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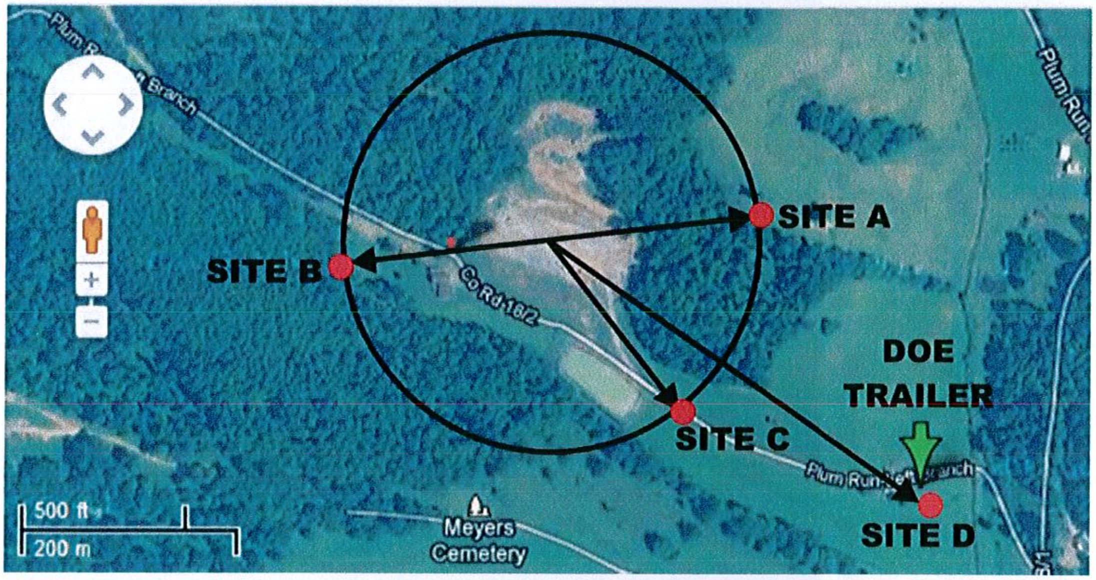

Figure 4.1b. Satellite photo of the Donna pad showing sampling sites (A,B,C, D) as red dots and location of DOE trailer as shown by the green arrow. Black circle is the 625 foot setback distance.

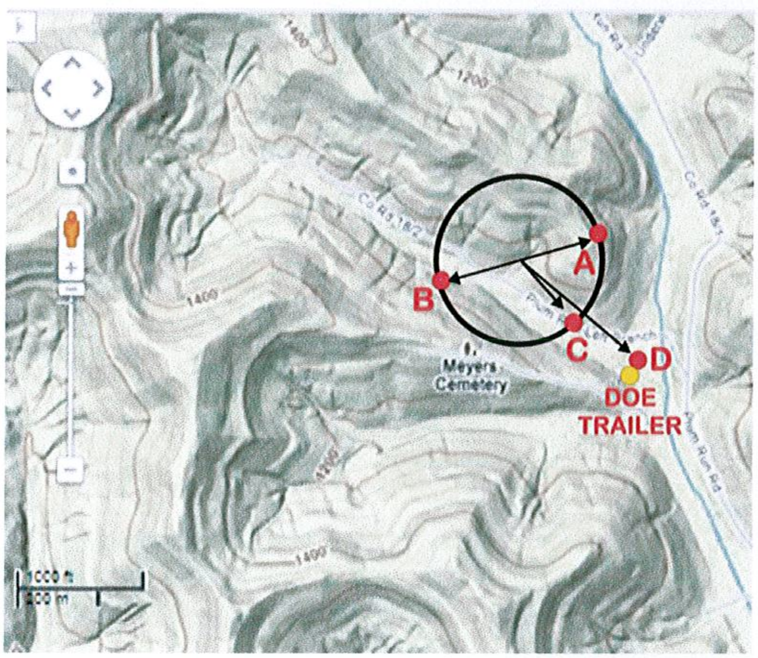

Fig 4.1c Terrain map of the Donna pad showing sampling sites (A,B,C, D) as red dots and location of DOE trailer as a yellow dot. Black circle is the 625 foot setback distance.

dep

west virginia department of environmental protection

Office of Oil and Gas
601 57th Street, S.E.
Charleston, WV 25304
Phone: (304) 926-0450
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Earl Ray Tomblin, Governor
Randy C. Huffman, Cabinet Secretary
www.dep.wv.gov

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.

[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

5

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
Division of Air Quality
601 57th Street, SE
Charleston, WV 25304

Submitted by:

Michael McCawley, PhD
West Virginia University
School of Public Health
PO Box 9190
Morgantown, WV 26506

May 3, 2013

6

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.

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40-55 dB - Adverse health effects are observed among the exposed population. Many people have to adapt

8

Pits and Impoundments Final Report

For

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

Prepared for:

Office of Oil and Gas
West Virginia Department of Environmental Protection
601 57th Street, SE
Charleston, WV 25304

Submitted by:

John Quaranta, Ph.D., P.E.
Richard Wise, M.S.C.E., E.I.T.
Andrew Darnell, M.S.C.E, E.I.T.

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West Virginia University
PO Box 6103
Morgantown, WV 26506-6103

December 17, 2012

9

sites were selected for evaluation, but prior to the completion of the project, one additional site was added, making 15 total sites visited.

Field evaluations and soil property testing were used to ascertain and document the safety and structural integrity of the pits and impoundments. The field observations were performed using an evaluation form developed for the project to maintain consistent data collection across all sites. The evaluation form contained the following sections: permit information, field as-built construction and site conditions, observation checklist, and site operations and maintenance questionnaire. Using this approach, researchers made visual observations of the site and the surrounding environment, documenting items of concern with Global Positioning System (GPS) referenced pictures. Field soil samples were collected using hand shovels at various locations on each site and were subsequently tested in the WVU CEE geotechnical laboratory in accordance with the American Society for Testing and Materials (ASTM) Standards. The specific laboratory soil property tests performed were field moisture content, grain-size distribution and hydrometer analysis, Atterberg limits, specific gravity, Standard Proctor, hydraulic conductivity, and shear strength. Of the 15 sites evaluated, six were chosen for *in situ* field compaction density and moisture content testing. The laboratory testing and the data collected in the field were compiled and served as the basis for the results of this study.

Results of Permit Reviews

The permit reviews of the candidate sites revealed that the permit files for 10 sites constructed prior to the enactment of §22-6A lacked geotechnical investigation reports. The permits for the three sites constructed after the enactment of §22-6A contained this information. Additionally, the permit information for two sites was not provided by the WVDEP at the time of the evaluation.

An analysis of the permits compared the permitted storage volumes with the storage volume requirements of dams as regulated by the WVDEP (WVCSR §22-14 & WVCSR §47-34). No sites were found to meet the requirements of a dam. However, the large quantities of water could be a potential hazard to the public and the environment if a failure were to occur because of the ridge-top location of several sites.

Results of Field Evaluation

At the start of each field evaluation, measurements of the pit or impoundment as-built construction were made and compared to the permitted design. Findings identified discrepancies between the permit and as-built dimensions for eight sites. The measurement discrepancies included larger as-built volume capacities, smaller crest berm widths, and steeper upstream and

(10)

downstream slopes than the permitted design specified. The significance of these deficiencies is summarized as follows:

- The as-built dimension discrepancies result in the pit or impoundment holding larger volumes of flowback water or freshwater than the permitted design.
- The differences in the crest berm width distances and the steepness of the slopes can negatively affect the safety and slope stability of the pit or impoundment.
- These deficiencies introduce uncertainty into the safety of the pit or impoundment due to unknown storage volumes and stresses on the foundation, slopes, and geomembrane liner systems.

The analysis of the field evaluations consisted of ranking the field data into a numeric scoring system. Using this method, a numerical score was obtained, and each site was ranked in terms of the field anomaly severity and frequency of occurrence. This score was based on a total of 100%, and the results ranged from a low of 59% to a high of 88%.

Results of Laboratory and Field Geotechnical Evaluation

Results of the laboratory testing indicated that none of the post §22-6A sites had soil conforming to the soil types specified by the WVDEP Design and Construction Standards for Centralized Pits. Of the remaining twelve pre §22-6A sites, only one site met the soil standards. However, the laboratory testing indicated that the soil types present at the sites may be suitable for the construction of pits and impoundments if proper compaction is achieved.

An assessment of the soil properties in the available site geotechnical investigations revealed several discrepancies when compared with laboratory data. The soil properties contained within the permit were characteristic of the top layers of excavation, which are not necessarily representative of the soils at the bottom of the excavation. Thus, the engineering properties of the soil tested during the excavation may not be consistent with the properties of the fill material used during construction. Furthermore, the foundation and slope designs of the structure may include soil properties that are not representative of site soil, which can contribute to post-construction issues. For the six sites where *in situ* field compaction density and moisture content testing was performed, the field data was compared with laboratory Standard Proctor density data. This analysis consisted of ascertaining the distribution of field data points in relation to the optimum compaction range for each site. The following areas of concern were identified:

- Three of the six sites had field data points within the optimum compaction range. Two of the sites had 14% of data points in compliance, and the other site had 22% of data points in compliance.

- The field data from the remaining three sites had 0% compliance with the optimum compaction range.
- Based on a total of 70 samples taken across all six sites, only six data points were within the acceptable range (8.5%).
- As a result of insufficient soil compaction density, the slopes of the pits and impoundments have a higher potential of developing subsurface erosion and elevated pore water pressures leading to slope instability.

In summary, the recurring problems and deficient areas from the field evaluations include the following:

- insufficient compaction density of site soil and excessive soil lift height
- surface soil erosion
- slope movement
- buried woody debris
- seepage and wet zones
- geomembrane liner deficiencies
- unsupported pipes

Overall, these deficiencies reflect a lack of adherence to the best management practices set forth in the West Virginia Erosion and Sediment Control Field Manual, as well as poor construction knowledge. These construction practices combined with a lack of field quality control and assurance are indicators of the source and frequency of the problems observed across all evaluated sites.

Site Operations and Infrastructure Evaluation

The Site Operations and Infrastructure Evaluation consisted of a questionnaire for the WVDEP Office of Oil and Gas Inspector and on-site company representative, although the company personnel present at the time of the field visit may or may not have been the principle site inspectors. The responses obtained for each question were compiled for analysis, and trends were established across all sites. The results indicate that none of the WVDEP inspectors had any formal training related to pits and impoundments inspection. In addition, no standardized method was used by the inspectors, which resulted in the use of the state regulations as an inspection guide. Consequently, the inspectors only targeted the readily-apparent problems such as slips and slides, while not recognizing, or fully understanding, the smaller problem indicators.

Another area of concern was that the responses from WVDEP inspectors and company representatives revealed that there was no set frequency for site inspections to be performed. The actual frequency of inspections, by the WVDEP or the company, varied from every three

Figure 4: Settlement Cracks in Anchor Trench

Figure 4 shows settlement cracks on the crest of the impoundment around the anchor trench. The significance of this observation is that these cracks can serve as pathways for water to infiltrate and saturate the soil. The wet soil adds weight to the top of the slopes and is a recognized mechanism for surface water infiltration leading to slope instability.

Figure 5: Bulges on Downstream Face

In Figure 5, the bulges underneath the liner indicate slope movements on the downstream face. The slope movements are evidence that the slope is no longer stable and that the ability for the structure to retain fluid has been compromised.

Figure 6: Slope Movement into Impoundment

Figure 6 depicts a slide into the impoundment. This slide is putting strain on the liner, endangering the anchor trench and increasing the tear potential for the liner. Additionally, the slide is just below the site access road and is thereby threatening the integrity of the roadway. The displacement of the liner threatens the entire containment system due to an increased potential for tears or punctures leading to impounding water loss.

Figure 11: Downstream Slope Movement into Ditch

Figure 11 depicts a downstream slope movement, as evidenced by the bulges underneath the liner and the movement of the grade stakes. A stream is located at the top right-hand corner of the picture. Thus, the slope movement is encroaching on the stream and threatening to disrupt the natural ecosystem.

16

Figure 12: Surface Erosion at Mills-Wetzel

One problem area observed at all sites was surface erosion, found in Question 1 on the observation checklist. This problem was the most observed and, hence, received the lowest average ranking of 2.00. Figure 12 shows an example of the surface erosion present at the Mills-Wetzel Freshwater Impoundment. The gully shown formed rapidly, as evidenced by the lack of vegetation. The formation of the gully may be a result of excessive slope length or angle on the downstream face. The West Virginia Erosion and Sediment Control Field Manual states that terracing shall be constructed for each additional 50 vertical feet of slope and shall be a minimum of 10 feet wide. This best management practice was not followed on the Mills-Wetzel site.

Figure 13: Slope Movement at SHL 4

Question 2 on the checklist related to the prevalence of slope movements on the downstream face. Two sites were found to have moderate slope movements, and severe slope movements were present on six sites. Figure 13 shows a severe slope movement on the SHL 4 Centralized Pit. Above the slope movement, there was a significant amount of standing water on the crest, and signs of seepage were found in the form of wet soil inside the depleted soil zone. Slope movements are a problem because the structural integrity of the downstream face has been compromised. This slope failure is an example of a shallow face failure with characteristics including a pronounced scarp, zones of depletion and accumulation, and flanks defining the width of the failed soil, which is approximately where the WVU field personnel are located.

Figure 15: Seepage at Pribble

Seepage and wet zones (addressed in Question 6) were problem areas found at all but two sites. Figure 15 shows a seepage area on the downstream face of the Pribble Freshwater Impoundment. Due to the lack of vegetation on the slope, the area where the grass is growing depicts seepage and moving water on the slope. Thus, water is being transported through the soil, which may lead to instability in this area.

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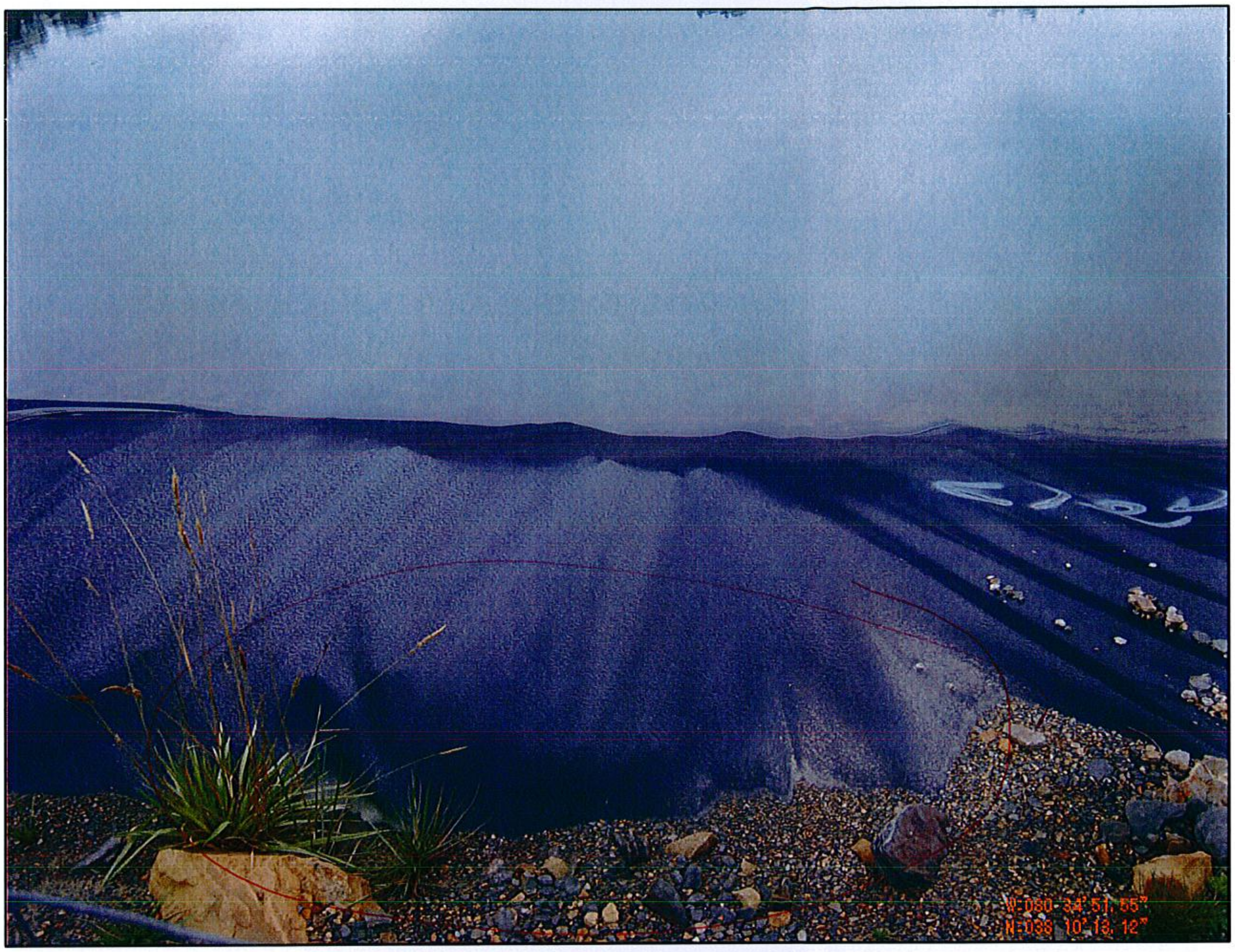

Figure 16: Liner Bulges at MWV

Another area of concern was bulges, tears, or holes in the liner, as indicated by Question 8. This problem was present at every site evaluated, with seven sites ranked as Low, four ranked as Moderate, and three ranked as High. Figure 16 depicts a liner stretched over an improperly prepared slope at the MWV Large Water Storage Pond 1. The underlying rock pressing on the liner and the strain caused by the bulges have a high likelihood to create tears or punctures in the liner and threaten the integrity of the containment system.

There were several construction deficiencies out of compliance with the West Virginia Erosion and Sediment Control Field Manual, and the WVDEP Design and Construction Standards for Centralized Pits. However, none of the deficiencies indicated imminent pit or impoundment failure potential at the time of the site visit. The problems identified do constitute a real hazard and present risk if allowed to progress, but all problems that were observed in the field could be corrected. Future construction, if done in conformance with the WVDEP guidelines, should pose minimal risk.

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
Division of Air Quality
601 57th Street, SE
Charleston, WV 25304

Submitted by:

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PO Box 9190
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May 3, 2013

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.

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

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.

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40-55 dB - Adverse health effects are observed among the exposed population. Many people have to adapt

26

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.

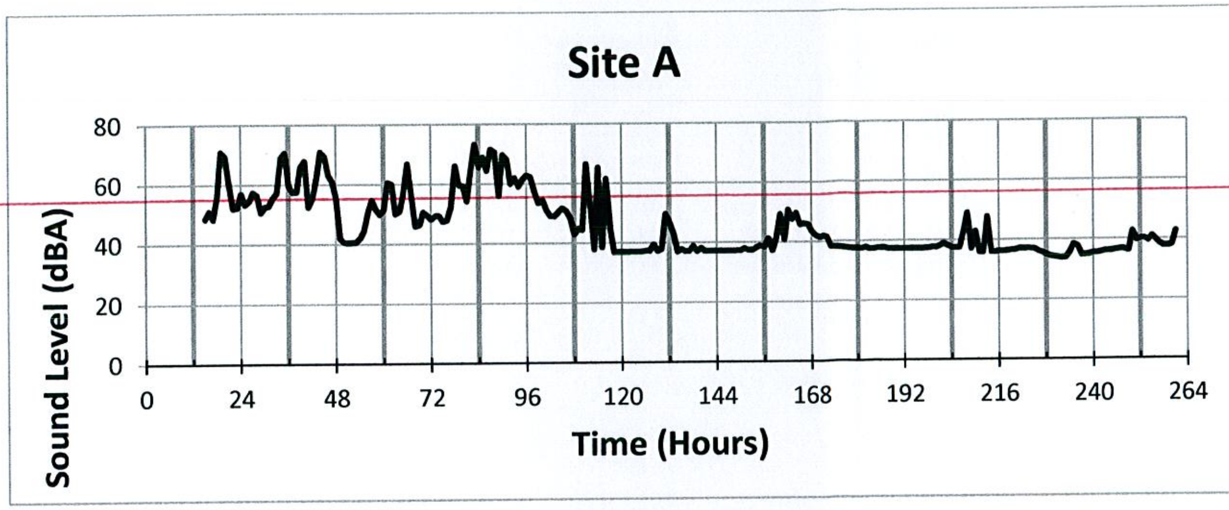
More recently, WHO - Europe (2011) has reported on the burden of disease as a result of the growing concern of the public, environmental health agencies, and policy makers in Europe, in terms of disability-adjusted life-years (DALYs) lost due to environmental noise.[13] The findings suggest that sleep 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.

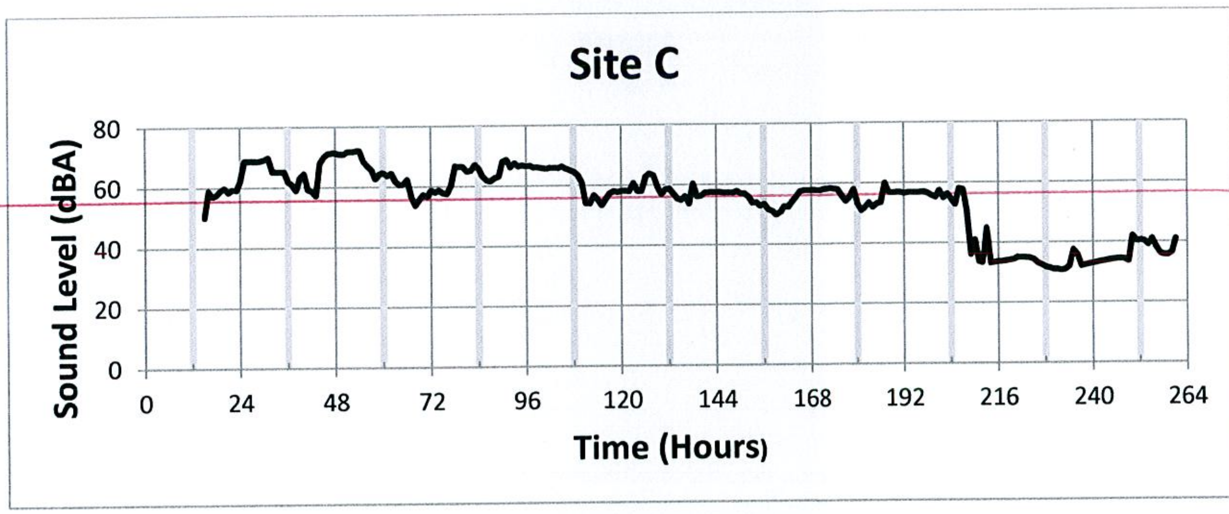
D3. Disturbance of Sleep Patterns by Light

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.





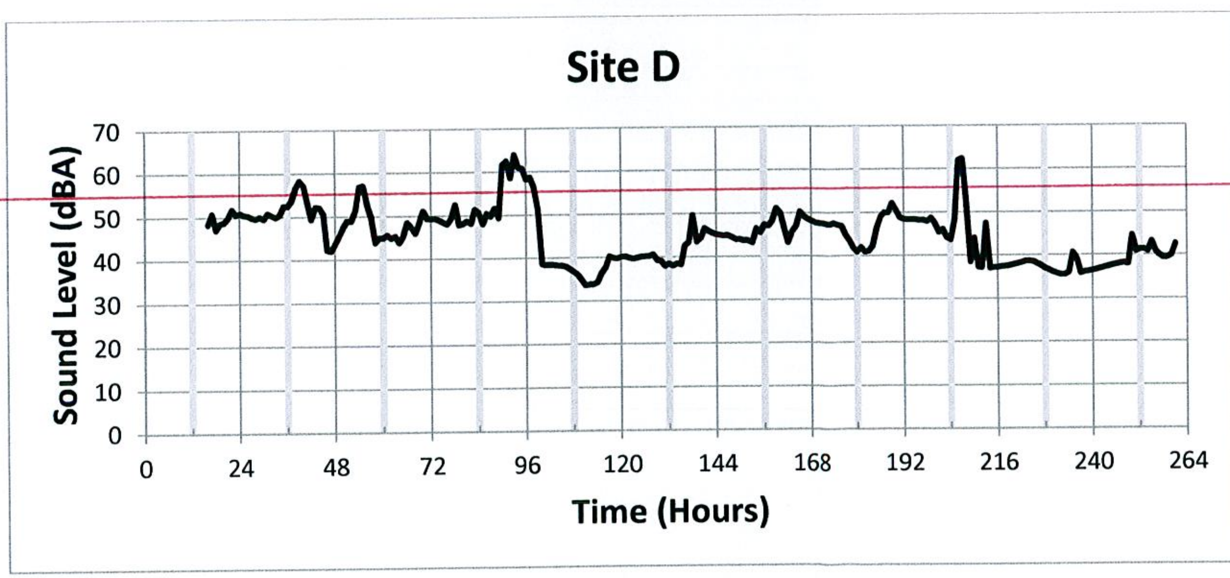


Figure 4.1j. Noise levels for Sites A, C, D at Donna Pad. Hours 0, 24, 48 etc. are midnight. Heavy, vertical lines are noon for each day.

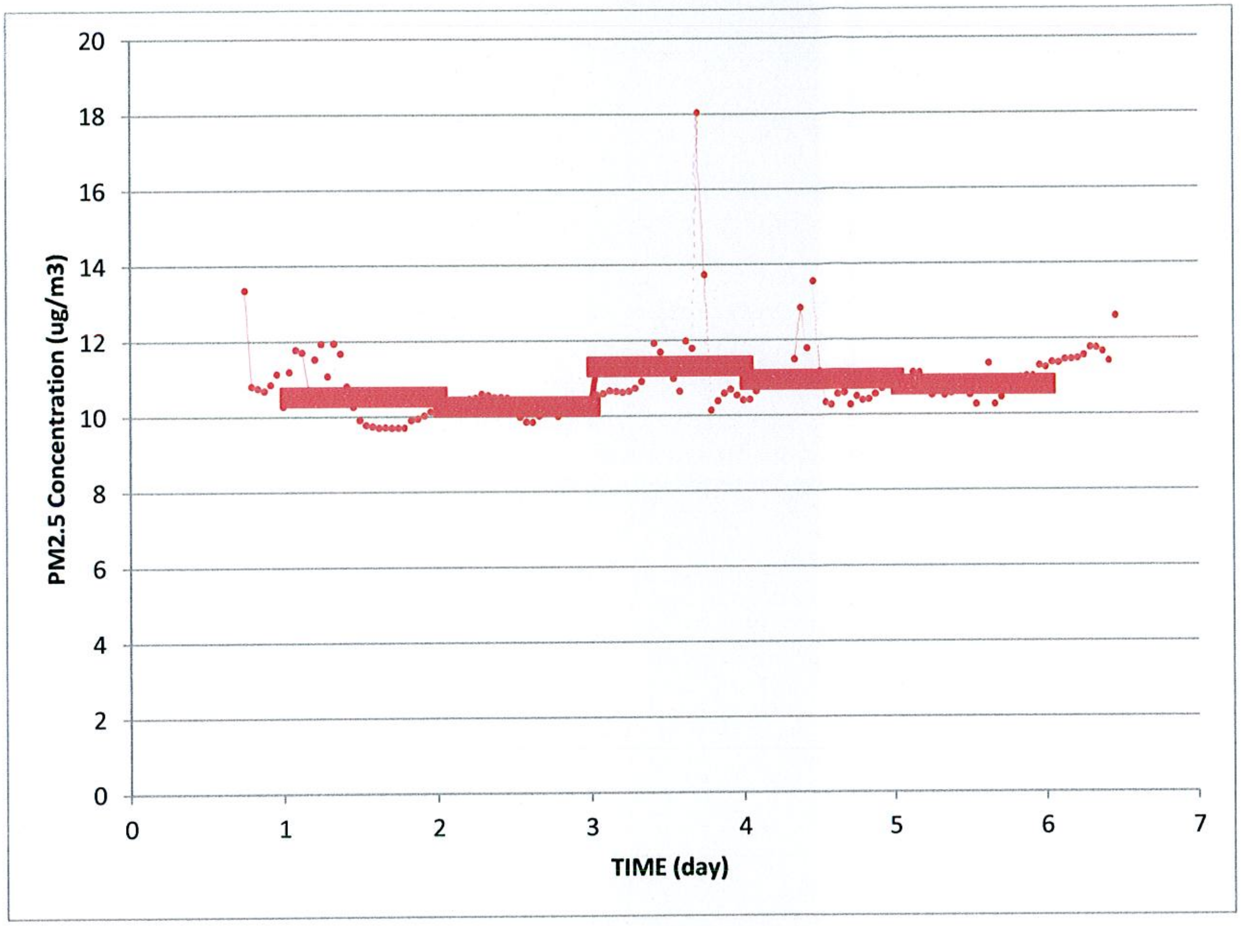
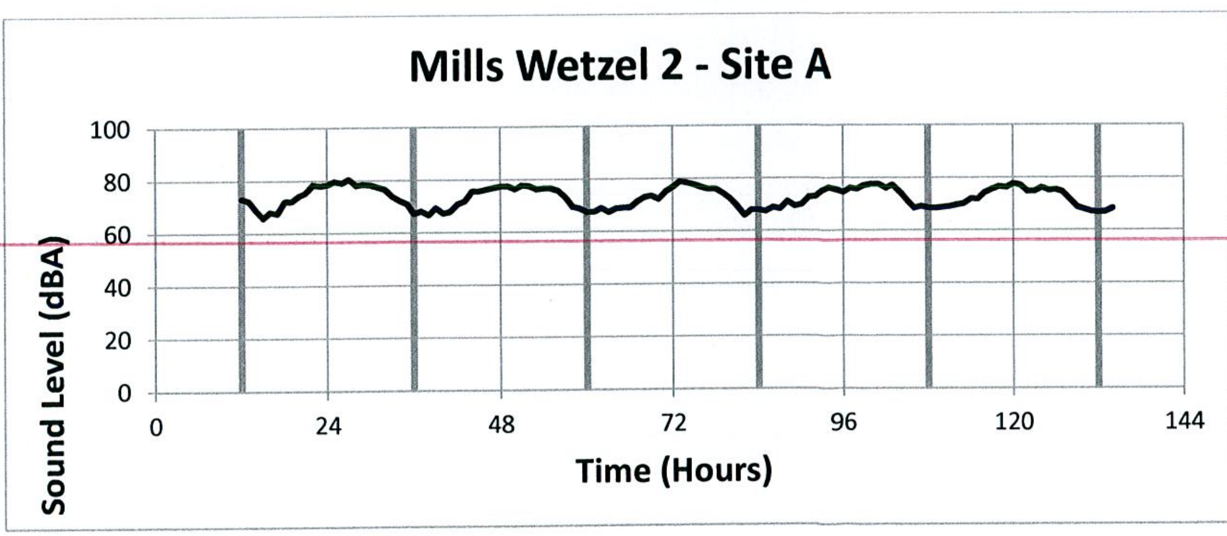


Figure 4.3k. MILLS-WETZEL PAD 2, PM 2.5 Dust Track 8/15-23/2012 data for Site C, with hourly data points and 24 hour averages represented as bar lines.

4.3.8 Noise Results



(24)

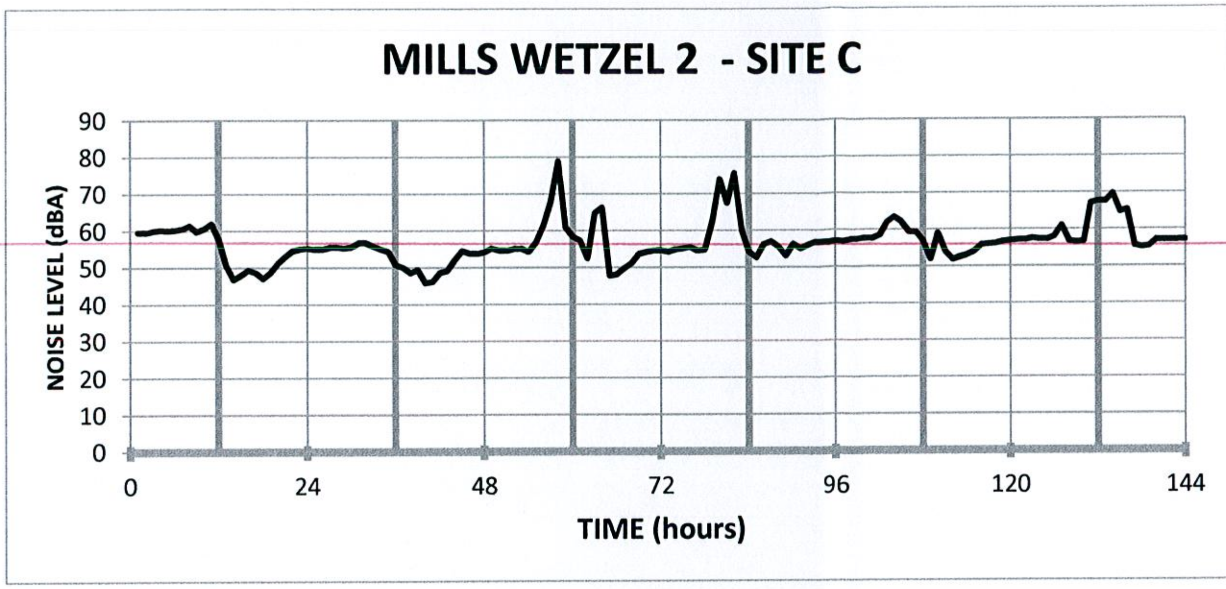


Figure 4.3l. Noise levels averaged 56 for site A and 73 for site C with an average level of 65 dBA with a standard deviation of 10 for the two sites together. Hours 0, 24, 48 etc. are midnight. Heavy, vertical lines are noon for each day.

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.

30

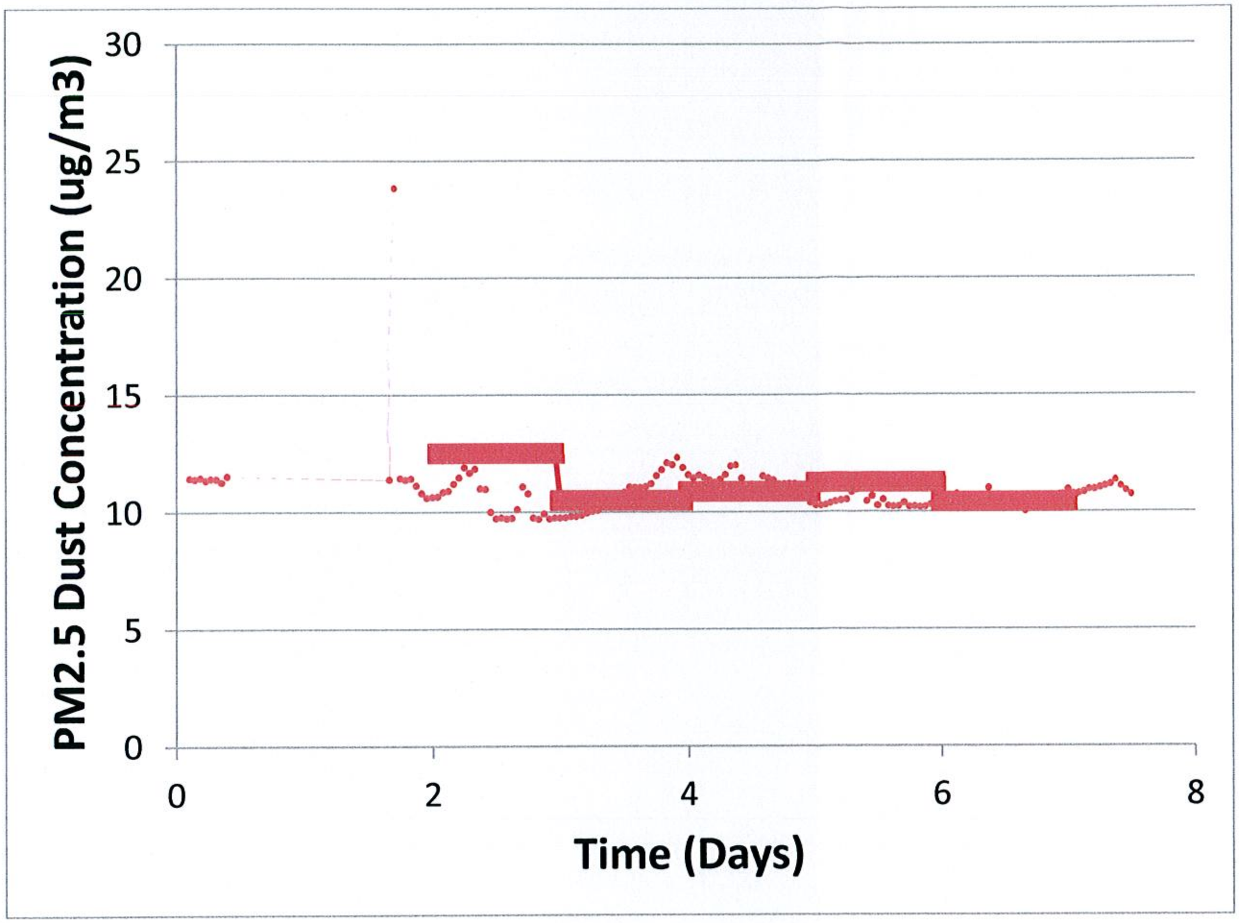
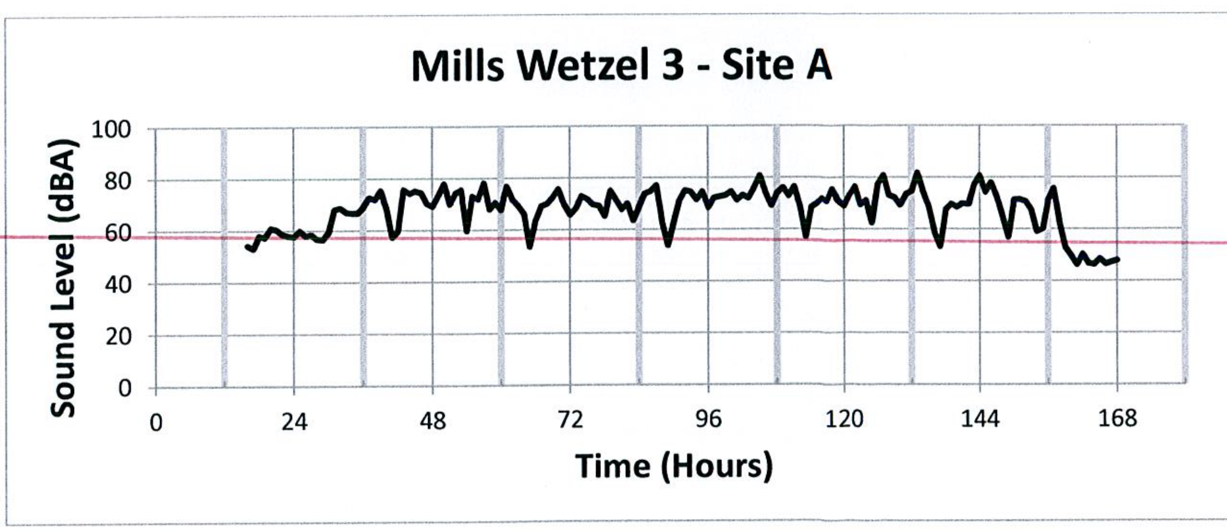


Figure 4.4d. MILLS-WETZEL PAD 3, PM 2.5 Dust Track 8/25-31/2012 data for Site C, with hourly data points and 24 hour averages represented as bar lines.

4.4.8 Noise Results



31

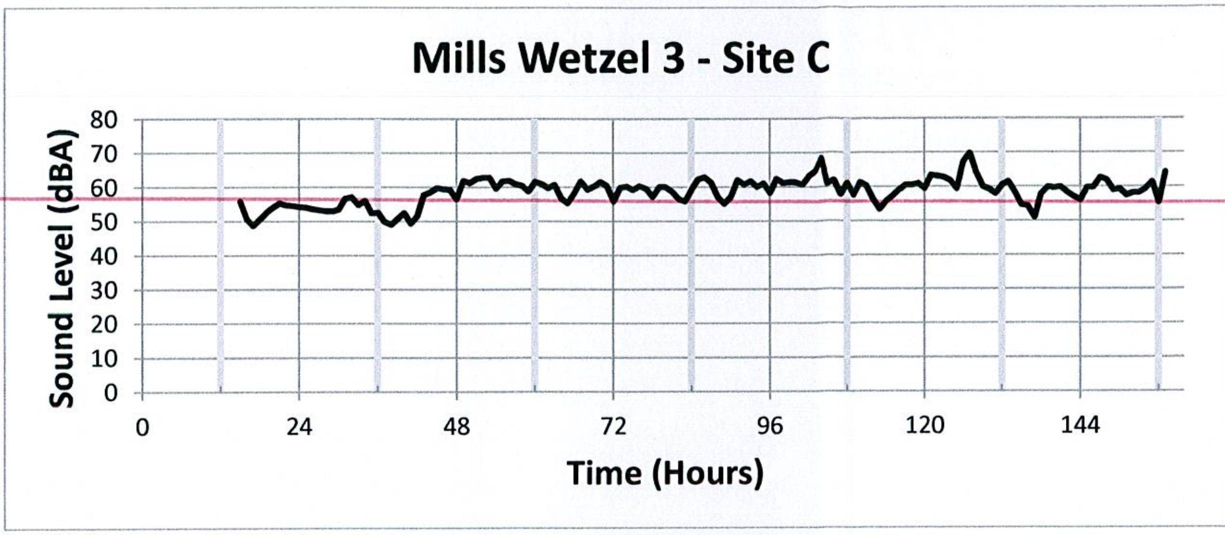


Figure 4.4e. Noise results for site A averaged 58 dBA and for Site C 69 dBA with an average between both sites of 64 dBA. Hours 0, 24, 48 etc. are midnight. Heavy, vertical lines are noon for each day.

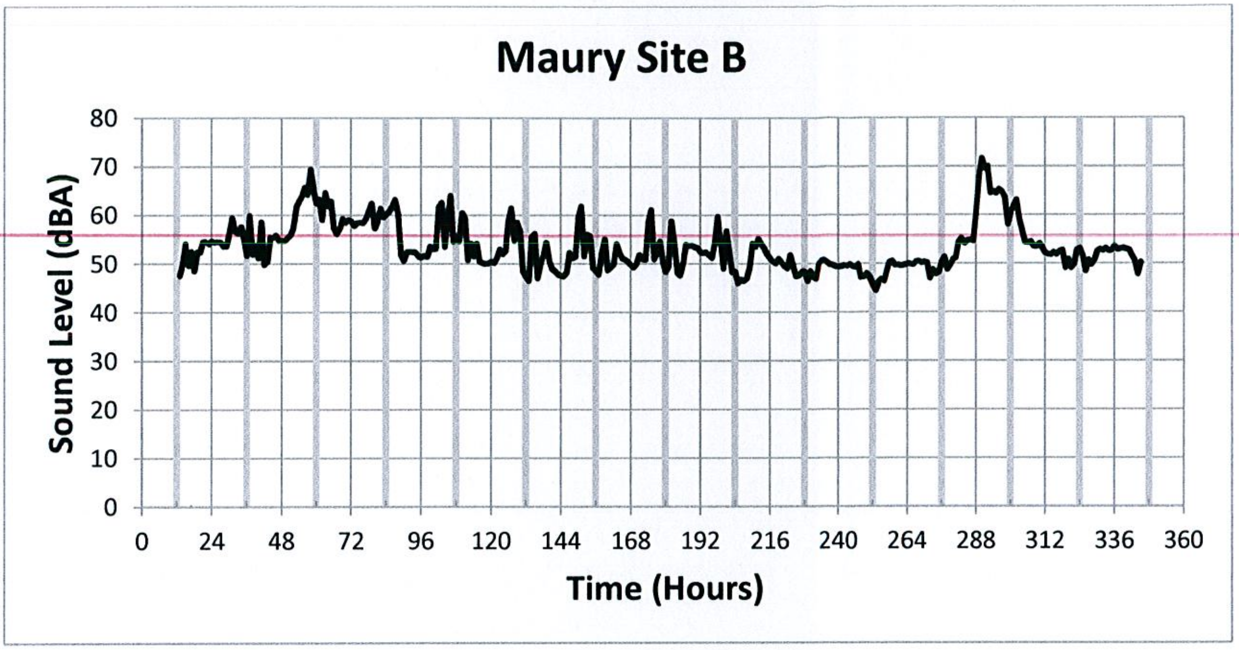
4.5 Maury pad (Hydraulic Fracturing and Flowback)

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**.

32

4.5.8 Noise Results



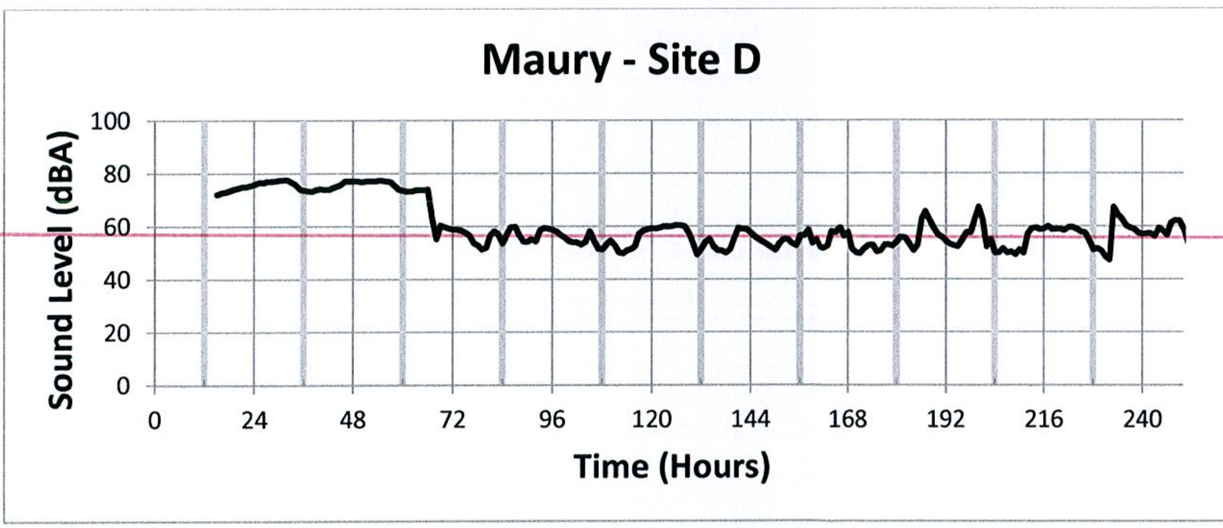


Figure 4.5u. Noise levels averaged 55 dBA for site B and 61 dBA for site D and 58 dBA overall. Hours 0, 24, 48 etc. are midnight. Heavy, vertical lines are noon for each day.

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.

4.6.8 Noise results

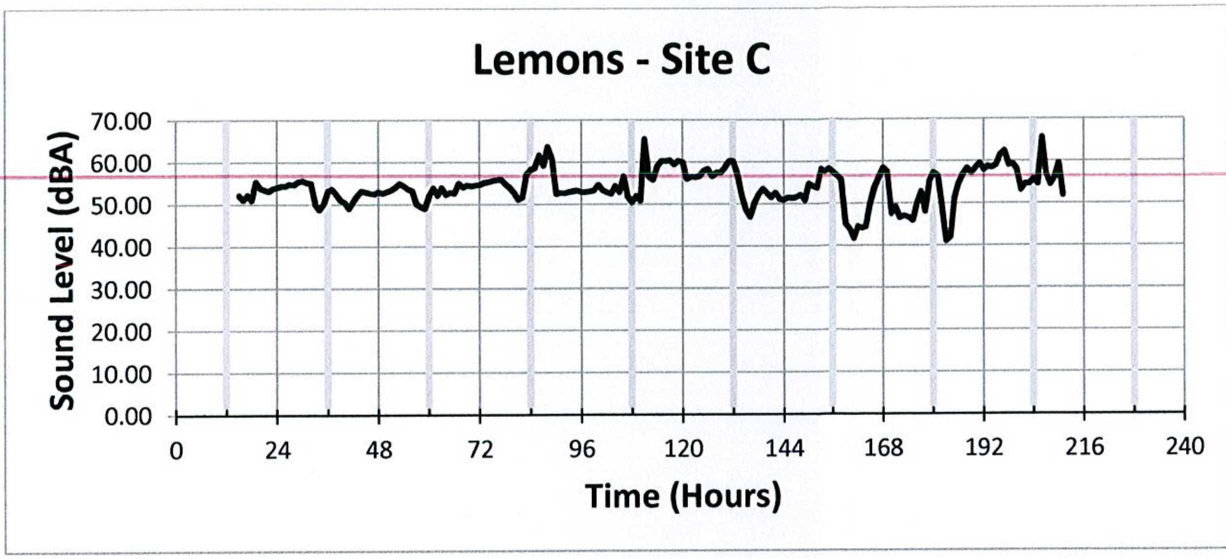


Figure 4.6n. Noise results for the period 9/20-30/12 for Site C averaged 54 dBA. Site A had battery problems. Hours 0, 24, 48 etc. are midnight. Heavy, vertical lines are noon for each day.

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.

34