



**DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF AIR QUALITY, TOXICS PROTECTION BRANCH**

AIR TOXICS ANALYTICAL SUPPORT TEAM

**FIRE AT EVANS ROAD
BEAUFORT COUNTY, NC**

June 1- August 4, 2008

ATAST Response # 08011

**Final Report
January 27, 2009**

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Acronyms

AEGL	Acute Exposure Guidelines
ATAST	Air Toxics Analytical Support Team
ATSDR	Agency for Toxic Substances and Disease Registry
EBAM™	Electronic Beta Attenuation Monitor
EMEG	Environmental Media Evaluation Guide
EQ	Environmental Quality (facility)
Cal EPA	California Environmental Protection Agency
CaREL	California Acute Reference Exposure Levels
CO	carbon monoxide
DAQ	Division of Air Quality
DENR	Department of Environment and Natural Resources
ERPG	Emergency Response Planning Guidelines
GC/MS	gas chromatograph/mass spectrophotometer
Hazmat	Hazardous Materials
HCN	hydrogen cyanide
H ₂ S	hydrogen sulfide
ICP	Incident Command Post
LEL	lower explosive limit
MAML	mobile air monitoring laboratory
NC	North Carolina
NCDFR	NC Division of Forest Resources
NH ₃	ammonia
NO	nitric oxide
NO ₂	nitrogen dioxide
PH ₃	phosphine
PM	particulate matter
ppb	part per billion
ppm	part per million
REL	Reference Exposure Level
SCAPA	Department of Energy Subcommittee on Consequence Assessment and Protective Actions
SO ₂	sulfur dioxide
TEEL	Temporary Emergency Exposure Limits
UAT	Urban Air Toxics Network
VOC	Volatile Organic Compound

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1.0 ABSTRACT

The North Carolina Division of Air Quality (DAQ) responded to requests for emergency monitoring to assess air quality resulting from a fire in the Pocosin National Wildlife Refuge in the counties of Washington, Hyde, and Tyrrell, NC. DAQ staff took measurements at 6 locations using continuous, real-time monitors for total fine and ultrafine particulate matter (PM₁₀ and PM_{2.5} respectively), total volatile organic compounds (VOCs), oxygen levels, and carbon monoxide (CO). DAQ also measured meteorological parameters at heights of 2 and 10 meters. Results of these various methods showed that the primary pollutant of concern was the PM_{2.5} concentration that were a constituent of the smoke plume from the fire. These levels on occasion did exceed the National Ambient Air Quality (NAAQ) Standard of 35 ug/m³. This standard is a 24 hr average concentration and as such was compared to the monitored running 24 hr average during the event and to the daily average in this report. In addition to particulate and carbon monoxide concentrations, EPA and DAQ personnel also performed air measurements for elemental mercury at various locations and found no levels above EPA health standards.

2.0 INTRODUCTION

On Sunday June 1, 2008, a fire began on privately owned land adjacent to the Pocosin National Wildlife Refuge, the source of which was attributed to a lightning strike. The initial location of the fire was a wooded area northwest of Gall Road, Belhaven, NC (Hyde County). The North Carolina Division of Forest Resources (NCDFR) began working the fire at approximately 1:30 p.m. Sunday. By 3 p.m. Monday June 2, the fire area had roughly tripled to 1700 acres. As with most large fires, shifting winds continually changed the burn patterns and rates. In addition to burning surface vegetation, the peat soil in this area also acted a fuel source for the fire and in many areas the fire began to burn underground. This type of fire tends to produce large amounts of smoke as it is primarily a smoldering fire and is notoriously difficult to extinguish. The inability to extinguish the fire was exacerbated by the relatively remote location. Only one nonresidential structure was threatened, and few others are in the immediate proximity. On June 3, 2008, Charles Ray Spencer, Chairman of the Hyde County Commissioners, declared a State of Emergency for Hyde County, specifically in the Grassy Ridge and Ponzer areas, large amounts of smoke were being generated by this fire.

As the fire progressed large amounts of smoke covered a large area of Eastern NC, the North Carolina Division of Air Quality's Air Toxics Analytical Support Team (ATAST) was requested to respond by the Department of Environment and Natural Resources (DENR) Secretary's office

on June 11, 2008. Eight¹ ATAST members departed at approximately 12:00 p.m. and arrived at approximately 2:30 p.m. at the NC DENR Washington Regional Office (WaRO) in Washington, NC for their initial debriefing on the situation and to receive information on the fire site and location of the Incident Command Post (ICP) in Ponzer, NC. The ICP was under the direction of the NCDFR, the lead responding agency for DENR. Staff from the WaRO² were attached to the ATAST to assist with various field tasks and to act as liaison to the ICP and to provide any needed administrative or technical assistance. Additional ATAST staff³ was dispatched to the scene as relief personnel at various times throughout the deployment from June 11 until June 19, 2008.

The deployment and operation of assets as well as the data collection from those assets are described in the operational narrative contained in Appendix A. In addition to the operational narrative, the final daily report filed on August 4 which describes the daily operational reports from June 11 until cessation of air monitoring on August 4, 2008 can be found in Appendix B.

3.0 AMBIENT AIR MONITORING

ATAST Emergency air monitoring is of most benefit when:

- Air-monitoring activities can aid in characterizing the degree of the hazard facing responders and the public during initial stages of response
- It can provide technical assistance to responders with tools such as air dispersion modeling, chemical review or meteorology.
- The team can coordinate with and provide technical support for decision-making or for information purposes.
- It can provide ongoing evaluation of air quality as conditions change to provide air monitoring data to the incident commander so that decisions can be made regarding public safety and potential exposures.

ATAST's objective was to determine the level of specific air contaminants in selected areas that were representative of potential exposures to the public. Those areas were primarily communities located downwind and/or proximate to the fire and the smoke plume. The six primary sampling locations are shown in Figure 1.

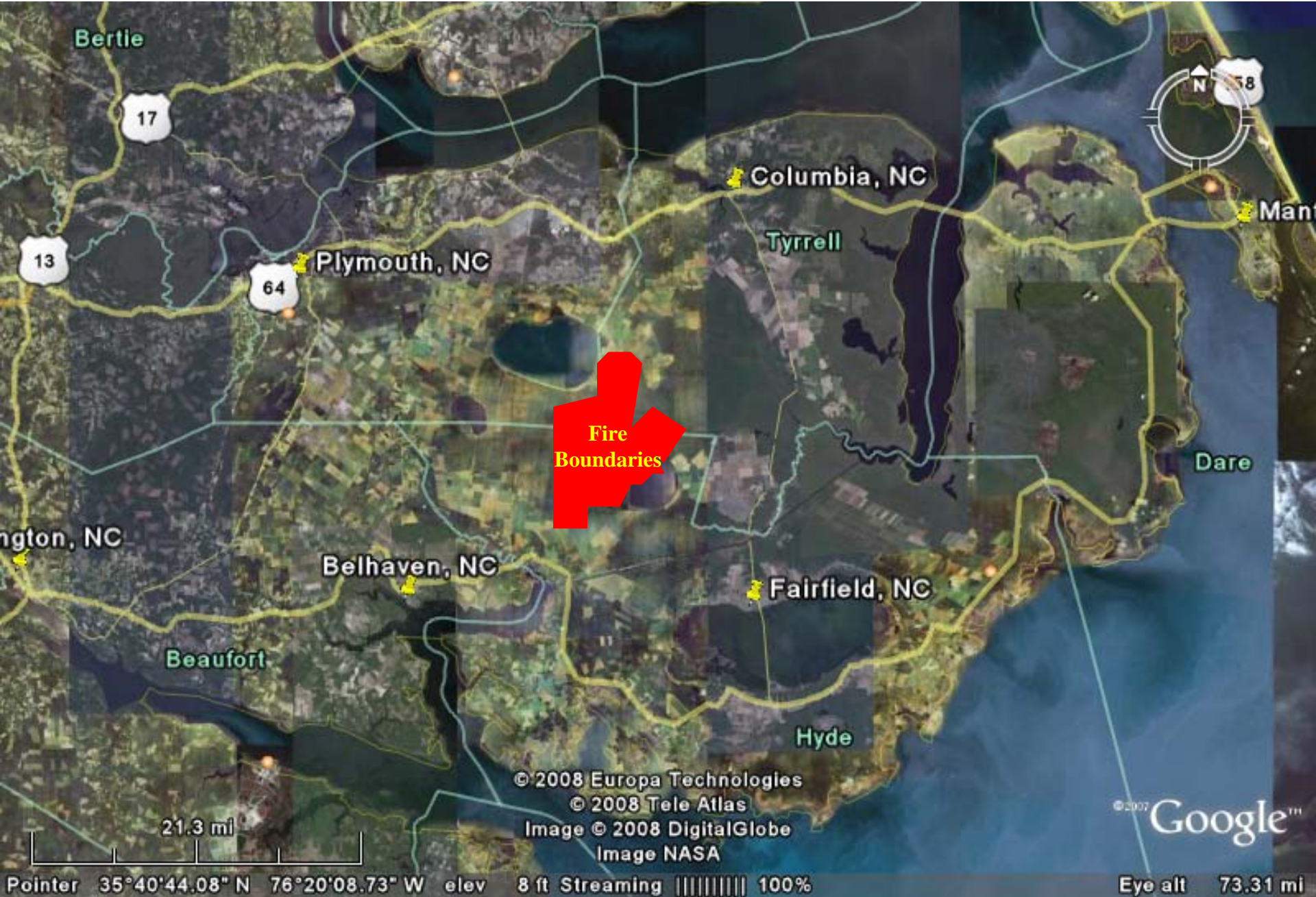
The operating assumption throughout the incident was that monitored levels of high PM concentrations were primarily due to smoke generated by the fire; whether directly downwind of the fire and/or caused by a radiative inversion near the monitor. A radiative inversion occurs when the ground cools much more quickly than the air, creating an extremely stable/stagnate layer of the air near the ground, which inhibits upward air motion and mixing. Fog is usually observed with these types of inversions, which acts like a cap on the atmosphere thereby trapping the particulate from the fire closer to ground level. We observed this phenomenon in the early morning hours most often at the Belhaven, Columbia, and Fairfield sites.

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² Mr. R. Fisher, Mr. S. Daniels, Mr. R. Bishop, and Mr. Rudy Whitehurst

³ Ms. K. Clevenger, Mr. S. Schliesser, Mr. R. Lasater, Ms. H. Guan, Mr. T. Pasley, Mr. G. Kangkolo, and Ms. R. Barrows

Figure 1. Primary Sampling



Sites were phased into operation as locations and equipment became available. Initially, three sites were located in Washington (WaRO), Belhaven (BFD) and Columbia (COL), NC. Sites four and five were then established in Fairfield (FFLD) and Plymouth (PLY), NC and a sixth site was located in Manteo (MTO), NC. Because of highly variable meteorology, weather and smoke forecasts and fire mitigation approaches, site operations were flexible employing varied monitoring times, sampling techniques and constituents sampled. Particulate matter (smoke) was the primary constituent under monitoring surveillance although other gaseous pollutants such as carbon monoxide and total volatile organic compounds were sampled. Mercury screening was also undertaken by EPA and ATAST personnel to ascertain whether elemental mercury was being released by the burning peat.

Air monitoring field instrumentation included in approximate order of deployment: AreaRae monitors (CO and total VOC), Omni™ filter samplers, Electronic Beta Attenuation Monitor (EBAM™) continuous particulate monitors equipped with meteorological stations, and Lumex™ and Tekran continuous mercury monitors. The deployment of instrumentation, collection of samples, and operational comments from the various sites are contained in the Operational Narrative (Appendix A) as well as in the daily status reports (Appendix B). The monitoring results and discussions are presented in the following sections.

4.0 AIR SAMPLING DATA AND ANALYSIS

As described in the Operational narrative (Appendix A), air sampling was conducted in six locations in Eastern NC (Figure 1) using AreaRae samplers, Omni™ filter samplers, EBAM™ samplers and mercury monitors. The data are presented in Appendices C-G; respectively, wind roses (wind speed and direction), Omni™ filter data, AreaRae data, EBAM™ temporal data, and EBAM™ data correlated to wind direction data.

4.1 Meteorological Data

Meteorological data were used to produce the wind roses in Appendix C. Each figure is composed of 6 wind roses, one from each site for a particular date and is arranged in an order which roughly corresponds to site locations relative to the fire. Therefore, the three top wind roses are the three sites north of the fire, Plymouth (NE), Columbia (NNE), and Manteo (NE) and the three lower windroses are the southern sites, Washington (WSW), Belhaven (SSW) and Fairfield (SE). The wind direction is plotted as the direction from which the wind is blowing towards the sampling station. In some cases there is no meteorological data for that particular site early in the response because there was no meteorological instrumentation at that site. The majority of the data recorded was obtained from the EBAM™ units although some data were initially obtained from the Mobile Air Monitoring Laboratory (MAML) meteorological station and used for the wind rose and other graphical representation for Washington until the EBAM™ at this location was operational. The EBAM™ meteorological data obtained was discrete 15 minute values meaning that they were instantaneous values datalogged at 15 minute intervals, i.e. they were not 15 minute average values. This was due to the nature of the EBAM™ datalogging capabilities. In some instances (noted on the wind rose), data was being collected by the EBAM™ unit as one hour discrete data points due to unfamiliarity with the monitors early in the response. This was primarily due to the unfamiliarity with the EBAM™

unit operation as the ATAST had no prior experience with operating these instruments. While this data logging scheme may not be optimal for determining the precise meteorological conditions it does provide a measure of the conditions at the time the data point was recorded.

Wind rose interpretation notes: The central number is the percentage of data points that are less than the lowest range value, in this case winds below 1 mph. The overall ray lengths represent the percentage of the data points when the wind was from that particular direction and the individual sections of the ray indicate the percentage of the data points when the wind was within that particular wind speed range (as indicated by the color and width of the ray shown in the key at the bottom of the figure) from that wind direction. The wind rose is divided into 16 segments and the ray is centered on the segment that is composed of wind directions from 11.25° on either side of that ray. For example, a ray along the easterly direction (90°) is generated from wind directions that are between 78.75° and 101.25°.

4.2 Omni™ Filter Samples (PM₁₀, PM_{2.5})

On the initial two days of the ATAST response three particulate filter monitoring sites were set up, Washington (June 11), Belhaven (June 11), and Columbia (June 12) to collect 10-micron particulate matter (PM₁₀) for 12 hrs. Subsequent to this they were converted to collection of 2.5-micron particulate matter (PM_{2.5}) over 24-hour average. Because the filter samples required a period of laboratory conditioning prior to obtaining final filter weights, the results were not available until a minimum of 24-36 hours post-sample collection. The need for filter sampling was obviated by the arrival of several continuous, telemetry-equipped EBAM™ units from the US EPA, US Fish and Wildlife, and US Forestry Service on June 12 and 13; therefore use of these samplers was discontinued on June 17. However, there were a few days that both were in operation given ATAST's initial unfamiliarity with the EBAMs™ operation. *Note: optimal operation of the EBAM™ units was achieved very quickly after the first installations and data collection periods between June 12 and June 14.*

The data from these samples are contained in Appendix D. On June 11 and 12th, two consecutive 12-hour samples were obtained for PM₁₀ at WaRO and Belhaven, so comparison to the 24 hr based NAAQS PM₁₀ standard (150 ug/m³) is possible by averaging the values obtained for these samples. By doing so, the PM₁₀ values at the respective sites are for WaRO 194 ug/m³ and BFD 91 ug/m³. This indicates that during the 24 hr period for the WARO sample the value was above the NAAQS standard of 150 ug/m³. [Note: Although the NAAQS standards are typically used to compare daily ambient air quality (midnight to midnight) and these samples were not collected on this timeframe, they can be compared to one another to provide a health based conclusion.]

From June 13 thru June 17, Omni™ samplers were changed to sampling on a 24 hr basis for PM_{2.5} in order to be more readily compared to the NAAQS standard for PM_{2.5} (35 ug/m³) as this was the basis of the DAQ Air Quality Index (AQI) forecast that was issued each day for the region. The data are shown in Appendix D and for the three sites it can be seen that the 35 ug/m³ was met or exceeded at WARO on June 13-14 (32.9 ug/m³) and at COL on June 14-15 (71.4 ug/m³) and June 16-17 (40.8 ug/m³). See Section 5 for discussion of these exceedances.

4.3 AreaRae Monitors (CO, Total VOCs)

The potential for whether there would be elevated levels of CO and VOC due even some distance from the fire and generally associated with some plume was considered. Therefore initially AreaRae monitors equipped with CO and VOC sensors were stationed at WARO, BFD, COL, PLY and FFLD at various times. The figures in Appendix E contain those data sets. Gaps in the data stream represent recharging or storage hiatus when not necessary for monitoring or when data logging was suspended for data collection.

ATAST's action level for CO is generally in the 25 ppm range, which means that if this concentration is reached or exceeded (for longer than a few minutes), ATAST typically considers that the area is not one to remain in with CO at this level. It does not mean that it is immediately dangerous but simply that caution should be used in remaining in this area. The data shows that this level was not reached at any of the sites during the time that CO was being monitored from June 11 – 17. It was also surmised that elevated levels at BFD on June 13 was probably due to emissions related to the nearby fire station traffic as the site area was being used as a shelter and seemed to be a central gathering spot in the community.

ATAST's action level for VOC is generally in the 10 ppm range, which means that if this concentration is reached or exceeded (for longer than a few minutes), ATAST typically considers that the area is not one to remain in with VOC at this level. It does not mean that it is immediately dangerous but simply that caution should be used in remaining in this area. The data shows that this level was not reached at any of the sites during the time that VOC was being monitored from June 11 – 17.

ATAST removed the AreaRae monitors from the various locations on various dates since to these low levels were observed and discontinued monitoring CO and VOC in the area completely their departure on June 19.

4.4 EBAM™ Monitors (PM₁₀, PM_{2.5})

As described earlier, Omni™ filter samplers were used to collect particulate samples and provide data on the PM₁₀ and PM_{2.5} concentrations from June 11 thru 16 (see section 4.2). ATAST also received EBAM™ units from EPA, US Forest Service and US Fish and Wildlife between June 12 and 14 (see Appendix A for operational details). These were installed at the sites as they became available (See Appendix A). ATAST had no experience with EBAMs™ prior to receiving them from the Federal agencies. Minimal instructional opportunity and unfamiliarity resulted in some initial mistakes, but these were quickly overcome as the team gained proficiency. A discussion associated with unfamiliarity with instruments is found later in this section.

The PM₁₀ and PM_{2.5} concentration data from the EBAMs™ were used to produce the graphs in Appendices F and G. In Appendix F, the data are plotted in 7-day periods from June 12 through August 4 for each site. The plots show the particulate size being monitored, the 1 hr average concentration at a given date and time, a running 24 hr concentration, and a midnight to midnight average concentration, and one or both NAAQS values for PM₁₀ and/or PM_{2.5}. This makes it relatively easy to determine whether the NAAQS standard was being exceeded during any consecutive 24 hr period and/or for a given calendar date. The PM size being monitored at a

particular time was dependent on the availability of equipment and monitoring needs. Because of other equipment failures, EBAMs™ were moved from one site to another to continue monitoring in what was deemed a higher priority area.

The polar plots in Appendix G, represent the correlation of the individual EBAM™ 1 hr average PM₁₀ or PM_{2.5} concentration data to a discrete wind direction measurement taken at the time the data point was recorded by the EBAM™. Each figure is composed of 6 polar PM vs wind direction graphs, one from each site for that particular date and is arranged in order which roughly corresponds to their location relative to the fire just as the wind rose graphics are arranged. That is, the three top wind roses are the three sites north of the fire, Plymouth (NE), Columbia (NNE), and Manteo (NE) and the three lower wind roses are the southern sites, Washington (WSW), Belhaven (SSW) and Fairfield (SE). Plotting these correlations give an approximation of the direction from which the wind was blowing during the time the sample was taken. One interprets the graph in the following manner. On each figure these concentration data and correlated wind direction are plotted such that each ray represents the direction from which the wind was blowing and the length and location of the data point on the concentric concentration range rings indicates the particulate matter concentration. ***Note: the concentration ranges vary from plot to plot depending on the range of concentrations observed at that site for that date.*** By taking the aggregated data view of the polar plot one can discern the apparent origin (source) of the majority of the particulate matter and their relative concentrations. As an example, Figure G2 for the Belhaven site the high PM 10 values are observed when the winds are from the NNE and NE, which is from the direction of the fire.

By using these two sets of plots in concert with the wind roses, it is possible to discern, in many cases, the potential source of the PM concentrations. As stated in Section 3.0, the operating assumption through-out the incident was that high PM concentrations were primarily due to smoke generated by the fire; whether this was due to being directly downwind of the fire and/or caused by a radiative inversion near the monitor. This radiative inversion effect was recorded predominantly between 21:00 hrs to 10:00 hrs the following day and was evidenced primarily by an increase and decrease in PM in the course of a few hours as observed in the hourly readings. These types of occurrences were recorded most frequently at BFD, COL, and FFLD which were the sites closest to the fire. An example of this is at COL on June 26. From Figure F9 one can see just after midnight there is a “peak” in the 1 hr average readings lasting approximately 9 hours. Then looking at Figure G16, one sees that these values were obtained when the winds were from the SSE and SE (direction of the fire) and that from Figure A15 for Columbia the winds were between 2-10 mph.

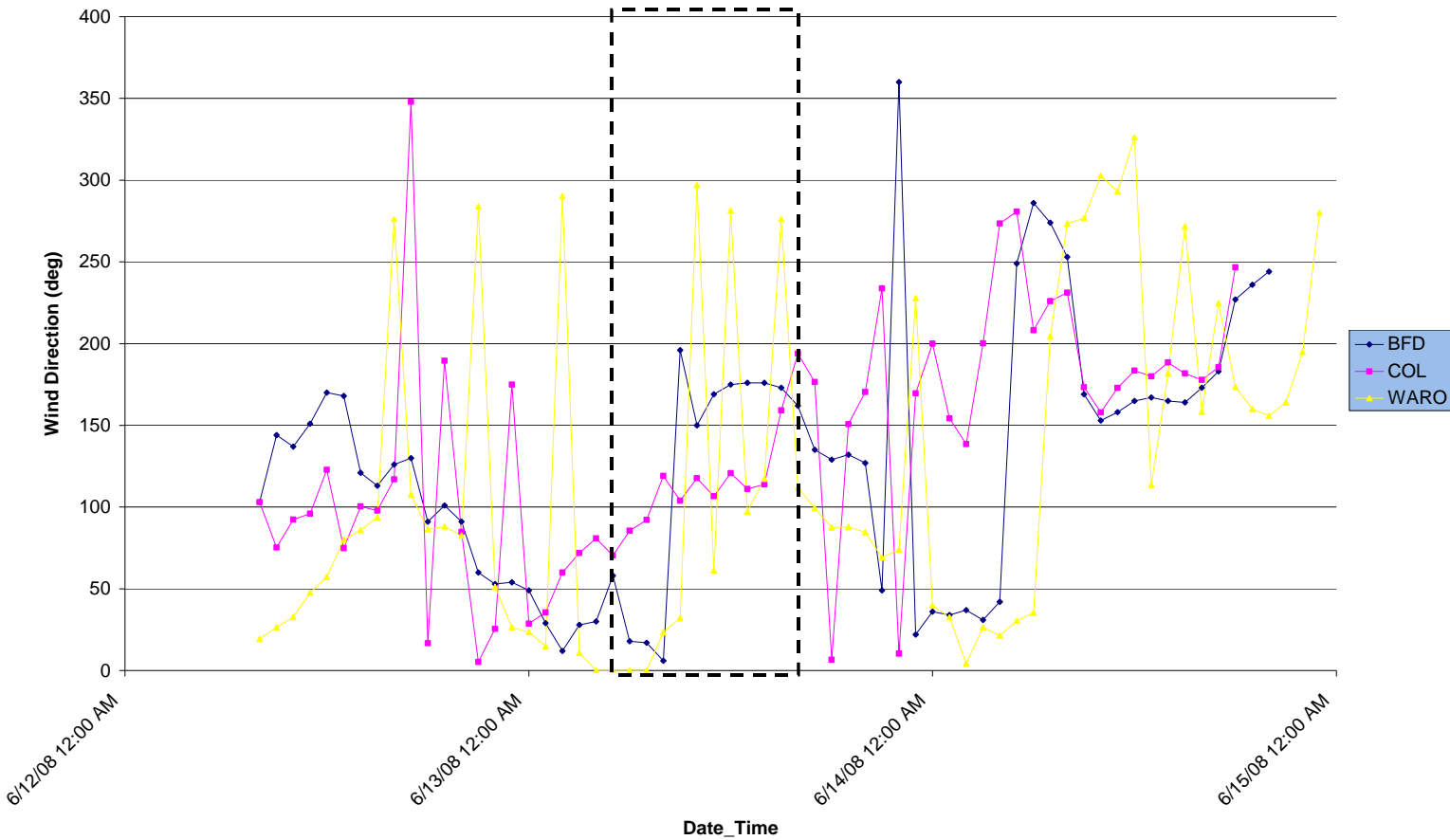
Additionally, looking at the Figures in Appendix F for each of the sites and comparing the running 24 hr average and daily 24 hr average PM concentrations over the course of the monitoring effort, that in general the site that was most often and most heavily impacted in terms of exceedance of the NAAQS standard was the Columbia site. This was due primarily to its location downwind of the prevailing wind direction during this time of year. Other exceedances at other sites were primarily due at least at the beginning of the event when those sites, as would be expected, were downwind of the fire. This can be seen as described earlier by looking at the polar graphs in Appendix G for those dates where exceedances are observed.

Occasionally, there did seem to be incongruities between the observed wind direction and the level of measured particulate matter; i.e., where particulate levels were elevated but the monitoring site was not generally downwind direction of the fire's smoke plume. In these instances early in the incident, it was surmised that this was due to combinations of circumstances such as light and highly variable winds, changes in directions of the prevailing winds thus causing large scale "swirling" of the very large smoke plume, proximity of the site to the fire, and/or inversions. Later in the incident timeline, it was surmised that these incongruities were related to potential local secondary sources such as open burning or agricultural burning. After the burn ban was lifted on July 19, 2008, sporadic, anomalies began to appear in the data making it difficult to correlate high levels of PM solely with the incident.

By observing the figures in Appendix F, a gradual trend over the event in PM_{2.5} reduction for the running 24 hr average occurs. This is especially prevalent at the Columbia site. This is surmised to be due to the above ground fire being brought under control and the underground fires being extinguished or burning themselves out.

One very notable episode during the incident occurred early during ATAST's response on June 13. The EBAMs™ at BFD and WARO both recorded extremely high values for PM₁₀ and PM_{2.5} respectively between the hours of 5:00 and 16:00 hrs, peaking at both locations at approximately 10:00 hrs. The other operational site at that time, COL showed no similar results. Looking at the meteorological data graphed below (Figure 2) for this date indicates why this was the case; the winds during this time were shifting from their previous directions to directions that put these two sites downwind of the fire. These values were reported to DAQ central office immediately. However, the subsequent routine quality assurance audit of the pump flow revealed that the pump in that WARO EBAM was not performing correctly. Thus the actual values were not accurate. However, given the magnitude of the "peak" and the corroborative data from the BFD site closer to the fire and in the same general relative downwind position as the wind changed direction, this data does indicate that there was a qualitative inference of a serious air quality incident. Invalidating the quantitative utility of the WARO data was partially due to inexperience in the use of these monitors (as stated earlier) but the use of common quality control audit procedures discovered the problem early enough in the response and permitted corrective action was taken to ensure no further data loss.

Figure 2. Wind Direction vs Date_Time for BFD, COL, and WARO June 12-14, 2008



4.5 Mercury Monitoring

Due to concern about potential elemental mercury released from burning peat, ATAST requested US EPA assistance to monitor ambient mercury levels using a Lumex elemental mercury monitor. This instrument could quickly provide quantitative screening data of ambient mercury concentrations and was portable so that a wider area could be screened more quickly than with the instrument ATAST had for monitoring elemental mercury (Tekran Model 2737A). The Lumex instrument reads instantaneous, real time values and averages data over 10-second time periods. In this way, data could be obtained using a short-term sampling format and quickly and directly indicated the magnitude of ambient mercury concentrations. The advantage of using a screening technique is that it helps assess the ‘appropriateness’ of locating a more sensitive sampler or sensitive sampling format (Tekran 2737A). Data obtained using a short-term sampling format can potentially over-emphasize concentration ‘peaks’ than data obtained from samples collected over a longer time average. Monitoring using a longer averaging period following a series of short-term ‘screening’ provides a more robust evaluation of ambient concentrations.

EPA personnel, Ken Rhame, monitored about 10 locations in proximity to the fire, in smoke plumes, and at the WaRO on June 12 and June 13 from 2-6 p.m.. Data were taken at each

location for approximately 5 minutes and the highest numbers observed for both “real time” and “10 second average” reported. Short-term, transient, real-time values were highly variable in the 10-50 ng/m³ range apparently changing with smoke density. Ten second averages ranged from 4-23 ng/m³. The report filed by Ken Rhyme is included in it’s entirety below.

**Evans Road Wildfire
Mercury Air Monitoring Results**

On Thursday June 12, US EPA began air monitoring for Mercury (Hg) at the request of NC DENR DAQ at the Evans Road Wildfire. US EPA used a Lumex™ 915+, the results reported are conservative in that EPA monitored at each location for approximately 5 minutes and reported the highest numbers observed for both “real time” and “10 second average”.

June 12, 2008

Location	Time	Results	ng/m³
Prices Auto Sales White Post Rd and Hwy 264	2:02 p.m.	Real Time 10 Second Avg	10 10
Northeastern Elementary School N 35°32.316’ W 076°42.625’	2:15 p.m.	Real Time 10 Second Avg	17 14
Bellhaven Fire Rescue N 35°32.394’ W 076°37.412’	2:26 p.m.	Real Time 10 Second Avg	10 6
Ponzer Community Park N 35°34.864’ W 076°29.088’	2:51 p.m.	Real Time 10 Second Avg	12 7
Kingdom Hall of Jehovah Witness N 35°35.052’ W 076°39.939’	3:49 p.m.	Real Time 10 Second Avg	9 7
Hwy 45 & Bridge N 35°36.023’ W 076°31.748’	4:20 p.m.	Real Time 10 Second Avg	24 23
Hwy 45 & Pat’s Rd. N 35°39.475’ W 076°35.481’	4:31 p.m.	Real Time 10 Second Avg	47 4

June 12, 2008 (cont)

Location	Time	Results	ng/m³
Hwy 45 & A Canal Rd	4:45 p.m.	Real Time	22

(Wenona Church of Christ)
N 35°42.721'
W 076°38.503'

10 Second Avg 5

Hwy 45 & Bell Rd
N 35°40.210'
W 076°43.405'

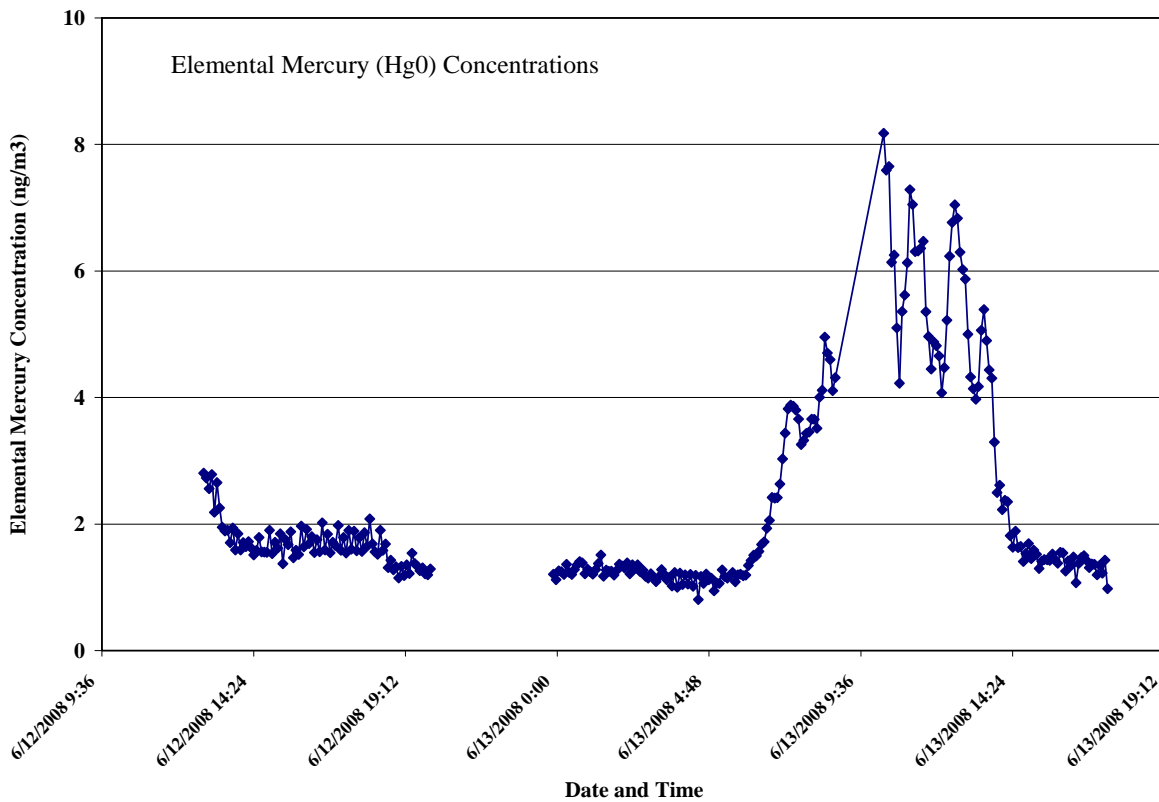
5:00 p.m. Real Time 13
10 Second Avg 6

Washington Square Mall
DENR Office Parking Lot

6:10 p.m. Real Time 12
10 Second Avg 9

Additionally, a Tekran 2737A was put in operation on June 12 and 13 at the WaRO and recorded 5 minute average elemental mercury concentrations over much of this time. Values obtained at this location never exceeded concentrations above 9 ng/m³. (see Figure 3 below)

Figure 3 Tekran 2737A Elemental Mercury Data June 12-13, 2008 at WaRO site.



The Lumex™ and Tekran instruments were operated simultaneously concurrently at the WaRO on June 13. The data was found to be in good agreement.

From previous work done at Pettigrew State Park adjacent to the Pocosin National Wildlife Refuge, ATAST knew that the typical concentration range of elemental mercury was consistently less than 3 ng/m³. Additionally, EPA has a reference concentration (RfC) of 300 ng/m³ (see <http://www.epa.gov/iris/subst/0370.htm> for additional details for this RfC value). Given this information, the elemental mercury vapor monitoring was discontinued on June 13.

5.0 HEALTH IMPLICATIONS

The above sections have described the data as it relates to various standards and levels of concern without specific regard to the health implications. These standards are however for the most part health based in nature. As such this section will discuss the particular health implications of those values used for comparison.

5.1 Reference Exposure Limits

Fifteen minute and thirty minute air data for PM₁₀ and PM_{2.5} collected by the EBAM™ monitors must be compared with “reference exposure levels” for these chemicals in order to determine the extent to which humans were exposed during the incident. There are no regulations regarding acute PM exposures for time periods less than 24-hours. Reference exposure levels for these chemicals were assessed using 24-hour standards.

EPA has established health impacts of inhalation exposures to PM₁₀ and PM_{2.5}. EPA established the 24-hour National Ambient Air Quality Standards (NAAQS) for PM₁₀ at 150 ug/m³, as part of the CAAA in 1990. Current guidance states that the maximum inhaled health standard for ambient PM_{2.5} for an adult is 35 ug/m³ over a 24-hour time period. These health standards for PM are based on a 24-hour average (midnight to midnight) of the monitored pollutant.⁴

These particles can be inhaled into the respiratory system where they accumulate. PM₁₀ can cause aggravation of the respiratory and cardiovascular system, whereas PM_{2.5} can lodge deeply into the lungs, and are believed to pose the largest health risks.⁵

Health studies have shown a significant association between exposure to PM_{2.5} and premature mortality. Other important effects include aggravation of respiratory and cardiovascular disease (as indicated by increased hospital admissions, emergency room visits, absences from school or work, and restricted activity days), lung disease, decreased lung function, asthma attacks, and certain cardiovascular problems such as heart attacks and cardiac arrhythmia. Individuals particularly sensitive to fine particle exposure include older adults, people with heart and lung disease, and children.³

The Division of Air Quality’s Ambient Monitoring section provided Air Quality Index⁶ (AQI) forecasts using the EBAM™ continuous monitoring data after June 11, 2008. Ambient monitoring was forecasting the AQI based on the stationary monitor network prior to June 11, 2008.

⁴ <http://epa.gov/air/criteria.html>

⁵ http://www.epa.gov/ttn/naaqs/pm/pm25_index.html

⁶ <http://airnow.gov/index.cfm?action=aqibroch.aqi#2> accessed 9/15/08.

The AQI is a range of values from 0 – 500 which indicate the levels of pollution for a given area, the higher the number, the more pollution exists. Particulate matter is one of the pollutants that make up the AQI. This index is broken down into six categories ranging from good air quality to hazardous. The color assigned to each category makes it easy for the public at large to understand the air quality in their region for the day. Figure 4 shows the ranges, colors, and health hazards associated with each category of the AQI.

Figure 4. Air Quality Index (AQI): Particle Pollution⁷

PM _{2.5} Conc (ug/m ³)	Index Value	Levels of Health Concern	Cautionary Statement
0.10 – 15.4	0 – 50	Good	None
15.5 – 35.4	51 – 100	Moderate	Unusually sensitive people should consider reducing prolonged or heavy exertion.
35.5 – 65.4	101 – 150	Unhealthy for Sensitive Groups	People with heart or lung disease, older adults, and children should reduce prolonged or heavy exertion.
65.5 – 150.4	151 – 200	Unhealthy	People with heart or lung disease, older adults, and children should avoid prolonged or heavy exertion. Everyone else should reduce prolonged or heavy exertion.
150.5 – 250.4	201 – 300	Very Unhealthy	People with heart or lung disease, older adults, and children should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion.
250.5 – 500	301 – 500	Hazardous	People with heart or lung disease, older adults, and children should remain indoors and keep activity levels low. Everyone else should avoid all physical activity outdoors.

The NAAQS for PM directly relates to the AQI as the health-based standard for a 24-hour period is equivalent to the Code Orange level for both PM_{2.5} (35 ug/m³) and PM₁₀ (150 ug/m³). NCDAQ, as well as a few other state agencies, have developed an interim AQI where 35.5 ug/m³ is considered a violation of the daily standard.

⁷ <http://www.airnow.gov/index.cfm?action=aqibroch.aqi#aqipar> accessed 9/16/08

The NAAQS for both PM_{2.5} and PM₁₀ was exceeded at BFD on June 14, 2008 (384 ug/m³) corresponding to a Code Maroon, making air quality for the 24-hr period hazardous to all adults. Table 1 indicates NAAQS exceedance for the entire monitoring event per site, per date with the corresponding AQI.

Table 1. PM_{2.5} NAAQS Exceedance, Evans Road Fire, June 12 – August 4, 2008

Site	Date (2008)	PM _{2.5} (ug/m ³)	AQI
BFD	June 14	384	Maroon
COL	June 14	79	Red
	June 15	66	Red
	June 16	38	Orange
	June 19	165	Purple
	June 20	81	Red
	June 21	263	Maroon
	June 22	73	Red
	June 23	88	Red
	June 27	74	Red
	June 28	75	Red
	June 29	127	Red
	June 30	43	Orange
	July 3	257	Maroon
	July 4	159	Purple
	July 5	73	Red
July 11	44	Orange	
FFLD	June 16	49	Orange
	June 17	42	Orange
	June 19	87	Red
	June 20	95	Red
	June 24	46	Orange
	July 2	49	Orange
MTO	June 19	46	Orange
	June 20	37	Orange
	June 22	39	Orange
	June 23	39	Orange
PLY	June 19	44	Orange
	June 25	86	Red
	July 11	38	Orange
WARO	June 13	354	Maroon

6.0 REFERENCES

- i. California Environmental Protection Agency. Air Toxics Hot Spots Program Risk Assessment Guidelines. Part 1. The Determination of Acute Reference Exposure Levels for

Airborne Toxicants. Office of Environmental Health Hazard Assessment, Air Toxics and Epidemiology Section. March 1999. <http://www.oehha.ca.gov/air/pdf/acuterel.pdf>

- ii. California Health and Safety Code Section 44303.
- iii. <http://www.epa.gov/oppt/aegl/>
- iv. <http://www.orau.gov/emi/scapa/erpgdefinitions.htm>