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
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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

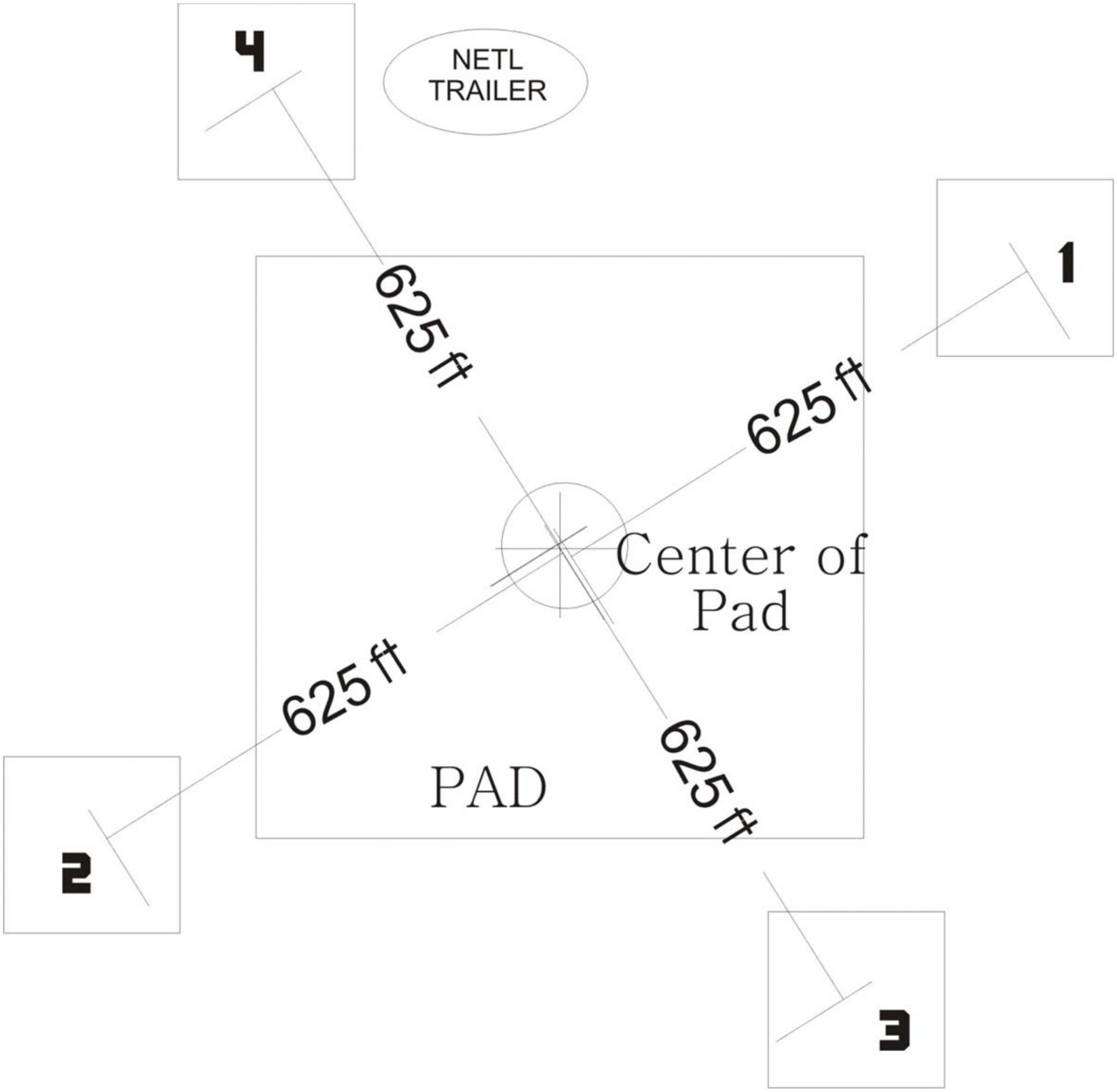

Figure 1. Typical arrangement of WAMS stations around drill pad. The distances noted are the optimum distances (taken from the center of the drill pad) the samplers will be placed. Circumstances may dictate lesser or greater distances be used. At least one station will be located with the NETL sampling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