydraulic fracturing methods to extract natural gas from shale beds has been steadily increasing in West Virginia. These techniques have raised environmental concerns from not only citizens, but also state agencies, which regulate these practices. On December 14, 2011, the West Virginia Legislature enacted the new Natural Gas Horizontal Well Control Act. This act requires that the West Virginia Department of Environmental Protection (WVDEP) to conduct an environmental impact study. This research study will assess: (1) the potential effects on surrounding air quality and generated light and noise and, (2) to identify potential health and safety issues possibly created by horizontal drilling and hydraulic fracturing methods. The intent of this Air, Noise, & Light Monitoring Plan is to identify and document any potential environmental and/or health impacts created by the natural gas extraction processes.

2 Roles and Responsibilities

A list of West Virginia University (WVU) staff involved in this study is included in **Appendix A** along with their contact information.

2. 1 West Virginia University

West Virginia University will design and conduct the air quality study. Specific responsibilities of WVU staff are described below:

Dr. Michael McCawley, Principal Investigator

- Provide oversight and direction of project
- Provide technical oversight concerning air, light, and noise monitoring at well sites
- Serve as lead investigator

2. 2 West Virginia Department of Environmental Protection

The West Virginia Department of Environmental Protection (WV DEP) is the sponsor of this study and will have the following role:

- Identify natural gas drilling community contacts and assist WVU in working with these individuals to obtain access to sampling sites for initial setup and an approximate seven-day sampling period.
- Provide available information on natural gas operations and other available pertinent information related to the sampling sites to WVU.
- Review and approve the Study Plan
- Review and approve the Study Report.

2. 3 Sampling Site Representatives

Field sampling will be conducted at the selected natural gas drilling sites. Individuals either working or living at these locations have agreed to:

- Provide access to sites – including off hour access
- Allow for photographs and data collection

3 Study Design

The intention of the field sampling methods described in this monitoring plan is to characterize and document possible air pollutants along with light and noise disruptions associated with natural gas development to determine potential environmental impacts. Marcellus gas wells at the various stages of development will be selected for this project (approximately 2-3). WVDEP will contact the natural gas developers to establish site access. In order to collect data at these selected locations, a range of sampling and analysis methods will be employed. Each sampling site will have four wireless air monitoring station (WAMS) locations. **Attachment 1** details the WAMS design. Reasons for using this arrangement are:

- These monitoring stations collect data continuously throughout the day and can transmit detailed data electronically to a data logger either on-board or remotely.
- The monitors are battery powered with solar charging capabilities.
- They can operate in remote locations.
- This gives the WAMS the ability to be placed anywhere around the drill site, regardless of the availability of power.
- WAMS are being used by the US DOE and results from this study can be compared to their work.

The limitation this imposes, however, is that larger, higher volume sampling equipment cannot be run using the battery in the units. Because this work is not for compliance but to inform decisions concerning compliance it is assumed that more detailed information is preferable to standard methods as long as the data from the methods being used can be adjusted for use with standard methods. The compensation for this is that the instruments that are run are continuous analyzers, supplying minute by minute readings of their particular agent. Each WAMS location will monitor hydrocarbons, noise level, light level, and particulate matter. Each WAMS location will also be equipped with a Summa canister to measure Hydrocarbon compounds (HCs) over a 72 hour period. The Summa canisters will be analyzed by Air Toxics LTD and allow HC speciation. The Summa canister represent a three day average rather than a single day as a trade-off between standard sampling methods and a better understanding of the process being sampled. The drilling process is expected to have numerous days when the production of organics is low. This may give results that are between the limit of detection and the limit of quantification and thus are unusable for determining an accurate average for the process or the six day sampling period. The longer the averaging time, the more likely a quantifiable amount of material is likely to be produced and detected by the canisters. Three days is the maximum sampling time attainable with the canisters. **Table 1** summarizes the pollutants/parameters to be sampled, the instrumentation to be used, the measurement technique, and detection limits. **Table 2** summarizes the HCs that will be speciated (if present) by Air Toxics

LTD. The sampling location will also be equipped with a mobile laboratory supplied by the Department of Energy; this trailer is designed to monitor various constituents, such as meteorological data (i.e. wind speed and direction, temperature, humidity, etc.).

The nature of this field study presents challenges and limitations to the study design including:

- Mountainous terrain in the study area may affect the local meteorology and thus the transport of emissions.
- Other sources of air pollutants, such as motor vehicles, may exist at the well site.
- Relative scarcity of natural gas sites in the area that may prove suitable for air quality monitoring (by virtue of location, access, security, availability, etc.).

These challenges and limitations, along with the normal variability of meteorological conditions, add to the complexity of selecting suitable sampling sites during the study period.

Table 1: WVU Mobile Air Monitoring-Sampling and Analysis Methods

Pollutants/ Parameters Measured	Instruments	Measurement Technique	Time Resolution of Data	Method Detection Limit (ppb)
Hydrocarbons	MiniRae 2000	Photoionization Detection (PID)	Once/Minute	+/- 0.1 ppm
Noise	Extech Sound Level Datalogger	IEC61672-1 Class 2 and ANSI S1.4 Type 2 standards	Electric Microphone Once/Minute	30 dB w/ accuracy of +/- 1.4 dB
Light	Extech SDL 400 Light Meter	Photometric	Once/Minute	1 lux resolution and accuracy of +/- 0.4%
PM2.5	TSI Dusttrak II Model 8530	Photometric detection by light scattering	Once/Minute	+/- 0.001 mg/m^3
HC's	Summa Canister	GC/MS (EPA TO-15)	72 hours	Variable by chemical species

Table 2: Summa Canister Analyte List by Method TO-14A/T0-15

Analyte	Reporting Limit (ppbv)	Initial Calibration %Relative Standard Deviation	Initial Calibration Verification/Laboratory Control Sample (%Recovery)	Precision Limits (Max. Relative Percent Difference)
1,1,2,2-Tetrachloroethane	0.5	30%	70 - 130	≤ 25
1,1,2-Trichloroethane	0.5	30%	70 - 130	≤ 25
1,1-Dichloroethane	0.5	30%	70 - 130	≤ 25
1,1-Dichloroethene	0.5	30%	70 - 130	≤ 25
1,2,4-Trichlorobenzene	2.0	30%	70 - 130	≤ 25
1,2,4-Trimethylbenzene	0.5	30%	70 - 130	≤ 25
1,2-Dibromoethane (EDB)	0.5	30%	70 - 130	≤ 25
1,2-Dichlorobenzene	0.5	30%	70 - 130	≤ 25
1,2-Dichloroethane	0.5	30%	70 - 130	≤ 25
1,2-Dichloropropane	0.5	30%	70 - 130	≤ 25
1,3,5-Trimethylbenzene	0.5	30%	70 - 130	≤ 25
1,3-Dichlorobenzene	0.5	30%	70 - 130	≤ 25
1,4-Dichlorobenzene	0.5	30%	70 - 130	≤ 25
Benzene	0.5	30%	70 - 130	≤ 25
Bromomethane*	5.0	30%	70 - 130	≤ 25
Carbon Tetrachloride	0.5	30%	70 - 130	≤ 25
Chlorobenzene	0.5	30%	70 - 130	≤ 25
Chloroethane	2.0	30%	70 - 130	≤ 25
Chloroform	0.5	30%	70 - 130	≤ 25
Chloromethane	5.0	30%	70 - 130	≤ 25
α-Chlorotoluene (Benzyl Chloride)	0.5	30%	70 - 130	≤ 25
cis-1,2-Dichloroethene	0.5	30%	70 - 130	≤ 25
cis-1,3-Dichloropropene	0.5	30%	70 - 130	≤ 25
Dichloromethane	5.0	30%	70 - 130	≤ 25
Ethylbenzene	0.5	30%	70 - 130	≤ 25
Freon 11 (Trichlorofluoromethane)	0.5	30%	70 - 130	≤ 25
Freon 113 (Trichlorotrifluoroethane)	0.5	30%	70 - 130	≤ 25
Freon 114	0.5	30%	70 - 130	≤ 25
Freon 12 (Dichlorodifluoromethane)	0.5	30%	70 - 130	≤ 25
Hexachlorobutadiene	2.0	30%	70 - 130	≤ 25
m,p-Xylene	0.5	30%	70 - 130	≤ 25
Methyl Chloroform (1,1,1-Trichloroethane)	0.5	30%	70 - 130	≤ 25
o-Xylene	0.5	30%	70 - 130	≤ 25
Styrene	0.5	30%	70 - 130	≤ 25
Tetrachloroethene	0.5	30%	70 - 130	≤ 25
Toluene	0.5	30%	70 - 130	≤ 25
trans-1,3-Dichloropropene	0.5	30%	70 - 130	≤ 25
Trichloroethene	0.5	30%	70 - 130	≤ 25

Analyte	**Reporting Limit (ppbv)**	**Initial Calibration %Relative Standard Deviation**	**Initial Calibration Verification/Laboratory Control Sample (%Recovery)**	**Precision Limits (Max. Relative Percent Difference)**
Vinyl Chloride	0.5	30%	70 - 130	≤ 25
1,3-Butadiene	0.5	30%	70 – 130	≤ 25
1,4-Dioxane	2.0	30%	70 – 130	≤ 25
2-Butanone (Methyl Ethyl Ketone)	2.0	30%	70 – 130	≤ 25
2-Hexanone	2.0	30%	70 – 130	≤ 25
4-Ethyltoluene	0.5	30%	70 – 130	≤ 25
4-Methyl-2-Pentanone (MIBK)	0.5	30%	70 – 130	≤ 25
Acetone	5.0	30%	70 – 130	≤ 25
Bromodichloromethane	0.5	30%	70 – 130	≤ 25
Bromoform	0.5	30%	70 – 130	≤ 25
Carbon Disulfide	2.0	30%	70 – 130	≤ 25
Cyclohexane	0.5	30%	70 – 130	≤ 25
Dibromochloromethane	0.5	30%	70 – 130	≤ 25
Ethanol	2.0	30%	70 – 130	≤ 25
Heptane	0.5	30%	70 – 130	≤ 25
Hexane	0.5	30%	70 – 130	≤ 25
Isopropanol (2-Propanol)	2.0	30%	70 – 130	≤ 25
Methyl t-Butyl Ether (MTBE)	0.5	30%	70 – 130	≤ 25
Tetrahydrofuran	0.5	30%	70 – 130	≤ 25
trans-1,2-Dichloroethene	0.5	30%	70 – 130	≤ 25
2,2,4-Trimethylpentane	0.5	30%	70 – 130	≤ 25
Cumene	0.5	30%	70 – 130	≤ 25
Propylbenzene	0.5	30%	70 – 130	≤ 25
3-Chloroprene	0.5	30%	70 – 130	≤ 25
Naphthalene**	2.0	40%	60 – 140	≤ 25
TPH (Gasoline) or NMOC (Hexane/Heptane)***	25	One Point Calibration	NA	≤ 25

4 Sampling Sites

Marcellus gas wells at the various stages of development will be selected for this project. WVDEP will contact the natural gas developers to establish site access. Once these locations are selected by the WVDEP, the site will be visited prior to sampling to determine the location where each sampler is to be placed. Up to four mobile WAMS sites for particulate, hydrocarbons, VOC's, light and noise monitoring will be co-located. At least one site will be placed with the DOE mobile laboratory. Factors to be considered for placement of the sampling equipment in order of priority include:

1. The sampling equipment should be placed a minimum of 625 feet from the drill rig or center of the drill pad if the drill rig is not in place

2. The sites selected for placing sampling equipment should be a minimum of 10 meters from the nearest drip line and when possible have no foliage between the drill pad site and the sample location.
3. At least one WAMS will be collocated with the NETL mobile unit.
4. Any occupied residence within 250 meters of the center of the drill pad will be selected as a sampling location, if permission can be obtained from the landowner.
5. Starting directly downwind in the dominant wind direction, one mobile site should be placed every 90 degrees (**Figure 1**), if possible, and still meet priorities 1 through 4.

Figure 1 depicts the arrangement of samplers at the well-sites. The equipment will be visually inspected at least once during the sampling period. **Table 2** summarizes the field testing activities and schedule.

Direct-reading total dust monitors will be used at every WAMS location with pre-weighed attached 37 mm PVC filters for radiation sampling. Noise and light measurements will be taken at all WAMS locations. MiniRae and SUMMA canisters will be used at all WAMS locations but the base station location and calibrated (zero and span) at the start of sampling and again once during the week for monitoring of hydrocarbons and HCs. The NETL mobile unit has the ability to monitor for up to 56 VOC species. The NETL mobile unit will also be used to monitor PM10, PM2.5, the HC species, and a suite of criteria air pollutants.

Figure 1: Sampler Arrangements at Well Sites

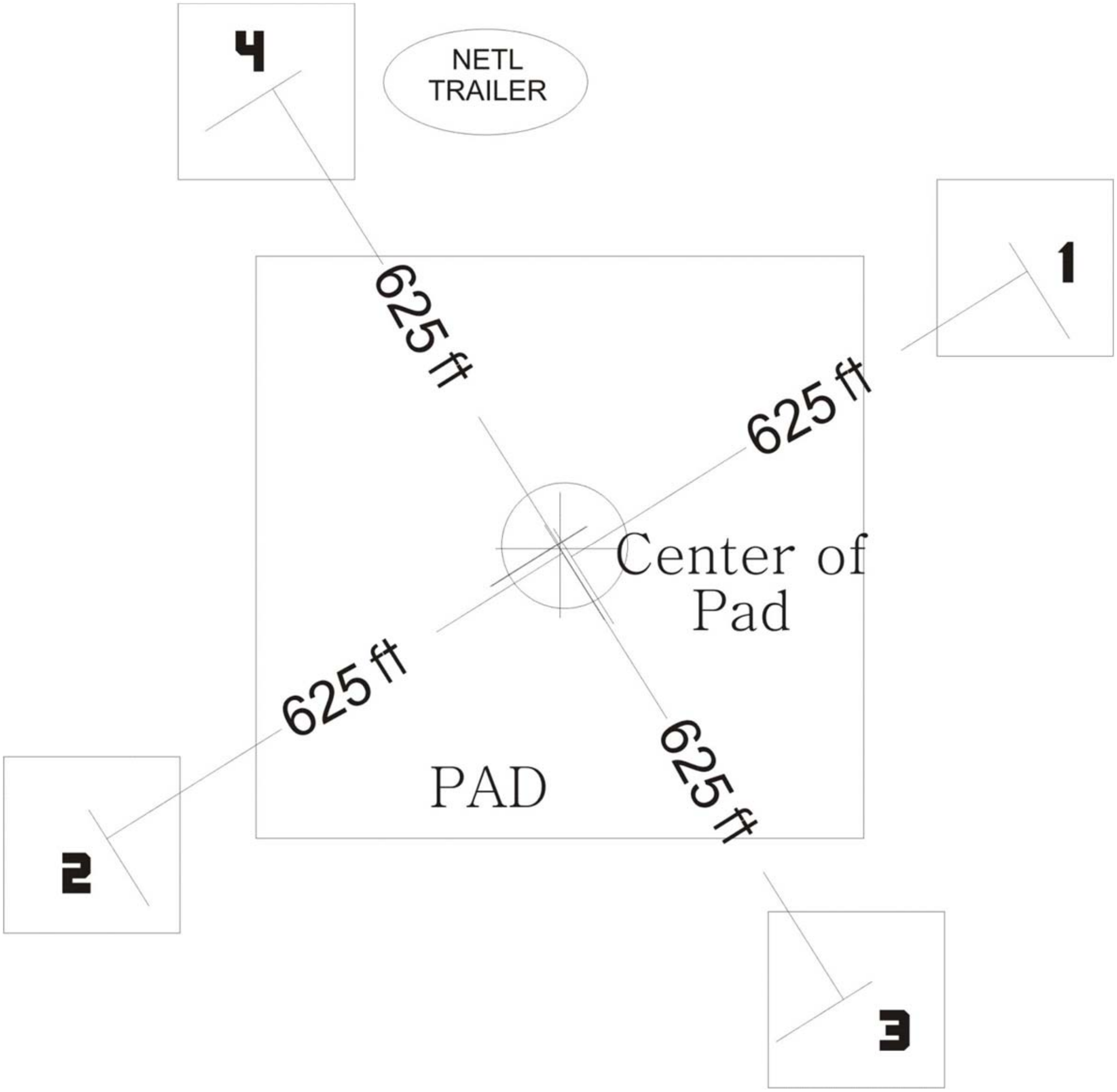


Figure 1. Typical arrangement of WAMS stations around drill pad. The distances noted are the optimum distances (taken from the center of the drill pad) the samplers will be placed. Circumstances may dictate lesser or greater distances be used. At least one station will be located with the NETL sampling trailer.

Table3: Summary of Field Sampling Activities

Day of Field Period	Activity
1	• Load and transport all equipment and supplies • Scout sampling site for placement of equipment • Set up of equipment and begin sampling
2-6	• Daily continuous sampling • Daily calibration of photo-ionization detectors • Daily visual/check of equipment • Recover Summa canisters (Thursday & Sunday)
7	• Complete Sampling • Take down of equipment from location

5 Field Sampling Methods

As shown in **Table 1,** various field sampling methods will be used for this study. Brief descriptions of these methods are given below. An example chain of custody form for Air Toxics LTD is included in **Appendix B**. Summa canisters will be stored and shipped as required to Air Toxics LTD to meet EPA standards.

5.1 General Equipment List for Field Sampling

1. 9 WAMS units in Pelican waterproof cases each with 160 W of solar power and consisting of:
    a. 4 MiniRae PID devices
    b. 5 Extech Sound Dataloggers
    c. 5 Extech Light meters
    d. 4 TSI Dusttrack Monitors
    e. 5 -130 AmpHour Marine Batteries
    f. 5 radio transceivers
    g. 1 laptop computer
6. Up to 8 Summa canisters per Drilling Location
7. Isobutylene(100ppm) and zero air for calibration of PIDs
8. Personal Protective Equipment
9. Tools for set-up
10. Field notebooks or data sheets

5.2 Wireless Air Monitoring Systems (WAMS) & Data Logging

WAMS

Natural gas drilling operations are generally found in remote and inaccessible areas. Naturally, this harsh topography makes environmental monitoring difficult. The solution to overcoming this obstacle is the use of wireless telemetry of data from battery operated monitors. West Virginia University has developed a system, known as WAMS, using small modules that can be attached to battery operated environmental monitors to send data distances of up to 25 km between stations. These modules operate using either directional or omni directional antennas to relay data between monitors and back to a central bas station where the data is stored and displayed on a computer. Hills, trees and other obstacles can shorten the transmission range and a practical test of the system is required to determine the best arrangement of monitors and types of antennas to maximize the system's operating range.

These devices are not recognized by the EPA for environmental air monitoring because they provide information that is not directly translatable to the mass monitoring methods the EPA currently uses. These monitors, instead, provide a relative measure of the amount of pollutants suspended in the air. They are useful for determining trends rather than absolute amounts. Each monitor is self-sufficient, drawing power from an attached solar panel and storing it in an accompanying lead acid battery. The monitors are expected to operate 24 hours per day for a 6 day period, transmitting data once every minute. Each monitor will be housed in a weather proof case for the duration of the sampling. A base station will need to be located in a nearby enclosed structure with available power to operate the data collection computer.

The Wireless Air Monitoring System (WAMS) consists of a field sampler and a base station. The field sampler itself is comprised of a water-tight case in which the electronic components are placed and a solar panel to provide power to the electronics when there is sufficient sunlight and to charge a battery to operate the system when the sunlight is insufficient. The unit has no need for other sources of power and can thus be used remotely.

The base station consists of a transceiver attached to a computer. Both the base station and the field unit have antennas attached. The antennas may be either directional or omni-directional depending upon the application as described below. A Pelican type 1560 case is used to protect the electronic components. The size was chosen based on the size of the battery. This case is the smallest one into which the battery and remaining components would fit. The battery is a 12 volt 130 amp-hour marine-type lead acid battery. The connection from the solar charge controller wires is connected to the battery with bolt on clamps. The battery is then also connected to the regulator to assure a constant 12 volt output. The remaining room in the case is filled with foam padding which prevents components (especially the approximately 30 pound battery) from moving around during transport. A 0.25 inch hole is drilled into the case for the air intake to the environmental monitor. A 1.5 inch hole is also drilled in the side of the case for the electrical connection between the solar panel and the solar charge controller. A single, standard, three-prong, 120 volt, 15 amp, female, electrical connector is placed in the hole and sealed with silicone around the edges. There are two solar panels connected to each case. Each panel has an 85 - 100 watt output and is connected to the equipment case with a 6 gage wire to a two-prong male electrical connector. The heavy gauge wire, less than 24 inches in length, is necessary to help prevent power loss.

Data Logging

The WAMS units transmit the environmental monitoring data using data logging technology. Data logging is the process of measuring and recording either physical or electrical parameters over time. A data logger works by converting physical phenomenon into electrical signals (i.e. voltage or current). The electronic signals are then converted or digitized into what is known as binary data. The data can be stored in the device and/or sent wirelessly from a transmitter to a receiver. If the data is transmitted, it could be received a remote computer which can be located on or off site. Off-site the data transfer is accomplished with the aid of data logging software and a modem. The offsite computer is equipped to store the transmitted data in a file for data analysis.

5.3 Particulate Matter

Particulate (PM2.5) sampling will be continuous, with one data point per minute. This monitor will be cleaned and calibrated as recommended by the manufacturer prior to being used in the field. The Dust Track monitor is a direct-reading instrument that measures particles using the scattering from a beam of a light that shines through the sample stream, much like a beam of sunlight illuminating dust floating in the air. The value that the monitor gives is directly proportional to the mass of the dust, but the unit must be calibrated for the actual density of the particulate to give a value that will match a filter sample. The Dust Track will be operated at a flow rate of 3.0 liters per minute with the PM 2.5 classifier attached. Dust Track readings will be post-corrected by applying a correction factor to the average six day mass value to account for the density of the dust. The concentration from the TEOM (which measures actual mass) will be correlated with the Dust Track reading in $\mu g/m^3$ from the WAMS site co-located with the trailer, a linear regression equation derived and the Dust Track readings will be corrected using that linear regression equation to give a density corrected value to the one per minute values to all of the Dust Tracks at that drill site. This density correction procedure will be repeated for all subsequent drill sites.

5.4 Hydrocarbons

Hydrocarbons will be measured continuously once per minute using a photo-ionization detector (PID) (MiniRae 2000), calibrated at the start of sampling and daily during the course of the sampling using a 100 ppm isobutylene in air calibration gas supplied with the MiniRae. Once these units are calibrated, they will monitor hydrocarbons every minute for the entire study period. The data will be transmitted electronically via data logging, which was described above. The calibration procedure for this unit is noted below:

Calibration Procedure for MiniRae:

Calibrating the MiniRAE 2000 monitor is a two-point process using “fresh air “ and the standard reference gas (also known as span gas). First a “Fresh air” calibration, which contains no detectable VOC (0.0 ppm), is used to set the zero point for the sensor. Then a standard reference gas that contains a known concentration of a given gas is used to set the second point of reference.

Step 1: Fresh Air Calibration

This procedure determines the zero point of the sensor calibration curve. To perform a fresh air calibration, use the calibration adapter to connect the MiniRAE 2000 to a “fresh” air source (i.e. Tedlar bag). The “fresh” air is clean dry air without any organic impurities. If such an air cylinder is not available, any clean ambient air without detectable contaminant or a charcoal filter can be used.

1. The first sub-menu shows: “Fresh air Cal?”

2. Make sure that the MiniRAE 2000 is connected to one of the “fresh” air sources described above.

3. Press the **[Y/+]** key, the display shows “zero in progress” followed by “wait..” and a countdown timer.

4. After about 15 seconds pause, the display will show the message “zeroed… reading = X.X ppm…” Press any key or wait about 20 seconds, the monitor will return back to “Fresh air Calibration?” submenu.

Note: The charcoal filter has a check box so that user can mark off a box each time the filter has been used. The charcoal filter should be replaced after 20 calibrations.

Step 2: Span Gas Calibration

This procedure determines the second point of the sensor calibration curve for the sensor. A cylinder of standard reference gas (span gas) fitted with a 500 cc/min. flow-limiting regulator or a flow-matching regulator is the simplest way to perform this procedure. Choose the 500 cc/min. regulator only if the flow rate matches or slightly exceeds the flow rate of the instrument pump. Alternatively, the span gas can first be filled into a Tedlar Bag, or delivered through a demand-flow regulator. Connect the calibration adapter to the inlet port of the MiniRAE 2000 Monitor, and connect the tubing to the regulator or Tedlar bag. Another alternative is to use a regulator with >500 cc/min flow but allow the excess flow to escape through a T or an open tube. In the latter method, the span gas flows out through an open tube slightly wider than the probe, and the probe is inserted into the calibration tube.

Before executing a span calibration, make sure the span value has been set correctly.

1. Make sure the monitor is connected to one of the span gas sources described above.

2. Press the **[Y/+]** key at the “Span Cal?” to start the calibration. The display shows the gas name and the span value of the corresponding gas.

3. The display shows “Apply gas now!” Turn on the valve of the span gas supply.

4. Display shows “wait.... 30” with a count down timer showing the number of remaining seconds while the monitor performs the calibration.

5. To abort the calibration, press any key during the count down. The display shows “Aborted!” and return to “Span Cal?” sub-menu.

6. When the count down timer reaches 0, the display shows the calibrated value.

Note: The reading should be very close to the span gas value.

7. During calibration, the monitor waits for an increased signal before starting the countdown timer. If a minimal response is not obtained after 35 seconds, the monitor displays “No Gas!” Check the span gas valve is on and for lamp or sensor failure before trying again.

8. The calibration can be started manually by pressing any key while the “Apply gas now!” is displayed.

9. After a span calibration is completed, the display will show the message “Span Cal Done! Turn Off Gas.”

10. Turn off the flow of gas. Disconnect the calibration adapter or Tedlar bag from the MiniRAE 2000 Monitor.

11. Press any key and it returns back to “Span Gas Cal?”

5.5 Hydrocarbons (HCs)

Over the course of the 6 day sampling period for each site, two Summa canisters will be used at each of the four WAMS locations. A Summa canister is a stainless steel vessel that has its internal surface area specially passivated via the “Summa” process. The “Summa” process chemical deactivation with an electro-polishing step to deactivate the inside of the container to make it inert. Air samples for HCs will be collected in cleaned, evacuated, 6 liter stainless steel SUMMA-type canisters obtained from Air Toxics LTD. The cleaning/evacuation of the canisters will be performed by Air Toxics LTD prior to shipment of the canisters using a series of pressurization/evacuation steps incorporating heat treatment (~ 80 ºC) and humidification of the canisters. The final evacuation will reduce the canister pressure to 10 milliTorr (mTorr). A flow orifice will be installed by the company onto each sampling canister so that time-integrated samples can be collected over a pre-determined time frame. The sample will enter the canister through a high temperature, stainless steel valve. The canister will hold a vacuum for up to 30 days. The valve placed on the canister restricts the flow into the 6.0 liter canister so that it will finish filling at the end of 72 hours, which is the pre-determined sampling time-frame. Within 12 hours of the end of each 72 hour sampling period, the canisters will be sent to Air Toxics LTD for analysis by GC/MS for the chemical species stipulated in TO-15. The HCs that may be speciated are listed in **Table 2**.

5.6 Noise and Light

A noise dosimeter (Extech Sound Level Datalogger) and light meter (Extech SDL 400 Light Meter) will be part of each of the four WAMS locations. The light meter will record data digitally, 24 hours per day. The noise dosimeter will also record 24 hours per day and be downloaded into a digital file at the end of each six day sampling period.

5.7 Radiation

Samples for radiation analysis will be collected on 5 mm polyvinyl chloride filters attach3ed to the Dust Track and operated at 3.0 liters per minute. The samples will optimally be run for 6 days to allow enough material to be collected that analysis can be done.

5.8 NETL Sampling

Collaborating with the Department of Energy's National Energy Technology Laboratory (NETL), a mobile air monitoring laboratory will be provided to serve as storage site for the base station. This mobile unit contains various monitoring instruments (Table 3) to measure methane and carbon isotopes in methane, particulate matter (PM10 and PM2.5), HCs, NOx, O3, SO2, ammonia, organic and elemental carbon, and radon. It is also equipped with a meteorological station to measure temperature, humidity, wind speed and direction and other variables. Data collected by the NETL mobile unit will be analyzed and provided as part of the monitoring results of this study. The PI of this study, Dr. McCawley, will be responsible for assuring that data collected by NETL becomes part of the air sampling data record for this study and will be the contact for all work with the NETL.

Table 3. NETL Mobile Air Monitoring Laboratory Instrumentation

6 Analytical Methods

Standard operating procedures are designed to optimize the accuracy and representativeness of the collected environmental data. In this study, virtually all of the collected data will be obtained using the WAMS system and instrumentation described in **Table 1**. The only parameters that will need to be analyzed are the filters attached to the Dust Track monitors for radiation and the HCs obtained from the Summa canisters. As mentioned prior, the canisters will be analyzed by Air Toxics LTD. Guidelines will be followed for sample collection, packaging, and transport of Summa canisters to maintain the integrity of the samples. Proper chain-of-custody requirements will be adhered. The procedures described below details how the filters and canisters will be analyzed.

6.1 Radiation Analysis

The analysis will be for alpha and beta radiation and will be done by Pace Analytical Laboratories, the same laboratory that will do the radiation analysis for water samples. They will use EPA Method 900.m. This method is applicable to measuring alpha emitters having energies above 3.9 MeV and beta emitters having maximum energies above 0.1 MeV.

6.1 HC Analysis

Summa canister analysis by Air Toxics LTD will follow the analytic standard operating procedures outlined in U.S. EPA Compendium Method TO-15A.[3] An gas chromatographic system equipped with a mass spectrometer (GC/MS) will be used for the analysis of the Method TO-15A VOCs present in the canister samples. The GC, equipped with an autosampler will be used with an preconcentrator that contains cryogenic preconcentration traps. Analytes will be chromatographically resolved on a silica capillary column, 60 m by 0.32 mm inner diameter (i.d.) (1 μm film thickness) using a constant flow rate of 1.2 cubic centimeters per minute (cc/min) of helium as the carrier gas and a sample volume injected of 200 cc. Temperature programming of the GC oven will include an initial ramping from 35 °C to 150 °C at 6 °C/min (5 minute initial hold) and then ramping to 220 °C at 15 °C/minute. The mass spectrometer will be operated in the full scan mode so that all masses are scanned between 35 and 300 atomic mass units (amu) at a rate of 1 scan per 0.4 seconds. The Method TO-15A VOCs will be identified by retention time and by comparison with known standards. The sample mass spectra also will be compared to reference spectra from the NIST mass spectral library. Quantification of the individual analytes will be based upon instrument response to known concentrations from a dilute calibration gas containing the Method TO-15A VOCs (traceable to a certified standard). Under these conditions, the individual VOC detection limits are expected to be approximately 0.1 ppb. Individual VOC concentrations will be reported in ppb averaged over the respective sampling time.

7 Data Management

7.1 Data Collection/Handling

Data will be acquired from electronic transmission (i.e. WAMS units) and from laboratory analysis (i.e. analysis of Summa canister contents by Air Toxics Laboratory LTD). Therefore, these data will be recorded either electronically or on laboratory data sheets. Data from the continuous monitors will be recorded electronically using data loggers and laptop computers. Electronic data will be backed up on external media (e.g., flash drives) and stored separately from the original data. Data from laboratory analysis sheets will be transcribed into a shared database, such as Microsoft Excel 7, for analysis.

Pertinent information, such as times, dates, etc. involved in data collection, and chain of custody forms will be maintained. Other data regarding testing protocols or other pertinent information regarding testing or observations made by field personnel will be recorded in field log books. As needed, data from these forms and record books will be transcribed into electronic databases, such as Microsoft Excel 7, to conduct calculations and statistical analysis. All hardcopy and electronic records including the NETL data will be maintained by the Principal Investigator and will be made available to WV DEP upon request.

7.2 Data Review

The data collected as a result of this study will generally be continuous in nature. The data will be reviewed and cleaned prior to analysis. Potential outliers will also be reviewed; this may include unexplained spikes or zero/negative readings. Any outliers that are identified will be flagged in the raw data files and removed from further data processing activities. A summary of outliers will be discussed in the final report. The data will be averaged to obtain hourly and daily concentrations from each of the WAMS units and Summa canisters. All raw and processed data will be made available to WV DEP upon request.

7.3 Data Comparisons

Several data analyses and comparisons will be made to investigate the concentrations and spatial and temporal variations that characterize the air quality at the well sites. The planned data analyses and comparisons will include at least the following:

- The hourly, daily, and weekly study averages of all measured species will be compiled, summarized, and compared to published regulatory and public health-based standards.

Air quality data from the continuous measurements will be provided in the Study Report. The report will summarize the observed air quality at the well sites; it will also state the outcomes of all data analyses and comparisons conducted. Based on the data analysis, potential health concerns associated with the natural gas development activities will be noted. All conclusions on health effects associated with Air Toxics will be made relative to the information contained in the EPA's Air Toxics Web Site:

(http://www.epa.gov/ttn/atw/toxsource/summary.html) and risk assessments made using the values in Tables 1 and 2 of that web site for the concentration found in any samples of any of the compounds listed in those tables.

Long-term monitoring recommendations will also be included as part of the final report to WVDEP. All raw and processed data will be made available to WVDEP as part of the final reporting activities.

8 Health and Safety

The utmost care will be taken to ensure the safety/health of all field personnel involved in this project. For the field personnel, several aspects of this study will require special attention including:

- Performing work outside during the summer time
- Lifting and moving awkward equipment or materials
- Travel on potentially remote or poorly lit country roads

The following procedures will be followed to minimize risks from these potential hazards.

- To limit the amount of time needed to perform work outside, all field personnel will be involved with the set-up and tear-down activities.
- To avoid accidents while moving awkward equipment or materials, field staff will be encouraged to use appropriate techniques (e.g., lifting with knees bent).
- Four-wheel drive or all-wheel drive vehicles will be used by the field staff during this study to minimize hazards associated with travel on potentially remote and poorly lit roads.
- Field personnel will not access any natural gas site without advanced approval/arrangement by WVDEP.
- Field staff will wear appropriate or required personal protective equipment (PPE) necessary to natural gas well development activity. Minimum PPE requirements include: hardhat, safety glasses, boots, gloves and fire-retardant clothing.
- If some acknowledge hazard/danger exists at the sampling sites during the sampling period, the field staff will exit without delay. WVDEP will be notified immediately of the situation.
- WVU field staff will attend site safety meetings and follow all safety procedures in place in the event an incident or accident occurs.

9 References

1. U.S. EPA, Compendium Method IO-3.1: Selection, Preparation and Extraction of Filter Material, U.S. Environmental Protection Agency, Office of Research and Development, EPA/625/R-96/010a, June 1999.

2. U.S. EPA, Compendium Method IO-3.4: Determination of Metals in Ambient Particulate Matter using Inductively Coupled Plasma Mass Spectrometry (ICP/MS), U.S. Environmental Protection Agency, Office of Research and Development, EPA/625/R-96/010a, June 1999.

3. U.S. EPA, 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), U.S. Environmental Protection Agency, Office of Research and Development, EPA/625/R-96/010b, January 1999.

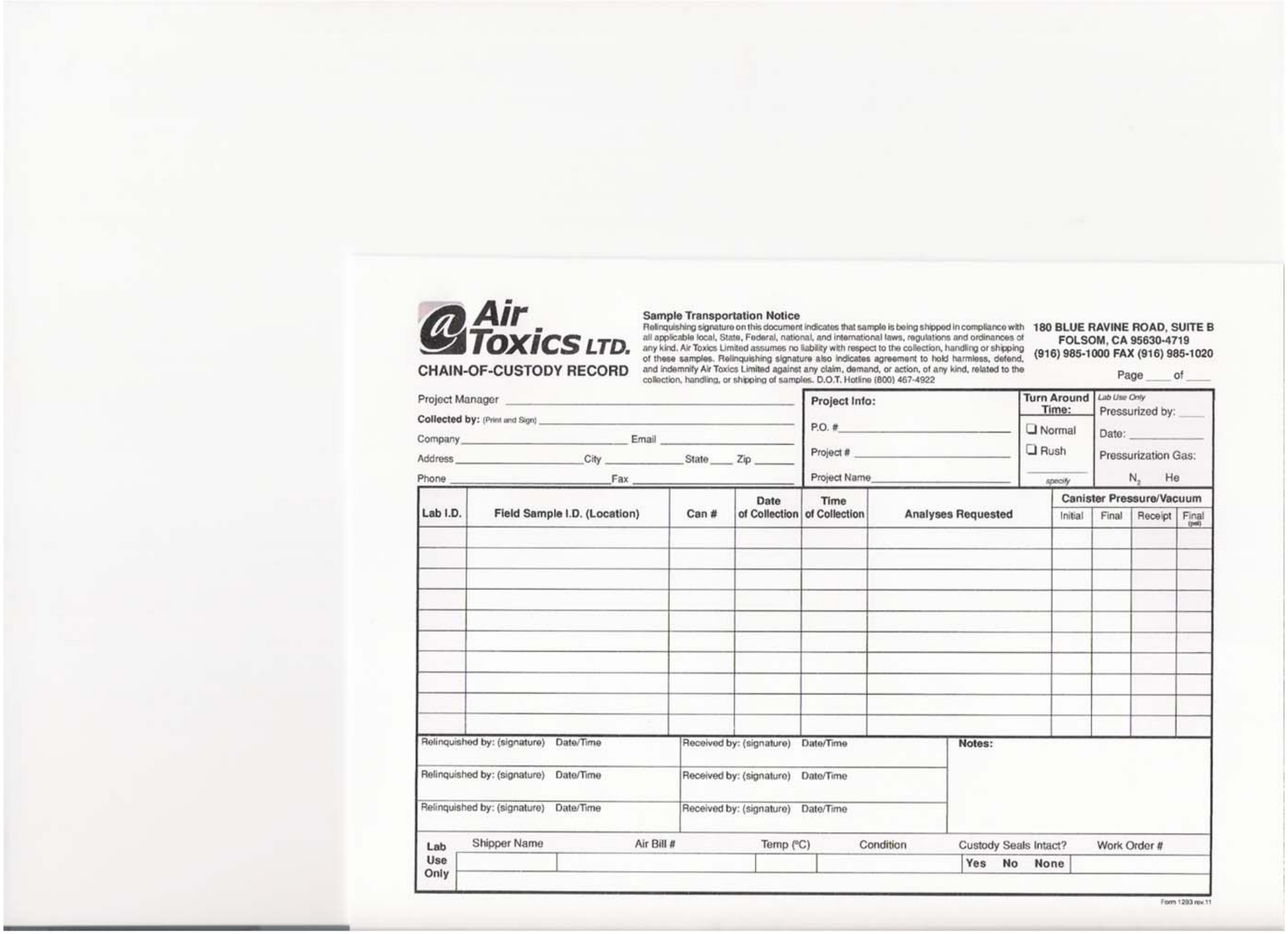
4. U.S. EPA, Exploration, Development, and Production of Crude Oil and Natural Gas Sampling Plan and Sampling Quality Assurance/Quality Control: Appendix G, U.S. Environmental Protection Agency, Office of Research and Development, EPA/530-SW-87-005, January, 1987.

5. Battelle, West Virginia Air Quality Assessment Near a Surface Mine Blasting Operation, January 2011.

Appendix A: WVU Project Staff

Name	Role	Email	Telephone	Address
Dr. Michael McCawley	Principal Investigator	mmccawley@hsc.wvu.edu	304-293-8042	PO Box 9190 Morgantown, WV 26506
Shilpa Gadala	Electrical Engineer		304-293-8042	PO Box 9190 Morgantown, WV 26506
Alyson Johnson	Graduate Assistant		304-293-8042	PO Box 9190 Morgantown, WV 26506

Appendix B: Sample Chain of Custody Form for Air Toxics LTD



Air Toxics LTD.

CHAIN-OF-CUSTODY RECORD

Sample Transportation Notice

Relinquishing signature on this document indicates that sample is being shipped in compliance with all applicable local, State, Federal, national, and international laws, regulations and ordinances of any kind. Air Toxics Limited assumes no liability with respect to the collection, handling or shipping of these samples. Relinquishing signature also indicates agreement to hold harmless, defend, and indemnify Air Toxics Limited against any claim, demand, or action, of any kind, related to the collection, handling, or shipping of samples. D.O.T. Hotline (800) 467-4922

180 BLUE RAVINE ROAD, SUITE B
FOLSOM, CA 95630-4719
(916) 985-1000 FAX (916) 985-1020

Page ____ of ____

Project Manager ______________________
Collected by: (Print and Sign) ______________________
Company ______________________ Email ______________________
Address ______________________ City ____________ State ____ Zip ______
Phone ______________________ Fax ______________________

Project Info:
P.O. # ______________________
Project # ______________________
Project Name ______________________

Turn Around Time:
☐ Normal
☐ Rush
________ specify

Lab Use Only
Pressurized by: ____
Date: ____________
Pressurization Gas:
N_2 He

Lab I.D.	Field Sample I.D. (Location)	Can #	Date of Collection	Time of Collection	Analyses Requested	Canister Pressure/Vacuum			
						Initial	Final	Receipt	Final (psi)

Relinquished by: (signature) Date/Time	Received by: (signature) Date/Time	**Notes:**
Relinquished by: (signature) Date/Time	Received by: (signature) Date/Time	
Relinquished by: (signature) Date/Time	Received by: (signature) Date/Time	

Lab Use Only	Shipper Name	Air Bill #	Temp (°C)	Condition	Custody Seals Intact?	Work Order #
					Yes No None	

Form 1293 rev.11