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PROTECTION

Commonwealth of Pennsylvania
Department of Environmental Protection

Long-Term Ambient Air Monitoring Project:
Marcellus Shale Gas Facilities

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Commonwealth of Pennsylvania

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Department of Environmental Protection

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Executive Summary

Since the beginning of 2005, there continues to be an increasing presence of industrial sites associated with the exploration, extraction, treatment, transport and/or processing (including fractionation) of natural gas and natural gas liquids (NGLs) obtained from the Marcellus Shale formation in Pennsylvania. These activities have occurred primarily in the southwest, northeast and northcentral regions of Pennsylvania.

In response to the increased amount of activity and concerns about potential adverse impacts of Marcellus Shale natural gas development activities on air quality, the Pennsylvania Department of Environmental Protection (PA DEP or Department) initiated a short-term, screening-level air quality sampling initiative in the northeast region from August 2010 through October 2010. The “*Technical Support Document*” (TSD) that outlines the methodology, goals and technical information and final reports of the initiative is available on the Department’s website.¹

While the short-term sampling effort did *not* address the cumulative impact of air emissions from natural gas operations in northeastern Pennsylvania, the sampling results provided basic information about the type of pollutants emitted to the atmosphere during selected phases of gas extraction operations in the Marcellus Shale formation. The findings of the project suggested that, as the development of the natural gas industry in Pennsylvania increases, the industry’s potentially increased contribution to ambient concentrations of criteria pollutants or their formation products, Volatile Organic Compounds or (VOCs), must be examined as any other criteria pollutant source contributor. This can be achieved with continued long-term monitoring and close examination of emissions-related information and data from all source categories in an area of concern.

Accordingly, in July 2012, the Department initiated a long-term, one-year ambient air monitoring project of Marcellus shale development to understand further the impacts of the shale gas industry on Pennsylvania’s overall air quality. The project placed emphasis on characterizing concentrations of criteria and hazardous air pollutants near permanent facilities related to the Marcellus Shale gas industry in Washington County, Pennsylvania. Washington County was specifically chosen because it was the first county to commence extraction from Marcellus Shale in Pennsylvania. Also, with the county’s continued natural gas field development, it has significant permanent gathering and treatment infrastructure either in place or in late-term development. Finally, Washington County has more historic ambient air monitoring stations than most other counties in this region. These stations can provide infrastructure for new air quality monitors as well as historic ambient concentration data for target criteria pollutants.

¹ The “*Technical Support Document*” (TSD) is available on the Department’s website at: <http://www.dep.pa.gov/Business/Air/BAQ/MonitoringTopics/ToxicPollutants/Pages/default.aspx#.VIWpVvMo6po>.

While the primary goal of the long-term project was to “determine any chronic or long-term risks to the public from individual or multiple shale gas sources,” there were three basic goals associated with this project. The first goal included examination of both toxic/hazardous air pollutants (HAP) and criteria pollutants. The second goal was to identify and assess potential increases in ambient concentrations of criteria pollutants in the project area over the duration of the project and to compare observed ambient concentrations to historical data collected both in the project area and other existing monitoring locations within the Commonwealth. The third goal of the project was to assess and identify potential implications that the observed results may have in other areas of the Commonwealth with varying populations and environmental conditions that might host similar facilities. Completion of these goals and objectives will enhance both the Department’s and the public’s understanding of potential air quality-related health risks associated with air quality impacts in areas that contain sources of air pollution related to the natural gas extraction, processing and transport industry.

It is important to note that this project did not examine potential acute or chronic impacts to individuals working in, adjacent to, or in the immediate vicinity of natural gas extraction, gathering and/or processing facilities. The risk/hazard screening used in this report should not be used as a surrogate for a full inhalation pathway risk/hazard assessment.

The establishment of the study goals and task criteria, resource planning, fiscal budgeting and preliminary siting activities commenced in late 2010 and through 2011. Implementation of the project began in early 2012 with the first monitoring stations commencing data collection in July of 2012. The general study protocol, “*Long-Term Ambient Air Monitoring Project near Permanent Marcellus Shale Gas Facilities Protocol*,” is available on the Department’s website.² The document presents key elements of the ambient air sampling plan and study protocol. In general, the study measured ambient airborne pollutants to determine potential air quality impacts associated with the processing and transmission of unconventional natural gas.

The long-term study included four specific air quality monitoring sites in Washington County. The sites included Meddings Road, Welsh Road, Jaspen Way, and Henderson Road. Each site was determined to be sufficient to characterize ambient air concentrations of criteria and/or toxic pollutants and meteorology in the study area potentially affected by emissions from the oil and gas operations. An additional fifth site located in Arendtsville, Adams County, was established outside of the natural gas development areas of Washington County. This site was to serve as a local background concentration study site. Meteorological measurements were collected from each of the monitoring sites.

The primary monitoring site in the project area, Meddings Road, measured criteria pollutants including Ozone, NO_x, Carbon Monoxide, PM_{2.5}, H₂S, select volatile organic toxic and hazardous pollutants, and methane and non-methane hydrocarbons (NMHC).

² The general study protocol, “*Long-Term Ambient Air Monitoring Project near Permanent Marcellus Shale Gas Facilities Protocol*” is available on the Department’s website at: <http://www.dep.pa.gov/Business/Air/BAQ/MonitoringTopics/ToxicPollutants/Pages/default.aspx#.VIWpVvMo6po>.

In the project area, and in addition to numerous unconventional natural gas wells with associated extraction and gas/liquid handling equipment (e.g., small dehydrators, condensate collection tanks, etc.), a number of permanent natural gas gathering, compression and processing facilities were in operation.

Data for target pollutant concentrations was collected at the project sites over a one-year period. The data was analyzed and compared to other sites in the project area and to a historical ambient air monitoring site in the rural setting of Arendtsville, Adams County, where no oil or natural gas production occurs.

The data was processed using validation and usability determinations prior to being analyzed for comparison to primary and secondary National Ambient Air Quality Standards (NAAQS) for criteria pollutants. Toxics/HAP data were validated and quality-assured using United States Environmental Protection Agency (U.S. EPA or EPA) methods for non-criteria pollutant data collection and consistent with guidance for data analysis for the National Air Toxics Trend Station (NATTS) program. Criteria pollutant data analysis consisted of employing EPA-required data reduction and analysis methods. Toxics risk/hazard screening was consistent with the Bureau of Air Quality's methodology for ambient toxic pollutant risk/hazard screening.

Findings and Recommendations for Future Action

Key findings of the long-term ambient air monitoring project include:

- The primary criteria pollutant monitoring site, Meddings Road, did not report NAAQS-related values for any of the monitored criteria pollutants (e.g., Ozone, NO₂, PM_{2.5}, CO) which exceeded the applicable NAAQS or indicated a probable future exceedance based on the data pattern. In addition, the pattern of recorded pollutant concentration measurements did not indicate a localized source impact which would cause an exceedance of any of the NAAQS evaluated.
- The Meddings Road site measured significantly fewer Air Quality Index (AQI) days less than "Good" than local comparison sites. The site measured 93 days classified as "Moderate" and one day classified as "Unhealthy for Sensitive Groups." In comparison, the Charleroi site measured 195 "Moderate" days and three "Unhealthy for Sensitive Groups" days. The Florence (a background impact site) measured 160 "Moderate" days and two "Unhealthy for Sensitive Groups" days.
- There was no significant difference in either cumulative estimated Excess Lifetime Cancer Risk (ELCR) or cumulative chronic non-cancer Hazard Quotient (HQ), also known as the Hazard Index (HI), between the four ambient air impact monitoring sites and the background site. The estimated ELCR for each of the five project sites fell between one in one million (1.0E-6) and one in ten thousand (1.0E-4). This is an acceptable range of ambient air inhalation risk for risk assessment screening purposes. Observed concentrations at sites were below levels where a chronic non-cancer hazard would be expected to manifest over a 70-year lifetime of exposure.

- All four of the project HAP monitoring sites individually had a cumulative ELCR and HQ that were comparable to another historical Commonwealth VOC background concentration ambient monitoring site. This background site is located in Arendtsville, Adams County, in a non-natural gas development area. It is not in the immediate vicinity of any potential stationary source of toxic air pollution.
- From an analysis of the LTMP data, the top six pollutants and respective HQs are:
 - (a) Benzene (HQs ranged from 0.02 to 0.03 $\mu\text{g}/\text{m}^3$),
 - (b) Carbon Tetrachloride (HQ of 0.01 $\mu\text{g}/\text{m}^3$),
 - (c) Dichlorodifluoromethane (HQ of 0.03 $\mu\text{g}/\text{m}^3$),
 - (d) Chloromethane (HQ of 0.01 $\mu\text{g}/\text{m}^3$),
 - (e) Formaldehyde (HQs of 0.07 and 0.22 $\mu\text{g}/\text{m}^3$ - only two sites produced data), and
 - (f) Acetaldehyde (HQs of 0.10 and 0.15 $\mu\text{g}/\text{m}^3$ - only two sites produced data)

The HQs for all sites and pollutants are listed in Tables 47 through 55.

- Additional detailed analyses of both the collected project HAP data and the historical HAP data collected throughout the state is needed to draw any conclusions about applying observed air toxics concentrations to other locations with different populations or local environmental conditions within the Commonwealth. At a minimum, additional site data would be required to augment the existing data so that further conclusions can be drawn from the project sites.

Key recommendations for future actions include:

- As unconventional natural gas extraction, gathering, and processing infrastructure develops to maturity, monitoring of criteria pollutants in the project area should continue. This will add important localized criteria pollutant information for the area. The Department redesignated the Meddings Road primary project site as the “Houston” Air Monitoring Station beginning in 2014 and will continue criteria pollutant monitoring for trend evaluation and NAAQS compliance.
- Even though the project’s observed toxic/HAP one year screening ambient inhalation risk/hazard concentrations were at levels within a one-in-one million to one-in-ten thousand ELCR range and the chronic hazard was estimated to be below levels of concern for non-cancer hazard development, insufficient data collection led to reduced representativeness of the sample sets. Additional systematic HAP sampling at the Meddings Road site would help to better characterize the toxic pollutant concentrations in the air and better assess future potential risk and hazard as gas development continues in the area.
- The Department will continue to analyze the collected project toxic/HAP data with the goal of providing additional comparisons of that data to other monitored areas in the Commonwealth as well as in other states and countries where unconventional natural gas development is occurring. Additionally, the Department will consider expanding the suite of chemicals for which quantitative analysis can be performed. This can include screening

for certain chemicals that might contribute to the formation of ground-level Ozone and are associated with natural gas and gas liquid extraction and processing, while not necessarily toxic or hazardous in nature.

- While the conclusions of the project indicate that ambient air impact from unconventional natural gas operations may be limited, particularly with chronic air toxic exposure, this project did not examine potential acute or chronic impacts to individuals working in, adjacent to, or in the immediate vicinity of natural gas extraction, gathering and/or processing facilities. The Department should use this and future monitoring data to support efforts by the public health/industrial hygiene community to assess these potential localized risks.
- The Department should partner with the EPA, other states, and the academic community to assess where potential regional ambient air monitoring of methane and non-methane hydrocarbons might be of benefit to the public.

Special Note

The Department acknowledges that the report was four years in the making. It is important to bear in mind that, over the duration of the approximate 1.5-year project (July 2012 through December 2013), data for numerous HAP and criteria pollutants had been collected at five (5) monitoring sites. The data collected was processed using validation and usability determinations, quality-assured, analyzed, and interpreted. When the draft report was completed, the Department relied on the assistance of the Pennsylvania Department of Health (PA DOH) and the Agency for Toxic Substances and Disease Registry (ATSDR) for the evaluation of possible health impacts. These agencies are providing independent review and data interpretation and health-risk assessments in a separate Health Consultation report. It is important to review both reports for a full understanding of the project.

Introduction

This project is part of the evolution of the Department's efforts to understand further the impacts of the shale gas industry on Pennsylvania's air quality. Study planning commenced when results from three short-term screening studies conducted in 2010 provided insight into the general nature of emissions associated with Pennsylvania natural gas production, processing, and transportation activities. Activities surrounding the establishment of project goal and task criteria, resource planning, fiscal budgeting and preliminary siting activities commenced in late 2010 and continued through 2011. On July 23, 2012, PA DEP released the document, "*Long-Term Ambient Air Monitoring Project near Permanent Marcellus Shale Gas Facilities Protocol*." The 2012 document presented key elements of the ambient air sampling plan and project protocol developed by the Department for its one-year project to examine the potential toxic air pollution near permanent facilities handling, transporting and processing unconventional natural gas extracted from the Marcellus Shale formation in Washington County.

On August 1, 2013, the Department released the document, "*Technical Support Document (TSD) for Long-Term Marcellus Ambient Air Monitoring Project Protocol*." The document provided supplemental information to the "*Long-Term Ambient Air Monitoring Project near Permanent Marcellus Shale Gas Facilities Protocol*" and provided additional information on the project's sampling site locations and equipment configurations.

Data collection for the project began in June 2012 at the first sampling site followed by all other sampling sites on October 12, 2012. Data collection at all sampling sites ended on December 30, 2013. On January 1, 2014, the Meddings Road sampling site was converted to a permanent monitoring station and continues to monitor for select criteria and toxic pollutants. This monitoring station is now designated as the "Houston" station in the Department's ambient air monitoring network.

This report presents the data collected during the project, the Department's interpretation of the observed data (consistent with the goals of the project specified in the protocol and TSD), and the collection of the data and conditions under which they were collected.

The report is organized into the following sections:

- I. Project Overview, which provides information on the project's goals, tasks, and overall design. It also depicts the management and oversight structure and identifies key Department resources that were employed in the execution of the project.
- II. Project Area and Sampling Site Development, which includes detailed information on the final overall project and the design of the individual sampling sites within the project area.
- III. Data Collection, which describes key events that occurred during data collection, the overall quality of the collected data, and the data sets used for analysis.

- IV. Risk/Hazard Screening Analysis, which presents the ambient air risk/hazard screening results.
- V. Findings and Recommendations, which discusses the Department's findings and recommendations for future action.

Raw data and relevant supporting documents are included either as appendices to this document or on the Department's website.

I. Project Overview

This section provides a description of the planning and management of the project, the project's purpose and goals, and the general tasks completed to achieve the project's purpose and goals.

A. Planning & Management

This project was planned and managed by the Department of Environmental Protection, Bureau of Air Quality, Division of Air Quality Monitoring. Questions concerning the project and its conclusions can be directed to the Project Manager via mail at:

PA Department of Environmental Protection
Bureau of Air Quality
Toxic Monitoring Section
Rachel Carson State Office Building
PO Box 8468
Harrisburg, PA 17105-8468

or by e-mail at: epairtoxics@pa.gov

The project employed staff from the Air Quality Monitoring (AQM) Division to complete most of the planned tasks associated with the project. Other Department and Bureau of Air Quality (BAQ) assets were employed as needed. All activities for the project were conducted by Department employees. A Health Consultation on the results of the air toxics inhalation risk/hazard screening was performed by the Pennsylvania Department of Health (PA DOH) and the Agency for Toxic Substances and Disease Registry (ATSDR).

Additional information on the planning and management of the project are included in the project sampling protocol TSD referenced previously.

B. Purpose and Goals

The purpose of this project is to determine and inform both the Department and the public at large about the potential *ambient* air quality impacts due to the increasing presence of industrial sites associated with the extraction, treatment, transport and/or processing (including fractionation) of natural gas and natural gas liquids (NGLs) obtained from the Marcellus Shale formation. Project sites in Washington County were chosen because this area has experienced and is still experiencing considerable unconventional natural gas infrastructure development. Additional discussion

regarding the need for this project and why this area of Pennsylvania was chosen is included in the TSD.

The project had three goals. The first goal was to determine any chronic or long-term risks to the public from individual or multiple shale gas sources. This goal includes examination of both hazardous air pollutants (HAP) and criteria pollutants³. For the purposes of this project, “shale gas sources” include, but are not limited to, permanent facilities in the project area that are associated with the extraction, treatment, transport and/or processing (including fractionation) of natural gas and natural gas liquids (NGLs) extracted from the Marcellus Shale formation underlying the Commonwealth. However, the ambient air sampling performed for the project collected and analyzed air influenced by *all* sources of target pollutants within the entire sampling area, not just sources of pollution associated with natural gas and NGL facilities.

The second goal of the project was to identify and assess potential increases in ambient concentrations of criteria pollutants in the project area over the time period of the project and to compare observed ambient concentrations to historical data collected both in the project area and other existing monitoring locations within the Commonwealth. Criteria pollutant measurement data that is collected will also be compared to the current corresponding primary and secondary NAAQS⁴.

The third goal of the project was to assess and identify potential implications that the observed results might have in other areas of the Commonwealth that have varying populations and environmental conditions and that might host similar facilities.

It is important to note that the project is not to be used as a substitution or surrogate for the full inhalation pathway risk/hazard assessment (i.e., the formal tiered community level inhalation risk assessment described by the U.S. EPA in its ambient air toxics risk assessment guidance). The Department should use this and future monitoring data to support efforts by the public health/industrial hygiene community to assess the potential localized risk.

C. Project Tasks

The TSD enumerated the completion of several tasks which would be needed to fulfill the project objectives. These tasks, along with an accompanying brief description of their completion, are described below.

³ A “criteria pollutant” is one for which a NAAQS has been established by the EPA under the federal Clean Air Act. Criteria pollutants include Carbon Monoxide, Lead, Nitrogen Dioxide, Ozone, Particulate Matter (2.5 and 10 microns aerodynamic diameter), and Sulfur Dioxide. Analysis of risk and hazard for criteria pollutants will be through comparison of observed data to NAAQS as this represents the best-known standard (primary and secondary) for protecting the health and welfare of humans.

⁴ Information on the NAAQS can be found on the EPA website at: <https://www.epa.gov/criteria-air-pollutants/naaqs-table>.

- Design an ambient air monitoring project that will gather systematic criteria and/or toxic pollutant concentration and accompanying meteorological data (MET) downwind from a permanent large source(s) and/or cluster of smaller permanent sources that are associated with shale gas extraction, treatment, transportation, and/or processing (including fractionation).

This task was accomplished with the activation of the final sampling equipment in October 2012. This is described on a site-by-site basis in Sections II and III.

- Create one or more sampling sites within the project area that monitor for criteria and/or toxic pollutants from representative shale gas sources. These sites will be optimized, where practicable, for sampling ambient air inhaled by an assumed local population. One or more additional sites will collect ambient air to represent either upwind or background concentrations of ambient air pollution.

This task was accomplished with the activation of the final sampling equipment in October 2012. This is described on a site-by-site basis in Section II.

- Deploy sampling equipment and infrastructure, where practicable, that is both consistent with EPA-approved or recommended sampling/monitoring methods and the project design. Any deviations from approved or recommended methods will be documented. All monitors and samplers will systematically collect data for at least one year or such a time that sufficient data exist to estimate mean ambient concentrations of the measured pollutant with an estimated statistical confidence.

This task was accomplished for equipment placement. However, the data quality for the one-year screening data did not meet the Data Quality Objectives (DQOs) for HAP measurement at all sites. Sufficient data does exist to estimate an annual mean concentration of certain toxic compounds. However, given the less-than-desired availability of valid HAP data during the risk/hazard screening period, the certainty in the estimate of the mean concentration of those pollutants is reduced. These limitations will be described in more detail in Section III.

- Acquire data and document data collection in a manner that allows for sufficient Quality Assurance and Quality Control (QA/QC) to provide confidence in the quality of the data. QA/QC protocols should be consistent with either EPA-required or EPA-recommended procedures where practicable

This task has been accomplished. Discussions of data quality assurance and quality control are in Section III with supporting data included in the LTMP Data Supplement.

- Analyze manual samples using EPA, ASTM International,⁵ or other acceptable methods using a laboratory that is accredited through the National Environmental

⁵ An international standards organization that until 2001 was known as the American Society of Testing and Materials. <http://www.astm.org/index.shtml>

Laboratory Accreditation Program (NELAP). The project will use the Department's NELAP-accredited Bureau of Laboratories (BOL) for analytical analysis.⁶

This task has been accomplished. All manual samples (criteria and HAP compounds) were analyzed by the BOL operating under valid and current NELAP accreditation for the compounds analyzed and methods used.

- Use and document data analysis methods that are consistent with scientific practice. Provide transparency on collected data and methods to achieve reproducibility of the results for the scientific community and other members of the public.

This task is accomplished with this document and the associated companion documents to be published by the Department. Section III of this document and the associated LTMP Data Supplement provide raw and supplementary data and additional detail on the analytical methods used for this report.

II. Project Area and Sampling Site Development

Consistent with the goals established in the previous section, the Department designed a project to best meet the goals with available staffing, equipment and analytical resources. Both the overall project and individual sampling site designs, where practicable, conformed with EPA requirements and guidance for both criteria and non-criteria ambient pollutant measurement. Additional information and references for ambient air monitoring sampling site design for criteria and non-criteria pollutants is included in the TSD.

It is important to note that the Department engaged in an expedited planning and equipment deployment schedule to more readily respond to the public's desire for as-immediate-as-possible information on potential ambient air impacts due to the development of Pennsylvania's unconventional natural gas resources. The Department balanced the need for more immediate information against a longer planning, deployment and data analysis timeline.

A. Overall Project Design

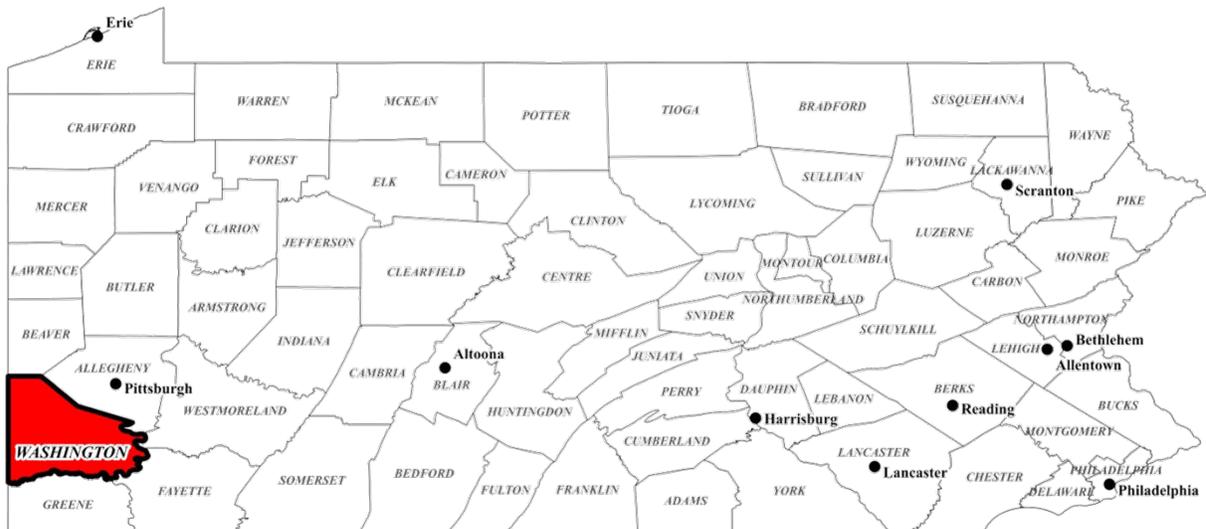
The series of three short-term screening studies informed the Department's decision to choose a location in the southwestern Pennsylvania portion of the Marcellus play as the focus for the long-term project.⁷ Given the association of HAPs with the chemical components of natural gas liquids and the abundance of these liquids in the gas held below the Southwestern region of the Commonwealth, the Southwestern region of Pennsylvania, coupled with its rapidly developing associated infrastructure for extracting, processing and transporting this gas and associated liquids, provided the most suitable area for a long-term project of ambient criteria pollutant and select toxic air pollutants.

⁶ Information on the Bureau of Laboratories and NELAP accreditation can be found on the Department's website at: <http://www.dep.pa.gov/business/otherprograms/labs/Pages/default.aspx>.

⁷ The Department's short-term monitoring efforts that pre-dated the initiation of this project are described in more detail in the TSD. These studies can be found on the Department's website at: <http://www.dep.pa.gov/Business/Air/BAQ/MonitoringTopics/ToxicPollutants/Pages/default.aspx#.VIWpVvMo6po>.

Washington County (Figure 1) was ultimately specifically chosen since it was the first county to commence extraction from the Marcellus Shale in Pennsylvania and, with that county’s continued natural gas field development, has significant permanent gathering and treatment infrastructure either in place, or in development. Furthermore, Washington County has more historic ambient air monitoring stations than most of the other counties in the region. These previously existing stations provided existing infrastructure for new monitors as well as historic ambient concentration data for target criteria pollutants.

Figure 1 - Washington County, Pennsylvania



Figures 2 and 3 show the general location of the project area chosen in 2012 during the planning phase of the project. They include the locations of the Commonwealth’s historic ambient monitoring stations and the positions of both active (producing) and inactive (not completed or completed but not producing) wells in addition to active or planned permitted unconventional gas facilities in Washington County. Due to the scale of the image, single dots for wells may represent multiple wells on a single well pad.

Natural gas facilities are the only sources of air pollution shown. Note that other sources of air pollution exist within the area and include other non-natural gas-related stationary sources, as well as area and mobile sources of pollution.

Figure 2 - Washington County Project Site (Early 2012)

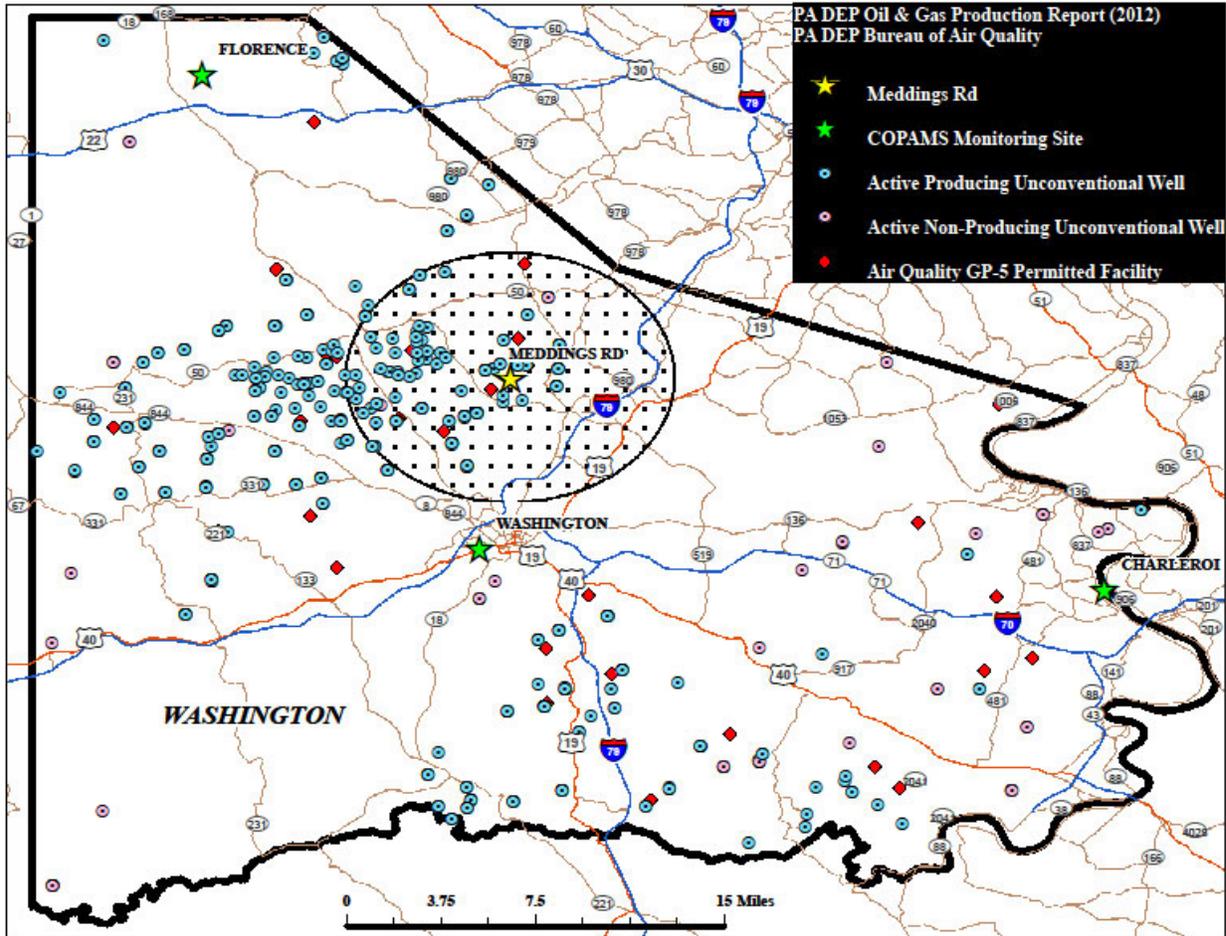
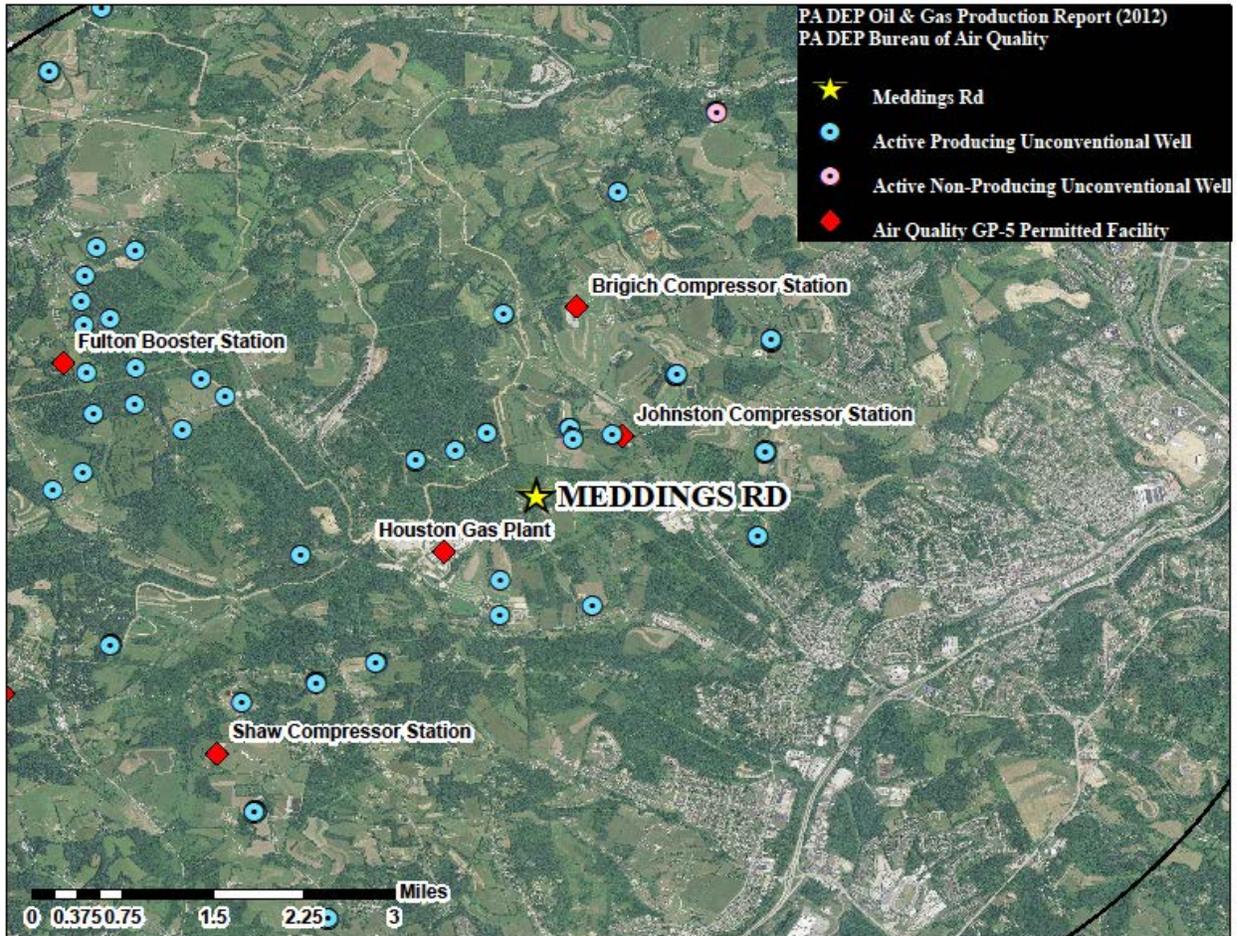


Figure 3 - Long-Term Project Study Area (Detail with ground imagery, early 2012)



The project consisted of multiple sampling sites within the Washington County area that generally measured downwind ambient concentrations of toxic and/or criteria pollutants from permanent shale gas air pollution sources. The permanent natural gas facilities of interest within the project area (red areas in Figure 3) include:

- newly-established natural gas compressor stations or gas treatment facilities (dewatering) that transport freshly extracted combined natural gas and gas liquids;
- natural gas processing and fractionation facilities; and
- a number of actively producing well pads with associated wet gas handling equipment (e.g. small dehydrators, condensate collection tanks, etc.).

As shown in Figure 3, Washington County also has a number of other permanent gas facilities in addition to the ones included in the project area. These facilities are largely compressor stations which can also contribute emissions to the area and be reflected in ambient air sampling results. The project will not attempt to make conclusions about the relative contribution of specific sources to the observed results. Similarly, the terms “upwind” and “downwind” are used in reference to

the location of monitoring sites relative to the natural gas facilities described above. The terms are not used to suggest that the sites are established to measure exclusively or in their entirety the emissions from a single natural gas facility or closely located groups of facilities.

Some of the permanent natural facilities in the county transport gas from conventional, shallow gas reserves (i.e., non-Marcellus, non-shale gas reserves). The facilities are largely in the southeastern portion of the county and are not the focus of this project. While the project attempts to isolate ambient pollutant concentration contributions from permanent shale gas extraction facilities in the project area, monitors and samplers employed both in the project area and the COPAMS network cannot differentiate between emissions from unconventional versus conventional permanent facilities.

Toxic pollutant sampling equipment and monitors were located in an attempt to collect data that represented the anticipated highest mean ambient air pollutant concentration to which a population might be exposed. These mean concentrations form the basis for the toxic inhalation cancer risk and non-cancer hazard screening assessments. Criteria pollutant analyzers were located in an effort to best capture representative concentration data for the area for comparison to primary and secondary NAAQS or “non-criteria pollutant” cancer or non-cancer hazard screening concentrations.

It is important to note that the purpose of this project is not to determine mean ambient concentrations of pollutants across the entire county or for all areas in the county in which unconventional natural gas extraction is occurring. The design does not include sufficient sampling site spatial distribution or number of sampling locations to confidently estimate those mean concentrations and is outside the scope of the project. The project contains specific site areas with monitors and/or samplers sited to characterize ambient air concentrations of criteria and toxic pollutants in those areas that are consistent with the project’s goals listed in Section I.

B. Sampling Site Information

The sampling sites were designed according to the needs of the project and to meet all aspects of EPA siting criteria found at 40 CFR Part 58 concerning monitoring for criteria pollutants or recommended design protocols for non-criteria/toxic pollutants.⁸ All criteria pollutant samples and measurements were collected using Federal Reference Method/Federal Equivalence Method (FRM/FEM) equipment and protocols.

Minimum specifications for HAP samplers⁹ and associated meteorological equipment at the

⁸ Information on toxic air pollutant monitoring and analytical methods can be found on EPA’s website at: <http://www.epa.gov/ttn/amtic/airtox.html>.

⁹ For this project, HAP sampling refers to the collection of ambient air data using two sampling methods for determining VOCs in ambient air. A HAP canister sampler collects whole air samples for analysis of 57 HAPs. The screened compounds are generally in the class of volatile organic compounds known as alkanes. A HAP carbonyl sampler uses chemical adsorption to isolate up to eight specific volatile organic HAP pollutants on cartridges that are subsequently analyzed in a laboratory. These carbonyl compounds are very reactive and differ significantly from the alkanes in that carbonyls cannot be reliably quantified using whole air (canister) methods. DEP will differentiate the two methods as HAP canister (or canister) and HAP carbonyl (or carbonyl) sampling.

sampling sites are described in the TSD. Meteorological equipment specifications for criteria pollutant monitoring at the primary site are consistent with the requirements established for primary and secondary NAAQS special purpose monitoring.

Table 1 summarizes the pollutants measured at all of the sampling sites for the project.

Table 1 - Project Site Pollutant Measurement Summary

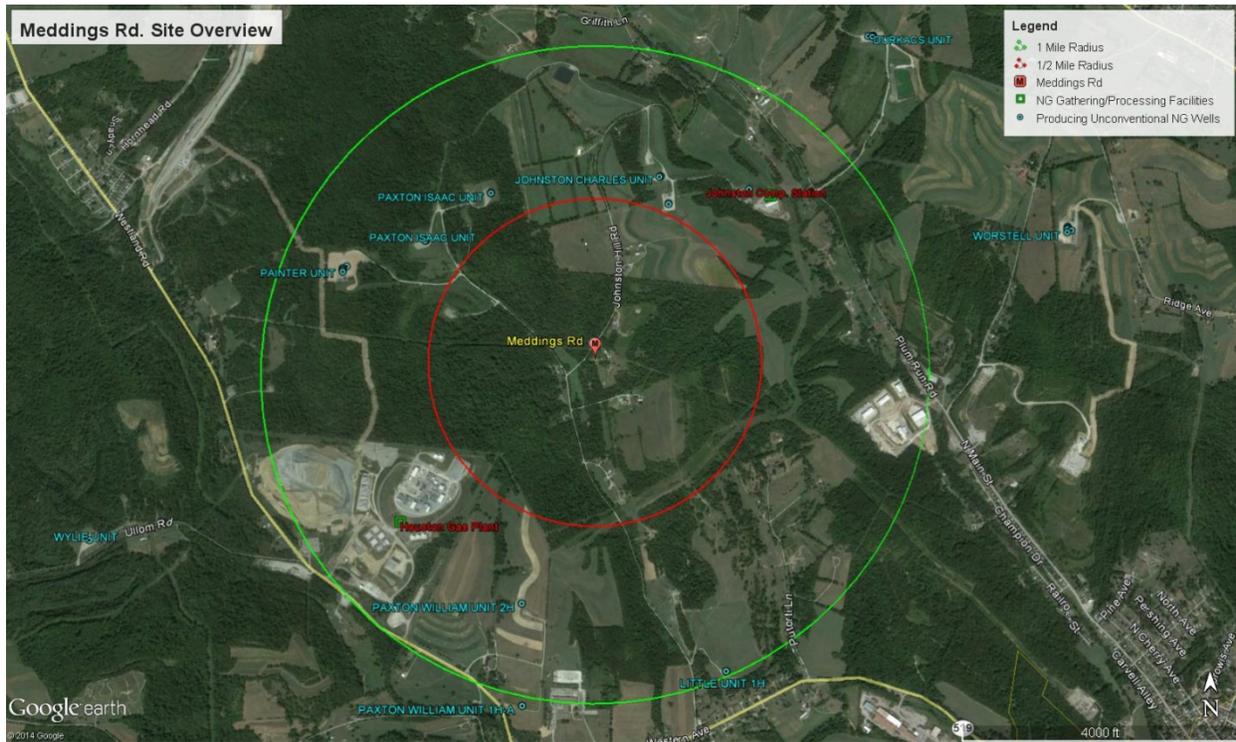
Project Site Name	Canister HAPS	Carbonyl HAPS	Ozone	NO _x /NO/NO ₂	CO	PM _{2.5}	Methane/NMHC	H ₂ S	Met
Meddings Rd	X	X	X	X	X	X	X	X	X
Welsh Rd	X								X
Jaspen Way	X								X
Henderson Rd	X	X						X	X

1. Primary Project Site - Meddings Road

The Department designated the project’s primary site as the location that houses both criteria and toxic pollutant monitors and samplers. It is located generally within the expected downwind influence of potential emissions from a large natural gas processing facility known as the MarkWest Liberty Midstream Resources, LLC (MarkWest) Houston facility. More information on this facility is included in the TSD.

The primary site, designated as the “Meddings Road” site (Figure 4), monitored and collected samples for HAPs, Ozone, NO_x, Carbon Monoxide (CO), PM_{2.5}, Methane, Total Non-Methane Hydrocarbons, H₂S, wind speed, wind direction and temperature. Appendix A lists the specific toxic organic analytes that were sampled. Air samples for HAPs were collected over 24 hours every sixth day.

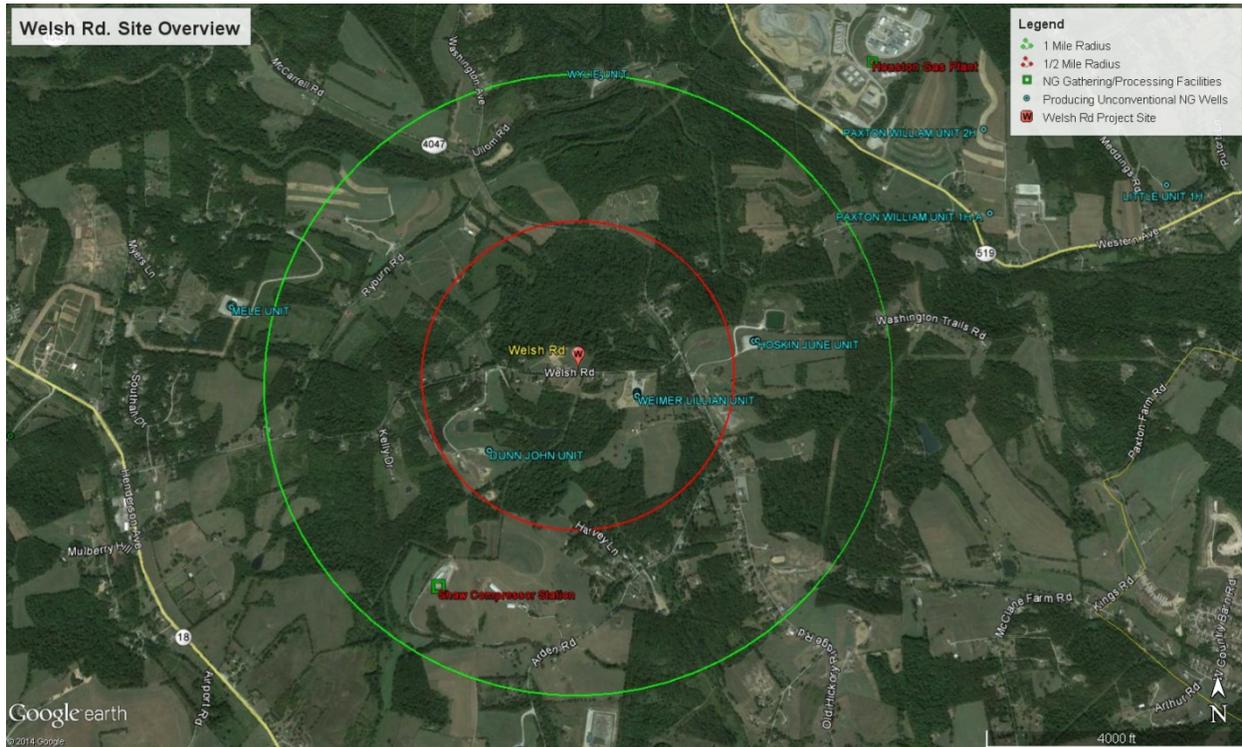
Figure 4 – Meddings Road Site Overview with Shale Gas Sources



2. Welsh Road Monitoring Site

A second site, designated “Welsh Road” and shown in Figure 5, was situated generally upwind from the fractionation plant. The Welsh Road site systematically sampled for select HAPs and measured wind speed, wind direction and temperature. This upwind site collected air samples for select HAPs over 24 hours every sixth day.

Figure 5 - Welsh Road Site Overview with Shale Gas Sources

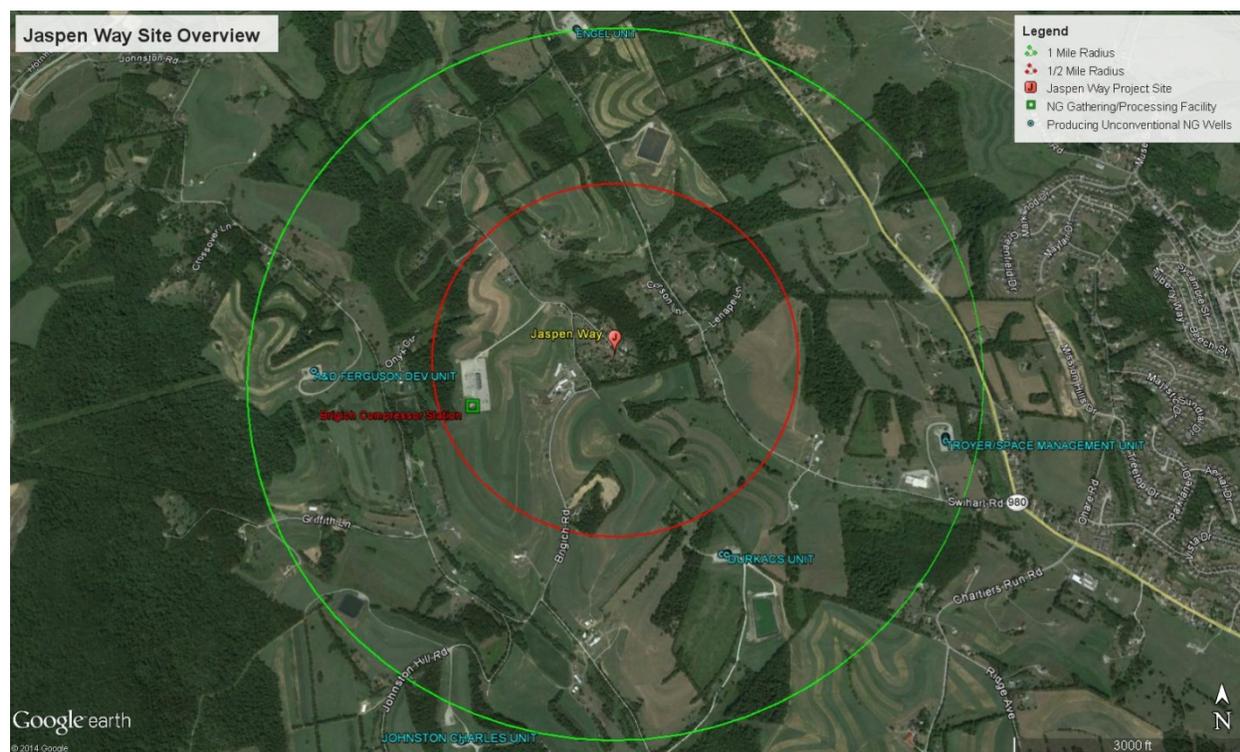


3. Jaspens Way Monitoring Site

The Jaspens Way site shown in Figure 6 is designed to collect ambient concentrations of toxic organic chemicals downwind of the “Brigich” natural gas compressor station. This compressor station, owned by MarkWest, is located approximately 2.2 miles (3.5 km) NNW of the Houston fractionation plant and moves natural gas and associated NGLs from nearby well pads to the plant for processing. The single HAP sampler for this site was located downwind in an effort to capture potential HAP emissions from the compressor station while simultaneously minimizing excessive influences from other potential non-natural gas-related emissions sources in the area.

The Jaspens Way site collected samples for select HAPs and measured wind speed, wind direction and temperature. HAP samples were collected over a 24-hour period every sixth day consistent with the national ambient sampling network schedule.

Figure 6 – Jaspden Way Site Overview with Shale Gas Sources



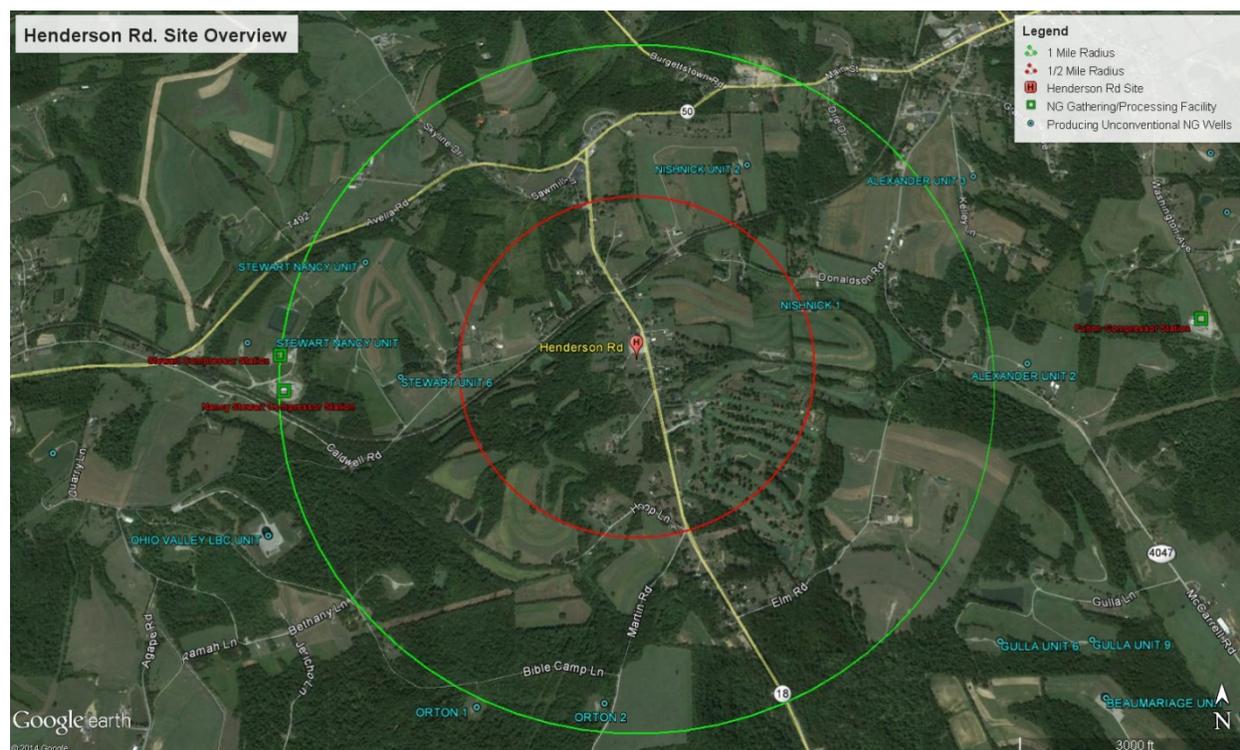
4. Henderson Road Monitoring Site

The Henderson Road site, shown in Figure 7, is designed to collect data on ambient concentrations of HAPs in an area largely downwind from two closely collocated permanent shale gas facilities (compressor station and gas fractionation plant), but situated in a more populated area with other sources of pollution not directly linked to the shale gas facilities (e.g., on-road traffic and school bus idling at a nearby bus garage). The shale gas facilities are located approximately 6.2 miles (10 km) west of the MarkWest Houston fractionation plant. Unlike the Jaspden Way site that sampled ambient downwind concentrations of toxic organic chemicals closer to the compressor station itself, the sampler for the Henderson Road site was located in a downwind location in a more populated area for the purpose of gathering sufficient data to perform, at a screening level, potential Excess Lifetime Cancer Risk and chronic non-cancer hazard for the local population in the sampling area compared to a background (i.e., assumed un-impacted) site. The sampler was located so that no natural gas wells or permanent natural gas infrastructure were located within the immediate area, specifically in a 0.5-mile (0.8 km) radius.

Between the planning and deployment phases of this project, the gas fractionation facility, Stewart Gas Plant owned by Laurel Mountain Midstream, LLC, ceased operations. The remaining facility, Nancy Stewart Booster Station owned by MarkWest, maintained operations for the duration of the project. Additionally, at the beginning of the project, there existed 10 producing Marcellus Shale gas wells and associated onsite sources that could contribute to downwind pollutant concentrations within 0.5 miles (0.8 km) of the compressor station.

HAP samples, including carbonyl compounds, were collected over a 24-hour period every six days and coincided with the national and Commonwealth ambient monitoring network schedule. H₂S was monitored continuously. Wind speed, wind direction and temperature data were continuously collected at this site.

Figure 7 - Overview of the Henderson Road Site and Shale Gas Sources



C. Project Site Pollutant Measurement Summary

Table 1 contains a summary of the pollutants measured and/or sampled at the project sites.

All manual samples were collected over a 24-hour period once every six days coinciding with the national and Commonwealth ambient monitoring network schedule. All other measurements were continuous or semi-continuous.

D. Background & Comparison Sites

The Department employed an existing Commonwealth of Pennsylvania Air Monitoring Station (COPAMS) located in Florence as shown in Figure 8. This station would serve as a “background” site for Ozone, PM_{2.5}, and Carbon Monoxide comparisons. Additional sampling equipment was added to the Florence COPAMS to collect HAP data. For the purposes of this project, this background site was designed to collect ambient air quality data generally upwind and out of the direct influence of the permanent natural gas facilities in the project area.

Similarly, the COPAMS station at Charleroi shown in Figure 9 provided continuous monitoring data for NO/NO₂/NO_x for comparative purposes. While the Charleroi COPAMS station collects

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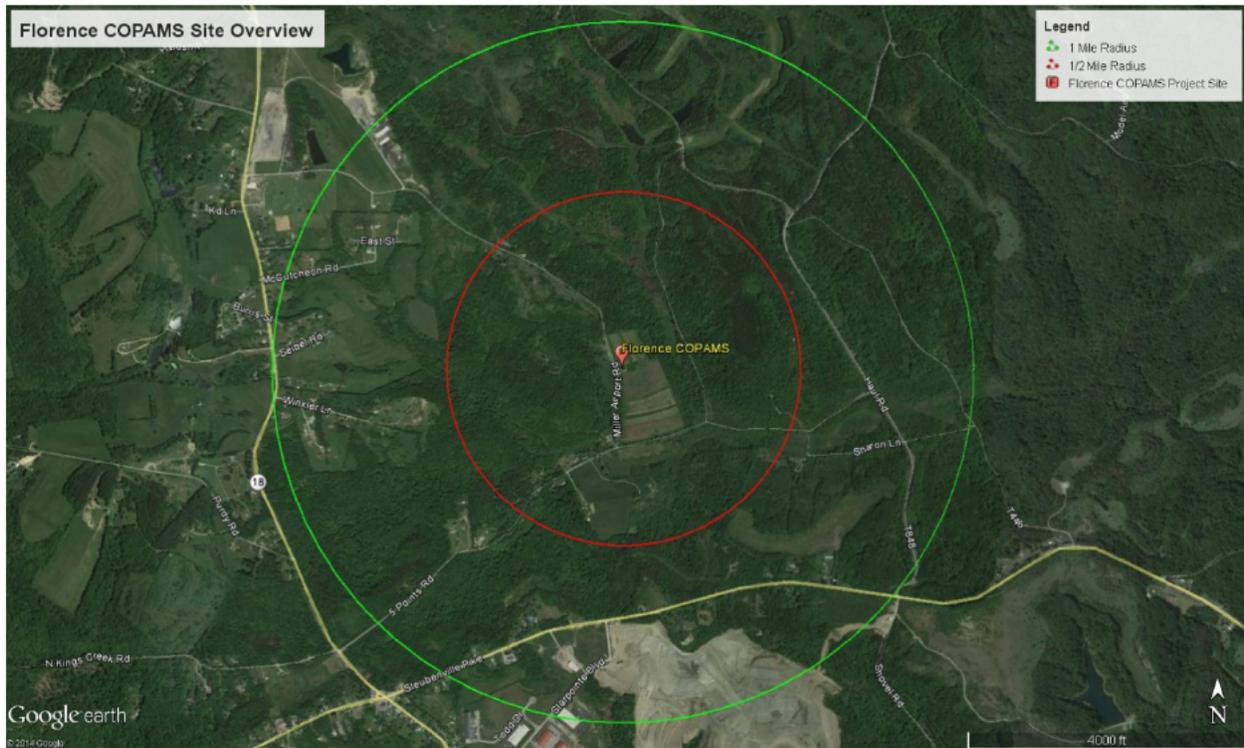
HAP data as part of the Commonwealth’s Air Toxics monitoring network, HAP data from the station was not used for comparison in the project due to the large diversity of sources contributing to the ambient air in the area of the monitor, thus complicating analysis.¹⁰

Table 2 summarizes the pollutants monitored at the background and comparison sites.

Table 2 - Background/Comparison Site Pollutant Measurement Summary

COPAMS Station	County	Type	AQS Site Code ¹¹	HAP Canister	HAP Carbonyl	Ozone	NOx	CO	PM2.5	Met
Florence	Washington	Rural	42-125-5001	X		X		X	X	X
Washington	Washington	Urban	42-125-0200			X			X	X
Charleroi	Washington	Urban	42-125-0005	X		X	X	X	X	X

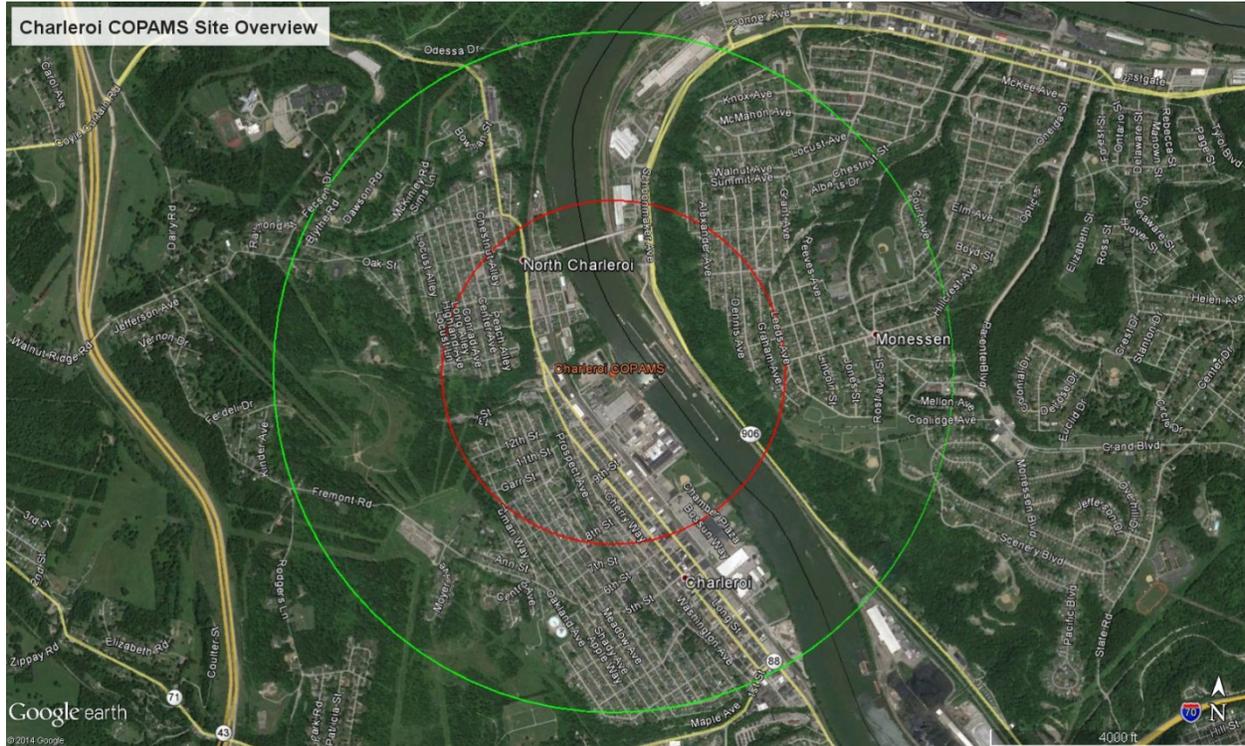
Figure 8 - Overview of Florence COPAMS Background Site



¹⁰ Latest and historical HAP data from the Charleroi COPAMS site is available from the Toxics Monitoring Site webpage at: <http://www.dep.pa.gov/Business/Air/BAO/MonitoringTopics/ToxicPollutants/Pages/Toxic-Monitoring-Sites-in-Pennsylvania.aspx#.ViaHEE3D-Uk>.

¹¹ AQS site codes are monitoring station identifiers used in the U.S. EPA Air Quality System (AQS). The AQS is a national repository of ambient air quality data. More information on AQS can be found at <https://www.epa.gov/aqs>.

Figure 9 - Overview of Charleroi COPAMS Comparison Site



For the analyses of criteria pollutant data obtained from the Meddings Road site, PA DEP selected three additional sites located in Washington County. Figure 10 illustrates the location of these sites with respect to the Meddings Road monitor. The sites are located within the Pittsburgh, PA, Metropolitan Statistical Area (Pittsburgh Metropolitan Statistical Area, MSA), as defined by the federal Office of Management and Budget.¹²

COPAMS Monitoring Sites

PA DEP operates the Commonwealth of Pennsylvania Air Monitoring System (COPAMS) as its air monitoring network to ascertain compliance with federal ambient air standards.

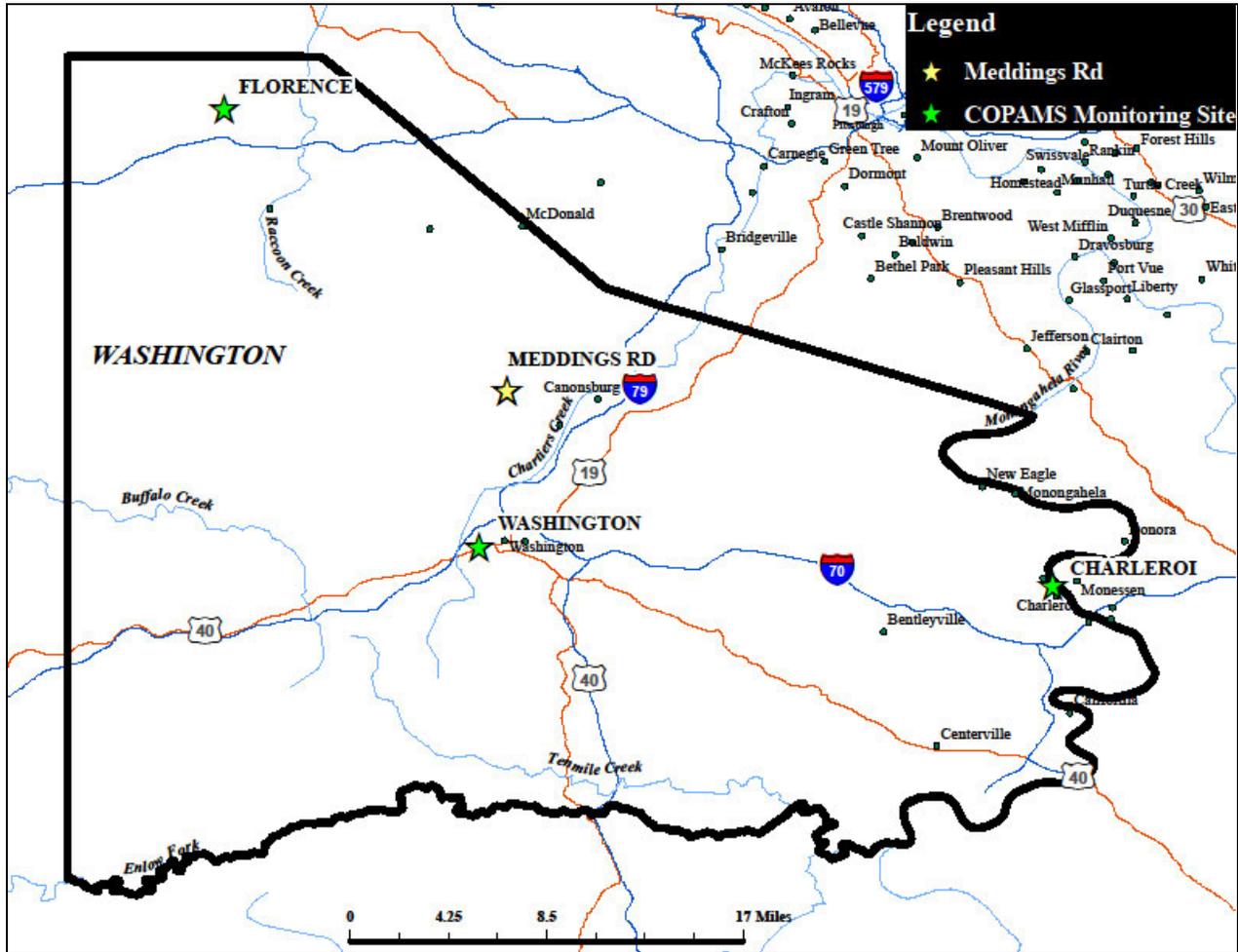
Charleroi (40.146583, -79.902222): The Charleroi monitoring station is sited next to the Monongahela River, which forms the eastern border of Washington County. Located in a river valley, this site is susceptible to meteorological inversions and, as such, ambient pollutant concentrations measured at this site are indicative of impacts from low-level nearby sources.

Florence (40.445472, -80.421222): The Florence monitoring station is sited in rural Washington County. This site is being used as the background comparison site and is impacted primarily by regional transport.

¹² <http://www.census.gov/population/metro/>

Washington (40.170638, -80.261722): The Washington monitoring station is the closest COPAMS monitoring station to the Meddings Road site. This site is in a more urbanized area than the Meddings site. In addition, due to its proximity of US Interstates 70 and 79, the Washington monitoring station is able to capture more emissions from the mobile sector than the Meddings Road site.

Figure 10 - Map of Meddings Road Site and Background/Comparison Sites



III. Data Collection

This section provides a description of the operational activities that occurred during the data collection phase of the project. A listing of data collected as well as a summary of data quality assurance/quality control activities are provided.

A. Data Collection Overview

Staff from the Field Operations Section and Toxics Monitoring Section maintained all sites and monitors and collected manual samples for the duration of the project. Staff from the Toxics Monitoring Section performed advanced maintenance, troubleshooting and calibration of toxics monitoring and sampling equipment when applicable. Sampler and analyzer auditing was conducted by the Division's Quality Assurance & Data Assessment Section. All deployed monitoring and sampling equipment was maintained consistent with the Division's standard operating procedures (SOP) for each monitor/sampler.

All monitoring and sampling equipment was operated in accordance with the applicable SOPs for each type and model of equipment. All equipment field operators were trained in the applicable SOP for equipment for which they were responsible in accordance with field operations training protocols contained in the respective SOPs and Quality Assurance Project Plans (QAPP).¹³

All HAP and non-criteria pollutant sampling and analysis equipment used in this project met the specifications for performance detailed in the TSD.

All collected samples subject to laboratory analysis were analyzed by the Department's Bureau of Laboratories using approved analysis methods in accordance with the laboratory's standard operating procedures. The Department's laboratory is accredited under the National Environmental Laboratory Accreditation Program (NELAP). More information on BOL's analytical methods can be found in the TSD.

Data collected from this project is organized and presented by pollutant and site. Relevant QA/QC or other information is included as needed. Complete data sets are available in spreadsheet form. Criteria pollutant data is summarized, discussed and compared to primary and secondary NAAQS. Collected HAP data is presented and summarized. Discussion of HAP data and presentation of the screening risk/hazard analysis is provided in Section IV.

B. Criteria Pollutants

1. National Ambient Air Quality Standards (NAAQS)

The Clean Air Act, which was last amended in 1990, requires EPA to set National Ambient Air Quality Standards for certain harmful pollutants called "criteria" pollutants. There are two types of standards: primary and secondary. Primary standards protect against adverse health effects,

¹³ This project employed existing SOPs and QAPPs specific to the equipment used or pollutant measured. The AQM Division collected and analyzed data for this project consistent with the Division's existing ambient air criteria and toxics monitoring networks. Fixed-point monitor H₂S and Methane/Non-methane Hydrocarbon protocols have been developed specifically for this project but rely on existing quality assurance protocols already in place for continuously monitored gaseous pollutants. More information on this subject is provided in the TSD.

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while secondary standards protect against environmental welfare effects such as damage to crops, vegetation and buildings, and decreased visibility. Criteria pollutants and standards are published in 40 CFR Part 50 and are shown below in Table 3. The standards are also available on EPA's website at <https://www.epa.gov/criteria-air-pollutants>. The long-term Marcellus project included monitoring for four of the criteria pollutants: Ozone, PM_{2.5}, NO₂ and CO.

Table 3 - Summary of National Ambient Air Quality Standards for Criteria Pollutants

Pollutant/ EPA Final Rule	Primary/ Secondary	Averaging Time	Level	Form	
Carbon Monoxide [76 FR 54294, Aug 31, 2011]	primary	8 hours	9 ppm	Not to be exceeded more than once per year	
		1 hour	35 ppm		
Lead [73 FR 66964, Nov 12, 2008]	primary and secondary	Rolling 3-month period	0.15 µg/m ³ ⁽¹⁾	Not to be exceeded	
Nitrogen Dioxide [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996]	primary	1 hour	100 ppb	98 th percentile of 1-hour daily maximum concentrations, averaged over 3 years	
	primary and secondary	1 year	53 ppb ⁽²⁾	Annual Mean	
Ozone [80 FR 65292, Oct 26, 2015]	primary and secondary	8 hours	0.070 ppm ⁽³⁾	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years	
Particle Pollution Dec 14, 2012 [78 FR 3086, Jan 15, 2013]	PM _{2.5}	primary	12.0 µg/m ³	annual mean, averaged over 3 years	
		secondary	15.0 µg/m ³	annual mean, averaged over 3 years	
	PM ₁₀	primary and secondary	24 hours	35 µg/m ³	98 th percentile, averaged over 3 years
		primary and secondary	24 hours	150 µg/m ³	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide [75 FR 35520, Jun 22, 2010] [38 FR 25678, Sep 14, 1973]	primary	1 hour	75 ppb ⁽⁴⁾	99 th percentile of 1-hour daily maximum concentrations, averaged over 3 years	
	secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year	
(1) In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 µg/m ³ as a calendar quarter average) also remain in effect.					
(2) The level of the annual NO ₂ standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.					
(3) Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O ₃ standards additionally remain in effect in some areas. Revocation of the previous (2008) O ₃ standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.					
(4) The previous SO ₂ standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet one year since the effective date of designation under the current (2010) standards and (2) any area for which implementation plans providing for attainment of the current (2010) standard have not been submitted and approved and which is designated nonattainment under the previous SO ₂ standards or is not meeting the requirements of a State Implementation Plan (SIP) call under the previous SO ₂ standards (40 CFR 50.4(3)). A SIP call is an EPA action requiring a state to resubmit all or part of its SIP to demonstrate attainment of the require NAAQS.					

2. General Descriptions of Criteria Pollutants

Ozone (O₃)

Ground-level Ozone, or photochemical smog, is a secondary pollutant. Ozone is generally not emitted directly into the atmosphere as Ozone but is formed by chemical reactions between other air pollutants. The primary pollutants involved in these reactions - volatile organic compounds (VOCs) and oxides of Nitrogen (NO_x) - form Ozone in the presence of sunlight and warm temperatures. Thus, sources that emit these Ozone precursors are sources of Ozone. Nitrogen oxides result from fossil fuel combustion, and sources commonly include power plants, industrial boilers, and motor vehicles. VOCs are emitted from a variety of sources, including motor vehicles,

chemical plants, refineries, and even natural (biogenic) sources. Ozone and the precursor pollutants that cause Ozone also can be transported into an area from pollution sources located hundreds of miles away. Because the formation of Ozone is boosted by increasing sunlight and temperatures, changing weather patterns contribute to yearly differences in Ozone concentrations, with peak concentrations occurring during the summer months. Ground-level Ozone is a strong irritant to the eyes and upper respiratory system and can hamper breathing. It also damages vegetation, including forest and agricultural crops, and man-made materials such as monuments and statues.

Ozone and PM_{2.5} can impact ambient concentrations on a more regional scale than other criteria pollutants. Ozone is almost exclusively a secondary pollutant, as ground-level Ozone is formed from NO_x and VOC compounds in the presence of sunlight. A sizeable portion of PM_{2.5} pollution is also a secondary pollutant, as fine particulate can be formed as a result of chemical reactions between gaseous emissions, such as Oxides of Nitrogen (NO_x) or Sulfur Dioxide (SO₂). Because time is required to form secondary pollutants, meteorological conditions - such as wind speed and direction, the amount of mixing in the atmosphere and solar radiation, impact both the concentration and distribution of these pollutants over areas further removed from the sources directly emitting precursor compounds.

Fine Particulate Matter (PM_{2.5})

Fine particulates may be primary (directly emitted) or secondary pollutants. Primary fine particulates include dust from roads, residential wood burning, and forest or agricultural fires. Secondary PM_{2.5} particulate emissions result primarily from industrial processes and fuel combustion, including power plants and motor vehicles. Fine particles can accumulate in the respiratory system and are associated with numerous adverse health effects, including decreased lung function and increased respiratory symptoms and disease. Sensitive groups that appear to be at greatest risk include the elderly, individuals with cardiopulmonary disease such as asthma, and children. PM_{2.5} is the major cause of reduced visibility in parts of the United States. Other environmental impacts occur when particles deposit onto soil, plants, water, or man-made materials such as monuments or statues.

Nitrogen Dioxide (NO₂)

Nitrogen dioxide is a highly toxic, reddish brown gas that is created primarily from fuel combustion in industrial sources and vehicles. It creates an odorous brown haze that causes eye and sinus irritation, blocks natural sunlight and reduces visibility. It can severely irritate the respiratory system and has been associated with acute effects in individuals diagnosed with respiratory disease. Nitrogen dioxide contributes to the creation of acid rain and plays a key role in nitrogen loading, adversely impacting forests and other ecosystems. Measurements of ambient NO₂ and CO concentrations are more indicative of nearby or local sources, such as heavily-traveled roads and highways.

In response to regional emission control programs over the past 10 to 15 years, Pennsylvania and the United States have experienced a downward trend of NO₂ concentrations. Over the past decade, ambient NO₂ concentrations in the Pittsburgh MSA have remained well below NAAQS levels. The downward trend in NO₂ concentrations has been attributed largely to decreased emissions from fossil fuel combustion sources including electric utilities, high-temperature operations at

other industrial sources, and operation of motor vehicles (NO₂ emissions indicators), due in part to various nationwide emissions reduction programs¹⁴.

Carbon Monoxide (CO)

Carbon monoxide is a byproduct of the incomplete burning of fuels. Industrial processes contribute to carbon monoxide pollution levels, but the largest man-made source of carbon monoxide is motor vehicle emissions. This pollutant is a health concern in areas of high traffic density or near industrial sources. Peak carbon monoxide concentrations typically occur during the colder months of the year when automotive emissions are greater and nighttime inversion (a weather-related phenomenon) conditions are more frequent. Carbon monoxide is a colorless, odorless, poisonous gas that has an affinity for hemoglobin, 210 times that of oxygen. By combining with the hemoglobin in the blood, it inhibits the delivery of oxygen to the body's tissue, thereby causing shortness of breath, asphyxia, and at sufficient concentrations, death. The health threat from carbon monoxide is most serious for those who suffer from cardiovascular disease. At much higher levels of exposure, healthy individuals are also affected.

3. Air Quality Index

The Air Quality Index (AQI) is the primary tool used by state and local agencies, including PA DEP, for measuring and reporting health effects of criteria pollutants. The AQI is also used for public air quality forecasting purposes. The AQI is published on DEP's website with hourly updates at the following link:

<http://www.dep.pa.gov/business/air/baq/monitoringtopics/airqualityindex/pages/default.aspx>.

AQI values are calculated based on concentration breakpoints specific to individual criteria pollutant and sample time. The AQI scale is divided into categories associated with health messages. The AQI for an area is based on the "critical pollutant," which is the pollutant associated with the highest AQI obtained from all monitored pollutants in the area. Sensitive populations include the elderly, children, people with asthma or other respiratory ailments and people with heart conditions. Table 4 displays the pollutant concentration ranges and associated AQI categories.

¹⁴ "Our Nation's Air, Status and Trends through 2010," EPA-454/R-12-001, February 2012, <http://www.epa.gov/airtrends/2011/report/fullreport.pdf>.

Table 4 - Summary of Air Quality Index (AQI) Categories and Breakpoints

These breakpoints							Equal these AQIs		
O ₃ (ppm) 8-hour	O ₃ (ppm) 1-hour (1)	PM _{2.5} (µg/m ³) 24-hour	PM ₁₀ (µg/m ³) 24-hour	CO (ppm) 8-hour	SO ₂ (ppb) 1-hour	NO ₂ (ppb) 1-hour	AQI	Category	
0.000-0.054	—	0.0—12.0	0-54	0.0-4.4	0-35	0-53	0-50	Good	Air quality is considered satisfactory, and air pollution poses little or no risk.
0.055-0.070	—	12.1—35.4	55-154	4.5-9.4	36-75	54-100	51-100	Moderate	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people. For example, people who are unusually sensitive to Ozone may experience respiratory symptoms.
0.071-0.085	0.125-0.164	35.5—55.4	155-254	9.5-12.4	76-185	101-360	101-150	Unhealthy for Sensitive Groups	Although the general public is not likely to be affected at this AQI range, people with lung disease, older adults and children are at a greater risk from exposure to Ozone. Persons with heart and lung disease, older adults and children are at greater risk from the presence of particles in the air.
0.086-0.105	0.165-0.204	55.5—150.4 ⁽³⁾	255-354	12.5-15.4	186-304 ⁽⁴⁾	361-649	151-200	Unhealthy	Everyone may begin to experience some adverse health effects and members of the sensitive groups may experience more serious effects.
0.106-0.200	0.205-0.404	150.5—250.4 ⁽³⁾	355-424	15.5-30.4	305-604 ⁽⁴⁾	650-1249	201-300	Very Unhealthy	This would trigger a health alert signifying that everyone may experience more serious health effects.
0.201 ⁽²⁾	0.405-0.504	250.5—350.4 ⁽³⁾	425-504	30.5-40.4	605-804 ⁽⁴⁾	1250-1649	301-400	Hazardous	This would trigger a health warning of emergency conditions. The entire population is more likely to be affected.
-2	0.505-0.604	350.5—500.4 ⁽³⁾	505-604	40.5-50.4	805-1004 ⁽⁴⁾	1650-2049	401-500		

¹ Areas are generally required to report the AQI based on 8-hour Ozone values. However, there are a small number of areas where an AQI based on 1-hour Ozone values would be more precautionary. In these cases, in addition to calculating the 8-hour Ozone index value, the 1-hour Ozone index value may be calculated, and the maximum of the two values reported.

² 8-hour O₃ values do not define higher AQI values (>301). AQI values > 301 are calculated with 1-hour O₃ concentrations.

³ If a different Significant Harm Level (SHL) for PM_{2.5} is promulgated, these numbers will change accordingly.

⁴ 1-hr SO₂ values do not define higher AQI values (≥200). AQI values of 200 or greater are calculated with 24-hour SO₂ concentrations.

4. Methods

Monitoring at the Meddings Road site was performed using EPA-approved Federal Reference Methods (FRM) or Federal Equivalent Methods (FEM). Table 5 displays the monitoring and analyses methods utilized by PA DEP at the Meddings Road site, as well as the regional COPAMS comparison sites identified in Section II.

Table 5 - PA DEP COPAMS Monitors: Monitoring and Analysis Methods

PARAMETER	MANUFACTURER/INSTRUMENT/MODEL	EPA METHOD DESIGNATION
Continuous Gaseous Sampling		
O ₃	Teledyne Advanced Pollution Instrumentation Model 400 Photometric Ozone Analyzer http://www.teledyneinstruments.com/	Automated Equivalent Method: EQOA-0992-087 57 FR 44565, 9/28/92 63 FR 31992, 6/11/98 67 FR 57811, 9/12/02
NO/NO ₂ /NO _x	Teledyne Advanced Pollution Instrumentation Model 200A Chemiluminescence Nitrogen Oxides Analyzer for Ambient Concentrations http://www.teledyneinstruments.com/	Automated Reference Method: RFNA-1194-099 59 FR 61892, 12/2/94
CO	Teledyne Advanced Pollution Instrumentation Model 300 CO Gas Filter Correlation Analyzer http://www.teledyneinstruments.com/	Automated Reference Method: RFCA-1093-093 58 FR 58166, 10/29/93
H ₂ S	Teledyne Advanced Pollution Instrumentation Model 101E H ₂ S UV Fluorescence Analyzer http://www.teledyneinstruments.com/	N/A
Particulate Sampling		
PM_{2.5}		
<i>Discrete</i>	R&P Partisol-Plus Model 2025 Sequential Air Sampler w/WINS and R&P Partisol-Plus Model 2025 Sequential Air Sampler w/VSCC http://www.thermoscientific.com/en/products/ambient-air-monitoring.html	Manual Reference Method: RFPS-0498-118 63 FR 18911, 4/16/98 67 FR 15567, 4/2/02 (EQPM-0202-145 redesignated as manual reference method 12/18/06)
<i>Continuous</i>	Met One Instruments Beta-Attenuation Mass (BAM) Model 1020 http://metone.com/air-quality-particulate-monitors/regulatory-2_trashed/bam-1020/	Automated Equivalent Method EQPM-0308-170 73 FR 13224, 3/12/08 73 FR 22362, 4/25/08

5. Criteria Pollutant Observations and Analysis

Ozone (O₃)

Overall, Pennsylvania has followed the nationwide downward trend of Ozone concentrations. The downward trend has been attributed to improvements in emission reduction programs for Ozone precursors, NO_x and VOC, from power plants and other industrial sources, as well as vehicular emissions.¹⁵ In southwestern Pennsylvania, Washington County is currently included in the Pittsburgh-Beaver Valley Nonattainment Area¹⁶ for the former 2008 Ozone NAAQS of 0.075 ppm. This nonattainment area also includes the counties of Allegheny, Armstrong, Beaver, Butler, Fayette and Westmoreland. In January 2017, EPA granted Pennsylvania’s request to issue a “clean

¹⁵ “Our Nation’s Air, Status and Trends through 2010”; EPA-454/R-12-001, February 2012, <http://www.epa.gov/airtrends/2011/report/fullreport.pdf>

¹⁶ Federal Register, 5/21/2012, 30087-30160 (77 FR 30087)

data determination”¹⁷ for the Pittsburgh-Beaver Valley Ozone Nonattainment Area, determining that all monitors in a nonattainment area are currently meeting the level of the 2008 Ozone NAAQS (i.e., “clean” data has been demonstrated). Currently, PA DEP is undergoing the process of redesignating the Pittsburgh-Beaver Valley Ozone Nonattainment Area to attainment for the 2008 standard. In addition, in November 2017, EPA designated all counties in the Pittsburgh-Beaver Valley region as “Attainment/Unclassifiable”¹⁸ for the current 2015 Ozone NAAQS of 0.070 ppm. Data through 2016 indicate that all monitors located within the Pittsburgh-Beaver Valley Ozone Nonattainment Area are currently meeting the current Ozone NAAQS.

Concentration measurements for Ozone and PM_{2.5} at the Meddings Road site correlated strongly with the regional comparison sites, indicating that concentrations for these pollutants were indicative of regional conditions.

Fine Particulate Matter (PM_{2.5})

As was the case for Ozone, Pennsylvania and the United States have experienced a downward trend of PM_{2.5} concentrations. The downward trend in PM_{2.5} concentrations has been attributed to improvements in emission reduction programs for sources of PM_{2.5}, including fossil fuel combustion and other industrial processes, as well as the operation of motor vehicles.¹⁹ In southwestern Pennsylvania, Washington County was included in the Pittsburgh-Beaver Valley PM_{2.5} Nonattainment Area²⁰, which also included the counties of Beaver, Butler, Westmoreland and portions of Allegheny, Armstrong, Greene and Lawrence, for the former 2006 PM_{2.5} NAAQS of 35 µg/m³ (24-hr) and 15.0 µg/m³ (annual). In May 2014, EPA granted Pennsylvania’s request to issue a “clean data determination”²¹ for the Pittsburgh-Beaver Valley PM_{2.5} Nonattainment Area, determining that all monitors in the nonattainment area were meeting the level of the 2006 PM_{2.5} NAAQS (i.e., “clean” data has been demonstrated). In October 2015, EPA redesignated the Pittsburgh-Beaver Valley PM_{2.5} Nonattainment Area as a “Maintenance” area²².

In January 2015, EPA designated the Pittsburgh-Beaver Valley region as “Attainment/Unclassifiable,” with the exception of Allegheny County²³, for the current 2012 PM_{2.5} NAAQS of 35 µg/m³ (24-hr) and 12.0 µg/m³ (annual). EPA designated the entirety of Allegheny County as nonattainment due to monitoring data measured in the Liberty-Clairton area¹⁸, which EPA had previously segregated from the Pittsburgh-Beaver Valley Nonattainment Area. Data

¹⁷ Federal Register, 12/6/2016, 87819-87820 (81 FR 87819)

¹⁸ Federal Register 11/16/2017, 54232-54287 (82 FR 54232)

¹⁹ “Our Nation’s Air, Status and Trends through 2010,” EPA-454/R-12-001, February 2012, <http://www.epa.gov/airtrends/2011/report/fullreport.pdf>.

²⁰ Federal Register, 11/13/2009, 58687-58781 (74 FR 58687)

²¹ Federal Register, 5/2/2014, 25014-25019 (79 FR 25014)

²² Federal Register, 10/2/2015, 59624-59627 (80 FR 59624)

²³ Federal Register, 1/15/2015, 2205-2284 (80 FR 2205)

through 2016 indicate that all monitors within the former Pittsburgh-Beaver Valley Nonattainment Area meet the current PM_{2.5} NAAQS.

Nitrogen Dioxide (NO₂)

For all criteria pollutants, the Meddings Road site reported values either in line with or lower than the regional comparison sites. Ambient pollutant measurements reported at the Meddings Road site correlated well with the comparison sites for the more regionally-distributed pollutants - Ozone and PM_{2.5}. Meddings Road measurements did not correlate with the comparison sites for the more localized pollutants: NO₂ and CO. The Meddings Road site did not report NAAQS-related values for any of the criteria pollutants which exceeded the applicable NAAQS, or indicated a probable future exceedance based on the data pattern. In addition, the Meddings Road site reported a lower number of days outside of the AQI “Good” range than the comparison sites.

Concentration measurements for NO₂ and CO at the Meddings Road site did not correlate with the regional comparison sites which indicated that ambient concentrations of these pollutants were primarily impacted by local sources.

Carbon Monoxide (CO)

Pennsylvania has followed the nationwide downward trend of CO concentrations. The downward trend in CO concentrations has been attributed largely to decreased emissions from mobile sources (the CO Emissions indicator)²⁴, due in part to increased emission controls and advances in automotive technologies. In southwestern Pennsylvania, portions of Allegheny County were originally designated as Nonattainment Areas for the 1971 CO NAAQS. These areas included high traffic density areas within the Central Business District (CBD) of Pittsburgh and certain other high traffic density areas. In 2003, EPA granted Pennsylvania’s request to redesignate the Pittsburgh area as attaining the standard. There have been no violations of the Carbon Monoxide NAAQS since the early 1990’s, and for the past decade, ambient CO concentrations in southwestern Pennsylvania have remained well below NAAQS levels.

a. Data Analyses for Meddings Road and Comparison Sites

The following sections present data analyses for the Meddings Road site and the comparison sites.

First, a summary of NAAQS-related summary statistics and AQI values for each pollutant is included. The 18-month analysis period allowed for direct comparison of measured concentration averages with the NO₂ and CO annual-based NAAQS. However, the Ozone, NO₂ (1-hour) and PM_{2.5} NAAQS were based on averaged data over a three-year period. For these standards, NAAQS-related summary values are presented.

Second, comparisons are presented between the sites in relation to the AQI values and characterizations. Tables displaying the AQI categories and the number of days each site registered values falling within these categories are included.

²⁴ “EPA’s Report on the Environment,” EPA/600/R-07/045F, May 2008, <http://www.epa.gov/roe/>.

Third, charts are presented that display a direct measured pollutant concentration comparison between the Meddings Road site and the comparison sites. For Ozone, NO₂ and CO, daily maximum 1-hour or 8-hour concentrations are used, as appropriate (as relates to pollutant-specific NAAQS). For PM_{2.5}, 24-hour measurements or averages are displayed.

Finally, to assess correlation, tables displaying the Pearson correlation coefficient “R” and scatter graphs displaying the coefficient of determination “R²” are presented. The correlation coefficient is a measure of the direction and strength of a linear relationship. “R” values are always between -1 and 1, with values closest to these thresholds representing the highest amount of correlation. Positive “R” values represent a positive correlation, meaning that as the first variable increases, the comparison value also increases. Negative “R” values represent a negative correlation, meaning that where the first variable increases, the comparison value decreases. All correlation coefficients calculated for this analysis were positive. Calculated “R” values greater than 0.7 represent a high degree of correlation, while “R” values greater than 0.9 represent a very high degree of correlation. “R” values below 0.5 represent a low degree of correlation, and values below 0.3 represent a degree of correlation which is negligible. The coefficient of determination is indicative of how well a regression line represents the data, specifically what percentage of the variation between the data pairs fit the regression line. For example, an “R²” value of 0.63 means that 63 percent of the variation between the data pairs can be explained by the regression line^{25,26}.

Ozone

The 8-hour Ozone NAAQS is currently 0.070 ppm, which is calculated based on a three-year average of annual 4th high daily maximum 8-hour values. Although the study period did not encompass three calendar years, NAAQS-related summary data for Ozone measurements are presented in Table 6. The table displays the 1st to the 4th high daily maximum 8-hour values for the comparison sites. The Florence site registered a 4th high 8-hour maximum in exceedance of the Ozone NAAQS level for the complete calendar year of 2013, while the remaining sites measured 4th maximums below the NAAQS level.

²⁵ <http://mathbits.com/MathBits/TISection/Statistics2/correlation.htm>

²⁶ <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3576830/table/T1/>

Table 6 - 1st Through 4th Highs of Daily Maximum 8-hour Concentrations in 2012 and 2013: Meddings Road vs. Comparison Sites

Ozone 8-Hour Maximums (ppm) and Exceedance Days, July 20, 2012 - December 31, 2013					
Year	Daily 8-Hr Max	Charleroi	Florence	Washington	Meddings Rd
2012 (July 20-Dec 31)	1 st Max	0.079	0.071	0.077	0.060
	2 nd Max	0.076	0.071	0.074	0.057
	3 rd Max	0.072	0.070	0.074	0.057
	4 th Max	0.070	0.070	0.073	0.056
2013	1 st Max	0.082	0.084	0.084	0.078
	2 nd Max	0.072	0.076	0.074	0.065
	3 rd Max	0.069	0.075	0.067	0.065
	4 th Max	0.064	0.071	0.067	0.063
2012 (July 20-Dec 31)	# Days >0.070	3	2	5	0
2013		2	4	2	1
Exceedance Day is any calendar day for which the maximum 8-hr ozone concentration is greater than the 2015 average 8-hr Ozone NAAQS of 0.070 parts per million (ppm)					
Red highlighted values are those values that were recorded as being higher than the 0.005 ppm 2015 8-hr Ozone NAAQS					

During the analysis period, 8-hour Ozone concentrations corresponding to the AQI “Moderate” range (0.055 - 0.070 ppm) were reported at one or more sites on 77 individual days. The Meddings Road site reported the maximum 8-hour Ozone concentration on six of the 77 days. Ozone concentrations corresponding to the AQI “Unhealthy for Sensitive Groups” range (0.071 - 0.085 ppm) were reported at one or more sites on 10 individual days. The Meddings Road site did not report the maximum concentration for any of the 10 days. Table 7 displays the AQI category distribution over the analysis period. As shown, the Meddings Road site recorded the least number of “Moderate” days. The Meddings Road site also had 15 days less days of observations than the comparison sites. On these 15 days, the three comparison sites did not experience an AQI value above the “Good” category.

Table 7 - Ozone Air Quality Index Summary: Meddings Road vs. Comparison Sites

Ozone AQI Category Distribution, No. of Days, Jul 20, 2012 - Dec 31, 2013				
AQI Category	Charleroi	Florence	Washington	Meddings Rd
GOOD	471	471	473	482
MODERATE	53	51	49	31
UNHEALTHY FOR SENSITIVE GROUPS	5	6	7	1

The distribution of AQI values over the comparison sites do not indicate a source unique to the Meddings Road site that would indicate a possible health concern, beyond the air quality impact of regional sources and shared meteorology.

Figures 11 and 12 display the daily maximum 8-hour Ozone concentrations for Meddings Road and the two comparison sites for 2012 and 2013. As shown, the Meddings Road site tracks the other comparison sites reasonably well, in both concentration value and pattern, most consistently on the mid-to-low end of the range of measured values. In 2012, Ozone concentrations at the Meddings Road site were lower than the comparison sites. The Meddings Road monitor passed QA/QC criteria in 2012. However, due to the monitor's low Ozone concentrations with respect to other nearby sites, the Ozone sensor was replaced. Starting in 2013, the Ozone concentrations at Meddings Road tracked very well with the Florence monitor, which would be expected due to the rural location of both monitors.

Figure 11 - Daily Maximum 8-hour Ozone Concentration for July 20, 2012 to December 31, 2012: Meddings Road vs. Comparison Sites

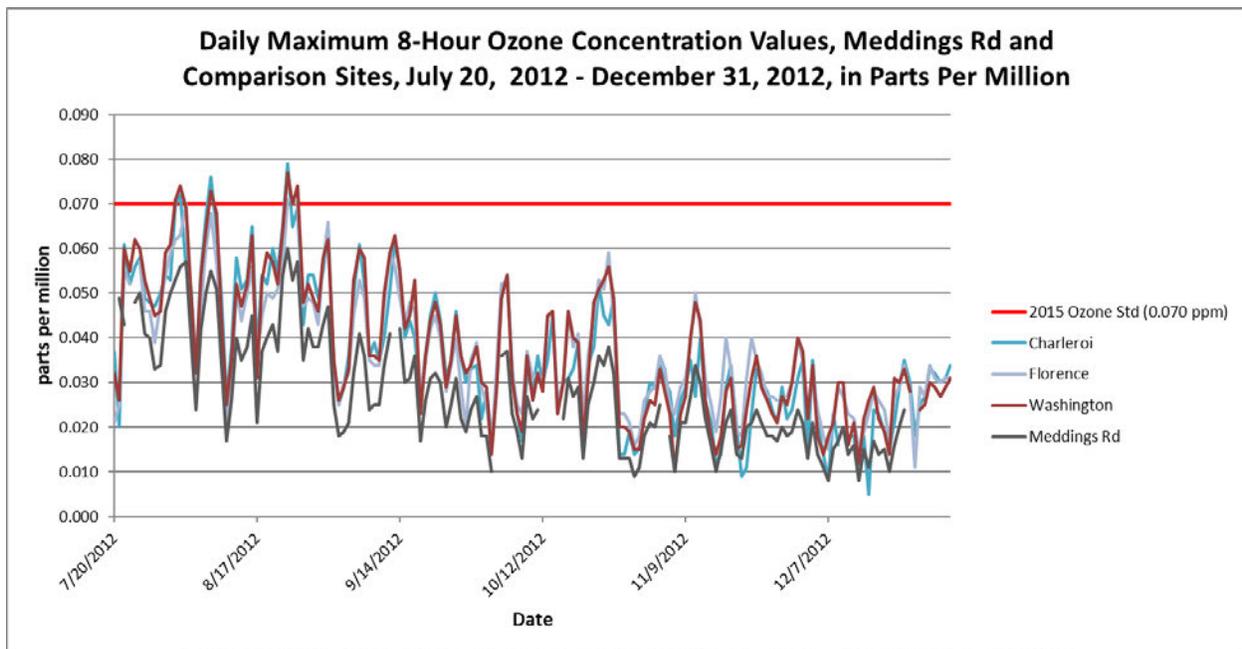


Figure 12 - Daily Maximum 8-hour Ozone Concentration for January 1, 2013 to December 31, 2013: Meddings Road vs. Comparison Sites

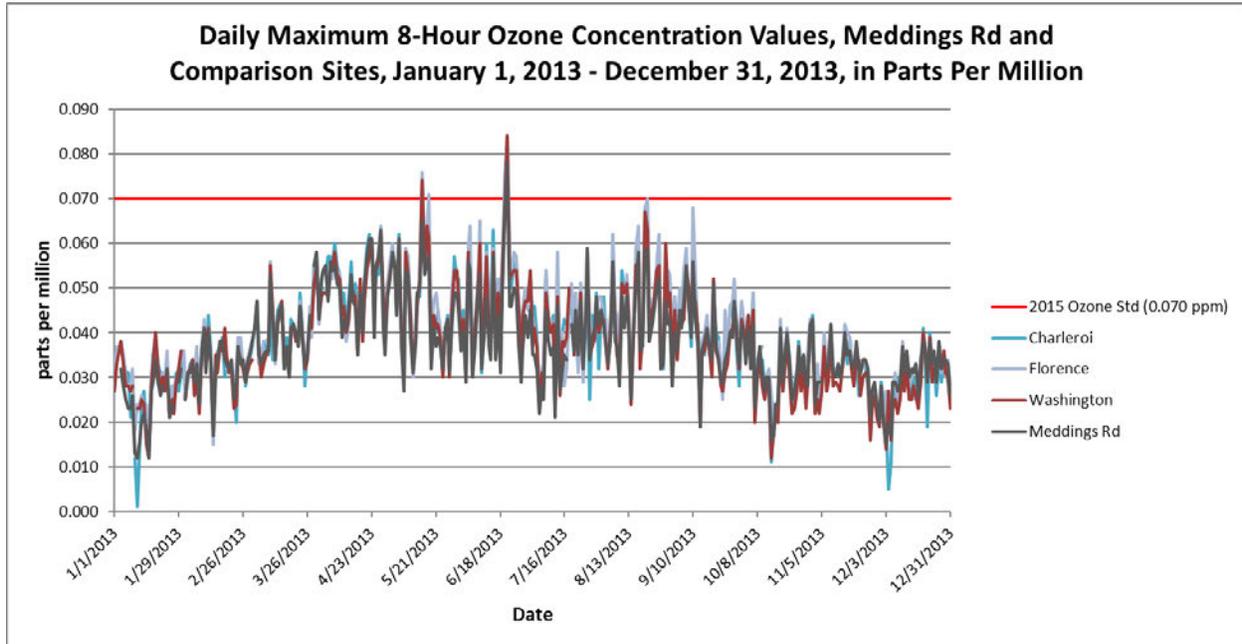
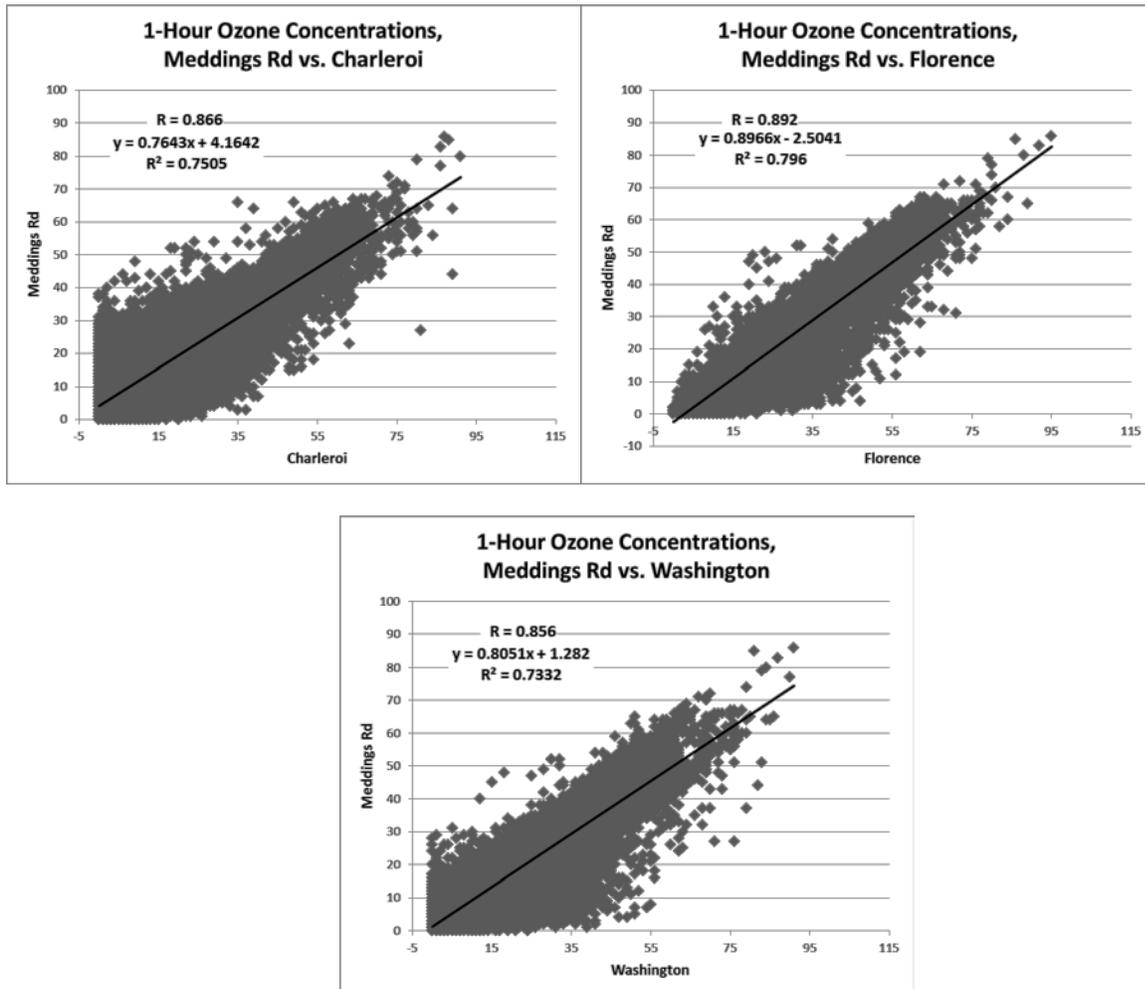


Figure 13 shows the Pearson correlation between Meddings Road and the comparison sites for the period July 20, 2012 to December 31, 2013. The Meddings Road site correlates strongly with the comparison sites.

Figure 13 - Graphical Representation of Daily Maximum 8-Hour Ozone Concentrations (ppb) at Meddings Road vs. Comparison Sites



The Ozone concentration measurements for the calendar year 2013 clearly display the seasonal impact on ground-level Ozone, with peak Ozone concentrations occurring during the summer months. As the correlation data illustrates in Figure 13, the Meddings Road monitor correlates the best with Florence. Both sites are located in rural portions of Washington County. As the Meddings Road values show in Figures 11 and 12, the Meddings site did not show any elevated values in Ozone which would indicate an impact from sources exclusive to the Meddings Road site and outside of shared meteorological impacts on Ozone concentrations in the region.

PM_{2.5}

The 24-hour PM_{2.5} NAAQS is 35µg/m³, based on a 3-year average of annual 98th percentile of daily 24-hour values. The 98th percentile value is defined as the value below which 98 percent of the data set, in this case daily 24-hour values, fall. Although the study period did not encompass three calendar years, NAAQS-related summary data for PM_{2.5} measurements are presented in Table 8. The table displays the 1st and 2nd maximum 24-hour values for the comparison sites, as well as the 98th percentile value for the calendar year 2013. No site registered a single 24-hour average in exceedance of the 24-hour PM_{2.5} NAAQS.

Table 8 - 1st and 2nd High and 98th Percentiles (if Applicable) of Daily Average PM_{2.5} Concentrations in 2012 and 2013: Meddings Road vs. Comparison Sites

PM _{2.5} Daily Average Maximums (µg/m ³) and Exceedance Days, August 2, 2012 - December 31, 2013					
Year	Daily 1-Hr Max	Charleroi	Florence	Washington	Meddings Rd
2012 (Aug 2-Dec 31)	1 st Max	24.4	18.1	29.6	20.1
	2 nd Max	22.9	17.5	20.7	18.5
2013	1 st Max	27.2	27.3	28.2	24.9
	2 nd Max	25.3	26.7	25.6	23.7
	98 th Percentile	22.2	20.6	21.2	17.9
2012 (July 20-Dec 31)	# Days >35	0	0	0	0
2013	# Days >35	0	0	0	0

The annual PM_{2.5} NAAQS is 12.0 µg/m³ which is based on a three-year average of annual means.

Table 9 displays the quarterly averages for all three sites for the study periods, as well as the subsequent annual means for the calendar year 2013. All sites recorded annual means below the annual PM_{2.5} NAAQS.

Table 9 - Quarterly Averages and Annual Means (if Applicable) in 2012 and 2013: Meddings Road vs. Comparison Sites

PM _{2.5} Quarterly and Annual Means (ppb), August 2, 2012 - December 31, 2013					
Year	Averages	Charleroi	Florence	Washington	Meddings Rd
2012 (Aug 2-Dec 31)	3 rd Quarter	10.59	9.17	9.98	9.91
	4 th Quarter	8.69	7.70	9.10	8.05
2013	1 st Quarter	10.02	8.79	10.02	8.37
	2 nd Quarter	10.91	8.33	9.26	8.45
	3 rd Quarter	12.24	10.41	11.47	10.09
	4 th Quarter	9.14	7.47	7.96	6.64
2013	Annual Mean	10.6	8.7	9.7	8.4

During the analysis period, 24-hour PM_{2.5} concentrations corresponding to the AQI “Moderate” range (12.1 - 35.4 µg/m³) were reported at one or more sites on 215 individual days. The Meddings Road site reported the maximum PM_{2.5} concentration on seven of the 215 days. Table 10 displays the AQI category distribution over the analysis period. As shown in the Table, the Meddings Road site recorded the least number of “Moderate” days. The Meddings Road site also had 39 less days of observations than the comparison sites. On 17 of these 39 days, one or more of the comparison sites measured PM_{2.5} values in the “Moderate” range.

Table 10 – PM_{2.5} Air Quality Index Summary: Meddings Road vs. Comparison Sites

PM _{2.5} AQI Category Distribution, No. of Days, Aug 2, 2012 - Dec 31, 2013				
AQI Category	Charleroi	Florence	Washington	Meddings Rd
GOOD	328	368	345	392
MODERATE	170	133	171	86

The distribution of AQI values over the comparison sites did not indicate a source unique to the Meddings Road site that would indicate a possible health concern, beyond the air quality impact of regional sources.

Figures 14 and 15 display the daily 24-hour PM_{2.5} concentrations for the Meddings Road site and the comparison sites for 2012 and 2013. As shown, the Meddings Road site follows the other comparison sites reasonably well, in both concentration value and pattern.

Figure 14 - Daily Average PM_{2.5} Concentrations for August 2, 2012 to December 31, 2012: Meddings Road vs. Comparison Sites

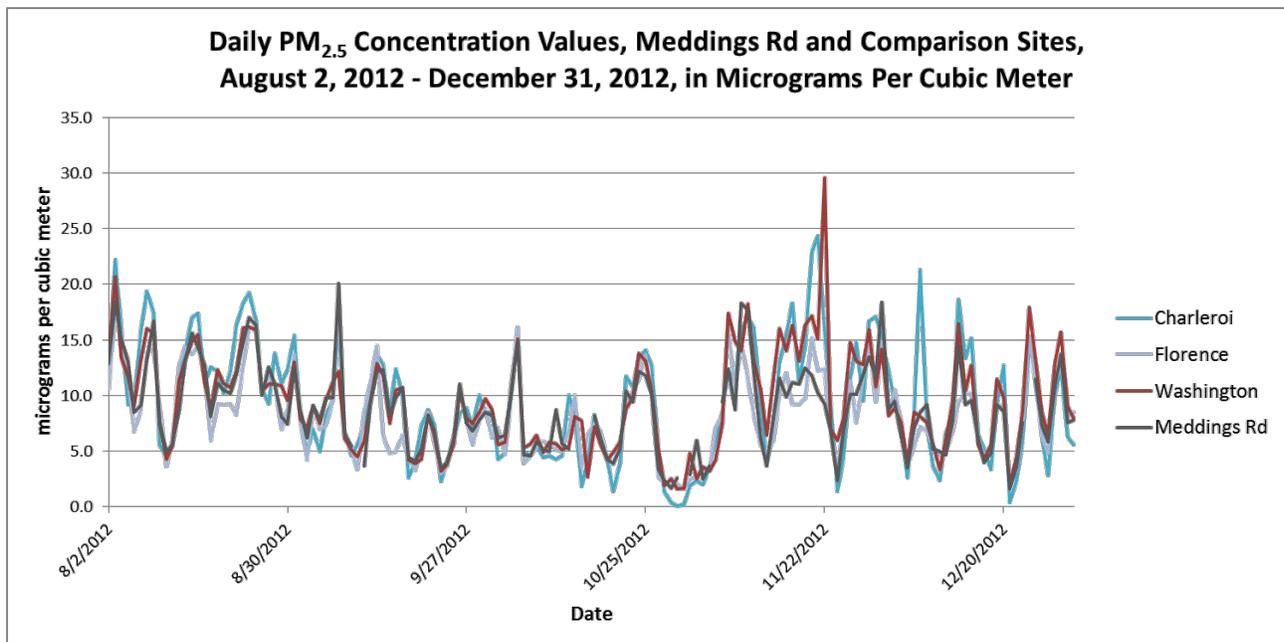


Figure 15 - Daily Average PM_{2.5} Concentrations for January 1, 2013 to December 31, 2013: Meddings Road vs. Comparison Sites

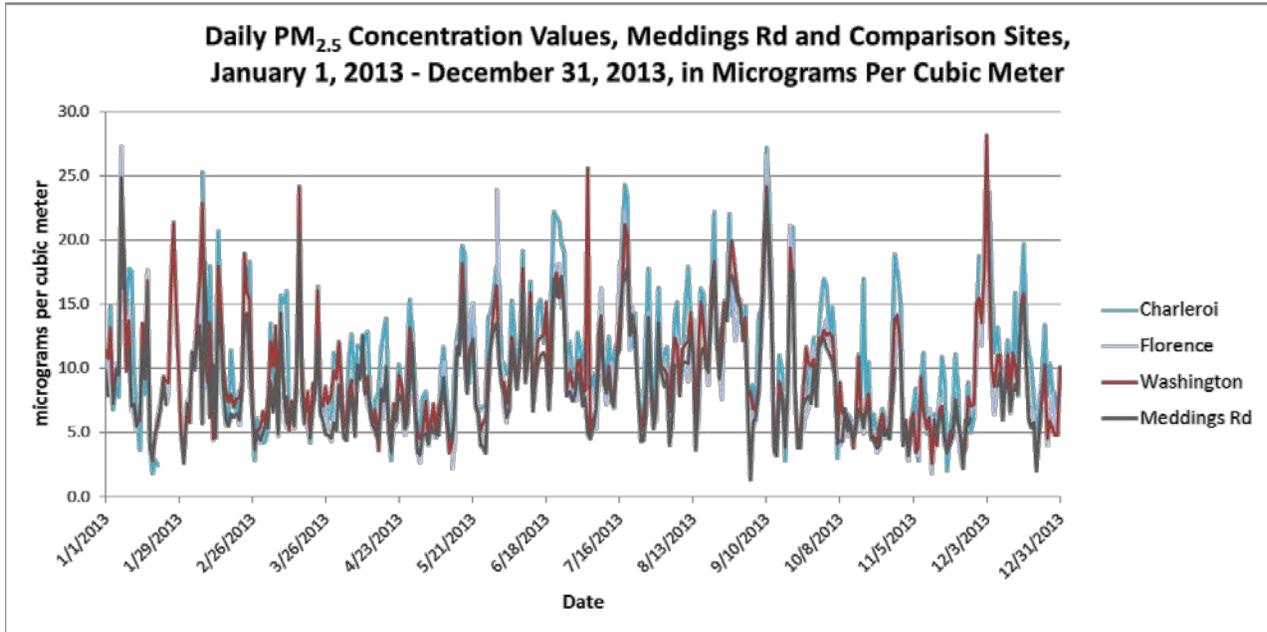
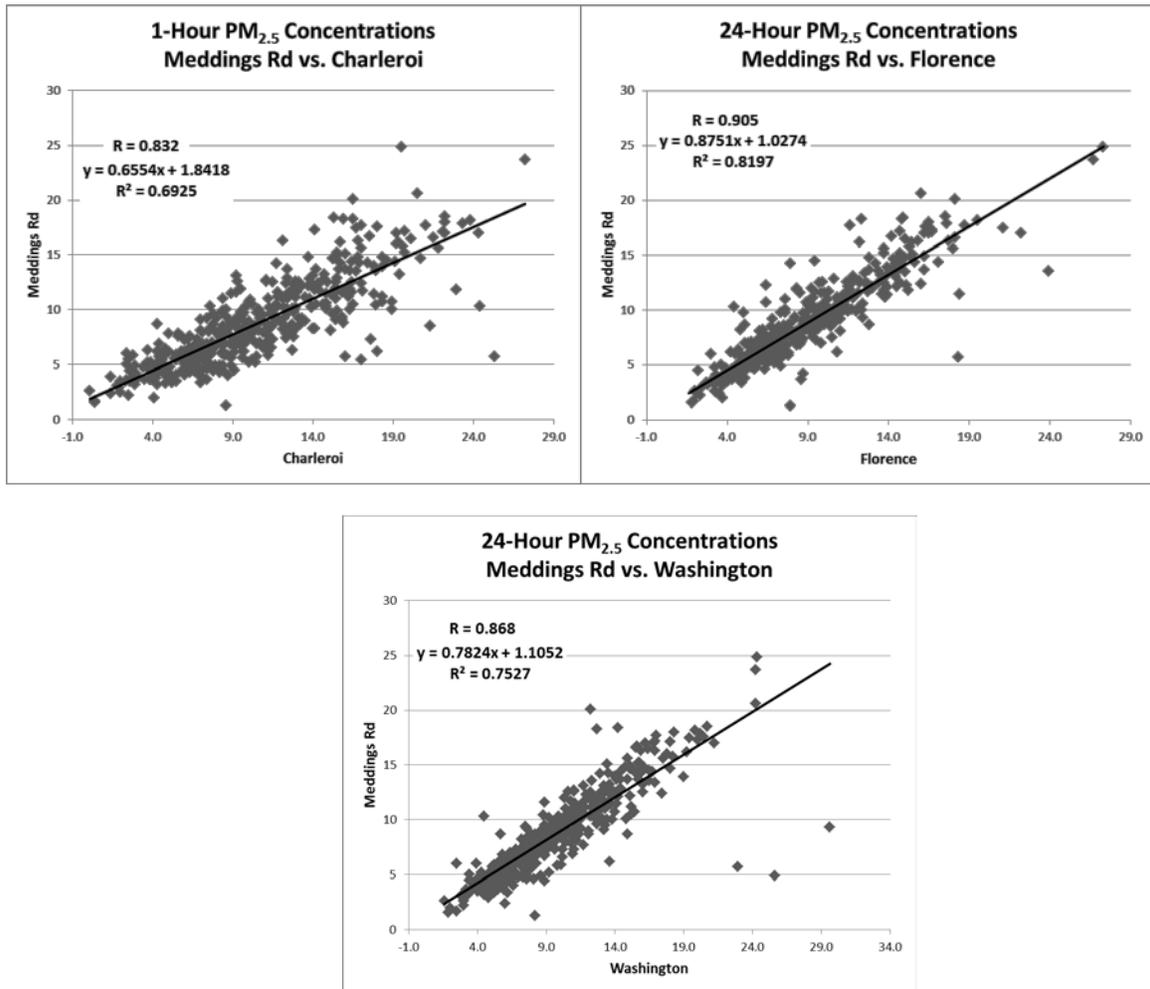


Figure 16 shows the Pearson correlation between Meddings Road and the comparison sites for the period August 2, 2012 to December 31, 2013. The Meddings Road site correlates strongly with the other comparison sites.

Figure 16 - Graphical Representation of Daily Average PM_{2.5} Concentrations (µg/m³) at Meddings Road vs. Comparison Sites



As shown in Figure 16, the Meddings Road monitor follows the trend of the Florence COPAMS monitor particularly well, indicating that PM_{2.5} concentrations measured at the Meddings Road monitor are more indicative of impacts in rural locations. In addition, there are most likely more localized sources (stationary and mobile) in Charleroi and Washington that are contributing to the slight deviation in peak 24-hour daily concentrations with the Meddings Road monitor.

The comparatively low PM_{2.5} concentrations measured at the Meddings Road site, as well as the pattern of correlation with the rural Florence site, do not indicate an impact of localized PM_{2.5} source measured by the Meddings Road site that would cause the monitored area to exceed the PM_{2.5} NAAQS.

NO₂

The 1-hour NO₂ NAAQS is 100 ppb, based on a 3-year average of annual 98th percentile of daily maximum 1-hour values. The 98th percentile value is defined as the value below which 98 percent of the data set, in this case daily maximum 1-hour values, fall. Although the study period did not encompass three calendar years, NAAQS-related summary data for NO₂ measurements are

presented in Table 11 which displays the 1st and 2nd daily maximum 1-hour values for the two sites, as well as the 98th percentile value for the calendar year 2013. Neither site registered a single hourly maximum in exceedance of the 1-hour NO₂ NAAQS.

Table 11 - 1st and 2nd High and 98th Percentiles (if Applicable) of Daily Maximum 1-Hour NO₂ Concentrations in 2012 and 2013: Meddings Road vs. Comparison Site

NO₂ 1-Hour Maximums (ppb) and Exceedance Days, July 20, 2012 - December 31, 2013			
Year	Daily 1-Hr Max	Charleroi	Meddings Rd
2012 (July 20-Dec 31)	1 st Max	43	26
	2 nd Max	40	25
2013	1 st Max	72	27
	2 nd Max	43	27
	98 th Percentile	34	23
2012 (July 20-Dec 31)	# Days >100	0	0
2013	# Days >100	0	0
Exceedance Day is any calendar day for which the maximum 1-hr NO ₂ concentration is greater than the 1-hr NO ₂ NAAQS of 100 parts per billion (ppb)			

The annual NO₂ NAAQS is 53 ppb and is based on a simple arithmetic mean of all 1-hour values reported in a calendar year. Table 12 displays the annual means for the comparison sites for the calendar year 2013. Both sites recorded annual means well below the annual NO₂ NAAQS.

Table 12 - Annual Average NO₂ Concentrations in 2013: Meddings Road vs. Comparison Sites

NO₂ Annual Means (ppb), January 1, 2013 - December 31, 2013		
Year	Charleroi	Meddings Rd
2013	8	4

During the analysis period, the Charleroi site recorded one 1-hour NO₂ concentration value corresponding with the AQI “Moderate” range (54-100 ppb). For the remainder of the analysis period, both sites recorded AQI values in the “Good” range (0-53 ppb).

Figures 17 and 18 display the daily maximum 1-hour NO₂ concentrations for the Meddings Road and Charleroi sites for 2012 and 2013. As shown, the Meddings Road monitor measured lower values than the Charleroi monitor.

Figure 17 - Daily Maximum 1-Hour NO₂ Concentrations for July 20, 2012 to December 31, 2012: Meddings Road vs. Comparison Sites

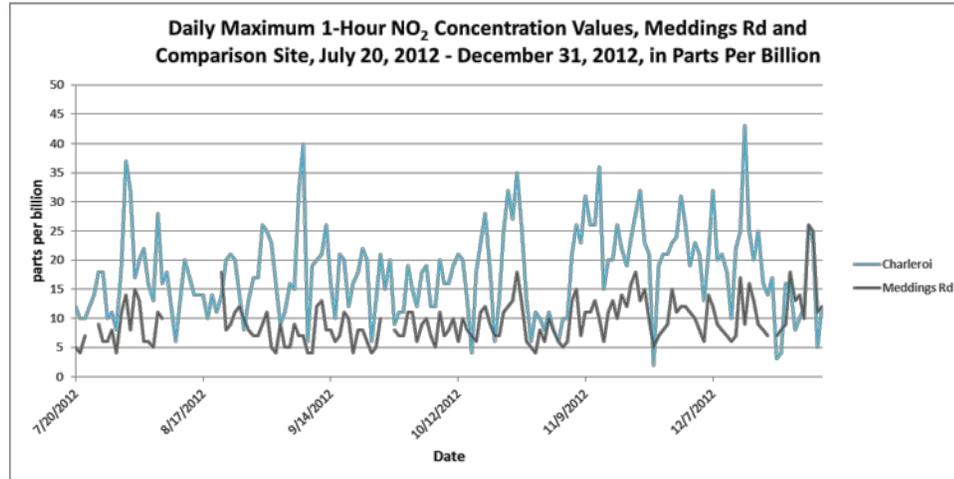


Figure 18 - Daily Maximum 1-Hour NO₂ Concentrations for January 1, 2013 to December 31, 2013: Meddings Road vs. Comparison Sites

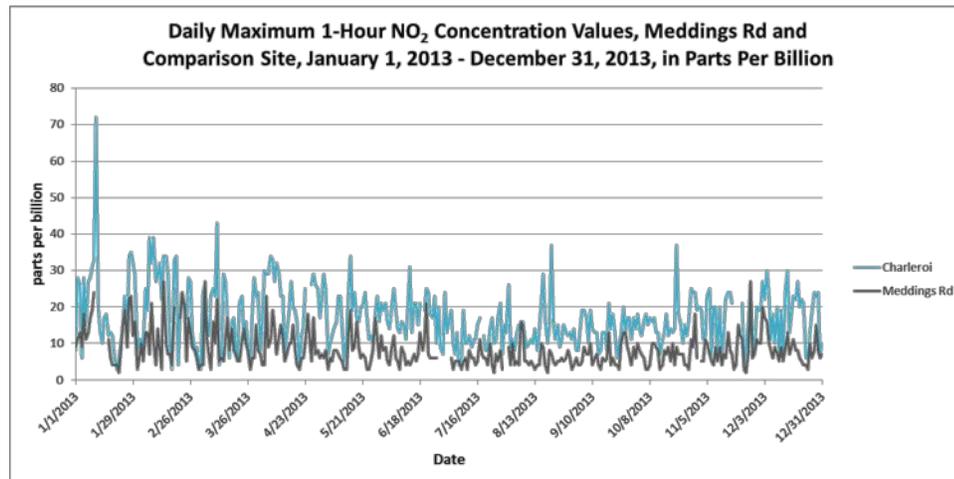
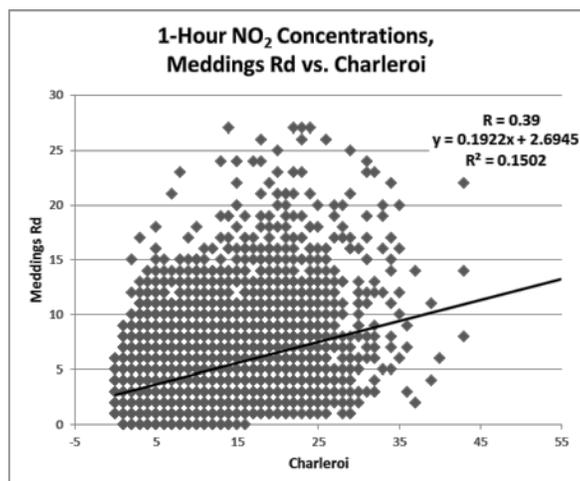


Figure 19 shows the Pearson correlation between Meddings Road and the Charleroi comparison site for the period July 20, 2012 to December 31, 2013. As expected with localized source impacts, the Meddings Road site correlates poorly with the comparison site.

Figure 19 - Graphical Representation of Daily Maximum 1-Hour NO₂ (ppb) at Meddings Road vs. Comparison Site



The Meddings Road monitor is located in a rural area. The Charleroi station is located in a more populated area with a greater mobile source contribution. Both the measured NO₂ concentrations and poor correlation between these sites are reflective of the impact of localized sources.

The comparatively low NO₂ concentrations measured at the Meddings Road site overall and pattern of hourly maxima (i.e., the absence of hourly maxima above 100 ppb) indicate that the monitoring did not find a local source impact which would cause the monitored area to exceed the NO₂ NAAQS and thus did not indicate an observed health concern.

CO

The 1-hour CO NAAQS is 35 ppm, not to be exceeded more than once per year. Table 13 displays the 1st and 2nd maximum 1-hour values for the comparison site. No site registered a single hourly maximum in exceedance of the 1-hour NAAQS.

Table 13 - 1st and 2nd High and No. of Exceedance Days of Daily Maximum 1-Hour CO Concentrations in 2012 and 2013: Meddings Road vs. Comparison Site

CO 1-Hour Maximums (ppm) and Exceedance Days, July 20, 2012 - December 31, 2013			
Year	Daily 1-Hr Max	Charleroi	Meddings Rd
2012 (July 20-Dec 31)	1 st Max	2.4	1.6
	2 nd Max	1.1	1.6
2013	1 st Max	2.0	1.4
	2 nd Max	1.2	1.1
2012 (July 20-Dec 31)	# Days >35	0	0
2013	# Days >35	0	0
Exceedance Day is any calendar day for which the maximum 1-hr CO concentration is greater than the 1-hr CO NAAQS of 35 parts per million (ppm)			

The 8-hour CO NAAQS is 9 ppm, not to be exceeded more than once per year, based on a non-overlapping 8-hour rolling average.

Table 14 displays the 1st and 2nd maximum non-overlapping 8-hour values for the comparison site. Neither site registered a single 8-hour maximum in exceedance of the 1-hour CO NAAQS.

Table 14 - 1st and 2nd High and Number of Exceedance Days of Daily Maximum 8-Hour CO Concentrations in 2012 and 2013: Meddings Road vs. Comparison Site

CO 8-Hour Maximums (ppm) and Exceedance Days, July 20, 2012 - December 31, 2013			
Year	Daily 1-Hr Max	Charleroi	Meddings Rd
2012 (July 20-Dec 31)	1 st Max	0.8	0.9
	2 nd Max	0.8	0.7
2013	1 st Max	0.9	0.7
	2 nd Max	0.7	0.4
2012 (July 20-Dec 31)	# Days >9	0	0
2013	# Days >9	0	0
Exceedance Day is any calendar day for which the maximum 1-hr CO concentration is greater than the 8-hr CO NAAQS of 9 parts per million (ppm)			

Both sites reported 8-hour CO concentrations values in the AQI “Good” range (0 - 4.4 ppm) for the duration of the analysis period.

Figures 20 through 23 display the daily maximum 1-hour and 8-hour CO concentrations for the Meddings Road and Charleroi comparison site for 2012 and 2013. As shown in the figures, the Meddings Road monitor measured lower but similar values compared to the Charleroi site.

Figure 20 - Daily Maximum 1-Hour CO Concentrations for July 20, 2012 to December 31, 2012: Meddings Road vs. Comparison Site

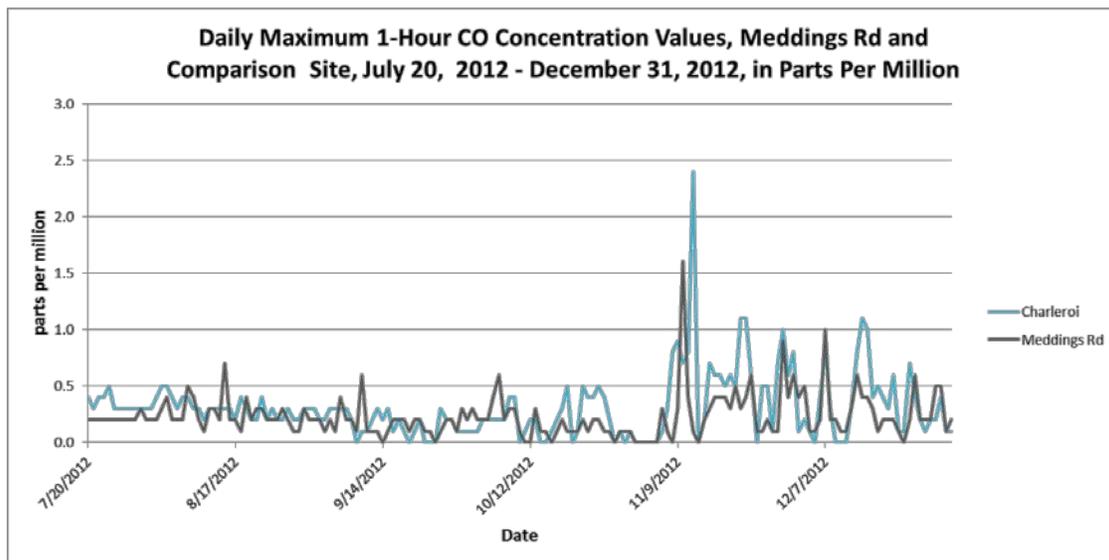


Figure 21 - Daily Maximum 1-Hour CO Concentrations for January 1, 2013 to December 31, 2013: Meddings Road vs. Comparison Site

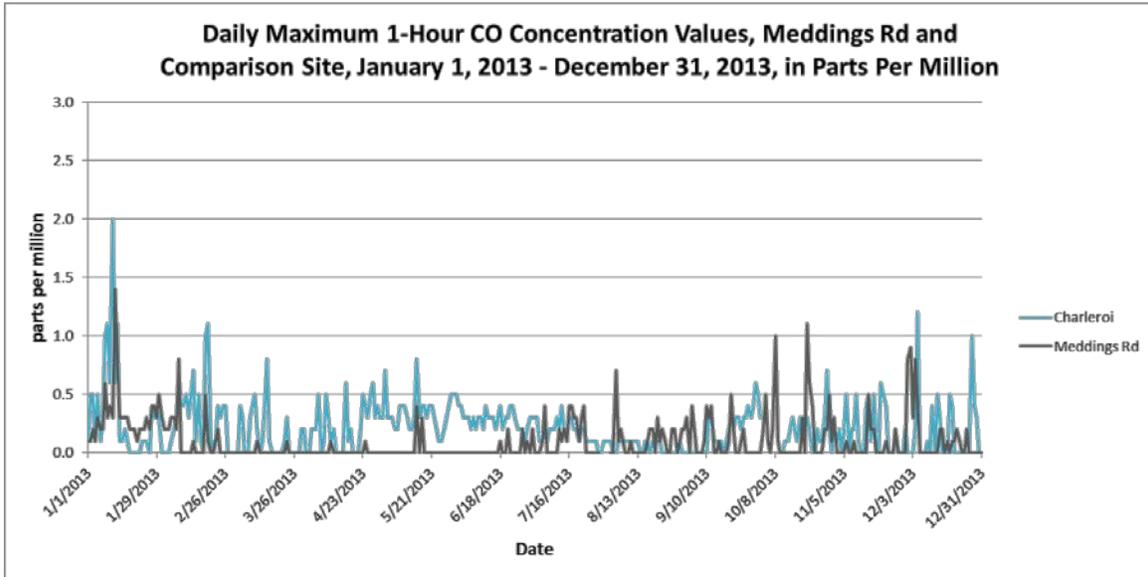


Figure 22 - Daily Maximum 8-Hour CO Concentrations for July 20, 2012 to December 31, 2012: Meddings Road vs. Comparison Site

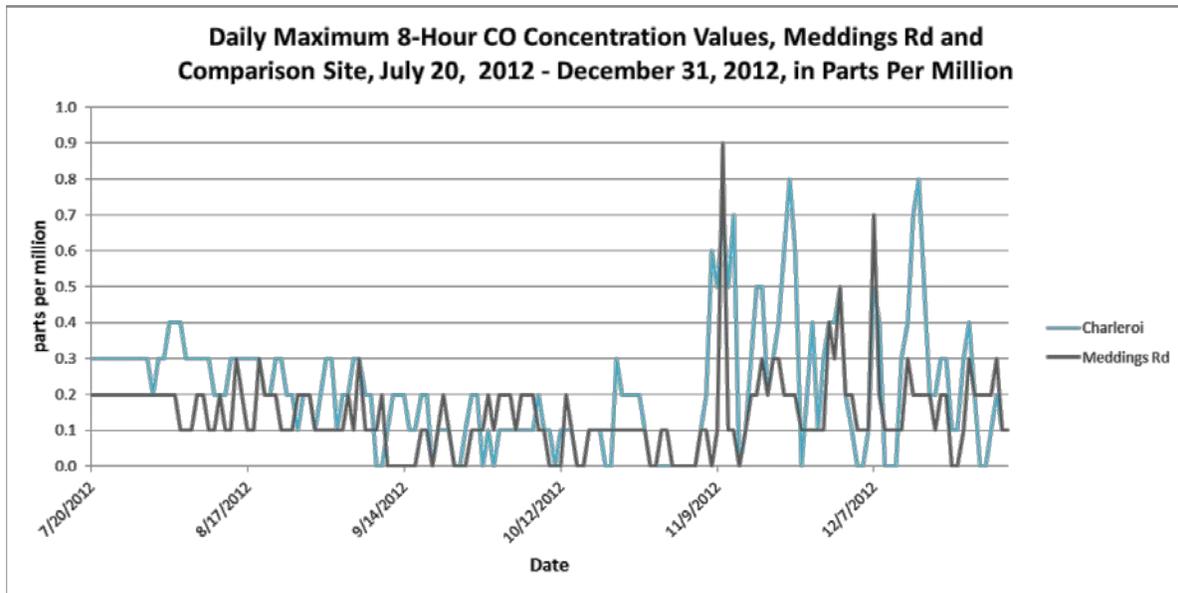


Figure 23 - Daily Maximum 8-Hour CO Concentrations for January 1, 2013 to December 31, 2013: Meddings Road vs. Comparison Site

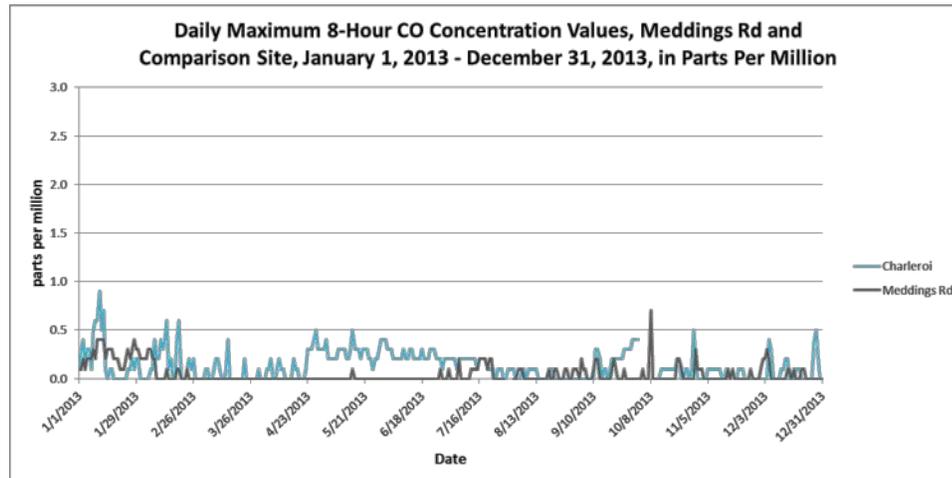
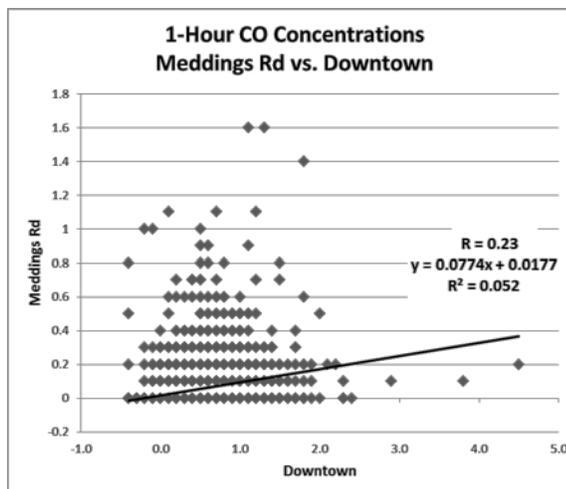


Figure 24 shows the Pearson correlation between Meddings Road and the Charleroi site for the period July 20, 2012 to December 31, 2013. As expected with localized source impacts, the Meddings Road site does not correlate with the Charleroi site.

Figure 24 - Graphical Representation of 1-Hour CO Concentrations (ppb) at Meddings Road vs. Comparison Site



The Meddings Road monitor is located approximately 1.5 km from the closest major road, with an Annual Average Daily Traffic (AADT) count of 3,700²⁷. The Charleroi station is located in an area with a greater mobile source contribution, less than 0.5 km from roads with an AADT count of approximately 8,900. Both the measured CO concentrations and poor correlation between these sites are reflective of the impact of localized sources.

²⁷ Traffic volume information can be accessed from the Pennsylvania Department of Transportation’s website at: <http://www.dot.state.pa.us/Internet/bureaus/pdplanres.nsf/infoBPRTrafficInfoTrafficVolumeMap>.

The low CO concentrations measured at the Meddings Road site overall and pattern of hourly maxima (i.e., the absence of hourly maxima above 9 ppm) do not indicate there is a local source impacting the Meddings Road site (which would cause the monitored area to exceed the CO NAAQS) and thus did not indicate a possible health concern.

C. Non-Criteria Pollutants

Non-criteria pollutants are those air pollutants in ambient air for which no national ambient air quality standards exist. Ambient air sampling and monitoring for these compounds, however, is performed with the goal of gathering data that is of sufficient quality and is representative of ambient air concentrations to allow the public, scientists and policymakers to make informed decisions on the presence and nature of non-criteria pollutants in the ambient air. Frequently, discussion of non-criteria pollutants centers around chemically toxic air pollutants such as those specifically listed as Hazardous Air Pollutants in the Federal Clean Air Act. Other non-criteria pollutants examined for this project include Hydrogen Sulfide, Methane and Non-Methane Hydrocarbons (NMHC).

This project included sampling, laboratory analysis, and data evaluation of select HAPs from all sampling sites. Additional chemical sampling for ketone and aldehyde HAPs (carbonyls) occurred at two sites. The results of this sampling as well as the use of the collected data for conducting a screening level assessment of potential ambient air lifetime cancer risks and chronic non-cancer hazards at each site is presented in the “Risk/Hazard Screening Analysis” section of this report.

Continuous Methane and Non-Methane Hydrocarbon (NMHC) measurement was conducted at the Meddings Road site. While Methane and total NMHC are not criteria pollutants, Methane is a greenhouse gas (GHG) and is regulated by the U.S. EPA. This project represented the first time that the Department monitored for ambient Methane/NMHC concentrations at any location in Pennsylvania. Unfortunately, the Department does not have confidence in the quality of the NMHC data and has reduced confidence in the Methane data due to issues with the monitoring equipment that could not be resolved during the project. The specific issues are discussed in the “Data Quality, Validation and Usability” section of this report.

1. Hazardous Air Pollutant (HAP) Sampling

The Department used two collection methods to obtain data for ambient concentrations of select toxic organic chemicals. The select toxic organic chemicals are a subset of the 187 listed compounds and compound classes that comprise the Hazardous Air Pollutant list, which is contained in the Federal Clean Air Act²⁸. Some additional non-HAP compounds of concern were also screened (e.g., n-propyl bromide). Acetone was sampled using two methods.

²⁸ The entire listing of the HAP compounds defined by the U.S. EPA is at: <http://www.epa.gov/ttn/atw/orig189.html>. EPA’s website on Air Toxics can be found at: <http://www.epa.gov/ttn/atw/index.html>.

EPA Method TO-15²⁹ was used to collect the 24-hour duration, whole air samples into six-liter stainless steel canisters every six days. Collected samples were then transported to the DEP laboratory for analysis using Gas Chromatography/Mass Spectroscopy (GC/MS) to provide quantitative analysis of 57 volatile toxic organic compounds. This analysis was performed for canisters at all project sites.

EPA Method TO11a³⁰ was used to collect the 24-hour duration samples onto chemically treated cartridges designed to allow for the collection and analysis of eight carbonyl compounds (ketones and aldehydes) that cannot be as reliably measured using canister methods. After a known volume of air is passed through a treated cartridge for a known duration, the cartridges are removed, sealed, chilled and transported to the DEP laboratory for analysis. By using the chemical extraction techniques of the TO-11a method, the laboratory can provide precise and accurate measurement of observed airborne concentrations of the eight toxic carbonyl compounds. This method uses High Performance Liquid Chromatography (HPLC) to determine the quantity of compound adsorbed to the cartridge during the sampling period. These eight compounds are also included in the Clean Air Act HAP list.

Details about both the canister and carbonyl collection and analysis methods are included in the TSD. Table 15 lists the compounds for which the canister and carbonyl samples were analyzed.

For this project, the 57 compounds for which the Department analyzed using the TO-15 canister method will be collectively referred to as “HAP sampling” or “HAP canister sampling.” The eight compounds analyzed using the TO-11a treated cartridge method will be collectively referred to as “HAP carbonyl compounds” or “HAP carbonyl sampling,” noting that the sampled carbonyl compounds are also included on the Clean Air Act HAP list.

For the purposes of length and readability, only those compounds for which there was at least one measured concentration above the analytical instrument’s Method Detection Limit³¹ (MDL) were included in the summary tables. The MDLs for the listed HAP compounds in Table 15 were the current MDLs used during the planning phase of the project. However, instrument MDLs for each analyzed compound changed, as they should have, through the course of the project as the Department’s analytical laboratory conducts its routine QA/QC procedures for the duration of the project. These changes in the MDLs over the course of the project are included in the data summary tables for each site. A discussion of the use of MDLs in comparison to the laboratory reporting limit is included in Appendix C.

Summary data and basic descriptive statistics are presented in order of project site. The “Risk/Hazard Screening Analysis” section includes additional analysis and discussion of the raw data presented in this section.

²⁹ EPA Ambient Air Monitoring methods for Air Toxics can be found at: <http://www.epa.gov/ttn/amtic/airtox.html>.

³⁰ DEP employed the TO-11a sampling method using the EPA 8315A analysis method for measuring carbonyls in air.

³¹ The Method Detection Limit (MDL) is the minimum concentration of a compound that can be reported with 99 percent confidence that the value is above zero, based on a standard deviation of at least seven repetitive measurements of the compound in an air sample at a concentration near the low standard.

Table 15 - Hazardous Air Pollutants Measured and Analyzed for Project

Target Pollutant List								
CA#	Analyte	MDL (ppbv)	CA#	Analyte	MDL (ppbv)	CA#	Analyte	MDL (ppbv)
74-82-8(Methane)	Methane/Non-Methane Compound	0.1 ppm / 5 ppb	622-96-8	1-Ethyl-4-methyl benzene	0.043	1634-04-4	2-Methoxy-2-methylpropane (MTBE)	0.030
10028-15-6	Ozone	<0.6 ppb	591-78-6	2-Hexanone	0.030	75-09-2	Methylene chloride	0.078
10102-44-0	Nitrogen Oxides	0.4 ppb	67-64-1	Acetone (2-Propanone)	0.076	108-10-1	4-Methyl-2-pentanone (MIBK)	0.040
630-08-0	Carbon Monoxide	<0.05 ppm	107-02-8	Acrolein*	0.057	142-82-5	n-Heptane	0.040
6/4/7783	Hydrogen Sulfide (AIR / Jerome)	0.4 ppb / 3 ppb	71-43-2	Benzene	0.030	110-54-3	n-Hexane	0.038
n/a	Particulate Matter (<2.5 microns)	n/a	75-27-4	Bromodichloromethane	0.017	95-47-6	o-Xylene	0.043
71-55-6	1,1,1-Trichloroethane	0.017	75-25-2	Bromof orm	0.019	115-07-1	Propene	0.030
79-34-5	1,1,2,2-Tetrachloroethane	0.019	74-83-9	Bromomethane	0.046	100-42-5	Styrene	0.041
79-00-5	1,1,2-Trichloroethane	0.018	75-15-0	Carbon disulfide	0.064	127-18-4	Tetrachloroethene (PERC)	0.030
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	0.061	56-23-5	Carbon tetrachloride	0.015	109-99-9	Tetrahydrofuran (THF)	0.027
75-34-3	1,1-Dichloroethane	0.021	108-90-7	Chlorobenzene	0.029	108-88-3	Toluene	0.028
75-35-4	1,1-Dichloroethene	0.059	75-00-3	Chloroethane	0.056	156-60-5	trans-1,2-Dichloroethene	0.025
120-82-1	1,2,4-Trichlorobenzene	0.048	75-01-4	Chloroethene	0.072	10061-02-6	trans-1,3-Dichloro-1-propene	0.021
95-63-6	1,2,4-Trimethylbenzene	0.043	67-86-3	Chlorof orm	0.019	79-01-6	Trichloroethylene (TCE)	0.025
106-93-4	1,2-Dibromomethane	0.025	74-87-3	Chloromethane	0.055	75-69-4	Trichlorofluoromethane	0.064
95-50-1	1,2-Dichlorobenzene	0.035	156-59-2	cis-1,2-Dichloroethene	0.028	75-07-0	Acetaldehyde (Ethanal)	0.035
107-06-2	1,2-Dichloroethane	0.026	10061-01-5	cis-1,3-Dichloro-1-propene	0.026	67-64-1	Acetone (2-Propanone)	0.054
78-87-5	1,2-Dichloropropane	0.021	110-82-7	Cyclohexane	0.027	100-52-7	Benzaldehyde	0.017
76-14-2	1,2-Dichloro-1,1,2,2-tetrafluoroethane	0.034	124-48-1	Dibromochloromethane	0.024	123-72-8	Butyraldehyde (Butanal)	0.024
108-67-8	1,3,5-Trimethylbenzene	0.045	75-71-8	Dichlorodifluoromethane	0.021	50-00-0	Formaldehyde	0.060
106-99-0	1,3-Butadiene	0.065	100-41-4	Ethylbenzene	0.040	590-96-3	Isovaleraldehyde (3-methyl-Butanal)	0.039
541-73-1	1,3-Dichlorobenzene	0.033	87-68-3	Hexachloro-1,3-butadiene	0.027	123-38-6	Propionaldehyde (Propanal)	0.026
106-46-7	1,4-Dichlorobenzene	0.030	108-38-3	m&p-Xylene	0.087	123-73-9	Crotonaldehyde (trans-2-Butenal)	0.029
106-94-5	1-Bromopropane	0.028	78-93-3	2-Butanone (Methyl Ethyl Ketone)	0.032			
	MDL	Minimum Detection Limit (by unit) for continuous monitors; Method Detection Limit (by unit-volume) for Canister/Carbonyl						
		Continuous Measurement Compounds						
		TO-11A Compound (Carbonyl) - DNPH Cartridge						
		TO-15 Compound - Canister						
		Compounds in bold are analytes potentially associated with permanent shale gas facilities through natural gas combustion, or direct/fugitive emissions of "wet" gas.						
		* While Acrolein (propenal) is being sampled, there exist high uncertainty in reported results due to sampling and analytical limitations. Because of this uncertainty, results for Acrolein may not be used for final risk analysis.						

Tables 16 through 25 contain the results of the TO-15 canister and TO-11a carbonyl monitoring that was performed throughout the course of the project. The data is presented by site and analysis method and presents results for screened compounds except for Acrolein, which are explained later in this report. For Acetone, which was sampled by both methods, only the canister results are presented since the Department has a significantly larger dataset of Acetone collected by the TO-15 canister method as opposed to the TO-11a method.

Each table consists of all detected canister and carbonyl compounds for each quality-assured sample obtained from each site. When applicable, the first table at each site lists compounds detected in 85 percent or more of the samples. The second table for a site lists those compounds for which less than 85 percent of the samples contained detected concentrations. Site information, including sampling method, duration and frequency, is included in the table header. Compound information, including common name, Chemical Abstract Service Number (CASN) and the instrument Method Detection Limit are provided. Valid sample numbers, detection frequency and basic statistics for the datasets are listed in the "Sampling Summary Information" and "Statistics" columns of the tables. Finally, a small graphical display ("quick display") of the detected data helps to depict the relative distribution of the data. TO-15 data is displayed in the "quick display" column with black bars, whereas TO-11a data is displayed with blue bars.

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Table 16 - Meddings Road Site - TO-15 Canister - %ND < 85

Site Name: Meddings Road						Site ID: 520V								
Sampling Period Start: 9/6/2012						Expected Samples: 81								
Sampling Period End: 12/30/2013						Valid Samples: 52								
Sampling Frequency: 1 sample every 6 days (1:6)						Site Data Availability: 64%								
Sampling Duration: 24 hrs.; Midnight to Midnight						Analysis: TO-15								
Compound & Analysis Information						Sample Summary Information			Statistics ^B					Data "Quick" Display ^D
Chemical Name	CASN ^A	Method Detection Limit (MDL)				Total No. Samples	No. Detects	Non-Detect (%)	Min Value ^C	Max Value ^C	2nd Max Value	Arithmetic Mean	Sample SD	
		ppbv	2012	2013a	2013b									
Toluene	108-88-3	0.028	0.063	0.042	0.039	52	52	0%	0.091	0.701	0.525	0.252	0.116	
Carbon tetrachloride	56-23-5	0.015	0.064	0.034	0.043	52	52	0%	0.075	0.119	0.107	0.095	0.008	
Acetone	67-64-1	0.076	0.075	0.063	0.103	52	52	0%	1.553	13.796	10.816	5.924	2.535	
Benzene	71-43-2	0.030	0.066	0.048	0.047	52	52	0%	0.057	0.442	0.403	0.184	0.093	
Chloromethane	74-87-3	0.055	0.074	0.041	0.052	49	49	0%	0.291	0.706	0.693	0.597	0.081	
Trichlorofluoromethane	75-69-4	0.064	0.066	0.042	0.055	52	52	0%	0.130	0.314	0.298	0.256	0.032	
Dichlorodifluoromethane	75-71-8	0.021	0.069	0.031	0.044	49	49	0%	0.195	0.642	0.639	0.563	0.089	
n-Hexane	110-54-3	0.038	0.049	0.037	0.044	52	51	2%	0.054	1.210	1.000	0.299	0.201	
n-Heptane	142-82-5	0.040	0.039	0.037	0.041	52	51	2%	0.101	1.340	1.050	0.478	0.281	
Propene	115-07-1	0.030	0.066	0.047	0.065	49	48	2%	0.433	11.498	7.820	2.628	1.978	
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	0.061	0.061	0.035	0.055	52	48	8%	0.076	0.117	0.106	0.085	0.008	
2-Butanone (MEK)	78-93-3	0.032	0.056	0.049	0.090	52	47	10%	0.117	3.096	1.587	0.593	0.471	
Carbon disulfide	75-15-0	0.064	0.052	0.041	0.076	51	43	16%	0.062	0.466	0.465	0.124	0.111	
Cyclohexane	110-82-7	0.027	0.072	0.046	0.041	52	41	21%	0.092	0.459	0.458	0.195	0.116	
Methylene chloride	75-09-2	0.078	0.078	0.043	0.077	43	29	33%	0.079	0.317	0.168	0.074	0.044	
^A - Chemical Abstract Service Number ^B - Assumes non-detects equal to 0 ppb for mean estimate ^C - Max/Min of detected values ^D - MS-Excel Sparkline function. Each Y-axis is scaled to the individual dataset. Red data point is the maximum observed value. Gaps represent non-detected (ND), missing, or voided samples.														

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Table 17 - Meddings Road Site - TO-15 Canister - %ND > 85

Site Name: Meddings Road		Site ID: 520V												
Sampling Period Start: 9/6/2012		Expected Samples: 81												
Sampling Period End: 12/30/2013		Valid Samples: 52												
Sampling Frequency: 1 sample every 6 days (1:6)		Site Data Availability: 64%												
Sampling Duration: 24 hrs.: Midnight to Midnight		Analysis: TO-15												
Compound & Analysis Information					Sample Summary Information			Statistics ^B					Data "Quick" Display ^D	
Chemical Name	CAS N ^A	Method Detection Limit (MDL) ppbv				Total No. Samples	No. Detects	Non-Detect (%)	Min Value ^C	Max Value ^C	2nd Max Value	Arithmetic Mean		Sample SD
		2012	2013a	2013b	5 Yr Avg									
m & p-Xylene	108-38-3	0.087	0.082	0.040	0.089	52	7	87%	0.092	0.170	0.168	0.018	0.029	
Tetrahydrofuran (THF)	109-99-9	0.027	0.070	0.032	0.053	52	6	88%	0.040	0.217	0.139	0.011	0.072	
Chloroform	67-66-3	0.019	0.063	0.035	0.037	52	6	88%	0.019	0.037	0.027	0.003	0.007	
Ethylbenzene	100-41-4	0.040	0.040	0.020	0.040	52	4	92%	0.041	0.088	0.061	0.004	0.013	
1,4-Dichlorobenzene	106-46-7	0.030	0.055	0.028	0.051	52	4	92%	0.031	0.063	0.058	0.004	0.014	
Tetrachloroethene (PERC)	127-18-4	0.030	0.056	0.028	0.041	52	4	92%	0.039	0.109	0.065	0.005	0.030	
o-Xylene	95-47-6	0.043	0.042	0.020	0.041	52	4	92%	0.042	0.087	0.060	0.005	0.019	
Styrene	100-42-5	0.041	0.039	0.016	0.042	52	3	94%	0.044	0.177	0.057	0.005	0.073	
4-Methyl-2-pentanone (MIBK)	108-10-1	0.040	0.031	0.037	0.063	52	3	94%	0.031	0.040	0.034	0.002	0.005	
Trichloroethylene (TCE)	79-01-6	0.025	0.063	0.034	0.044	52	2	96%	0.028	0.036	0.028	0.001	0.006	
1,2,4-Trimethylbenzene	95-63-6	0.043	0.038	0.014	0.045	52	2	96%	0.043	0.046	0.043	0.002	0.002	
1-Bromopropane	106-94-5	0.028	0.052	0.044	0.037	52	1	98%	0.044	0.044	NA	0.001	NA	
Chlorobenzene	108-90-7	0.029	0.063	0.035	0.040	52	1	98%	0.040	0.040	NA	0.001	NA	
1,1,1-Trichloroethane	71-55-6	0.017	0.063	0.034	0.045	52	1	98%	0.027	0.027	NA	0.001	NA	
Bromoform	75-25-2	0.019	0.062	0.025	0.038	52	1	98%	0.021	0.021	NA	0.000	NA	
Bromodichloromethane	75-27-4	0.017	0.066	0.038	0.038	52	1	98%	0.023	0.023	NA	0.000	NA	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	76-14-2	0.034	0.066	0.035	0.048	52	1	98%	0.039	0.039	NA	0.001	NA	
1,2-Dichloropropane	78-87-5	0.021	0.063	0.049	0.039	52	1	98%	0.029	0.029	NA	0.001	NA	
Hexachloro-1,3-butadiene	87-68-3	0.027	0.057	0.073	0.047	52	1	98%	0.034	0.034	NA	0.001	NA	

^A - Chemical Abstract Service Number
^B - Assumes non-detects equal to 0 ppb for mean estimate
^C - Max/Min of detected values
^D - MS-Excel Sparkline function. Each Y-axis is scaled to the individual dataset. Red data point is the maximum observed value. Gaps represent non-detected (ND), missing, or voided samples.

Table 18 - Meddings Road Site - TO-11a Carbonyl - All Detects

Site Name: Meddings Rd Sampling Period Start: 8/31/2012 Sampling Period End: 12/30/2013 Sampling Frequency: 1 sample every 6 days Sample Duration: 24 hrs; Midnight to Midnight					Site ID: 520C Expected Samples: 82 Valid Samples Obtained: 58 Site Data Availability: 71% Analysis: TO-11a									
Compound & Analysis Information					Sample Summary Information				Statistics ^C					Data "Quick" Display ^E
Chemical Name	CASN ^A	Method Detection Limit (MDL) ^B ug/m ³			Total No. Samples	No. Detects	% Non-Detect	% Data Availability	1st Max Value	2nd Max Value	Min Value ^D	Arith Mean	Std. Dev.	
		2012	2012/13	2013					ug/m ³					
Acetaldehyde	75-07-0	0.019	0.017	0.014	52	52	0%	63%	3.194	3.090	0.799	1.485	0.510	
Formaldehyde	50-00-0	0.049	0.014	0.045	55	55	0%	67%	14.236	11.111	0.694	3.566	3.418	
Propionaldehyde	123-38-6	0.011	0.010	0.006	57	56	2%	70%	0.556	0.451	0.122	0.241	0.088	
Butyraldehyde (Butanal)	123-72-8	0.008	0.018	0.006	50	44	12%	61%	3.368	2.778	0.347	0.828	0.714	
Benzaldehyde	100-52-7	0.004	0.006	0.010	11	8	27%	13%	1.250	1.181	0.208	0.562	0.362	
<p>A: Chemical Abstract Service Number</p> <p>B: Method Detection Limit - 2012/2013 MDL column applies for samples analyzed between 10/17/2012 and 10/23/2013</p> <p>C: Descriptive statistics for each compound dataset. Assumes non-detects equal 0 ppbv for mean estimate.</p> <p>D: Minimum observed detected value for the dataset</p> <p>E: Uses MS-Excel "Sparkline" function to display a reduced definition graph of a dataset. Each Y-axis is scaled to the individual compound. Red data point is the maximum observed value. Gaps represent non-detect (ND), missing or voided samples.</p>														

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Table 19 - Welsh Road Site - TO-15 Canister - All Detects

Site Name: Welsh Road		Site ID: 521V												
Sampling Period Start: 8/31/2012		Expected Samples: 82												
Sampling Period End: 12/20/2013		Valid Samples: 56												
Sampling Frequency: 1 sample every 6 days (1:6)		Site Data Availability: 68%												
Sampling Duration: 24 hrs.; Midnight to Midnight		Analysis: TO-15												
Compound & Analysis Information					Sample Summary Information			Statistics ^B					Data "Quick" Display ^D	
Chemical Name	CA SN ^A	Method Detection Limit (MDL) ppbv				Total No. Samples	No. Detects	Non-Detect (%)	Min Value ^C	Max Value ^C	2nd Max Value	Arithmetic Mean		Sample SD
		2012	2013a	2013b	5 Yr Avg									
Toluene	108-88-3	0.028	0.083	0.042	0.039	56	56	0%	0.081	9.816	8.306	1.681	2.455	
Carbon tetrachloride	56-23-5	0.015	0.084	0.034	0.043	56	56	0%	0.074	0.126	0.121	0.095	0.010	
Acetone	67-64-1	0.076	0.075	0.083	0.103	56	56	0%	0.886	12.092	11.941	4.287	2.662	
Benzene	71-43-2	0.030	0.066	0.048	0.047	56	56	0%	0.098	0.630	0.548	0.225	0.105	
Chloromethane	74-87-3	0.055	0.074	0.041	0.052	54	54	0%	0.271	0.781	0.720	0.574	0.099	
Trichlorofluoromethane	75-69-4	0.064	0.066	0.042	0.055	56	56	0%	0.105	0.345	0.326	0.261	0.037	
Dichlorodifluoromethane	75-71-8	0.021	0.069	0.031	0.044	54	54	0%	0.147	0.781	0.694	0.556	0.115	
Propene	115-07-1	0.030	0.066	0.047	0.065	54	53	2%	0.230	3.565	3.483	1.677	0.747	
n-Hexane	110-54-3	0.038	0.049	0.037	0.044	56	54	4%	0.053	0.492	0.335	0.165	0.082	
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	0.061	0.061	0.035	0.055	55	52	5%	0.076	0.110	0.109	0.085	0.008	
2-Butanone (MEQ)	78-93-3	0.032	0.056	0.049	0.090	51	46	10%	0.134	1.222	1.157	0.386	0.291	
n-Heptane	142-82-5	0.040	0.039	0.037	0.041	55	40	27%	0.040	0.143	0.123	0.049	0.025	
Methylene chloride	75-09-2	0.078	0.078	0.043	0.077	41	18	56%	0.079	0.215	0.211	0.053	0.047	
Styrene	100-42-5	0.041	0.039	0.016	0.042	56	20	64%	0.041	0.304	0.261	0.032	0.070	
Cyclohexane	110-82-7	0.027	0.072	0.046	0.041	56	19	66%	0.030	0.225	0.158	0.026	0.048	
m&p-Xylene	108-38-3	0.087	0.082	0.040	0.069	56	14	75%	0.091	0.146	0.145	0.029	0.021	
Chloroform	67-66-3	0.019	0.083	0.035	0.037	56	9	84%	0.019	0.033	0.026	0.004	0.005	
Ethylbenzene	100-41-4	0.040	0.040	0.020	0.040	55	5	91%	0.044	0.050	0.049	0.004	0.002	
o-Xylene	95-47-6	0.043	0.042	0.020	0.041	55	4	93%	0.044	0.050	0.047	0.003	0.003	
Carbon disulfide	75-15-0	0.064	0.052	0.041	0.076	56	2	96%	0.056	0.088	0.056	0.003	0.023	
1,2,4-Trimethylbenzene	95-63-6	0.043	0.038	0.014	0.045	55	1	98%	0.039	0.039	NA	0.001	NA	
1,4-Dichlorobenzene	106-46-7	0.030	0.055	0.028	0.051	56	1	98%	0.031	0.031	NA	0.001	NA	
1,3-Butadiene	106-99-0	0.065	0.067	0.052	0.092	56	1	98%	0.087	0.087	NA	0.002	NA	
Bromomethane	74-83-9	0.046	0.083	0.053	0.051	56	1	98%	0.195	0.195	NA	0.003	NA	

^A - Chemical Abstract Service Number
^B - Assumes non-detects equal to 0 ppb for mean estimate
^C - Max/Min of detected values
^D - MS-Excel Sparkline function. Each Y-axis is scaled to the individual dataset. Red data point is the maximum observed value. Gaps represent non-detected (ND), missing, or voided samples.

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Table 20 - Jaspén Way Site - TO-15 Canister - %ND < 85

Site Name: Jaspén Way		Site ID: 522V	
Sampling Period Start: 6/14/2012		Expected Samples: 95	
Sampling Period End: 12/20/2013		Valid Samples: 71	
Sampling Frequency: 1 sample every 6 days (1:6)		Site Data Availability: 75%	
Sampling Duration: 24 hrs.; Midnight to Midnight		Analysis: TO-15	

Compound & Analysis Information						Sample Summary Information			Statistics ^B					Data "Quick" Display ^D
Chemical Name	CAS# ^A	Method Detection Limit (MDL) ppbv				Total No. Samples	No. Detects	Non-Detect (%)	Min Value ^C	Max Value ^C	2nd Max Value	Arithmetic Mean	Sample SD	
		2012	2013a	2013b	5 Yr Avg									
n-Hexane	110-54-3	0.038	0.049	0.037	0.044	71	71	0%	0.049	0.706	0.526	0.194	0.122	
Carbon tetrachloride	56-23-5	0.015	0.064	0.034	0.043	71	71	0%	0.070	0.119	0.115	0.095	0.010	
Acetone	67-64-1	0.076	0.075	0.063	0.103	68	68	0%	1.042	61.332	50.278	9.519	10.206	
Chloromethane	74-87-3	0.055	0.074	0.041	0.052	69	69	0%	0.299	0.797	0.765	0.594	0.091	
Trichlorofluoromethane	75-69-4	0.064	0.066	0.042	0.055	71	71	0%	0.158	0.325	0.325	0.260	0.033	
Dichlorodifluoromethane	75-71-8	0.021	0.069	0.031	0.044	69	69	0%	0.157	0.694	0.692	0.562	0.103	
1,1,2-Trichloro-1,2,2-trifluoroethane	78-13-1	0.061	0.061	0.035	0.055	71	70	1%	0.070	0.120	0.118	0.091	0.011	
Toluene	108-88-3	0.028	0.063	0.042	0.039	70	69	1%	0.048	0.720	0.515	0.179	0.104	
Benzene	71-43-2	0.030	0.066	0.048	0.047	71	69	3%	0.056	0.687	0.512	0.165	0.105	
Propene	115-07-1	0.030	0.066	0.047	0.065	69	67	3%	0.352	5.092	4.526	1.912	1.039	
2-Butanone (MEK)	78-93-3	0.032	0.056	0.049	0.090	68	64	6%	0.135	2.548	2.455	0.626	0.534	
n-Heptane	142-82-5	0.040	0.039	0.037	0.041	71	57	20%	0.040	0.245	0.199	0.062	0.038	
Styrene	100-42-5	0.041	0.039	0.016	0.042	71	50	30%	0.032	1.184	0.722	0.186	0.201	
1,2,4-Trimethylbenzene	95-63-6	0.043	0.038	0.014	0.045	71	44	38%	0.015	0.261	0.248	0.069	0.057	
Methylene chloride	75-09-2	0.078	0.078	0.043	0.077	59	36	39%	0.079	0.310	0.166	0.066	0.041	
m&p-Xylene	108-38-3	0.087	0.082	0.040	0.069	71	43	39%	0.069	0.870	0.616	0.120	0.138	
1-Ethyl-4-methylbenzene	622-96-8	0.043	0.035	0.015	0.046	71	35	51%	0.035	0.165	0.133	0.034	0.026	
Cyclohexane	110-82-7	0.027	0.072	0.046	0.041	71	32	55%	0.030	0.164	0.155	0.032	0.031	
o-Xylene	95-47-6	0.043	0.042	0.020	0.041	71	32	55%	0.021	0.197	0.142	0.028	0.032	
Ethylbenzene	100-41-4	0.040	0.040	0.020	0.040	71	26	63%	0.025	0.187	0.137	0.023	0.032	
Chloroform	67-66-3	0.019	0.063	0.035	0.037	70	24	66%	0.019	0.050	0.042	0.009	0.008	

A - Chemical Abstract Service Number
B - Assumes non-detects equal to 0 ppb for mean estimate
C - Max/Min of detected values
D - MS-Excel Sparkline function. Each Y-axis is scaled to the individual dataset. Red data point is the maximum observed value. Gaps represent non-detected (ND), missing, or voided samples.

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Table 21 - Jaspens Way Site - TO-15 Canister - %ND > 85

Site Name: Jaspens Way						Site ID: 522V								
Sampling Period Start: 6/14/2012						Expected Samples: 95								
Sampling Period End: 12/20/2013						Valid Samples: 71								
Sampling Frequency: 1 sample every 6 days (1:6)						Site Data Availability: 75%								
Sampling Duration: 24 hrs.; Midnight to Midnight						Analysis: TO-15								
Compound & Analysis Information						Sample Summary Information			Statistics ^B					Data "Quick" Display ^D
Chemical Name	CASN ^A	Method Detection Limit (MDL) ppbv				Total No. Samples	No. Detects	Non-Detect (%)	Min Value ^C	Max Value ^C	2nd Max Value	Arithmetic Mean	Sample SD	
		2012	2013a	2013b	5 Yr Avg				ppbv					
1,3,5-Trimethylbenzene	108-67-8	0.045	0.040	0.018	0.050	71	6	92%	0.025	0.073	0.058	0.004	0.017	
Carbon disulfide	75-15-0	0.064	0.052	0.041	0.076	71	4	94%	0.056	0.124	0.108	0.005	0.033	
2-Hexanone	591-78-6	0.030	0.045	0.037	0.068	71	3	96%	0.069	0.128	0.069	0.004	0.034	
1,1,1-Trichloroethane	71-55-6	0.017	0.063	0.034	0.045	71	3	96%	0.021	0.918	0.023	0.014	0.517	
1,2-Dichloropropane	78-87-5	0.021	0.063	0.049	0.039	71	3	96%	0.022	0.032	0.024	0.001	0.005	
Tetrahydrofuran (THF)	109-99-9	0.027	0.070	0.032	0.053	71	2	97%	0.033	0.046	0.033	0.001	0.009	
Bromodichloromethane	75-27-4	0.017	0.066	0.038	0.038	71	2	97%	0.018	0.018	0.018	0.001	0.000	
1,3-Butadiene	106-99-0	0.065	0.067	0.052	0.092	71	1	99%	0.066	0.066	NA	0.001	NA	
1,2-Dichloroethane	107-06-2	0.026	0.045	0.037	0.036	71	1	99%	0.021	0.021	NA	0.000	NA	
4-Methyl-2-pentanone (MIBK)	108-10-1	0.040	0.031	0.037	0.063	71	1	99%	0.037	0.037	NA	0.001	NA	
Tetrachloroethene (PERC)	127-18-4	0.030	0.056	0.028	0.041	71	1	99%	0.030	0.030	NA	0.000	NA	
Chloroethane	75-00-3	0.056	0.092	0.058	0.057	71	1	99%	0.061	0.061	NA	0.001	NA	
^A - Chemical Abstract Service Number ^B - Assumes non-detects equal to 0 ppb for mean estimate ^C - Max/Min of detected values ^D - MS-Excel Sparkline function. Each Y-axis is scaled to the individual dataset. Red data point is the maximum observed value. Gaps represent non-detected(ND), missing, or voided samples.														

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Table 22 - Henderson Road Site - TO-15 Canister - %ND < 85

Site Name: Henderson Road		Site ID: 523V	
Sampling Period Start: 8/7/2012		Expected Samples: 86	
Sampling Period End: 12/30/2013		Valid Samples: 73	
Sampling Frequency: 1 sample every 6 days (1:6)		Site Data Availability: 85%	
Sampling Duration: 24 hrs.; Midnight to Midnight		Analysis: TO-15	

Compound & Analysis Information					Sample Summary Information			Statistics ^B					Data "Quick" Display ^D	
Chemical Name	CASN ^A	Method Detection Limit (MDL) ppbv				Total No. Samples	No. Detects	Non-Detect (%)	Min Value ^C	Max Value ^C	2nd Max Value	Arithmetic Mean		Sample SD
		2012	2013a	2013b	5 Yr Avg									
Toluene	108-88-3	0.028	0.063	0.042	0.039	70	70	0%	0.068	0.403	0.332	0.159	0.073	
Carbon tetrachloride	56-23-5	0.015	0.064	0.034	0.043	73	73	0%	0.050	0.126	0.120	0.095	0.012	
Acetone	67-64-1	0.076	0.075	0.063	0.103	73	73	0%	1.098	14.890	13.458	4.963	2.921	
Chloromethane	74-87-3	0.055	0.074	0.041	0.052	72	72	0%	0.225	0.819	0.755	0.583	0.110	
Dichlorodifluoromethane	75-71-8	0.021	0.069	0.031	0.044	72	72	0%	0.143	0.798	0.761	0.561	0.113	
n-Hexane	110-54-3	0.038	0.049	0.037	0.044	73	72	1%	0.041	1.080	0.964	0.276	0.229	
Propene	115-07-1	0.030	0.066	0.047	0.065	72	71	1%	0.381	8.699	6.008	2.069	1.469	
1,1,2-Trichloro-1,2,2-trifluoroethane	78-13-1	0.061	0.061	0.035	0.055	73	71	3%	0.065	0.123	0.117	0.091	0.011	
Trichlorofluoromethane	75-69-4	0.064	0.066	0.042	0.055	73	70	4%	0.120	0.363	0.344	0.251	0.038	
Benzene	71-43-2	0.030	0.066	0.048	0.047	72	69	4%	0.060	0.380	0.366	0.147	0.070	
2-Butanone (MEQ)	78-93-3	0.032	0.056	0.049	0.090	66	61	8%	0.050	1.107	0.920	0.368	0.219	
n-Heptane	142-82-5	0.040	0.039	0.037	0.041	73	55	25%	0.038	0.294	0.290	0.072	0.062	
Methylene chloride	75-09-2	0.078	0.078	0.043	0.077	54	33	39%	0.079	1.132	0.273	0.088	0.185	
Styrene	100-42-5	0.041	0.039	0.016	0.042	73	43	41%	0.040	0.785	0.338	0.069	0.128	
Cyclohexane	110-82-7	0.027	0.072	0.046	0.041	73	26	64%	0.035	0.215	0.185	0.035	0.045	
m&p-Xylene	108-38-3	0.087	0.082	0.040	0.069	73	13	82%	0.094	0.227	0.210	0.024	0.041	
Chloroform	67-66-3	0.019	0.063	0.035	0.037	73	13	82%	0.018	0.030	0.028	0.004	0.004	
1,2,4-Trimethylbenzene	95-63-6	0.043	0.038	0.014	0.045	73	12	84%	0.015	0.156	0.094	0.011	0.035	

^A - Chemical Abstract Service Number
^B - Assumes non-detects equal to 0 ppb for mean estimate
^C - Max/Min of detected values
^D - MS-Excel Sparkline function. Each Y-axis is scaled to the individual dataset. Red data point is the maximum observed value. Gaps represent non-detected (ND), missing, or voided samples.

Table 23 - Henderson Road Site - TO-15 Canister - %ND > 85

Site Name:		Henderson Road						Site ID:		523V				
Sampling Period Start:		8/7/2012						Expected Samples:		86				
Sampling Period End:		12/30/2013						Valid Samples:		73				
Sampling Frequency:		1 sample every 6 days (1:6)						Site Data Availability:		85%				
Sampling Duration:		24 hrs.; Midnight to Midnight						Analysis:		TO-15				
Compound & Analysis Information						Sample Summary Information			Statistics ^B					Data "Quick" Display ^D
Chemical Name	CASN ^A	Method Detection Limit (MDL) ppbv				Total No. Samples	No. Detects	Non-Detect (%)	Min Value ^C	Max Value ^C	2nd Max Value	Arithmetic Mean	Sample SD	
		2012	2013a	2013b	5 Yr Avg									
o-Xylene	95-47-6	0.043	0.042	0.020	0.041	73	5	93%	0.045	0.076	0.060	0.004	0.013	
Ethylbenzene	100-41-4	0.040	0.040	0.020	0.040	73	3	96%	0.040	0.061	0.050	0.002	0.011	
1-Ethyl-4-methylbenzene	622-96-8	0.043	0.035	0.015	0.046	73	3	96%	0.035	0.077	0.046	0.002	0.022	
1,3-Butadiene	106-99-0	0.065	0.067	0.052	0.092	73	2	97%	0.059	0.116	0.059	0.002	0.040	
Tetrachloroethene (PERC)	127-18-4	0.030	0.056	0.028	0.041	73	2	97%	0.074	0.328	0.074	0.006	0.180	
Carbon disulfide	75-15-0	0.064	0.052	0.041	0.076	73	2	97%	0.119	0.266	0.119	0.005	0.104	
1,2-Dichloroethane	107-06-2	0.026	0.045	0.037	0.036	72	1	99%	0.028	0.028	NA	0.000	NA	
2-Methoxy-2-methylpropane (MTBE)	1634-04-4	0.030	0.052	0.035	0.051	73	1	99%	0.124	0.124	NA	0.002	NA	
<p>^A - Chemical Abstract Service Number</p> <p>^B - Assumes non-detects equal to 0 ppb for mean estimate</p> <p>^C - Max/Min of detected values</p> <p>^D - MS-Excel Sparkline function. Each Y-axis is scaled to the individual dataset. Red data point is the maximum observed value. Gaps represent non-detected (ND), missing, or voided samples.</p>														

Table 24 - Henderson Road Site - TO-11a Carbonyl - All Detects

Site Name: Henderson Rd Sampling Period Start: 9/18/2012 Sampling Period End: 12/30/2013 Sampling Frequency: 1 sample every 6 days Sample Duration: 24 hrs; Midnight to Midnight					Site ID: 523C Expected Samples: 79 Valid Samples Obtained: 47 Site Data Availability: 59% Analysis: TO-11a									
Compound & Analysis Information					Sample Summary Information				Statistics ^C					Data "Quick" Display ^E
Chemical Name	CASN ^A	Method Detection Limit (MDL) ^B ug/m ³			Total No. Samples	No. Detects	% Non-Detect	% Data Availability	1st Max Value	2nd Max Value	Min Value ^D	Arith Mean	Std. Dev.	
		2012	2012/13	2013					ug/m ³					
Acetaldehyde	75-07-0	0.019	0.017	0.014	43	43	0%	54%	1.458	1.417	0.201	0.861	0.301	
Formaldehyde	50-00-0	0.049	0.014	0.045	47	43	9%	59%	2.917	2.303	0.049	0.825	0.610	
Butyraldehyde (Butanal)	123-72-8	0.008	0.018	0.006	33	30	9%	42%	0.590	0.556	0.085	0.329	0.117	
Propionaldehyde	123-38-6	0.011	0.010	0.006	47	11	77%	59%	0.194	0.160	0.045	0.028	0.045	
Isovaleraldehyde	590-86-3	0.011	0.008	0.008	47	1	98%	59%	0.008	NA	0.008	0.000	NA	
<p>A: Chemical Abstract Service Number</p> <p>B: Method Detection Limit - 2012/2013 MDL column applies for samples analyzed between 10/17/2012 and 10/23/2013</p> <p>C: Descriptive statistics for each compound dataset. Assumes non-detects equal 0 ppbv for mean estimate.</p> <p>D: Minimum observed detected value for the dataset</p> <p>E: Uses MS-Excel "Sparkline" function to display a reduced definition graph of a dataset. Each Y-axis is scaled to the individual compound. Red data point is the maximum observed value. Gaps represent non-detect (ND), missing or voided samples.</p>														

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Table 25 - Florence COPAMS Site - TO-15 Canister - All Detects

Site Name: Florence COPAMS		Site ID: 504V	
Sampling Period Start: 10/12/2012		Expected Samples: 75	
Sampling Period End: 12/30/2013		Valid Samples: 65	
Sampling Frequency: 1 sample every 6 days (1:6)		Site Data Availability: 87%	
Sampling Duration: 24 hrs.; Midnight to Midnight		Analysis: TO-15	

Compound & Analysis Information					Sample Summary Information			Statistics ^B					Data "Quick" Display ^D	
Chemical Name	CASN ^A	Method Detection Limit (MDL) ppbv				Total No. Samples	No. Detects	Non-Detect (%)	Min Value ^C	Max Value ^C	2nd Max Value	Arithmetic Mean		Sample SD
		2012	2013a	2013b	5 Yr Avg									
Carbon tetrachloride	56-23-5	0.015	0.064	0.034	0.043	65	65	0%	0.065	0.130	0.119	0.098	0.011	
Acetone	67-64-1	0.076	0.075	0.063	0.103	65	65	0%	0.889	12.309	9.840	4.056	2.354	
Chloromethane	74-87-3	0.055	0.074	0.041	0.052	62	62	0%	0.441	0.782	0.731	0.606	0.073	
Trichlorofluoromethane	75-69-4	0.064	0.066	0.042	0.055	65	65	0%	0.171	0.327	0.316	0.267	0.027	
Dichlorodifluoromethane	75-71-8	0.021	0.069	0.031	0.044	62	62	0%	0.182	0.714	0.696	0.586	0.077	
Toluene	108-88-3	0.028	0.063	0.042	0.039	64	63	2%	0.049	0.251	0.230	0.127	0.045	
Propene	115-07-1	0.030	0.066	0.047	0.065	62	61	2%	0.223	2.340	2.135	0.955	0.471	
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	0.061	0.061	0.035	0.055	64	62	3%	0.075	0.110	0.109	0.090	0.009	
2-Butanone (MEK)	78-93-3	0.032	0.056	0.049	0.090	62	60	3%	0.095	1.068	0.983	0.376	0.219	
Benzene	71-43-2	0.030	0.066	0.048	0.047	63	59	6%	0.078	0.586	0.421	0.178	0.091	
n-Hexane	110-54-3	0.038	0.049	0.037	0.044	64	54	16%	0.047	0.212	0.150	0.079	0.034	
Methylene chloride	75-09-2	0.078	0.078	0.043	0.077	49	33	33%	0.079	2.436	0.603	0.127	0.413	
n-Heptane	142-82-5	0.040	0.039	0.037	0.041	65	10	85%	0.040	0.065	0.051	0.007	0.008	
Cyclohexane	110-82-7	0.027	0.072	0.046	0.041	65	8	88%	0.030	0.097	0.090	0.007	0.024	
Chloroform	67-66-3	0.019	0.063	0.035	0.037	65	6	91%	0.018	0.020	0.020	0.002	0.001	
Carbon disulfide	75-15-0	0.064	0.052	0.041	0.076	65	2	97%	0.056	0.178	0.056	0.004	0.086	
1,2-Dichloroethane	107-06-2	0.026	0.045	0.037	0.036	65	1	98%	0.028	0.028	NA	0.000	NA	
m&p-Xylene	108-38-3	0.087	0.082	0.040	0.089	65	1	98%	0.083	0.083	NA	0.001	NA	

^A - Chemical Abstract Service Number
^B - Assumes non-detects equal to 0 ppb for mean estimate
^C - Max/Min of detected values
^D - MS-Excel Sparkline function. Each Y-axis is scaled to the individual dataset. Red data point is the maximum observed value. Gaps represent non-detected (ND), missing, or voided samples.

2. Hydrogen Sulfide (H₂S)

While no federal NAAQS exists for H₂S, Pennsylvania has established a one-hour ambient air quality standard of 0.1 ppm and a 24-hr standard of 0.005 ppm³².

Table 26 displays the 1st and 2nd daily maximum 1-hour and 24-hour H₂S concentrations reported at the Meddings Road site. No single 1-hour maximum or 24-hour average exceeded the state ambient air standard.

Table 26 - 1st and 2nd Highs of Daily Maximum 1-hour and 24-Hour Concentrations in 2012 and 2013: Meddings Road

Year	H ₂ S 1-Hour Maximums (ppm)		H ₂ S 24-Hour Maximums (ppm)	
	Daily 1-Hr Max	Meddings Rd	Daily 24-Hr Max	Meddings Rd
2012 (July 20-Dec 31)	1 st Max	0.001	1 st Max	0.000
	2 nd Max	0.001	2 nd Max	0.000
2013	1 st Max	0.004	1 st Max	0.003
	2 nd Max	0.004	2 nd Max	0.003

Continuous data for ambient air concentrations of Hydrogen Sulfide (H₂S) were collected at the primary site (Meddings Road) from July 20, 2012, through Dec. 31, 2013. Additional H₂S data was collected at the Henderson Road project site. The Henderson monitor showed several 24-hour periods during which the observed value was greater than the comparison value; however, there were issues with the monitor. It is not a continuous analyzer as is Meddings Road but a semi-continuous fence line screening monitor. The numbers are not comparable to what would be used as a standard Pennsylvania H₂S compliance monitor. Additionally, the monitor was situated adjacent to an elevated sand mound (ESM) on-lot sewage treatment system. Typical designs of ESM systems have a septic tank. This tank could be a source of trace amounts of H₂S depending on residence times and aeration of waste from the medical center. Because of this sampling uncertainty, results of H₂S concentrations observed at the Henderson Road site are inconclusive regarding the concentration or the source of the emissions.

3. Methane/Non-Methane Hydrocarbons (NMHC)

The U.S. EPA reports that Methane is the second most prevalent greenhouse gas emitted in the United States. This is primarily due to human activities. Methane’s lifetime in the atmosphere is 12 years and it yields 21 times the 100-year global warming potential as carbon dioxide³³. Therefore, there has been increasing interest in measuring the amount of Methane emitted from not just the new development of unconventional natural gas resources but from historical “legacy” emissions from active and abandoned conventional natural gas production and other sources (e.g., coal bed Methane).

³² 25 Pa. Code § 131.13, 9/4/1998, <http://www.pacode.com/secure/data/025/chapter131/chap131toc.html>.

³³ <http://epa.gov/climatechange/ghgemissions/gases/ch4.html>

Given this interest, the Department initiated in this project its first continuous measurement of both Methane and total Non-Methane Hydrocarbons (NMHC) at the primary project site (Meddings Road). While it was not intended for measurement at this single point to determine Methane contribution by a few industrial sectors, data collected can inform the Department about the character of Methane and, to a lesser degree, total NMHC concentration distribution at a location over time.

A Synspec model A114 analyzer, acquired for this project, sampled and analyzed ambient air for Methane and total NMHC at the primary project site. The instrument is an automated gas chromatograph that samples and analyzes ambient air on a 10-minute cycle. A syringe pump draws a measured volume of air through a cooled adsorbent that traps all hydrocarbons except Methane, which passes through the trap and is collected in a gas sample loop. The Methane sample is analyzed, the trap is heated to release the adsorbed compounds, and a multi-port valve is switched to analyze the NMHC collected on the trap. The flame ionization detector (FID) responds approximately in proportion to the number of Carbon atoms in the hydrocarbon compounds. Therefore, results are reported in parts per billion carbon (ppbC), units that are commonly used for hydrocarbons in air. For example, three parts per billion (ppb) by volume of Methane with one Carbon has approximately the same detector response as one ppb by volume of Propane with three Carbons.

The analyzer was calibrated by the manufacturer prior to delivery. During the project, the instrument was calibrated with commercial gas cylinder standards containing Methane and Propane in air that were acquired from Praxair, Inc. and Linde Specialty Gases. The Methane concentration accuracy was certified +/-5 percent and the Propane concentration accuracy was certified +/-10 percent.

The gas cylinder standard and zero air were automatically analyzed every 24 hours to validate the instrument response. The analyzer was set to automatically update the calibration factors if the response factors changed by more than 5 percent. The project plan was to confirm the response with a second +/- 1 percent certified Methane standard. However, the instrument had to be returned to the vendor for repair before this was done. Accordingly, the instrument was not calibrated over a range of concentrations. Thus, the response factor is based on a linear fit to the detector response for zero air and a single concentration near 2000 ppb.

After the analyzer was installed and the initial calibration check was performed, data collection began on September 27, 2012. This was the Department's first experience using this equipment, and there were a number of times during which it failed to operate. The most common problem was that the detector flame extinguished. There were also several periods when the data was lost due to both mechanical problems with the Parker Balston TOC-1250 pure air generator and station power outages. The analyzer was shut down at the end of August 2013 and returned to the vendor for service. Although the analyzer was reinstalled in late November 2013, the nightly data from calibrations showed that the instrument operation was still unstable. As a result, data collected during the period from the November re-installation until stability was regained in December 2013 were excluded.

The total NMHC results were determined to be unreliable due to high zero air calibration peak areas. This means that hydrocarbons were being improperly detected by the monitor during calibration with a standard that contained no hydrocarbons. No solution for this problem was found during the project. Because the monitor was unable to be calibrated properly to enable accurate and precise measurement of NMHCs, the data was invalidated and not used for this project.

D. Meteorological Data

Analysis of meteorological data such as wind speed and wind direction was conducted at several sites. The analysis included data from November 1, 2012 until October 31, 2013. Data was collected for Meddings Road, Jaspen Way, Henderson Road, and Welsh Road. Wind speed and direction at the Meddings Road site were measured from a height of approximately 30 feet above ground, while winds at the other sites were measured from a 10-foot height. For the Henderson Road site, the base elevation, which is the station elevation above sea level plus the height of the wind sensor, was approximately 1,275 feet. Jaspen Way was approximately 1,260 feet in elevation, Welsh Road was approximately 1,340 feet in elevation, and Meddings Road was approximately 90 feet in elevation. Data from the Henderson Road and Jaspen way sites showed wind direction predominately from the west and southwest, while Welsh Road data showed winds mainly from the northeast and southwest. A seasonal average speed difference was detected at each site between the summer and winter months, with summer months averaging two to three miles per hour less than in the winter. The site with the most data completeness was the Henderson Road site, while data was sparser at the Jaspen Way and Welsh Road sites. Most of these data losses occurred during the winter months due to freezing of the sonic wind equipment.

Table 27 displays the meteorological data completeness, average wind speed, percentage of hours where calm winds were observed, and number of missing records by site.

Table 27 - Meteorological Data Parameter Comparison (Nov. 1, 2012 to Oct. 31, 2013)

Site Name	Base Elevation (ft.)	Met Instrumentation Height (ft.)	Average Wind Speed (mph)	% Hours Complete	No. of Missing Records	% of Calm Hours
Henderson Road	1275	10	3.2	99.99	1	4.04
Jaspen Way	1260	10	4.3	83.37	1457	2.61
Welsh Road	1340	10	2.4	96.30	324	34.95
Meddings Road	990	~32.8 (10 m)	4.2	90.40	841	32.69

At the Meddings Road site, the data suggests that there was extensive channeling of winds through valley areas when winds were from either the northwest or the southeast. It was also apparent that the Meddings site was the most influenced by differences in terrain, with elevational differences

of 150 to 200 feet within a half-mile radius of the site in all directions. Wind speeds were lower on average at the Henderson Road and Welsh Road sites due to the sensors being placed 10 feet off the ground. The higher degree of friction with the surrounding terrain resulted in these lower wind speeds. Average wind speeds at Jaspens Way were higher due to the prevailing wind being from the west, and elevations just to the west of the site were about 100 feet lower. At the Henderson Road site, west to northwest winds tended to funnel between two areas of higher terrain. Slightly higher terrain both to the west and east of the Welsh Road site tended to result in more winds either from the south-southwest or the north-northeast.

Figures 25 through 28 display wind roses for each of the project sites. Wind roses denote the direction from which the wind is blowing.

Figure 25 - 12-Month Wind Rose for Meddings Road Project Site

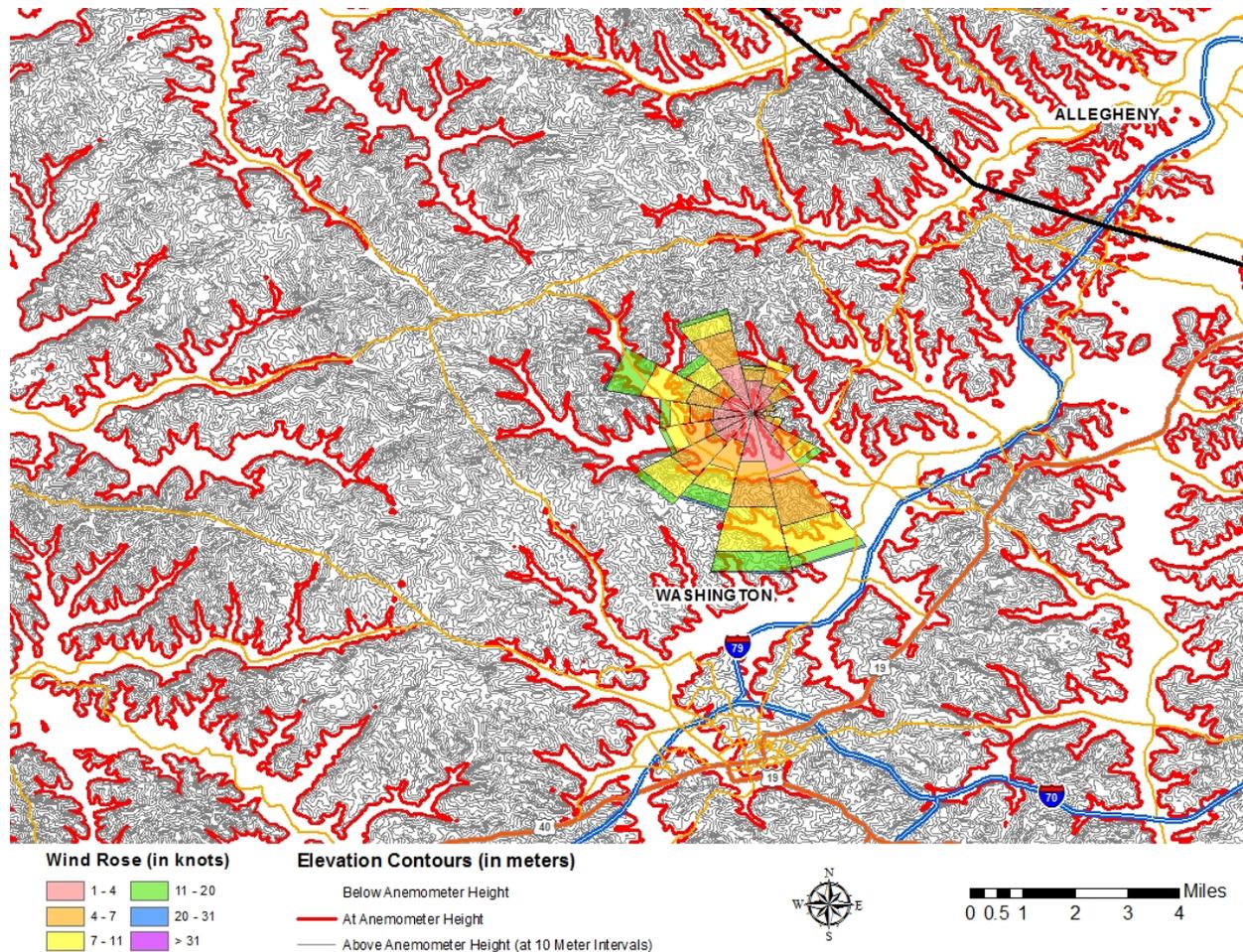


Figure 26 - 12- Month Wind Rose for Jaspem Way Project Site

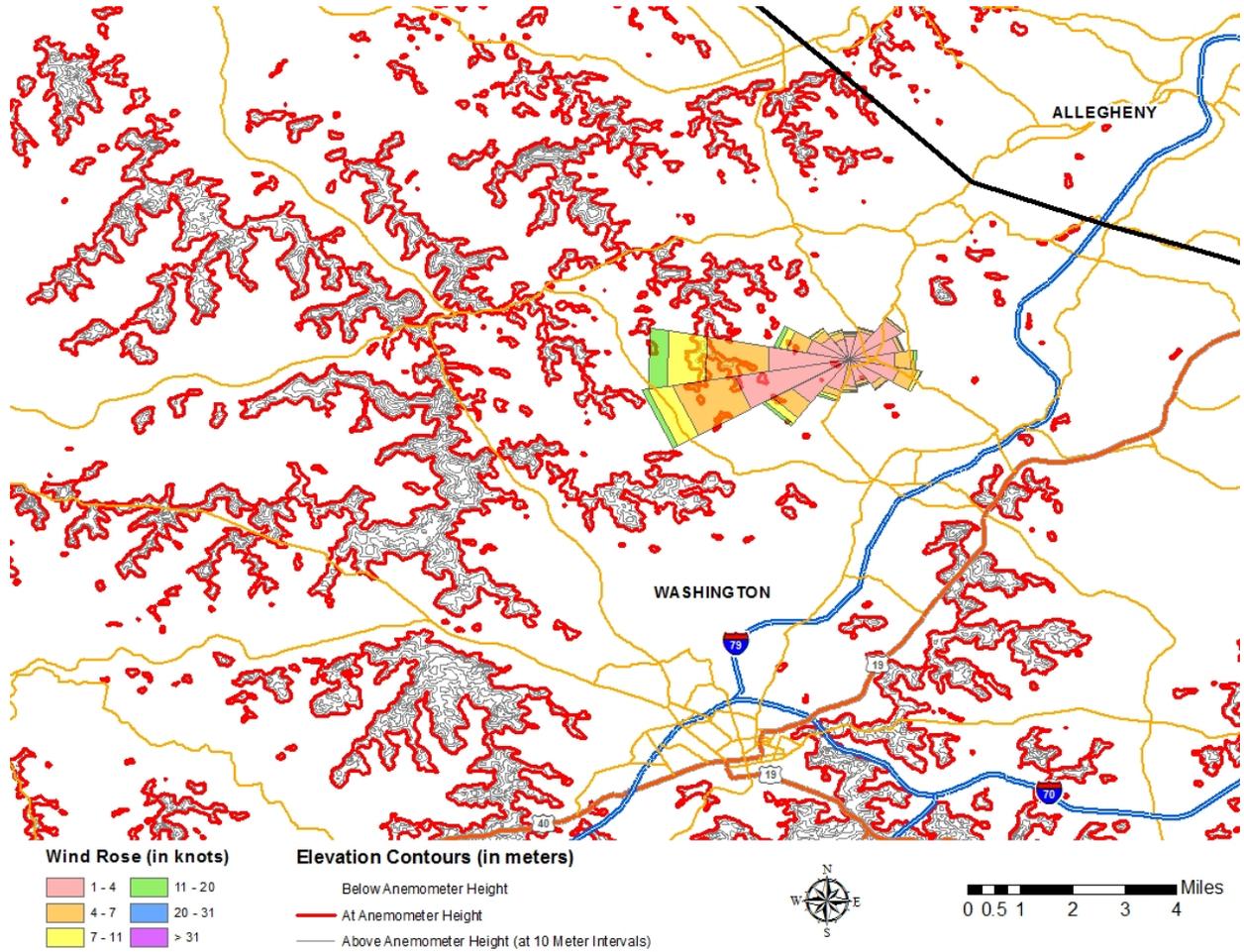


Figure 27 - 12-Month Wind Rose for Welsh Road Project Site

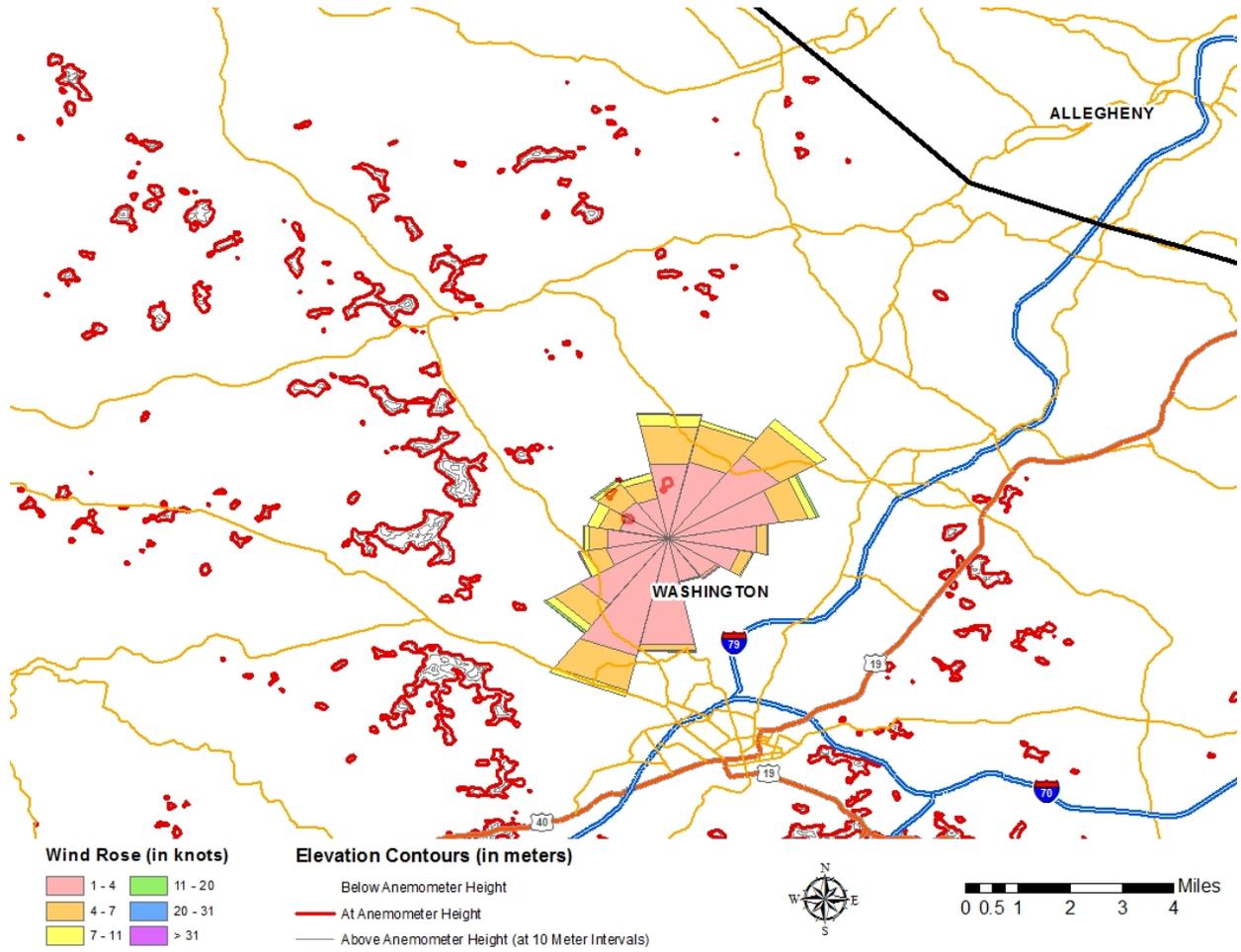
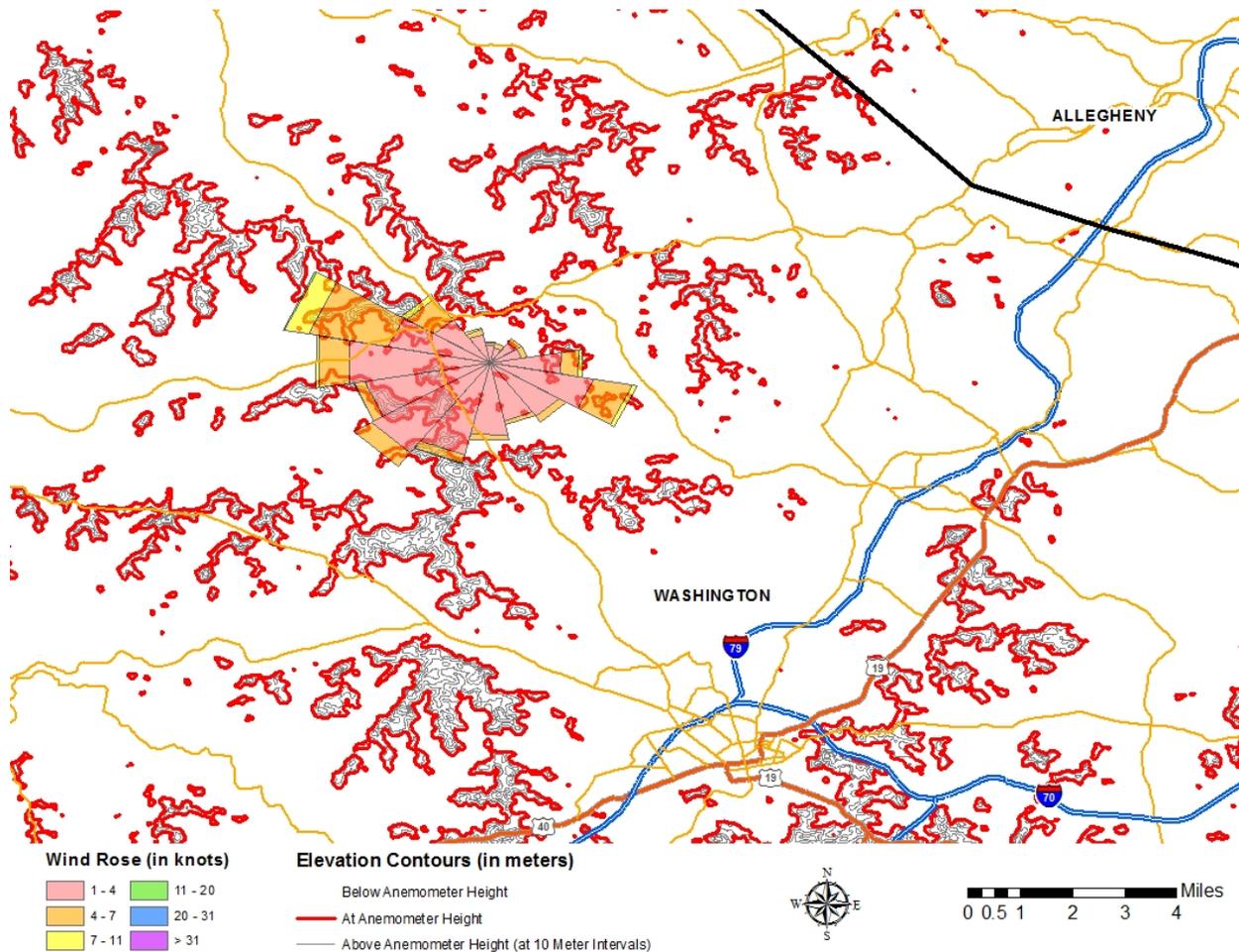


Figure 28 - 12-Month Wind Rose for Henderson Road Project Site



E. Data Quality, Validation and Usability

Criteria Pollutant Monitoring

All criteria pollutant monitors at the Meddings Road and the regional comparison sites were operated and maintained according to State and Local Monitoring Stations (SLAMS) criteria in 40 CFR Part 58. Quality assurance (QA) requirements are set forth in 40 CFR Part 58 Appendix A, “Quality Assurance Requirements for State and Local Air Monitoring Stations” and summarized in Table 28 on the next page. Monitors that did not meet QA acceptance criteria were recalibrated, repaired or replaced. Where the cause of the failure was determined to be the monitor and not attributable to other non-monitor issues such as faulty calibration equipment or standards, data from monitors not meeting QA acceptance criteria were invalidated. Table 28 includes scheduled QA checks that were performed on all criteria pollutant monitors at the Meddings Road and the Charleroi, Florence and Washington regional comparison sites. Note that several acceptance criteria were made more stringent in April 2013 to conform with guidance in EPA’s “Quality Assurance Handbook for Air Pollution Measurement Systems,” Volume II.

Table 28 - Quality Assurance Check Frequency and Acceptance Criteria for Criteria Pollutant Monitors

QA Check	Frequency	Acceptance Criteria
<i>Ozone Continuous</i>		
Calibration	3 x per year	±10%
Zero Check	Daily	±10 parts per billion
Span Check	Daily	±10% / ±7% starting April 2013
Precision Check	Every 2 weeks	±7%
Performance Audit	Annually	±10%
<i>CO Continuous</i>		
Calibration	2 x per year	±15%
Zero Check	Daily	±1 parts per million
Span Check	Daily	±20% / ±10% starting April 2013
Precision Check	Every 2 weeks	±15% / ±10% starting April 2013
Performance Audit	Annually	±15%
<i>NO₂ Continuous</i>		
Calibration	2 x per year	±15%
Zero Check	Daily	±10 parts per billion
Span Check	Daily	±20% / ±10% starting April 2013
Precision Check	Every 2 weeks	±15% / ±10% starting April 2013
Performance Audit	Annually	±15%
<i>H₂S Continuous</i>		
Calibration	2 x per year	±15%
Zero Check	Daily	±10 parts per billion
Span Check	Daily	±20% / ±10% starting April 2013
Precision Check	Every 2 weeks	±15% / ±10% starting April 2013
Performance Audit	Annually	±15%
<i>PM_{2.5} Continuous</i>		
Calibration	2 x per year	
Temperature		±2%
Pressure		±10mmHg
Flow		±3.4%
Flow Verification	Monthly	±3.4%
Performance Audit	2 x per year	
Temperature		±2%

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QA Check	Frequency	Acceptance Criteria
<i>PM_{2.5} Continuous (continued)</i>		
Pressure		±10mmHg
Flow		±6%
<i>PM_{2.5} FRM Manual Method</i>		
Calibration	Annually	
Temperature		±2%
Pressure		±10mmHg
Flow		±4%
Flow Verification	Monthly	±4%
Performance Audit	2 x per year	
Temperature		±2%
Pressure		±10mmHg
Flow		±4%

Pollutant standards utilized by PA DEP in its Ambient Air Monitoring Networks are either National Institute of Standards and Technology (NIST)-traceable standards or calibrated/verified to a NIST-traceable standard. Table 29 displays the standards used for the QA checks listed in Table 28.

Table 29 - Quality Assurance Calibration Standards for Criteria Pollutant Monitors

	Standard	Standard Type	Recertification Frequency	Recertification Acceptance Criteria
<i>Calibration Standards</i>				
<i>Primary Standards</i>				
Ozone Concentration	Thermo Scientific Model 49i-PS	Local Primary	Annually	±3% of reference standard, Sent to EPA for recertification
NO ₂ & CO Concentration	Praxair Tri-Blend Gas Cylinder	EPA Protocol	96 months	±1% of reference standard
H ₂ S Concentration	Praxair H ₂ S Gas Cylinder	EPA Protocol	36 months	±2% of reference standard
Ozone, NO ₂ , CO & H ₂ S Flow	DHI Molbloc 1E2-VCR-V-Q	Local Primary	Annually	±0.5% of reference standard, Sent to manufacturer for recertification
Pressure	Princo Instruments Model Forin-type Mercury Barometer	Local Primary	N/A	N/A

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	Standard	Standard Type	Recertification Frequency	Recertification Acceptance Criteria
<i>Field Transfer Standards</i>				
Ozone, NO ₂ , CO & H ₂ S Concentration	EnviroNics Model S 9100 Calibrator, including Perma-Pure Model ZS-100 Zero Air Supply, and gas cylinder	Field Transfer	Every 6 months	±2% of primary standard
Ozone, NO ₂ , CO, & H ₂ S Flow	Gilian Gilibrator	Field Transfer	Annually	±2.0 of primary
PM _{2.5} Flow	Streamline Pro Model SX	Field Transfer	Annually	Sent to manufacturer for recertification
Ozone, NO ₂ , CO, H ₂ S & PM _{2.5} Pressure	Streamline Pro Model SX	Field Transfer	Annually	Sent to manufacturer for recertification
PM _{2.5} Temperature	Streamline Pro Model SX	Field Transfer	Annually	Sent to manufacturer for recertification
<i>Span/Precision/Zero Check</i>				
NO ₂ , CO & H ₂ S Concentration	Permeation Tube Calibrator Model 145	Field Transfer	Every 6 months	±2.0 EnviroNics Model S 9100
Ozone Concentration	API Model 400 series	Field Monitor	3 x per year	±15% EnviroNics Model S 9100
<i>Performance Audits - field transfer standards are the same models as above, dedicated to QA staff</i>				

The following is summary of selected quality assurance check results performed at the Meddings Road and comparison sites. Detailed quality assurance check results and monitor maintenance reports are located in the “LTMP Supplemental Information” section on the Department’s website.³⁴

Automated bi-weekly precision checks were performed on all automated gaseous pollutant monitors operated by PA DEP. The precision check was performed by challenging the monitor with a pollutant standard of known concentration. The percent difference between the known concentration and the monitor response is plotted in Figures 29 through 32, along with the upper and lower acceptance criteria limits.

³⁴

<http://www.dep.pa.gov/Business/Air/BAQ/MonitoringTopics/ToxicPollutants/Pages/default.aspx#.VIWpVvMo6po>.

Figure 29 - Carbon Monoxide (CO) Precision Checks

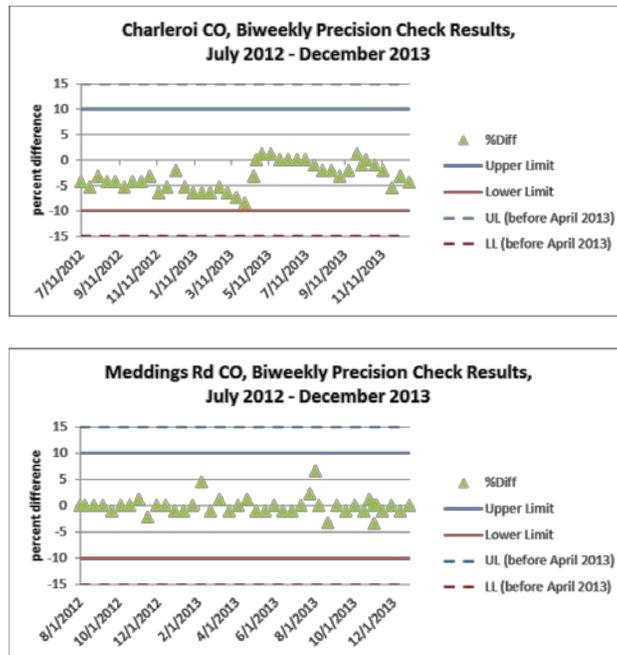


Figure 30 - Nitrogen Dioxide (NO₂) Precision Checks

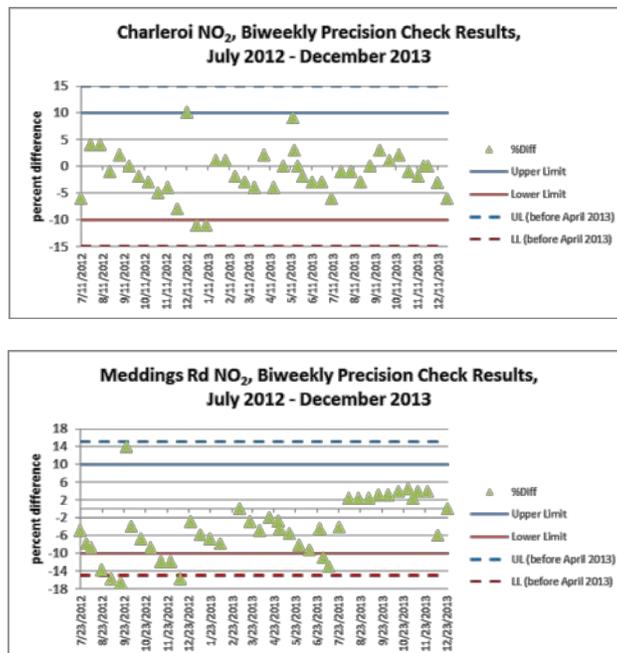


Figure 31 - Ozone (O₃) Precision Checks

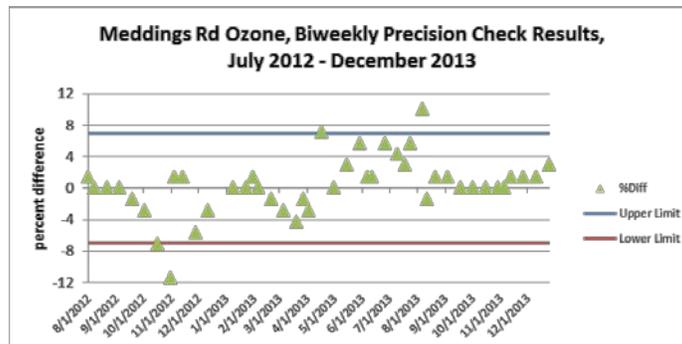
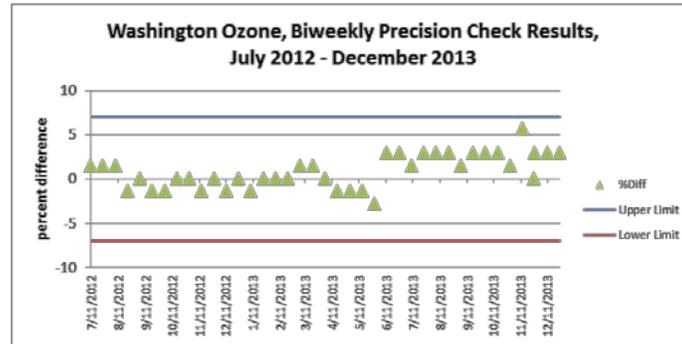
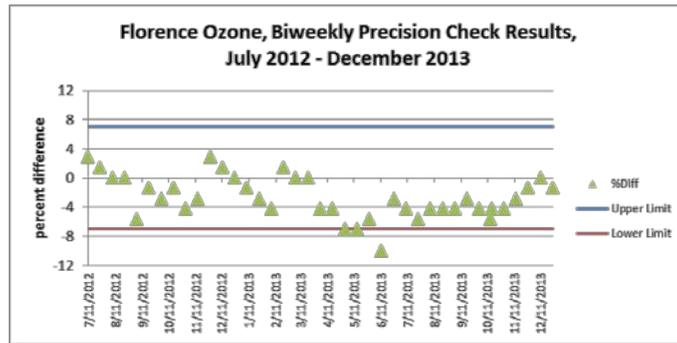
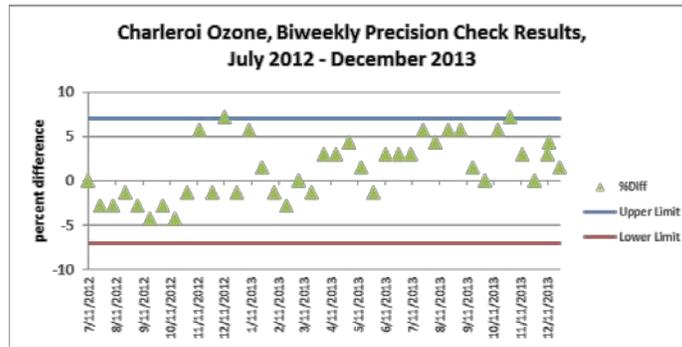
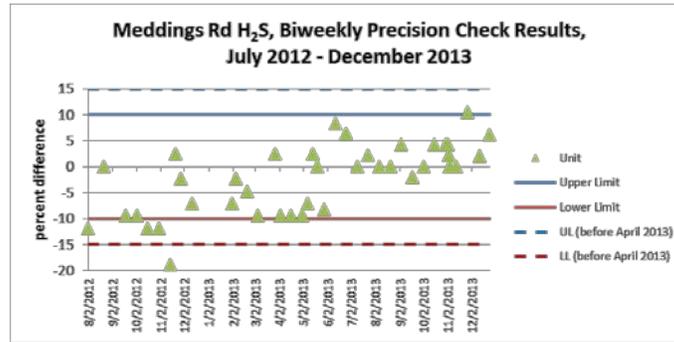
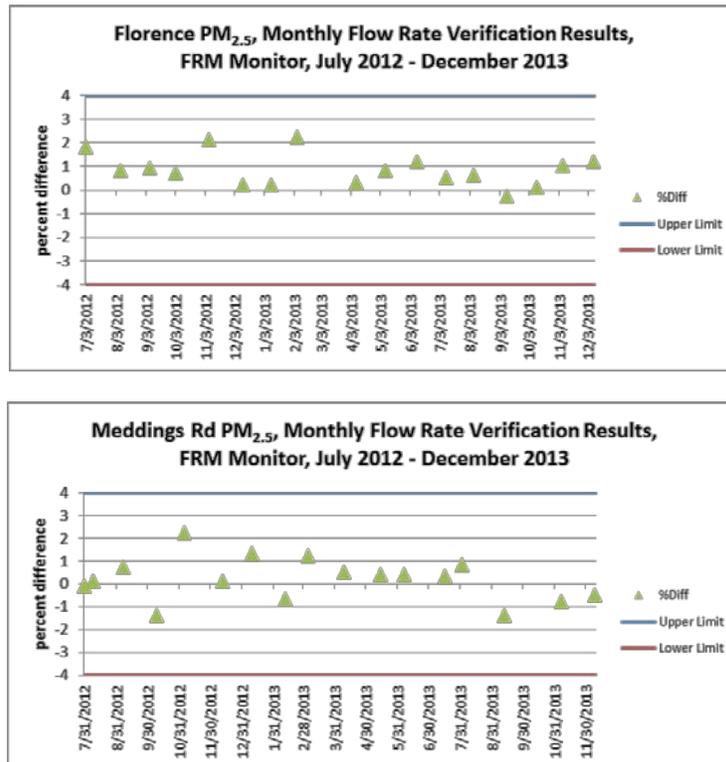


Figure 32 - Hydrogen Sulfide (H₂S) Precision Check



Flow rate verifications were performed by the Department’s Air Quality Field Operations staff on a monthly basis for both the continuous- and manual-method PM_{2.5} monitors. Flow rate verifications were performed by measuring the sample flow using a flow rate transfer standard and comparing the result to the flow rate reported by the monitor. The percent difference between the transfer standard measurement flow and the monitor response is plotted in Figures 33 and 34, along with the upper and lower acceptance criteria limits.

Figure 33 - PM_{2.5} Flow Rate Verifications - FRM Manual Method Monitors



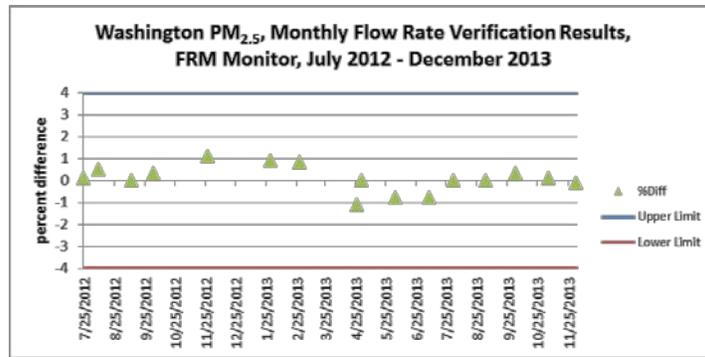
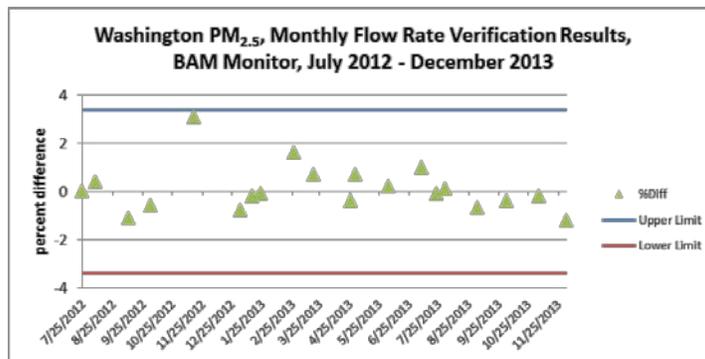
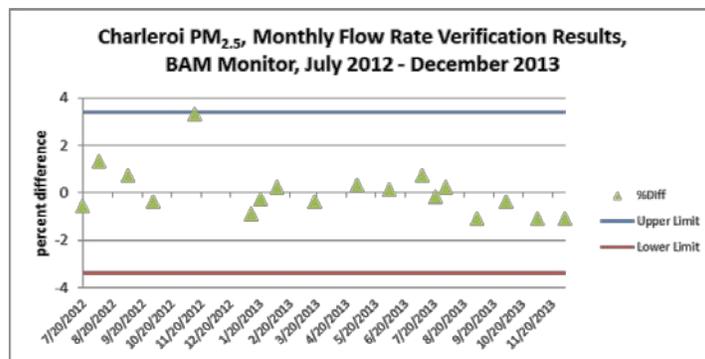


Figure 34 - PM_{2.5} Flow Rate Verifications - Continuous Method Monitors



Performance audits were performed by QA staff on all gaseous pollutant monitors on an annual basis while particulate monitors were audited twice per year. Performance audits were performed using calibration equipment and standards dedicated to QA staff. The results of the audits are summarized in Tables 30 through 33.

Table 30 - Charleroi COPAMS Performance Audits Results

Charleroi Performance Audits, July 2012 - December 2013				
Audit Date	CO	NO ₂	Ozone	PM _{2.5} BAM
8/22/2012	PASS	PASS	PASS	PASS
5/31/2013				PASS
10/8/2013	FAIL*	PASS	PASS	PASS
* Monitor was recalibrated 10/9/2013, Data was invalidated from prior "passed" precision check on 10/2 through calibration on 10/9				

Table 31 - Florence COPAMS Project Site Performance Audits Results

Florence Performance Audits, July 2012 - December 2013			
Audit Date	Ozone	PM _{2.5} BAM	PM _{2.5} FRM
8/23/2014	PASS	PASS	PASS
5/30/2014	PASS	PASS	PASS
10/8/2013		PASS	PASS

Table 32 - Washington COPAMS Project Site Performance Audits Results

Washington Performance Audits, July 2012 - December 2013			
Audit Date	Ozone	PM _{2.5} BAM	PM _{2.5} FRM
8/22/2012	PASS	PASS	PASS*
5/30/2013	PASS	PASS	PASS
10/8/2013		PASS	PASS*
* Monitor failed leak check - leak was repaired			

Table 33 - Meddings Road Project Site Performance Audits Results

Meddings Rd Performance Audits, July 2012 - December 2013					
Audit Date	CO	NO ₂	Ozone	PM _{2.5} FRM	H ₂ S
8/23/2014	PASS	PASS	PASS	PASS	PASS
4/22/2013	PASS	PASS	PASS	PASS	PASS
10/8/2013	PASS	PASS	PASS	PASS	PASS

Table 34 describes gaps in data completeness at the Meddings Road site during the project period, including data invalidated as a result of QA check results.

Table 34 - Data Gaps at Meddings Road Site for Criteria Pollutants and Hydrogen Sulfide (H₂S)

Data Gaps - Meddings Road Site		
CO		
7/23/2012	7/24/2012	Power outage - no power to datalogger
11/12/2013	11/13/2013	
NO₂		
7/23/2012	7/24/2012	Power outage - no power to datalogger
8/9/2012	8/20/2012	NO ₂ sample line disconnected
9/26/2012	9/27/2012	Span calibration check out of limit
1/11/2013	1/16/2013	NO ₂ sample line disconnected
2/19/2013	2/20/2013	Span calibration check out of limit
6/27/2013	7/2/2013	Span calibration check out of limit
7/29/2013	7/30/2013	Sensor in maintenance mode
O₃		
7/23/2012	7/24/2012	Power outage - no power to datalogger
9/13/2012	9/14/2012	Calibration check out of limit; sensor was erratic
10/3/2012	10/4/2012	Span calibration check out of limit
10/12/2012	10/16/2012	Span calibration check out of limit
12/23/2012	1/3/2013	Span calibration check out of limit
1/23/2013	1/24/2013	Span calibration check out of limit
PM_{2.5}		
10/14/2012	10/16/2012	monitor did not sample
1/25/2013	1/27/2013	elapsed sample time <24 hrs.
11/6/2013	11/12/2013	filter exchange error
11/28/2013	12/6/2013	filter exchange error
12/25/2013	12/31/2013	monitor did not sample
H₂S		
7/23/2012	7/24/2012	Power outage - no power to datalogger
8/31/2012	9/17/2012	Sensor in maintenance mode, bad pump
5/6/2013	5/8/2013	Span calibration check out of limit
9/6/2013	9/9/2013	Sensor in maintenance mode
9/9/2013	9/13/2013	Calibration check out of limit
11/18/2013	11/19/2013	Span calibration check out of limit
12/2/2013	12/12/2013	Span calibration check out of limit

Additional QA information for criteria pollutant monitoring data is discussed in more detail in the “LTMP Supplemental Information” portion on the Department’s website.³⁵

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<http://www.dep.pa.gov/Business/Air/BAQ/MonitoringTopics/ToxicPollutants/Pages/default.aspx#.VIWpVvMo6po>.

Non-Criteria Pollutant/HAP Monitoring

For manual HAP canister and carbonyl sampling, the Division's Quality Assurance and Data Assessment Section determined if Measurement Quality Objectives (MQOs) were met for each sample and evaluated whether individual site data sets met project Data Quality Objectives (DQOs) for data availability and completeness. The assessment included an examination and verification that (a) samples were analyzed within the maximum sample retention time windows established by the corresponding analysis method, (b) that sampling flow rate and/or beginning and ending canister pressures were within the established method parameters and (c) that routine QA checks were performed consistent with the goals described in the project sampling protocol TSD. Deviations from DQOs and their effect(s) on the study results are discussed in the "Data Analysis and Conclusions" section.

For HAP sampling, the project plan assumes that DQOs will be met if the monitoring sites satisfy the goal of one-in-six-day sampling, 85 percent data completeness for the period evaluated, and a 15 percent measurement Coefficient of Variance (CV). Laboratory analysis procedures for QA and validation for reporting were consistent with the requirements for laboratories accredited under the National Environmental Laboratory Accreditation Program (NELAP). The Department's Bureau of Laboratories is NELAP-accredited.

Additional information on laboratory procedures and protocols is included in the project sampling protocol TSD.

IV. Risk/Hazard Screening Analysis

One of the goals of the project is to use the collected data to perform a screening-level analysis of the HAP concentrations for estimating the potential chronic inhalation lifetime cancer risk and non-cancer hazard. However, it is important to note that the Department's ambient air screening risk analysis is not a complete inhalation pathway risk assessment. The overall project was planned and executed to address immediate public concerns with ambient levels of criteria pollutants and HAPs in not only the chosen project area but in other areas of Pennsylvania impacted by the unconventional natural gas development boom. The design of the screening analysis for toxic HAP inhalation risk was intended to balance not only the immediate public concern about the potential long-term risks of HAP exposure, but to yield results to inform the Department if additional, more detailed ambient inhalation risk assessment is warranted. Therefore, the screening risk analysis conducted for this report does not contain all the planning, implementation and analytical elements in a robust Tier 1 or Tier 2 risk assessment³⁶. This analysis is the examination of the observed concentrations of HAPs across the background site (Florence COPAMS) and four project sites for a one-year period and an examination of historic ambient air HAP concentrations at a remote site in Adams County not affected by the extraction of natural gas.

³⁶ Formal risk assessments are categorized in a three-tier system.

The following assumptions and limitations apply to this screening risk assessment:

- The chronic risk estimates are based on an individual that is exposed to the monitored concentrations over 70 years, for 24 hours per day.
- Actual risks to the estimated exposed concentrations could be less than expressed in the screening risk assessment due to the application of conservative screening values.
- The analysis does not take into account any changes in the actual concentrations that may occur in the future.
- The estimate of the mean concentration used for risk/hazard screening has inherent uncertainty. This uncertainty is directly related to both the overall percentage availability of data at each sampling location and the percent frequency at which each chemical was quantifiably detected in the available samples.
- The ambient air HAP concentration estimates are only representative at the location where the samples were obtained. Risk assessors must exercise care when applying actual monitored ambient concentration data for health-based risk assessments related to other specific geographic areas or source-specific emissions.
- The screening analysis only accounts for the direct inhalation pathway of outdoor air of an average U.S. adult, 24 hours per day, 365 days per year, for 70 years. Indirect exposure pathways or pathways associated with indoor residential or occupational exposure are not included. These pathways could introduce additional risk/hazard not accounted for in this screening.
- The risk and hazard assumptions used for the screening do not account solely for sensitive or vulnerable populations including children or the elderly. It is based on information for an average U.S. adult.
- There is considerable uncertainty in cumulative risk/hazard estimates involving multiple pollutants with simultaneous exposures. This uncertainty is reflected in the conservative assumptions made with regard to exposure. Additionally, the expressed risk/hazard is only for the toxic compounds for which the Department analyzed and for which either reviewed data on lifetime cancer inhalation risk or lifetime non-cancer inhalation hazard exist. It is not meant to encompass all potential risk/hazard from all known toxic or potentially toxic VOCs to which any individual or population could be exposed during a lifetime.

The monitoring locations were described previously in this document. Datasets from the background site and four project sites were analyzed to determine the optimal simultaneous data availability percentages for all sites for any given one-year period. As opposed to using the complete data set for each individual site, this method allows the Department to use a one-year period for data analysis that is the most temporally representative across all sites and eliminates

bias that could be introduced by potential seasonal fluctuation at sites where more data was collected³⁷.

The Department chose the available TO-15 and TO-11a data from the period from November 5, 2012 to October 31, 2013. Sampling for both TO-15 and TO-11A compounds was conducted on a schedule of one sample every six days which yielded a maximum of 61 samples for the one-year period³⁸. According to the DQO specified for the project³⁹, a minimum of 85 percent of the collectable samples for the screening year should be collected and valid to ensure significant confidence in the estimate of the mean concentration for any sampled compound for the given one-year screening period. Achieving a collection rate, expressed as “percent Data Availability” (DA%), at any given site of less than 85 percent does not invalidate the estimate of the mean concentrations from the site, but it does increase the overall uncertainty in the accuracy of that estimate.

This screening does not attempt to quantify the precise uncertainty associated with individual compound means estimated at sites where the DA% was less than 85 percent.

This screening only examines a one-year data set in its entirety and provides annual mean concentration estimates for the purpose of risk/hazard screening. Inferences cannot be made about seasonal fluctuations within the project year at one site or between sites because gaps in the data do not allow for representative sampling on a seasonal basis.

The frequent absence of detection of individual HAPs during the course of a year, expressed as a percent non-detect rate (%ND), is another area of uncertainty in any mean concentration estimate. High non-detection rates for a HAP occur when the true concentration of a HAP is below the quantifiable limits of detection for the analytical instrument or of a reporting limit for a laboratory.

The toxicity of HAPs is not limited by detection or reporting limits. In other words, real concentrations of HAPs below current analytical detection limits may pose an incremental cancer risk or non-cancer hazard. For this reason and for the purposes of this risk/hazard screening, the Department substituted an assumed concentration of one half (50 percent) the analytical instrument’s Method Detection Limit (MDL) at the time of that sample’s analysis for any HAP concentration reported as a non-detect (ND). This conservatively places an assumed cancer risk and/or non-cancer hazard on any screened HAP for which established lifetime ambient air exposure cancer risk factors or chronic non-cancer reference concentrations exist.

Other methods for mean estimation exist such as the Kaplan-Meier mean estimation or upper confidence limit estimation methods and might be recommended for data sets with high

³⁷ All VOC sampling equipment was not deployed simultaneously and equipment issues allowed for sizeable gaps in available data at three sites. Using the contemporaneous one-year data set allowed the Department to better meet the DQO’s specified in the TSD and provide a better statistical estimate of the individual mean HAP concentration used for the risk screening analysis.

³⁸ The non-continuous sampling schedule followed the national EPA ambient air quality monitoring network 1-in-6-day schedule.

³⁹ Refer to the TSD located on the Department’s website.

percentages of non-detection data. However, for this screening, the ½ MDL substitution method is used.

For the purposes of this screening, measurements of concentrations of Acrolein were excluded. Acrolein measurement in ambient air employing summa canister collection technology is highly uncertain and is believed to be biased high. This means that observed measurements of Acrolein using the methods employed by this project are likely significantly higher than actual concentrations in the ambient air. Additional information on Acrolein measurement and the accompanying uncertainty is discussed in more detail in the “LTMP Supplemental Information” on the Department’s website.⁴⁰

Data observed from the TO-11a Carbonyl method and the accompanying risk/hazard screening is presented separately from the TO-15 data. This is largely due to differences in data processing for the two methods. However, valid screened Carbonyl HAPs collected by the TO-11a method are included in the overall risk/hazard screening summary.

A. Presentation of Data

Tables 35 through 45 show the HAP data summary from each site. Each table is sorted from lowest to highest by the percent rate of non-detection for the one-year screening period for each sampled HAP compound. For all sites except the Florence COPAMS, separate tables list those compounds that were detected greater than 15 percent of the total available samples for the year (%ND < 85) and those compounds that were detected at least once but in less than 15 percent of the total samples for the screening period (%ND >85). Compounds that were not detected in any sample at the site are not included.

For each table, the applicable MDL for each compound is listed for the time period specified. Additionally, a five-year average (2009-2013) of the MDLs used for TO-15 analysis are included for comparison because MDLs can fluctuate over time within a single laboratory analytical instrument. Sample summary information shows both the percent data availability and the rate of non-detection for both the full and screening datasets. The arithmetic means or averages of the detected compounds with one half of the MDL substituted for each non-detected chemical are shown in both ppbv and µg/m³. Averages for both the one-year screening period and the entire dataset are included. Last, screening period data are shown graphically. The axis for the concentration (y-axis) for each chemical is auto-scaled to itself, but all displayed HAPs are scaled to the same one-year screening period.

The Department has chosen to include data that is indicated by the laboratory as being at a measurable concentration below the laboratory reporting limit but above the instrument’s MDL. This data is “flagged” by the laboratory as being presumptive evidence of a concentration below the reporting limit concentration but with less accuracy than non-flagged data. More information on the use of MDLs and the Reporting Limits (RL) for the project is included in Appendix C.

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<http://www.dep.pa.gov/Business/Air/BAQ/MonitoringTopics/ToxicPollutants/Pages/default.aspx#.VIWpVvMo6po>.

1. Meddings Road Site

This site sampled for both TO-15 and TO-11a HAP compounds. The 85 percent site availability goal was not met due to equipment malfunctions that required servicing of equipment by the vendor. However, the 79 percent data availability for the screening year can provide mean concentration estimates with some degree of certainty. As will be discussed, many of the concentrations of the observed HAPs are similar across all sites and in comparison with other ambient HAP monitoring sites in Pennsylvania.

Table 35 summarizes the 15 TO-15 HAPs that were detected in more than 15 percent of the 48 valid samples collected during the one-year screening period. Twelve HAPs were detected in more than 85 percent of the collected samples.

Table 36 summarizes the 19 TO-15 HAPs that were detected less than 15 percent of the time in the 48 valid samples collected during the one-year screening period. Of these 19 detects, 12 had only one instance of detection, and that detection was in a single sample.

As discussed in the QA section, the canister sampler at Meddings Road was deployed in September 2012 but experienced operating issues affecting reliability that required removal of the sampler beginning in December 2012. This unit was replaced with an identical model sampler in January 2013. Even though the accuracy of the initial sampler was questionable, the data collected from that sampler is included in the screening. In addition, even though that sampler provided only three of the 48 valid samples (six percent) during the screening period, their inclusion is a conservative approach and provides a more protective screening examination of the potential chronic cancer risk and non-cancer hazard.

Table 37 summarizes the three TO-11a Carbonyl HAPs that were detected at the Meddings Road site in more than 15 percent of the 48 valid samples collected during the one-year screening period. All three HAPs were detected in more than 85 percent of the collected samples.

Table 35 - Meddings Road Site - TO-15 Canister - Risk Screening - %ND < 85

Site Name: Meddings Road		Site ID: 520V											
Screening Period Start: 11/5/2012		Data Availability (Max): 79%											
Screening Period End: 10/31/2013													
Compound & Analysis Information							Sample Summary Information			1/2 MDL Summary Statistics			
Chemical Name	CASN ^A	Molecular Weight g/mol	Method Detection Limit (MDL) ppbv				Data Availability & Non Detect Rates (%)			Arithmetic Mean (1/2 MDL Substitution)			
			2012	2013a	2013b	5 Yr Avg	All Samples % DA	1 yr Screening		All Samples		1 yr Screening	
								% DA	% ND	ppbv	ug/m3	ppbv	ug/m3
Toluene	108-88-3	92.1	0.028	0.063	0.042	0.039	64%	79%	0%	0.252	0.948	0.233	0.879
Carbon tetrachloride	56-23-5	153.8	0.015	0.064	0.034	0.043	64%	79%	0%	0.095	0.596	0.095	0.598
Acetone	67-64-1	58.1	0.076	0.075	0.063	0.103	64%	79%	0%	5.924	14.077	5.677	13.490
Benzene	71-43-2	78.1	0.030	0.066	0.048	0.047	64%	79%	0%	0.184	0.589	0.183	0.585
Chloromethane	74-87-3	50.5	0.055	0.074	0.041	0.052	60%	74%	0%	0.597	1.233	0.599	1.237
Trichlorofluoromethane	75-69-4	137.4	0.064	0.066	0.042	0.055	64%	79%	0%	0.256	1.437	0.257	1.442
Dichlorodifluoromethane	75-71-8	120.9	0.021	0.069	0.031	0.044	60%	74%	0%	0.563	2.784	0.563	2.783
n-Hexane	110-54-3	86.2	0.038	0.049	0.037	0.044	64%	79%	2%	0.299	1.056	0.290	1.023
n-Heptane	142-82-5	100.2	0.040	0.039	0.037	0.041	64%	79%	2%	0.478	1.959	0.485	1.986
Propene	115-07-1	42.1	0.030	0.066	0.047	0.065	60%	74%	2%	2.628	4.526	2.637	4.541
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	187.4	0.061	0.061	0.035	0.055	64%	79%	6%	0.088	0.671	0.088	0.678
2-Butanone (MEK)	78-93-3	72.1	0.032	0.056	0.049	0.090	64%	79%	10%	0.596	1.756	0.526	1.550
Carbon disulfide	75-15-0	76.1	0.064	0.052	0.041	0.076	63%	77%	17%	0.128	0.397	0.103	0.320
Cyclohexane	110-82-7	84.2	0.027	0.072	0.046	0.041	64%	79%	21%	0.202	0.697	0.206	0.710
Methylene chloride	75-09-2	84.9	0.078	0.078	0.043	0.077	53%	64%	28%	0.087	0.301	0.090	0.314
A - Chemical Abstract Service Number													

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Table 36 - Meddings Road Site TO-15 Canister - Risk Screening - %ND > 85

Site Name:		Meddings Road						Site ID:		520V			
Screening Period Start:		11/5/2012						Data Availability (Max):		79%			
Screening Period End:		10/31/2013											
Compound & Analysis Information							Sample Summary Information			1/2 MDL Summary Statistics			
Chemical Name	CASN ^A	Molecular Weight g/mol	Method Detection Limit (MDL) ppbv				Data Availability & Non Detect Rates (%)			Arithmetic Mean (1/2 MDL Substitution)			
			2012	2013a	2013b	5 Yr Avg	All Samples % DA	1 yr Screening		All Samples		1 yr Screening	
								% DA	% ND	ppbv	ug/m3	ppbv	ug/m3
m & p-Xylene	108-38-3	106.2	0.087	0.082	0.040	0.069	64%	79%	92%	0.053	0.231	0.048	0.209
4-Methyl-2-pentanone (MIBK)	108-10-1	100.2	0.040	0.031	0.037	0.063	64%	79%	94%	0.017	0.071	0.017	0.070
Tetrachloroethene (PERC)	127-18-4	165.8	0.030	0.056	0.028	0.041	64%	79%	94%	0.030	0.204	0.029	0.199
Chloroform	67-66-3	119.4	0.019	0.063	0.035	0.037	64%	79%	94%	0.030	0.148	0.031	0.152
Ethylbenzene	100-41-4	106.2	0.040	0.040	0.020	0.040	64%	79%	96%	0.034	0.146	0.033	0.144
Tetrahydrofuran (THF)	109-99-9	72.1	0.027	0.070	0.032	0.053	64%	79%	96%	0.041	0.122	0.035	0.103
o-Xylene	95-47-6	106.2	0.043	0.042	0.020	0.041	64%	79%	96%	0.024	0.105	0.022	0.097
Styrene	100-42-5	104.2	0.041	0.039	0.016	0.042	64%	79%	98%	0.024	0.103	0.021	0.087
1,4-Dichlorobenzene	106-46-7	147	0.030	0.055	0.028	0.051	64%	79%	98%	0.021	0.129	0.020	0.120
1-Bromopropane	106-94-5	123	0.028	0.052	0.044	0.037	64%	79%	98%	0.023	0.118	0.024	0.123
Chlorobenzene	108-90-7	112.6	0.029	0.063	0.035	0.040	64%	79%	98%	0.030	0.137	0.031	0.143
1,1,1-Trichloroethane	71-55-6	133.4	0.017	0.063	0.034	0.045	64%	79%	98%	0.029	0.157	0.030	0.166
Bromoform	75-25-2	252.8	0.019	0.062	0.025	0.038	64%	79%	98%	0.028	0.293	0.030	0.309
Bromodichloromethane	75-27-4	163.8	0.017	0.066	0.038	0.038	64%	79%	98%	0.030	0.201	0.032	0.213
1,2-Dichloro-1,1,2,2-tetrafluoroethane	76-14-2	170.9	0.034	0.068	0.035	0.048	64%	79%	98%	0.032	0.225	0.033	0.233
1,2-Dichloropropane	78-87-5	113	0.021	0.063	0.049	0.039	64%	79%	98%	0.029	0.134	0.031	0.141
Trichloroethylene (TCE)	79-01-6	131.4	0.025	0.063	0.034	0.044	64%	79%	98%	0.030	0.160	0.031	0.166
Hexachloro-1,3-butadiene	87-68-3	260.7	0.027	0.057	0.073	0.047	64%	79%	98%	0.027	0.287	0.028	0.298
1,2,4-Trimethylbenzene	95-63-6	120.2	0.043	0.038	0.014	0.045	64%	79%	98%	0.020	0.099	0.020	0.096

^A - Chemical Abstract Service Number

Table 37 - Meddings Road Site - TO-11a Carbonyl - Risk Screening - %ND < 85

Site Name: Meddings Road		Site ID: 520C									
Screening Period Start: 11/5/2012		Data Availability (Max): 75%									
Screening Period End: 10/31/2013		Analysis: TO-11a									
Compound & Analysis Information					Sample Summary Information				1/2 MDL Summary Statistics		
Chemical Name	CAS ^A	Molecular Weight g/mol	Method Detection Limit (MDL)			Data Availability & Non Detect Rates (%)				Arithmetic Mean (1/2 MDL Substitution)	
			ppbv			All Samples		1 yr Screening		All Samples	1 yr Screening
			2012	2012/13	2013	% DA	% ND	% DA	% ND	ug/m ³	ug/m ³
Acetaldehyde	75-07-0	44.1	0.019	0.017	0.014	63%	0%	67%	0%	1.485	1.337
Formaldehyde	50-00-0	30	0.049	0.014	0.045	67%	0%	72%	0%	3.566	2.137
Propionaldehyde	123-38-6	58.1	0.011	0.010	0.006	70%	2%	75%	2%	0.241	0.222
Butyraldehyde (Butanal)	123-72-8	72.1	0.008	0.018	0.006	61%	12%	64%	15%	0.828	0.549
A - Chemical Abstract Service Number											

2. Welsh Road Site

Tables 38 and 39 present the HAP data for the Welsh Road site. Sixteen HAPs were detected at this site in more than 15 percent of the samples. Eleven of these HAPs were detected in more than 85 percent of the samples. Six HAPs were detected in less than 15 percent of the samples.

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Table 38 - Welsh Road Site - TO-15 Canister - Risk Screening - %ND < 85

Site Name:		Welsh Road						Site ID:		521V				
Screening Period Start:		11/5/2012						Data Availability (Max):		66%				
Screening Period End:		10/31/2013												
Compound & Analysis Information							Sample Summary Information			1/2 MDL Summary Statistics				
Chemical Name	CASN ^A	Molecular Weight g/mol	Method Detection Limit (MDL) ppbv				Data Availability & Non Detect Rates (%)			Arithmetic Mean (1/2 MDL Substitution)				
			2012	2013a	2013b	5 Yr Avg	All Samples		1 yr Screening		All Samples		1 yr Screening	
							% DA	% DA	% ND	ppbv	ug/m3	ppbv	ug/m3	
Toluene	108-88-3	92.1	0.028	0.063	0.042	0.039	68%	66%	0%	1.681	6.331	2.251	8.478	
Carbon tetrachloride	56-23-5	153.8	0.015	0.064	0.034	0.043	68%	66%	0%	0.095	0.596	0.094	0.588	
Acetone	67-64-1	58.1	0.076	0.075	0.063	0.103	68%	66%	0%	4.287	10.186	4.298	10.214	
Benzene	71-43-2	78.1	0.030	0.066	0.048	0.047	68%	66%	0%	0.225	0.717	0.254	0.810	
Chloromethane	74-87-3	50.5	0.055	0.074	0.041	0.052	66%	62%	0%	0.574	1.186	0.582	1.203	
Trichlorofluoromethane	75-69-4	137.4	0.064	0.066	0.042	0.055	68%	66%	0%	0.261	1.466	0.258	1.452	
Dichlorodifluoromethane	75-71-8	120.9	0.021	0.069	0.031	0.044	66%	62%	0%	0.556	2.750	0.542	2.681	
Propene	115-07-1	42.1	0.030	0.066	0.047	0.065	66%	62%	3%	1.678	2.889	1.714	2.952	
n-Hexane	110-54-3	86.2	0.038	0.049	0.037	0.044	68%	66%	5%	0.166	0.586	0.164	0.579	
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	187.4	0.061	0.061	0.035	0.055	67%	64%	5%	0.087	0.664	0.086	0.657	
2-Butanone (MEK)	78-93-3	72.1	0.032	0.056	0.049	0.090	62%	59%	14%	0.389	1.147	0.399	1.176	
n-Heptane	142-82-5	100.2	0.040	0.039	0.037	0.041	67%	64%	23%	0.055	0.224	0.056	0.228	
Methylene chloride	75-09-2	84.9	0.078	0.078	0.043	0.077	50%	51%	52%	0.075	0.259	0.078	0.271	
Styrene	100-42-5	104.2	0.041	0.039	0.016	0.042	68%	66%	68%	0.044	0.190	0.035	0.149	
Cyclohexane	110-82-7	84.2	0.027	0.072	0.046	0.041	68%	66%	73%	0.047	0.163	0.050	0.171	
m&p-Xylene	108-38-3	106.2	0.087	0.082	0.040	0.069	68%	66%	75%	0.059	0.258	0.062	0.270	
^A - Chemical Abstract Service Number														

Table 39 - Welsh Road Site - TO-15 Canister - Risk Screening - %ND > 85

Site Name:		Welsh Road					Site ID:		521V				
Screening Period Start:		11/5/2012					Data Availability (Max):		66%				
Screening Period End:		10/31/2013											
Compound & Analysis Information							Sample Summary Information			1/2 MDL Summary Statistics			
Chemical Name	CASN ^A	Molecular Weight g/mol	Method Detection Limit (MDL) ppbv				Data Availability & Non Detect Rates (%)			Arithmetic Mean (1/2 MDL Substitution)			
			2012	2013a	2013b	5 Yr Avg	All Samples	1 yr Screening		All Samples		1 yr Screening	
							% DA	% DA	% ND	ppbv	ug/m3	ppbv	ug/m3
Ethylbenzene	100-41-4	106.2	0.040	0.040	0.020	0.040	67%	64%	90%	0.033	0.145	0.033	0.145
o-Xylene	95-47-6	106.2	0.043	0.042	0.020	0.041	67%	64%	90%	0.022	0.097	0.024	0.103
Chloroform	67-66-3	119.4	0.019	0.063	0.035	0.037	68%	66%	93%	0.026	0.126	0.028	0.136
Carbon disulfide	75-15-0	76.1	0.064	0.052	0.041	0.076	68%	66%	95%	0.029	0.091	0.030	0.092
1,2,4-Trimethylbenzene	95-63-6	120.2	0.043	0.038	0.014	0.045	67%	64%	97%	0.020	0.096	0.020	0.098
Bromomethane	74-83-9	95	0.046	0.083	0.053	0.051	68%	66%	98%	0.037	0.146	0.042	0.162

^A - Chemical Abstract Service Number

3. Henderson Road Site

Tables 40 and 41 present the TO-15 HAP data for the Henderson Road site. Fifteen HAPs were detected at this site in more than 15 percent of the samples. Eleven of these HAPs were detected in more than 85 percent of the samples. Ten HAPs were detected in less than 15 percent of the samples with six of those only detected on one occasion.

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Table 40 - Henderson Road Site - TO-15 Canister - Risk Screening - %ND < 85

Site Name:		Henderson Road						Site ID:		523V			
Screening Period Start:		11/5/2012						Data Availability (Max):		80%			
Screening Period End:		10/31/2013											
Compound & Analysis Information							Sample Summary Information			1/2 MDL Summary Statistics			
Chemical Name	CASN ^A	Molecular Weight g/mol	Method Detection Limit (MDL) ppbv				Data Availability & Non Detect Rates (%)			Arithmetic Mean (1/2 MDL Substitution)			
			2012	2013a	2013b	5 Yr Avg	All Samples % DA	1 yr Screening		All Samples		1 yr Screening	
								% DA	% ND	ppbv	ug/m3	ppbv	ug/m3
Toluene	108-88-3	92.1	0.028	0.063	0.042	0.039	81%	75%	0%	0.159	0.600	0.152	0.572
Carbon tetrachloride	56-23-5	153.8	0.015	0.064	0.034	0.043	85%	80%	0%	0.095	0.597	0.094	0.589
Acetone	67-64-1	58.1	0.076	0.075	0.063	0.103	85%	80%	0%	4.953	11.770	4.558	10.831
Chloromethane	74-87-3	50.5	0.055	0.074	0.041	0.052	84%	79%	0%	0.583	1.203	0.582	1.202
Trichlorofluoromethane	75-69-4	137.4	0.064	0.066	0.042	0.055	85%	80%	0%	0.252	1.418	0.259	1.453
Dichlorodifluoromethane	75-71-8	120.9	0.021	0.069	0.031	0.044	84%	79%	0%	0.561	2.775	0.539	2.667
n-Hexane	110-54-3	86.2	0.038	0.049	0.037	0.044	85%	80%	2%	0.276	0.974	0.272	0.958
Propene	115-07-1	42.1	0.030	0.066	0.047	0.065	84%	79%	2%	2.069	3.563	2.043	3.517
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	187.4	0.061	0.061	0.035	0.055	85%	80%	4%	0.092	0.702	0.090	0.690
Benzene	71-43-2	78.1	0.030	0.066	0.048	0.047	84%	79%	6%	0.149	0.475	0.145	0.463
2-Butanone (MEK)	78-93-3	72.1	0.032	0.056	0.049	0.090	77%	74%	11%	0.370	1.092	0.355	1.048
n-Heptane	142-82-5	100.2	0.040	0.039	0.037	0.041	85%	80%	22%	0.077	0.314	0.072	0.295
Methylene chloride	75-09-2	84.9	0.078	0.078	0.043	0.077	63%	62%	29%	0.104	0.360	0.122	0.423
Styrene	100-42-5	104.2	0.041	0.039	0.016	0.042	85%	80%	39%	0.076	0.324	0.050	0.212
Cyclohexane	110-82-7	84.2	0.027	0.072	0.046	0.041	85%	80%	71%	0.054	0.187	0.050	0.174

^A - Chemical Abstract Service Number

Table 41 - Henderson Road Site - TO-15 Canister - Risk Screening - %ND > 85

Site Name:		Henderson Road						Site ID:		523V			
Screening Period Start:		11/5/2012						Data Availability (Max):		80%			
Screening Period End:		10/31/2013											
Compound & Analysis Information							Sample Summary Information			1/2 MDL Summary Statistics			
Chemical Name	CAS N ^A	Molecular Weight g/mol	Method Detection Limit (MDL) ppbv				Data Availability & Non Detect Rates (%)			Arithmetic Mean (1/2 MDL Substitution)			
			2012	2013a	2013b	5 Yr Avg	All Samples % DA	1 yr Screening		All Samples		1 yr Screening	
								% DA	% DA	% ND	ppbv	ug/m ³	ppbv
m & p-Xylene	108-38-3	106.2	0.087	0.082	0.040	0.069	85%	80%	94%	0.056	0.243	0.046	0.200
Chloroform	67-66-3	119.4	0.019	0.063	0.035	0.037	85%	80%	94%	0.025	0.124	0.028	0.137
1,2,4-Trimethylbenzene	95-63-6	120.2	0.043	0.038	0.014	0.045	85%	80%	94%	0.026	0.128	0.022	0.110
Tetrachloroethene (PERC)	127-18-4	165.8	0.030	0.056	0.028	0.041	85%	80%	96%	0.027	0.185	0.033	0.222
Ethylbenzene	100-41-4	106.2	0.040	0.040	0.020	0.040	85%	80%	98%	0.020	0.089	0.020	0.089
1,3-Butadiene	106-99-0	54.1	0.065	0.067	0.052	0.092	85%	80%	98%	0.034	0.076	0.035	0.077
1,2-Dichloroethane	107-06-2	99	0.026	0.045	0.037	0.036	84%	80%	98%	0.019	0.078	0.021	0.085
1-Ethyl-4-methylbenzene	622-96-8	120.2	0.043	0.035	0.015	0.046	85%	80%	98%	0.019	0.095	0.019	0.093
Carbon disulfide	75-15-0	76.1	0.064	0.052	0.041	0.076	85%	80%	98%	0.032	0.100	0.032	0.100
o-Xylene	95-47-6	106.2	0.043	0.042	0.020	0.041	85%	80%	98%	0.023	0.098	0.022	0.094
A - Chemical Abstract Service Number													

Table 42 summarizes the three TO-11a Carbonyl HAPs that were detected at the Henderson Road site in more than 15 percent of the 48 valid samples collected. All three HAPs were detected in more than 85 percent of the collected samples.

Table 42 - Henderson Road Site - TO-11a Carbonyl - Risk Screening - %ND > 85

Site Name:	Henderson Road	Site ID:	523C								
Screening Period Start:	11/5/2012	Data Availability (Max):	85%								
Screening Period End:	10/31/2013	Analysis:	TO-11a								
Compound & Analysis Information				Sample Summary Information				1/2 MDL Summary Statistics			
Chemical Name	CASN ^A	Molecular Weight g/mol	Method Detection Limit (MDL) ppbv			Data Availability & Non Detect Rates (%)				Arithmetic Mean (1/2 MDL Substitution)	
			2012	2012/13	2013	All Samples		1 yr Screening		All Samples ug/m ³	1 yr Screening ug/m ³
						% DA	% ND	% DA	% ND		
Acetaldehyde	75-07-0	44.1	0.019	0.017	0.014	54%	0%	48%	0%	0.861	0.929
Formaldehyde	50-00-0	30	0.049	0.014	0.045	59%	9%	77%	34%	0.825	0.697
Butyraldehyde (Butanal)	123-72-8	72.1	0.008	0.018	0.006	42%	9%	54%	39%	0.329	0.216
Propionaldehyde	123-38-6	58.1	0.011	0.010	0.006	59%	77%	77%	83%	0.028	0.022
A - Chemical Abstract Service Number											

4. Jaspen Way Site

Tables 43 and 44 present the TO-15 HAP data for the Jaspen Way site. Twenty HAPs were detected at this site in more than 15 percent of the samples. Eleven of these HAPs were detected in more than 85 percent of the samples. Eight HAPs were detected in less than 15 percent of the samples with five of those only detected on one occasion.

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Table 43 - Jaspens Way Site - TO-15 Canister - Risk Screening - %ND <85

Site Name: Jaspens Way		Site ID: 522V											
Screening Period Start: 11/5/2012		Data Availability (Max): 67%											
Screening Period End: 10/31/2013													
Compound & Analysis Information							Sample Summary Information			1/2 MDL Summary Statistics			
Chemical Name	CASN ^A	Molecular Weight g/mol	Method Detection Limit (MDL) ppbv				Data Availability & Non Detect Rates (%)			Arithmetic Mean (1/2 MDL Substitution)			
			2012	2013a	2013b	5 Yr Avg	All Samples	1 yr Screening		All Samples		1 yr Screening	
							% DA	% DA	% ND	ppbv	ug/m3	ppbv	ug/m3
n-Hexane	110-54-3	86.2	0.038	0.049	0.037	0.044	75%	67%	0%	0.194	0.684	0.171	0.602
Propene	115-07-1	42.1	0.030	0.066	0.047	0.065	73%	64%	0%	1.912	3.292	1.911	3.290
Carbon tetrachloride	56-23-5	153.8	0.015	0.064	0.034	0.043	75%	67%	0%	0.095	0.601	0.093	0.585
Acetone	67-64-1	58.1	0.076	0.075	0.063	0.103	72%	67%	0%	9.519	22.621	6.857	16.295
Chloromethane	74-87-3	50.5	0.055	0.074	0.041	0.052	73%	64%	0%	0.594	1.227	0.593	1.225
Trichlorofluoromethane	75-69-4	137.4	0.064	0.066	0.042	0.055	75%	67%	0%	0.260	1.461	0.259	1.455
Dichlorodifluoromethane	75-71-8	120.9	0.021	0.069	0.031	0.044	73%	64%	0%	0.562	2.779	0.539	2.665
Toluene	108-88-3	92.1	0.028	0.063	0.042	0.039	74%	67%	2%	0.180	0.677	0.179	0.673
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	187.4	0.061	0.061	0.035	0.055	75%	67%	2%	0.091	0.700	0.089	0.683
Benzene	71-43-2	78.1	0.030	0.066	0.048	0.047	75%	67%	5%	0.166	0.530	0.174	0.557
2-Butanone (MEK)	78-93-3	72.1	0.032	0.056	0.049	0.090	72%	66%	10%	0.627	1.850	0.502	1.481
n-Heptane	142-82-5	100.2	0.040	0.039	0.037	0.041	75%	67%	15%	0.066	0.272	0.058	0.239
Styrene	100-42-5	104.2	0.041	0.039	0.016	0.042	75%	67%	34%	0.191	0.815	0.158	0.673
Methylene chloride	75-09-2	84.9	0.078	0.078	0.043	0.077	62%	61%	41%	0.082	0.284	0.085	0.295
m&p-Xylene	108-38-3	106.2	0.087	0.082	0.040	0.069	75%	67%	46%	0.135	0.587	0.099	0.431
1,2,4-Trimethylbenzene	95-63-6	120.2	0.043	0.038	0.014	0.045	75%	67%	49%	0.076	0.374	0.077	0.377
1-Ethyl-4-methylbenzene	622-96-8	120.2	0.043	0.035	0.015	0.046	75%	67%	54%	0.042	0.209	0.041	0.202
Cyclohexane	110-82-7	84.2	0.027	0.072	0.046	0.041	75%	67%	66%	0.049	0.170	0.049	0.170
o-Xylene	95-47-6	106.2	0.043	0.042	0.020	0.041	75%	67%	66%	0.039	0.170	0.032	0.139
Ethylbenzene	100-41-4	106.2	0.040	0.040	0.020	0.040	75%	67%	80%	0.035	0.151	0.026	0.113
^A - Chemical Abstract Service Number													

Table 44 - Jaspén Way Site - TO-15 Canister - Risk Screening - %ND >85

Site Name: Jaspén Way		Site ID: 522V											
Screening Period Start: 11/5/2012		Data Availability (Max): 67%											
Screening Period End: 10/31/2013													
Compound & Analysis Information							Sample Summary Information			1/2 MDL Summary Statistics			
Chemical Name	CASN ^A	Molecular Weight g/mol	Method Detection Limit (MDL) ppbv				Data Availability & Non Detect Rates (%)			Arithmetic Mean (1/2 MDL Substitution)			
			2012	2013a	2013b	5 Yr Avg	All Samples % DA	1 yr Screening		All Samples		1 yr Screening	
								% DA	% ND	ppbv	ug/m ³	ppbv	ug/m ³
1,3,5-Trimethylbenzene	108-67-8	120.2	0.045	0.040	0.018	0.050	75%	67%	88%	0.022	0.110	0.024	0.116
Chloroform	67-66-3	119.4	0.019	0.063	0.035	0.037	74%	67%	90%	0.026	0.126	0.027	0.133
2-Hexanone	591-78-6	100.2	0.030	0.045	0.037	0.068	75%	67%	93%	0.022	0.088	0.026	0.105
1,3-Butadiene	106-99-0	54.1	0.065	0.067	0.052	0.092	75%	67%	98%	0.033	0.073	0.034	0.075
1,2-Dichloroethane	107-06-2	99	0.026	0.045	0.037	0.036	75%	67%	98%	0.018	0.072	0.020	0.082
4-Methyl-2-pentanone (MIBK)	108-10-1	100.2	0.040	0.031	0.037	0.063	75%	67%	98%	0.018	0.074	0.017	0.070
Tetrachloroethene (PERC)	127-18-4	165.8	0.030	0.056	0.028	0.041	75%	67%	98%	0.021	0.144	0.025	0.171
Carbon disulfide	75-15-0	76.1	0.064	0.052	0.041	0.076	75%	67%	98%	0.031	0.098	0.028	0.088

^A - Chemical Abstract Service Number

5. Florence COPAMS Site

Table 45 presents the TO-15 HAP data for the Florence COPAMS site. Thirteen HAPs were detected at this site in more than 15 percent of the samples. Ten of these HAPs were detected in more than 85 percent of the samples. Five HAPs were detected in less than 15 percent of the samples with two of those only detected on one occasion.

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Table 45 - Florence COPAMS Site - TO-15 Canister - Risk Screening - All Detects

Site Name:		Florence COPAMS							Site ID:		504V			
Screening Period Start:		11/5/2012							Data Availability (Max):		85%			
Screening Period End:		10/31/2013												
Compound & Analysis Information							Sample Summary Information			1/2 MDL Summary Statistics				
Chemical Name	CASN ^A	Molecular Weight g/mol	Method Detection Limit (MDL) ppbv				Data Availability & Non Detect Rates (%)			Arithmetic Mean (1/2 MDL Substitution)				
			2012	2013a	2013b	5 Yr Avg	All Samples		1 yr Screening		All Samples		1 yr Screening	
							% DA	% DA	% ND	ppbv	ug/m3	ppbv	ug/m3	
Propene	115-07-1	42.1	0.030	0.066	0.047	0.065	83%	80%	0%	0.955	1.645	1.034	1.781	
Carbon tetrachloride	56-23-5	153.8	0.015	0.064	0.034	0.043	87%	85%	0%	0.098	0.617	0.097	0.613	
Acetone	67-64-1	58.1	0.076	0.075	0.063	0.103	87%	85%	0%	4.056	9.639	4.406	10.470	
Chloromethane	74-87-3	50.5	0.055	0.074	0.041	0.052	83%	80%	0%	0.606	1.251	0.616	1.272	
Trichlorofluoromethane	75-69-4	137.4	0.064	0.066	0.042	0.055	87%	85%	0%	0.267	1.502	0.265	1.487	
Dichlorodifluoromethane	75-71-8	120.9	0.021	0.069	0.031	0.044	83%	80%	0%	0.586	2.897	0.580	2.867	
Toluene	108-88-3	92.1	0.028	0.063	0.042	0.039	85%	84%	2%	0.128	0.481	0.134	0.504	
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	187.4	0.061	0.061	0.035	0.055	85%	84%	4%	0.091	0.698	0.091	0.694	
2-Butanone (MEK)	78-93-3	72.1	0.032	0.056	0.049	0.090	83%	84%	4%	0.377	1.112	0.397	1.170	
Benzene	71-43-2	78.1	0.030	0.066	0.048	0.047	84%	85%	8%	0.180	0.575	0.186	0.594	
n-Hexane	110-54-3	86.2	0.038	0.049	0.037	0.044	85%	84%	16%	0.083	0.291	0.087	0.306	
Methylene chloride	75-09-2	84.9	0.078	0.078	0.043	0.077	65%	72%	32%	0.140	0.485	0.146	0.509	
n-Heptane	142-82-5	100.2	0.040	0.039	0.037	0.041	87%	85%	83%	0.024	0.097	0.024	0.099	
Cyclohexane	110-82-7	84.2	0.027	0.072	0.046	0.041	87%	85%	90%	0.037	0.126	0.037	0.128	
Chloroform	67-66-3	119.4	0.019	0.063	0.035	0.037	87%	85%	92%	0.028	0.135	0.029	0.143	
Carbon disulfide	75-15-0	76.1	0.064	0.052	0.041	0.076	87%	85%	96%	0.029	0.091	0.030	0.094	
1,2-Dichloroethane	107-06-2	99	0.026	0.045	0.037	0.036	87%	85%	98%	0.021	0.084	0.022	0.087	
m&p-Xylene	108-38-3	106.2	0.087	0.082	0.040	0.069	87%	85%	98%	0.040	0.176	0.042	0.183	
A - Chemical Abstract Service Number														

B. Lifetime Cancer Risk and Non-Cancer Hazard Quantification

Excess Lifetime Cancer Risk for each compound was calculated using unit risk factors (URFs). The risk for non-cancer health effects was calculated using reference air concentrations (RfCs). The URF is a measure of the probability of developing an incidence of cancer from exposure over a lifetime to a specified concentration of a given HAP. The RfC is the concentration below which no (non-cancer) adverse health effects are expected to occur over a lifetime of continuous exposure.

For this project, the Department used the U.S. Department of Energy, Oak Ridge National Laboratory Risk Assessment Information System (RAIS) and the U.S. EPA Integrated Risk Information System (IRIS) databases as the primary sources for the risk factors and reference concentrations. These databases aggregate toxicological information from multiple sources. Additionally, both of these systems place Weight of Evidence (WOE) classifications on each of the factors based on toxicological and public health professional review of the body of medical and toxicological evidence on the cancer and non-cancer health effects on exposed individuals and populations. For screening purposes, PA DEP assumes that all URF and RfC values for screened HAPs have the highest WOE classification.

While these two sources provide largely the same toxicity information, the EPA risk tables and associated screening level concentration values are designed for the assessment of risk and hazard associated with the remediation of Superfund sites and brownfields. The EPA screening level concentrations are included here for informational purposes and to highlight single stationary source risk/hazard screening values using modeled data for comparison to the monitored ambient air concentration data. Discussion on the use of the EPA screening values is included in the “LTMP Supplemental Information” section.

The URF and RfC are derived by assuming an adult weighing 70 kilograms (154 pounds) will breathe 20 cubic meters (706 ft³) of outdoor air each day for 365 days a year, over a 70-year lifetime of exposure. The Department makes no adjustment to this exposure estimate and assumes that the screening concentrations are representative of the true concentrations of HAPs inhaled by a population where the samples were taken. Indirect exposure pathways or pathways associated with indoor residential or occupational exposure are not included. These pathways could introduce additional risk/hazard not accounted for in this screening. In addition, the risk/hazard screening does not take into account sensitive or susceptible populations such as children or the elderly.

The excess lifetime cancer risk (ELCR) is calculated for each compound by multiplying its URF by the screening concentration. The individual risks for each HAP are then totaled to estimate a total excess lifetime cancer risk at that site. For screening purposes, the Department does not consider potential synergistic or antagonistic effects of HAP mixtures.

Excess lifetime cancer risk numbers are written in an exponential format, for example, 1.0E-04. Using Table 46 to interpret these numbers, an ELCR of 1.2E-05 means that 1.2 more people in a population of 100,000 (or 12 more in a million) could potentially have an incidence of cancer. This is above and beyond the national lifetime cancer risk of slightly less than 1 in 2 in men, and slightly more than 1 in 3 in women.

Table 46 - Interpreting Risk Numbers

Risk	Exponential	Decimal	Read as...
1.0E-08	1x10 ⁻⁸	0.00000001	1 in 100 million
1.0E-07	1x10 ⁻⁷	0.0000001	1 in 10 million
1.0E-06	1x10 ⁻⁶	0.000001	1 in 1 million
1.0E-05	1x10 ⁻⁵	0.00001	1 in 100,000
1.0E-04	1x10 ⁻⁴	0.0001	1 in 10,000

The hazard quotient (HQ) reflects an occurrence of a non-cancer health effect over a lifetime of exposure. The HQ associated with each of the relevant compounds is calculated by dividing the compound average screening concentration by the respective RfC. The individual hazard quotients for each compound are totaled to get the hazard index (HI). If this value is less than one and inhalation is the only source of exposure, then those chemicals' concentrations are not likely to cause adverse non-cancer health effects over an assumed lifetime. Because multiple HAPs are being screened, the hazard quotient for each HAP compound is adjusted to 0.1 to prevent a large underestimation of potential hazard. This is consistent with EPA guidance for conducting ambient air inhalation risk assessment screening. The guidance is located on EPA's website at <https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide-june-2017>.

Tables 47 through 53 show the screened HAPs at each project site, their screening concentrations and the calculated ELCR and HQ for each compound based on either the RAIS or EPA IRIS-sourced URFs and RfCs. The EPA cleanup screening level for risk/hazard screening at Superfund sites is also included. HAPs with screening concentrations above the EPA values are noted. Screened HAPs without either an ELCR or HQ listed do not have an associated URF or RfC in either referenced database. Absence of a URF or RfC does not mean that the HAP is not toxic or that it cannot potentially increase ELCR or the lifetime hazard. It means that insufficient health and toxicological inhalation data exist to develop a URF or RfC to the minimum standards needed by toxicologists and public health professionals to establish a factor or reference concentration.

TO-11a HAP data for both the Meddings and Henderson Road sites are provided in separate tables.

Tables 54 and 55 summarize the ELCR and HQ calculations for each site by analyte and list the specific URFs and RfCs used in the calculations. As TO-11a carbonyl sampling was only conducted at two of the five sites, the ELCR/HQ totals are also displayed by HAP sampling method. Discussion of the risk/hazard values continues in the "Screened Cumulative Risk/Hazard from HAPs" section.

Table 47 - Meddings Road Site - TO-15 Canister Screening Concentrations and Risk / Hazard Estimates

Site Name: Meddings Rd				Site ID: 520V						
Analysis: TO-15				Screening Duration: 1 year (11/5/12 - 10/31/13)						
Compound & Analysis Information				Chronic Lifetime Cancer Risk				Chronic Lifetime Hazard		
Chemical Name	CASN ^A	%ND	Screen Concentration ug/m ³	RAIS	EPA R3			RAIS	EPA R3	
				ELCR	ELCR	Cancer Screening Level (SL)	Observed > SL	Hazard Quotient (HQ)	Hazard Quotient (HQ)	Non-Cancer Screening Level (SL)
					ug/m ³				ug/m ³	
Toluene	108-88-3	0%	0.879					0.000	0.000	520
Carbon tetrachloride	56-23-5	0%	0.598	3.6E-06	3.6E-06	0.470	Y	0.006	0.006	10
Acetone	67-64-1	0%	13.490					0.000	0.000	3200
Benzene	71-43-2	0%	0.585	4.6E-06	4.6E-06	0.360	Y	0.020	0.020	3.1
Chloromethane	74-87-3	0%	1.237	2.2E-06				0.014	0.014	9.4
Trichlorofluoromethane	75-69-4	0%	1.442					0.002	0.002	73
Dichlorodifluoromethane	75-71-8	0%	2.783					0.028	0.028	10
n-Heptane	142-82-5	2%	1.986							
n-Hexane	110-54-3	2%	1.023					0.001	0.001	73
Propene	115-07-1	2%	4.541					0.002	0.002	310
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	6%	0.678					0.000	0.000	3100
2-Butanone (MEK)	78-93-3	10%	1.550					0.000	0.000	520
Carbon disulfide	75-15-0	17%	0.320					0.000	0.000	73
Cyclohexane	110-82-7	21%	0.710					0.000	0.000	630
Methylene chloride	75-09-2	28%	0.314	3.1E-09	3.1E-09	100.000		0.001	0.001	63

Table 48 - Meddings Road Site - TO-11a Carbonyl Screening Concentrations and Risk / Hazard Estimates

Site Name: Meddings Rd				Site ID: 520C							
Analysis: TO-11a				Chronic Lifetime Cancer Risk				Chronic Lifetime Hazard			
Compound & Analysis Information				RAIS	EPA R3			RAIS	EPA R3		
Chemical Name	CASN ^A	%ND	Screening Concentration ug/m ³	ELCR	ELCR	Cancer Screening Level (SL)	Observed > SL	Hazard Quotient (HQ)	Hazard Quotient (HQ)	Non-Cancer Screening Level (SL)	Observed > SL
						ug/m ³				ug/m ³	ug/m ³
Formaldehyde	50-00-0	0%	2.137	2.8E-05	2.8E-05	0.22	Y	0.22	0.22	1.00	Y
Acetaldehyde	75-07-0	0%	1.34	2.9E-06	2.9E-06	1.30	Y	0.15	0.15	0.94	Y
Propionaldehyde	123-38-6	2%	0.222					0.03	0.03	0.83	
Butyraldehyde (Butanal)	123-72-8	15%	0.549								

Table 49 - Welsh Road Site - TO-15 Canister Screening Concentrations and Risk/Hazard Estimates

Site Name: Welsh Rd				Site ID: 520V							
Analysis: TO-15				Screening Duration: 1 year (11/5/12 - 10/31/13)							
Compound & Analysis Information				Chronic Lifetime Cancer Risk				Chronic Lifetime Hazard			
Chemical Name	CASN ^A	%ND	Screen Concentration ug/m ³	RAIS	EPA R3			RAIS	EPA R3		
				ELCR	ELCR	Cancer Screening ug/m ³	Observed > SL	Hazard Quotient (HQ)	Hazard Quotient (HQ)	Non-Cancer ug/m ³	Observed > SL
Toluene	108-88-3	0%	8.478					0.002	0.002	520	
Carbon tetrachloride	56-23-5	0%	0.588	3.5E-06	3.5E-06	0.470	Y	0.006	0.006	10	
Acetone	67-64-1	0%	10.214					0.000	0.000	3200	
Benzene	71-43-2	0%	0.810	6.3E-06	6.3E-06	0.360	Y	0.027	0.027	3.1	
Chloromethane	74-87-3	0%	1.203	2.2E-06				0.013	0.013	9.4	
Trichlorofluoromethane	75-69-4	0%	1.452					0.002	0.002	73	
Dichlorodifluoromethane	75-71-8	0%	2.681					0.027	0.027	10	
Propene	115-07-1	3%	2.952					0.001	0.001	310	
n-Hexane	110-54-3	5%	0.579					0.001	0.001	73	
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	5%	0.657					0.000	0.000	3100	
2-Butanone (MEK)	78-93-3	14%	1.176					0.000	0.000	520	
n-Heptane	142-82-5	23%	0.228								
Methylene chloride	75-09-2	52%	0.271	2.7E-09	2.7E-09	100.000		0.000	0.000	63	
Styrene	100-42-5	68%	0.148					0.000	0.000	100	
Cyclohexane	110-82-7	73%	0.171					0.000	0.000	630	
m&p-Xylene	108-38-3	75%	0.270					0.003	0.003	10	

Table 50 - Jasp en Way Site - TO-15 Canister Screening Concentrations and Risk/Hazard Estimates

Site Name: Jasp en Way				Site IDs: 522V						
Compound & Analysis Information				Chronic Lifetime Cancer Risk				Chronic Lifetime Hazard		
Chemical Name	CAS N ^A	%ND	Screening Concentration ug/m ³	RAIS	EPA R3			RAIS	EPA R3	
				ELCR	ELCR	Cancer Screening Level (SL) ug/m ³	Observed > SL	Hazard Quotient (HQ)	Hazard Quotient (HQ)	Non-Cancer Screening Level (SL) ug/m ³
n-Hexane	110-54-3	0%	0.602					0.001	0.001	73
Propene	115-07-1	0%	3.290					0.001	0.001	310
Carbon tetrachloride	56-23-5	0%	0.585	3.5E-06	3.5E-06	0.470	Y	0.006	0.006	10
Acetone	67-64-1	0%	16.295					0.001	0.001	3200
Chlorom ethane	74-87-3	0%	1.225	2.2E-06				0.014	0.014	9.4
Trichlorofluorom ethane	75-69-4	0%	1.455					0.002	0.002	73
Dichlorodifluorom ethane	75-71-8	0%	2.665					0.027	0.027	10
Toluene	108-88-3	2%	0.673					0.000	0.000	520
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	2%	0.683					0.000	0.000	3100
Benzene	71-43-2	5%	0.557	4.3E-06	4.3E-06	0.360	Y	0.019	0.019	3.1
2-Butanone (MEK)	78-93-3	10%	1.481					0.000	0.000	520
n-Heptane	142-82-5	15%	0.239							
Styrene	100-42-5	34%	0.673					0.001	0.001	100
Methylene chloride	75-09-2	41%	0.295	2.9E-09	2.9E-09	100.000		0.000	0.000	63
m & p-Xylene	108-38-3	46%	0.431					0.004	0.004	10
1,2,4-Trim ethylbenzene	95-63-6	49%	0.377					0.054	0.054	0.73
1-Ethyl-4-m ethylbenzene	622-96-8	54%	0.202							
Cyclohexane	110-82-7	66%	0.170					0.000	0.000	630
o-Xylene	95-47-6	66%	0.139					0.001	0.001	10
Ethylbenzene	100-41-4	80%	0.113	2.8E-07	2.8E-07	1.100		0.000	0.000	100

Table 51 - Henderson Road Site - TO-15 Canister Screening Concentrations and Risk/Hazard Estimates

Site Name: Henderson Rd Analysis: TO-15				Site ID: 523V Screening Duration: 1 year (11/5/12 - 10/31/13)						
Compound & Analysis Information				Chronic Lifetime Cancer Risk				Chronic Lifetime Hazard		
Chemical Name	CASN ^A	%ND	Screening Concentration ug/m ³	RAIS	EPA R3			RAIS	EPA R3	
				ELCR	ELCR	Cancer Screening Level (SL) ug/m ³	Observed > SL	Hazard Quotient (HQ)	Hazard Quotient (HQ)	Non-Cancer Screening ug/m ³
Toluene	108-88-3	0%	0.572					0.000	0.000	520
Carbon tetrachloride	56-23-5	0%	0.589	3.5E-06	3.5E-06	0.470	Y	0.006	0.006	10
Acetone	67-64-1	0%	10.831					0.000	0.000	3200
Chloromethane	74-87-3	0%	1.202	2.2E-06				0.013	0.013	9
Trichlorofluoromethane	75-69-4	0%	1.453					0.002	0.002	73
Dichlorodifluoromethane	75-71-8	0%	2.667					0.027	0.027	10.00
n-Hexane	110-54-3	2%	0.958					0.001	0.001	73.00
Propene	115-07-1	2%	3.517					0.001	0.001	310.00
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	4%	0.690					0.000	0.000	3100.0000
Benzene	71-43-2	6%	0.463	3.6E-06	3.6E-06	0.360	Y	0.015	0.015	3.10
2-Butanone (MEK)	78-93-3	11%	1.048					0.000	0.000	520
n-Heptane	142-82-5	22%	0.295							
Methylene chloride	75-09-2	29%	0.423	4.2E-09	4.2E-09	100.000		0.001	0.001	63
Styrene	100-42-5	39%	0.212					0.000	0.000	100
Cyclohexane	110-82-7	71%	0.174					0.000	0.000	630.0

Table 52 - Henderson Road Site - TO-11a Carbonyl Screening Concentrations and Risk/Hazard Estimates

Site Name: Henderson Rd				Site ID: 523C							
Analysis: TO-11a				Screening Duration: 1yr. (11/5/12 - 10/31/13)							
Compound & Analysis Information				Chronic Lifetime Cancer Risk				Chronic Lifetime Hazard			
Chemical Name	CASN ^A	%ND	Screening Concentration ug/m ³	RAIS	EPA R3			RAIS	EPA R3		
				ELCR	ELCR	Cancer Screening Level (SL) ug/m ³	Observed > SL	Hazard Quotient (HQ)	Hazard Quotient (HQ)	Non-Cancer Screening Level (SL) ug/m ³	Observed > SL
Acetaldehyde	75-07-0	0%	0.929	8.8E-09	8.8E-09	1.30		0.00	0.00	0.94	
Formaldehyde	50-00-0	34%	0.697	9.1E-06	9.1E-06	0.22	Y	0.07	0.07	1.00	
Butyraldehyde (Butanal)	123-72-8	39%	0.216								
Propionaldehyde	123-38-6	83%	0.022					0.22	0.22	0.83	Y

Table 53 - Florence COPAMS Site - TO-15 Canister Screening Concentrations and Risk/Hazard Estimates

Site Name: Florence COPAMS				Site ID: 504V						
Compound & Analysis Information				Chronic Lifetime Cancer Risk				Chronic Lifetime Hazard		
Chemical Name	CA SN ^A	%ND	Screening Concentration ug/m ³	RAIS	EPA R3			RAIS	EPA R3	
				ELCR	ELCR	Cancer Screening Level (SL) ug/m ³	Observed > SL	Hazard Quotient (HQ)	Hazard Quotient (HQ)	Non-Cancer Screening Level (SL) ug/m ³
Propene	115-07-1	0%	1.781					0.001	0.001	310
Carbon tetrachloride	56-23-5	0%	0.613	3.7E-06	3.7E-06	0.470	Y	0.006	0.006	10
Acetone	67-64-1	0%	10.470					0.000	0.000	3200
Chloromethane	74-87-3	0%	1.272	2.3E-06				0.014	0.014	9.4
Trichlorofluoromethane	75-69-4	0%	1.487					0.002	0.002	73
Dichlorodifluoromethane	75-71-8	0%	2.867					0.029	0.029	10
Toluene	108-88-3	2%	0.504					0.000	0.000	520
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	4%	0.694					0.000	0.000	3100
2-Butanone (MEK)	78-93-3	4%	1.170					0.000	0.000	520
Benzene	71-43-2	8%	0.594	4.6E-06	4.6E-06	0.360	Y	0.020	0.020	3.1
n-Hexane	110-54-3	16%	0.306					0.000	0.000	73
Methylene chloride	75-09-2	32%	0.509	5.1E-09	5.1E-09	100.000		0.001	0.001	63
n-Heptane	142-82-5	83%	0.099							

Table 54 - Summary of Screened Excess Lifetime Cancer Risk (ELCR) Values for Project by Site

Chemical Information			Sampling Sites										Cancer Risk Factors			
Chemical Name	CASN ^A	MW ^B (g/mol)	Meddings Rd		Welsh Rd		Jaspen Way		Henderson Rd		Florence COPAMS		RAIS Unit Risk Factor (URF)		EPA Indiv. Unit Risk (IUR)	
			Screen Conc	ELCR ^C	Screen Conc	ELCR	Screen Conc	ELCR	Screen Conc	ELCR	Screen Conc	ELCR	(m ³ /ug)	Source ^D	(ug/m ³) ⁻¹	Source
Carbon tetrachloride	56-23-5	153.8	0.598	3.6E-06	0.588	3.5E-06	0.585	3.5E-06	0.589	3.5E-06	0.613	3.7E-06	6.0E-06	IRIS	6.0E-06	IRIS
Benzene	71-43-2	78.1	0.585	4.6E-06	0.81	6.3E-06	0.557	4.3E-06	0.463	3.6E-06	0.594	4.6E-06	7.8E-06	IRIS	7.8E-06	IRIS
Chloromethane	74-87-3	50.5	1.237	2.2E-06	1.203	2.2E-06	1.225	2.2E-06	1.202	2.2E-06	1.272	2.3E-06	1.8E-06	HEAST		
Methylene chloride	75-09-2	84.9	0.314	3.1E-09	0.271	2.7E-09	0.295	3.0E-09	0.423	4.2E-09	0.509	5.1E-09	1.0E-08	IRIS	1.0E-08	IRIS
Ethylbenzene	100-41-4	106.2	N/A	N/A	N/A	N/A	0.113	2.8E-07	N/A	N/A	N/A	N/A	2.5E-06	Cal EPA	2.5E-06	Cal EPA
Formaldehyde (TO-11)	50-00-0	30.0	2.137	2.8E-05	N/A	N/A	N/A	N/A	0.697	9.1E-06	N/A	N/A	1.3E-05	IRIS	1.3E-05	IRIS
Acetaldehyde (TO-11)	75-07-0	44.1	1.34	2.9E-06	N/A	N/A	N/A	N/A	0.929	2.0E-06	N/A	N/A	2.2E-06	IRIS	2.2E-06	IRIS
Total ELCR (TO15)			1.0E-05		1.2E-05		1.0E-05		9.3E-06		1.1E-05					
Total ELCR (TO11)			3.1E-05		N/A		N/A		1.1E-05		N/A					
Cumulative ELCR (All)			4.1E-05		1.2E-05		1.0E-05		2.0E-05		1.1E-05					

A - Chemical Abstract Service Number
B - Chemical Molecular Weight in grams per mole compound
C - Extended Lifetime Cancer Risk
D - Source of URF or IUR used. The higher factor representing the higher unit risk is used for the calculation.

ATSDR - Agency for Toxic Substances and Disease Registry
 CalEPA - California Environmental Protection Agency
 HEAST - Health Effects Assessment Summary Tables (U.S. EPA)
 IRIS - Integrated Risk Information System (U.S. EPA);
 PPRTV - Provisional Peer Reviewed Toxicity Values (U.S. DOE / Oak Ridge Natl. Lab)

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Table 55 - Summary of Screened Hazard Quotient (HQ) Values for Project by Site

Chemical Information			Sampling Sites										Hazard Reference Concentrations				
Chemical Name	CASN ^A	MW ^B (g/mol)	Meddings Rd		Welsh Rd		Jaspen Way		Henderson Rd		Florence COPAMS		RAIS Reference Concentration (RfC)		EPA Reference Concentration (RfC)		
			Screen Conc	HQ ^C	Screen Conc	HQ	Screen Conc	HQ	Screen Conc	HQ	Screen Conc	HQ	ug/m ³	Source ^D	ug/m ³	Source	
Toluene	108-88-3	92.1	0.879	0.00	8.478	0.00	0.673	0.00	0.572	0.00	0.504	0.00	5000	IRIS	5000	IRIS	
Carbon tetrachloride	56-23-5	153.8	0.598	0.01	0.588	0.01	0.585	0.01	0.589	0.01	0.613	0.01	100	IRIS	100	IRIS	
Acetone	67-64-1	58.1	13.490	0.00	10.214	0.00	16.295	0.00	10.831	0.00	10.470	0.00	30881	ATSDR	31000	ATSDR	
Benzene	71-43-2	78.1	0.585	0.02	0.810	0.03	0.557	0.02	0.463	0.02	0.594	0.02	30	IRIS	30	IRIS	
Chloromethane	74-87-3	50.5	1.237	0.01	1.203	0.01	1.225	0.01	1.202	0.01	1.272	0.01	90	IRIS	90	IRIS	
Trichlorofluoromethane	75-69-4	137.4	1.442	0.00	1.452	0.00	1.455	0.00	1.453	0.00	1.487	0.00	700	HEAST	700	HEAST	
Dichlorodifluoromethane	75-71-8	120.9	2.783	0.03	2.681	0.03	2.665	0.03	2.667	0.03	2.867	0.03	100	PPRTV(S)	100	PPRTV(S)	
n-Hexane	110-54-3	86.2	1.023	0.00	0.579	0.00	0.602	0.00	0.958	0.00	0.306	0.00	700	IRIS	700	IRIS	
Propene	115-07-1	42.1	4.541	0.00	2.952	0.00	3.290	0.00	3.517	0.00	1.781	0.00	3000	CalEPA	3000	CalEPA	
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	187.4	0.678	0.00	0.657	0.00	0.683	0.00	0.690	0.00	0.694	0.00	30000	HEAST	30000	HEAST	
2-Butanone (MEK)	78-93-3	72.1	1.550	0.00	1.176	0.00	1.481	0.00	1.048	0.00	1.170	0.00	5000	IRIS	5000	IRIS	
Carbon disulfide	75-15-0	76.1	0.320	0.00	N/A		N/A		N/A		N/A		700	IRIS	700	IRIS	
Cyclohexane	110-82-7	84.2	0.710	0.00	0.171	0.00	0.170	0.00	0.174	0.00	N/A		6000	IRIS	6000	IRIS	
Methylene chloride	75-09-2	84.9	0.314	0.00	0.271	0.00	0.295	0.00	0.423	0.00	0.509	0.00	600	IRIS	600	IRIS	
m & p-Xylene	108-38-3	106.2	N/A		0.270	0.00	0.431	0.00	N/A		N/A		100	IRIS	100	IRIS	
Styrene	100-42-5	104.2	N/A		0.148	0.00	0.673	0.00	0.212	0.00	N/A		1000	IRIS	1000	IRIS	
1,2,4-Trimethylbenzene	95-63-6	120.2	N/A		N/A		0.377	0.05	N/A		N/A		7	PPRTV	7	PPRTV	
o-Xylene	95-47-6	106.2	N/A		N/A		0.139	0.00	N/A		N/A		100	IRIS	100	IRIS	
Ethylbenzene	100-41-4	106.2	N/A		N/A		0.113	0.00	N/A		N/A		1000	IRIS	1000	IRIS	
Formaldehyde (TO-11)	50-00-0	30	2.137	0.22	N/A		N/A		0.697	0.07	N/A		9.83	ATSDR	9.8	ATSDR	
Acetaldehyde (TO-11)	75-07-0	44.1	1.34	0.15	N/A		N/A		0.929	0.10	N/A		9	IRIS	9	IRIS	
Total HQ (TO15)			0.07		0.08		0.13		0.07		0.07						
Total HQ (TO11)			0.37		N/A		N/A		0.17		N/A						
Cumulative HQ (All)			0.44		0.08		0.13		0.24		0.07						
A - Chemical Abstract Service Number										ATSDR - Agency for Toxic Substances and Disease Registry							
B - Chemical Molecular Weight in grams per mole compound										CalEPA - California Environmental Protection Agency							
C - Hazard Quotient										HEAST - Health Effects Assessment Summary Tables (U.S. EPA)							
D - Source of RfC used. The higher concentration representing the higher hazard is used for the calculation.										IRIS - Integrated Risk Information System (U.S. EPA);							
										PPRTV - Provisional Peer Reviewed Toxicity Values (U.S. DOE / Oak Ridge Natl. Lab)							

C. Cumulative Risk/Hazard from HAPs at Study Area

Seven HAPs of the 63 screened HAPs were identified as having concentrations in ambient air that contribute to total ELCR. The cumulative ELCR at all sites is between one in one million (1.0E-06) and one in ten thousand (1.0E-04). This range is generally considered to be an acceptable range of ELCR for conducting risk assessments at Superfund or hazardous cleanup sites. However, as noted previously, the EPA screening levels are largely based on modeled emissions data assumptions for specific known stationary sources and not necessarily analogous to screening for ambient air at locations removed from a specific identified source.

Observed screening concentrations of TO-15 HAPs at all sites, including the Florence COPAMS background site, appear largely similar; however, insufficient data exists to make a confident statistical comparison of the observed distribution of HAP concentrations over the course of the study. Estimated cumulative cancer risks for the observed HAPs range from slightly less than one (0.93) increased cancer incidence in 100,000 people at the Henderson Road site to an increased risk of slightly more than one (1.2) cancer incident in 100,000 people at the Welsh Road site.

At the Meddings and Henderson Road sites where TO-11a HAP compounds were sampled, the additional observed compounds contributed to the calculation. Of note is the difference in screening concentrations of formaldehyde. The Meddings Road site showed concentrations and estimated risk three times greater than at the Henderson Road site (3.1 versus 1.1 additional lifetime cancer incidence per 100,000 population). However, given the lower confidence in the estimate of the observed concentrations of the TO-11a HAP compounds sampled, the observed difference might be illusory. This is largely due to the reduced overall data availability in the carbonyl sampling, a significant five-month gap of seasonal spring and early summer data, and potential contamination issues with the carbonyl sampling equipment. It is important to note that new dual canister/carbonyl cartridge samplers were purchased and deployed for this project. During the project, it was determined that reagent compounds from the cartridges were being introduced into the canister sampling stream and affecting carbonyl sampling blanks and therefore introducing a potential bias on results from those samplers. While TO-15 canister results are believed to be largely unbiased by this equipment design issue, the same is not true for the carbonyl results. For that reason, the Department is qualifying its conclusions concerning the carbonyl data with an unspecified sampling and analysis uncertainty.

Assuming that the screening concentrations of acetaldehyde and formaldehyde estimated for the Meddings Road site were also found at Welsh Road, Jaspens Way, and the Florence COPAMS, the estimated ELCR at all project sites ranges between 2 and 4.3 additional lifetime cancer incidence per 100,000 population.

The screened non-cancer hazard quotients for TO-15 HAPs at the project sites were all well below the Hazard Index of 1.0 indicating that the screened concentrations were below the levels where a lifetime non-cancer hazard could occur. Similar to the cancer risk screening, the Meddings Road site showed a higher hazard associated with chronic exposure to acetaldehyde and formaldehyde; however, those concentrations result in a Hazard Index of less than 1.0 (0.37 at Meddings Road and 0.17 at Henderson Road). As noted in the TO-15 HAP risk discussion, uncertainty in the sampling equipment and the sub-optimum overall data availability of the TO-11a data make it

difficult to make definitive conclusions regarding differences between the screened concentrations at the two sites.

D. Arendtsville HAP Risk/Hazard Screening

Historical ambient air HAP sampling at the Department’s Arendtsville COPAMS site in Adams County can provide ambient concentration data of air in a lightly populated, predominately agricultural area similar to the project sites. The Arendtsville site, shown in Figure 35, is located in a university agricultural research orchard adjacent to a large commercial peach and apple orchard. This site is not directly impacted by any large stationary source and has limited access to on-road vehicular traffic, although non-road farm machinery and vehicles do operate on occasion in the fields and orchards surrounding the site. The Arendtsville site has not experienced the development of either conventional or unconventional natural gas extraction. Table 56 contains a summary of the TO-15 and TO-11a data collected from the Arendtsville site for the two-year period from 2012 through 2013.

Figure 35 - Overview of Arendtsville COPAMS Comparison Site

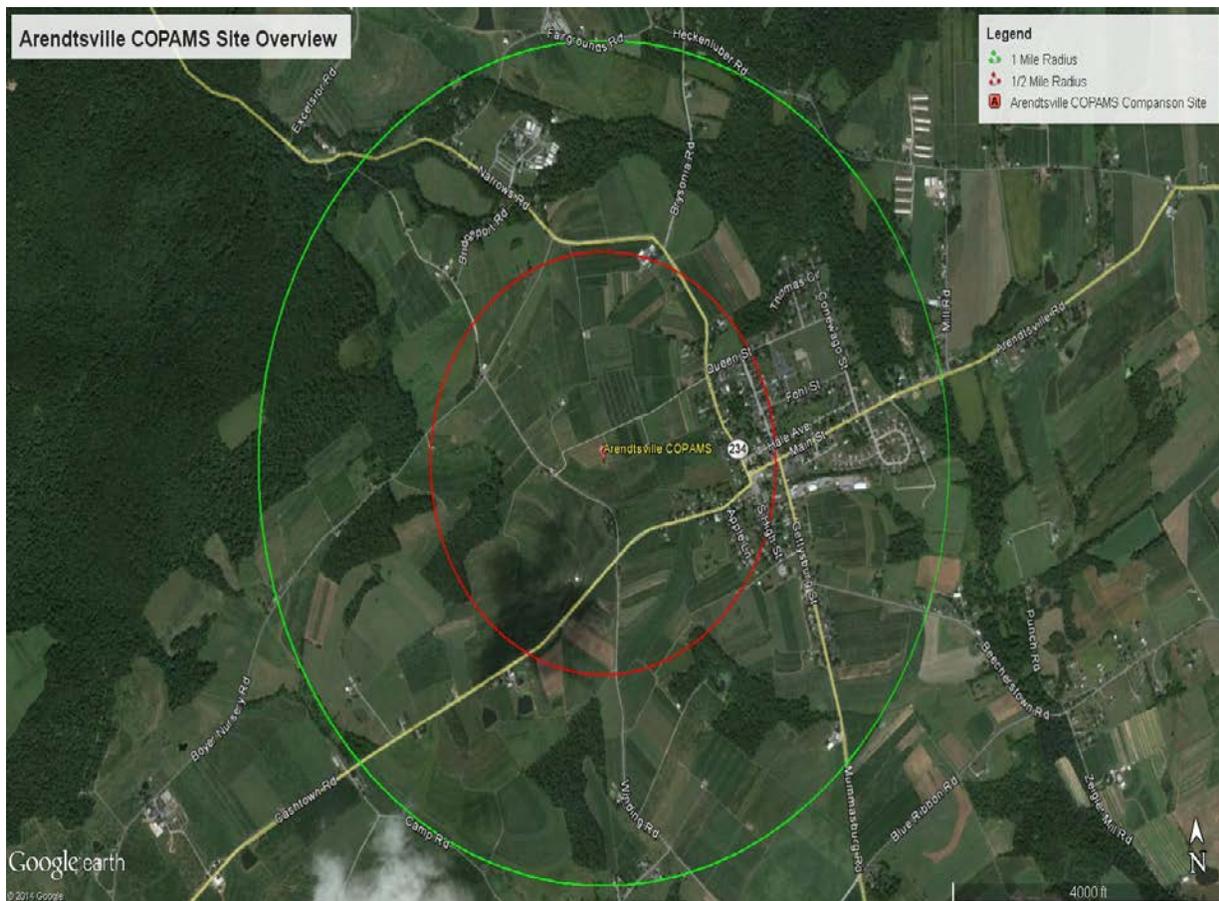


Table 56 - TO-15 and TO-11a HAP Data Summary for Arendtsville COPAMS

Site Name: Arendtsville COPAMS				Site ID(s): 39AV & 39AC		Sampling Period: 1/4/2012 - 12/30/2013				
Compound & Analysis Information			Sample Summary Information		Screening Concentrations		Lifetime Extended Cancer Risk (ELCR) and Non-Cancer Hazard Quotient (HQ)			
Chemical Name	CASN ^A	MW (g/mol)	% DA	%ND	2 yr (2012-2013)		RAIS		EPA Region 3	
					ppbv	ug/m3	ELCR	HQ	ELCR	HQ
Toluene	108-88-3	92.1	79%	0%	1.262	4.755		0.001		0.001
Propene	115-07-1	42.1	80%	0%	0.548	0.943		0.000		0.000
Carbon tetrachloride	56-23-5	153.8	80%	0%	0.094	0.593	3.6E-06	0.006	3.6E-06	0.006
Acetone	67-64-1	58.1	77%	0%	5.855	13.913		0.000		0.000
Chloromethane	74-87-3	50.5	80%	0%	0.599	1.238	2.2E-06	0.014		0.014
Trichlorofluoromethane	75-69-4	137.4	80%	0%	0.259	1.454		0.002		0.002
Dichlorodifluoromethane	75-71-8	120.9	80%	0%	0.571	2.825		0.028		0.028
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	187.4	80%	1%	0.090	0.691		0.000		0.000
2-Butanone (MEK)	78-93-3	72.1	80%	3%	0.569	1.678		0.000		0.000
Benzene	71-43-2	78.1	80%	7%	0.250	0.797	6.2E-06	0.027	6.2E-06	0.027
Carbon disulfide	75-15-0	76.1	80%	43%	0.094	0.294		0.000		0.000
Methylene chloride	75-09-2	84.9	77%	53%	0.068	0.236	2.4E-09	0.000	2.4E-09	0.000
n-Hexane	110-54-3	86.2	80%	58%	0.039	0.137		0.000		0.000
Chloroform	67-66-3	119.4	80%	73%	0.020	0.100	2.3E-06	0.001	2.3E-06	0.001
Cyclohexane	110-82-7	84.2	80%	84%	0.030	0.104		0.000		0.000
Formaldehyde (TO-11a)	50-00-0		66%	0%	2.037	2.499	3.2E-05	0.254	3.2E-05	0.255
Acetaldehyde (TO-11a)	75-07-0		63%	0%	1.133	1.390	3.1E-06	0.154	3.1E-06	0.154
Total Risk / HQ (TO-15)							1.4E-05	0.081	1.2E-05	0.081
Total Risk / HQ (TO-11a)							3.6E-05	0.409	3.6E-05	0.409
Total Risk / HQ (TO-15 & TO-11a)							5.0E-05	0.49	4.8E-05	0.49

The total estimated ELCR for TO-15 HAP compounds is just above 1.4 additional incidents of cancer per 100,000 population (1.4E-05). This total estimated risk is similar to the TO-15 ELCRs estimated for the project sites. Likewise, the TO-11a concentrations of formaldehyde and acetaldehyde at the Arendtsville site are comparable to those observed at the Meddings Road site and higher than observed at the Henderson Road site. This yields an estimated risk from TO-11a monitored compounds at slightly more than three and one half increased lifetime incidents of cancer in a population of 100,000 (3.6E-05). Cumulatively, the estimated ELCR for the monitored HAP compounds at the Arendtsville site is five additional incidents of cancer per 100,000 population (5.0E-05). Despite the uncertainty in the screening value estimation due to the sampling issues with the TO-11a data, the differences in screened compound *cumulative* ELCR and HQ between the project sites and the Arendtsville data are likely small.

It is important to note that portions of the 2013 TO-11a data from the Arendtsville site might also be biased. While investigating the contamination issues suspected with the dual canister/carbonyl cartridge samplers, samplers were interchanged between the Arendtsville COPAMS station and the Meddings and Henderson project sites. This was done to attempt to isolate the root cause of the sampler contamination issue. Because a portion of the Arendtsville comparison dataset was

obtained using the dual sampler, which is now suspected of having a design-based contamination issue, results using this data should be qualified with additional uncertainty pending a resolution of the sampler issue.

E. Summary of Risk/Hazard Assessment Screening

The Department has no cumulative risk/hazard-based ambient air quality standard for background concentrations of any of the 63 screened HAPs nor does it establish a “permissible” level of ELCR or HQ for background ambient air. The process of formal community level inhalation or multi-pathway tiered risk assessment is generally recommended for communities where associated pathways and risks may be complex or unknown. The process allows for the risk assessors, public health professionals, community members, and all levels of government to examine the risks and hazards specifically for a community and design a process of identifying and estimating risk and hazard and determine between what may be acceptable and unacceptable incremental risks and hazards extant in their community.

Insufficient data exists to determine with statistical certainty differences and/or similarities in the varying composition of the total HAPs observed between the project sites. It is unknown if variation in screening concentrations between sites is due to either one specific category or multiple source categories. Additional data of sufficient quantity, quality, and free of potential instrument-induced bias will be required to perform such an analysis.

One year of observed concentrations at five project sites (four impact sites and one background) for the 63 screened HAP compounds were used to calculate ambient air lifetime inhalation risk/hazard screening concentration values. The values were then compared to widely accepted lifetime inhalation cancer risk factors and lifetime chronic non-cancer hazard reference concentrations. The resulting estimated cumulative screening ELCR and non-cancer HQs at all sites were largely similar. All sites also showed ambient concentrations comparable to those observed at the Arendtsville site. No conclusions can be drawn from the data regarding differences in the concentrations of individual compounds between project sites. This limitation is largely due to poor overall availability of HAP and carbonyl data at all but the non-impact site coupled with persistent carbonyl sampling equipment issues at two project sites and, subsequently, the Arendtsville comparison site.

Given the overall systematic uncertainty of the screening concentrations due to reduced data availability, it is unknown if the HAP sampling is significantly representative at the impact sites to draw conclusions beyond the general similarity of cumulative risk/hazard of the suspected impacted sites to observed screening concentrations at the Florence COPAMS. It is important to note that the data availability goal of 85 percent for TO-15 sampling was achieved at the Florence COPAMS site for the screening period (87 percent). The certainty of the screening concentrations for this site is higher and suitable for screening purposes.

Furthermore, the Department assumes carbonyl risk/hazard screening concentrations at sites where sampling did not occur. Given the uncertainty in carbonyl sampling for this project coupled with the relatively higher risks and hazards generally associated with carbonyl exposure, that assumption should be viewed cautiously unless/until the carbonyl sampling issues are resolved.

Given the above limitations to the observed data and the uncertainty and assumptions associated with ambient air inhalation chronic lifetime risk/hazard assessment screening procedures described previously, there does not appear to be a large difference in either cumulative estimated ELCR or cumulative chronic non-cancer HQ between the four ambient air monitoring sites situated in an area heavily developed by the oil and gas and a background site in general proximity to the four sites but in an area largely undeveloped for gas extraction. The cumulative ELCR and HQ of all five sites were also comparable to another historical Commonwealth HAP and carbonyl ambient monitoring site.

V. Findings and Recommendations

This section summarizes the project conclusions and compares those conclusions to the stated goals of the project. Department recommendations for continued study of key elements of the conclusions and discussion are provided.

Goal 1: *Determine any chronic or long-term risks to the public from individual or multiple shale gas sources. This goal included examination of both criteria and toxic/hazardous air pollutants.*

Criteria Pollutant Findings and Discussion

The Meddings Road criteria pollutant monitoring site did not report NAAQS-related values for any of the criteria pollutants which exceeded the applicable NAAQS or indicated a probable future exceedance based on the data pattern. In addition, the pattern of recorded pollutant concentration measurements did not indicate a localized source impact which would cause an exceedance of any of the NAAQS evaluated.

The risks/hazard associated with criteria pollutants is incorporated into the NAAQS. Observed values consistently below the NAAQS would ensure the long-term health and welfare of the residents of that area against the effects of chronic ambient criteria pollutant exposure.

The Department monitored for Ozone, PM_{2.5}, NO₂ and CO at the Meddings Road site. Data analyses were conducted on the sample results in relation to the pollutant-specific NAAQS and Air Quality Index qualifiers. The monitoring period from July 2012 through December 2013 did not allow for direct comparison to the three-year based Ozone, PM_{2.5} and 1-hour NO₂ NAAQS; however, NAAQS-related summary statistics were calculated from the sampling results.

The Ozone NAAQS is based on a three-year average of 4th highest daily maximum 8-hour concentration averages. For the partial year 2012, the 4th highest 8-hour concentration was 0.056 ppm. For 2013, the 4th highest 8-hour average calculated from hourly Ozone concentrations recorded at the Meddings Road site was 0.063 ppm. Both values were below the 8-hour Ozone NAAQS of 0.070 ppm.

The PM_{2.5} NAAQS are based on three-year averages of annual means and 98th percentiles of daily (24-hour) averages. With 145 valid days, the partial year 2012 98th percentile corresponds to the 3rd highest 24-hour value. With 333 valid days, the 98th percentile for 2013 corresponds to the 7th highest 24-hour value. For the partial year 2012, the annual mean of PM_{2.5} concentrations recorded at the Meddings Road site was 9.0 µg/m³, while the 98th percentile was 18.4 µg/m³. For 2013, the

annual mean of PM_{2.5} concentrations recorded at the Meddings Road site was 8.4 µg/m³ while the 98th percentile was 17.9 µg/m³. Even if the year 2013 utilized the 3rd highest 24-hour PM_{2.5} concentration, as was the case for year 2012, the concentration would have only been 20.6 µg/m³. These results were below the annual and 24-hour PM_{2.5} NAAQS of 12.0 µg/m³ and 35 µg/m³, respectively.

The 1-hour NO₂ NAAQS is based on a 3-year average of 98th percentiles of daily 1-hour maximum concentrations. With 148 valid days, the partial year 2012, 98th percentile corresponds to the 3rd highest daily maximum one-hour value. With 348 valid days, the 98th percentile for 2013 corresponds to the 7th highest daily maximum one-hour value. For the partial year 2012, the 98th percentile of daily maximum one-hour NO₂ concentrations recorded at the Meddings Road site was 18 ppb. For 2013, the 98th percentile of daily maximum one-hour NO₂ concentrations recorded at the Meddings Road site was 23 ppb. Even if the year 2013 utilized the 3rd highest one-hour NO₂ concentration, as was the case for year 2012, the concentration would have only been 27 ppb. These results were significantly below the one-hour NO₂ NAAQS of 100 ppb. The annual NO₂ NAAQS was also analyzed for the 2013 data. The 2013 annual NO₂ concentration mean calculated from sampling data at the Meddings Road site was 4 ppb, less than one-tenth the annual NO₂ NAAQS of 53 ppb.

The 18-month sampling period allowed for comparison with the yearly-based CO NAAQS for 2012 and 2013. CO concentrations in 2012 and 2013 recorded at the Meddings Road site were significantly below the CO NAAQS. The CO NAAQS are met when the standard levels are not exceeded more than once per year. Therefore, a comparison of 2nd highest maximum concentration averages to the NAAQS was used to assess CO values. For the partial year 2012, the 2nd highest one-hour and 8-hour CO concentrations were 1.6 ppm and 0.7 ppm. The second highest one-hour and 8-hour average CO concentrations recorded at the Meddings Road site were 1.1 ppm and 0.4 ppm. The 2012 and 2013 CO concentrations are less than one-twentieth of the one-hour and 8-hour CO NAAQS of 35 ppm and 9 ppm, respectively.

An analysis of the ambient air monitoring data was completed to compare the ambient air levels to EPA's Air Quality Index (AQI) scale. AQI qualifiers include, in increasing severity, "Good," "Moderate," "Unhealthy for Sensitive Groups," "Unhealthy," and "Hazardous." During the 18-month monitoring period, the Meddings Road site measured seven "Moderate" days for Ozone and one "Unhealthy for Sensitive Groups" day. The monitored days remaining were qualified as "Good." For PM_{2.5}, the Meddings Road site measured 86 "Moderate" days, while the remainder of days qualified as "Good." All monitored days for NO₂ and CO were qualified as "Good."

After the initial calculations were completed, results from the Meddings Road site were compared to three additional sites: Charleroi, representing monitoring impacts due to low-level local sources within a river valley; Washington, representing monitoring impacts from a more urbanized area and mobile sources (due to the proximity of two major US interstates in relation to the monitor); and Florence, representing monitoring impacts from regional transport. Pollutant concentrations measured at the Meddings Road site fell either in line with or lower than the three regional comparison sites. In addition, the Meddings Road site measured significantly fewer AQI days below "Good" than the comparison sites. The Meddings Road site measured 86 days classified as "Moderate" and one day classified as "Unhealthy for Sensitive Groups." In comparison, the

Charleroi site measured 174 “Moderate” days and 3 “Unhealthy for Sensitive Groups,” Washington measured 177 “Moderate” days and 2 “Unhealthy for Sensitive Groups,” and Florence measured 142 “Moderate” and 2 “Unhealthy for Sensitive Groups.”

Concentration values recorded at the Meddings Road site correlated well with the comparison sites for the more regionally distributed pollutants Ozone and PM_{2.5}. These results did not indicate impact on the Meddings Road monitor from sources outside of shared meteorological or regional source impacts. Pollutant concentrations measured at the Meddings Road site did not correlate with the comparison sites for the more localized pollutants NO₂ and CO, indicating that site was primarily impacted by local sources. The Meddings Road site recorded significantly lower NO₂ and CO values than the comparison sites.

Hazardous Air Pollutant Findings and Discussion

For the estimated risk/hazard associated with the toxic/hazardous air pollutants, seven compounds of the 63 screened toxic and hazardous air pollutants were identified as having concentrations in ambient air that contribute to total cumulative ELCR. Twenty-one compounds were identified that contribute to potential lifetime non-cancer hazard expressed as an HQ. The cumulative ELCR at each project site is between one in one million (1.0E-06) and one in ten thousand (1.0E-04), which is a customary range of risk acceptance for ambient air screening purposes. The cumulative HQ for all screened compounds was below one, indicating that observed concentrations at the monitoring sites would be unlikely to result in a deleterious non-cancer health effect over 70 years of exposure.

Observed ambient concentrations of screened toxic and hazardous air pollutants at all five project sites were generally comparable to a low-impact background monitoring site located near Arendtsville, Pennsylvania, in Adams County. This rural, largely agricultural comparison site is unimpacted by any oil and gas exploration, drilling, extraction or processing infrastructure.

However, gaps in sampling toxic pollutant data and potential sampler contamination at project sites make the overall data less representative than desired and increases uncertainty in the estimate of the values used for the chronic ambient air inhalation risk/hazard screening. Actual concentrations may have been higher or lower than estimated for this project. Further statistical examination of the toxics data from the project compared to more complete historical and current data sets from other Commonwealth monitoring sites might or might not be warranted. As stated previously, insufficient data exist to perform statistically meaningful inter-site comparison or comparison to historic HAP data collected at ambient air toxics monitoring sites in the Commonwealth. The reduced quantity of representative data from the project sites would make any statistical comparison difficult, if not impossible, without significant examination and treatment of the data.

The resulting estimated cumulative screening ELCR and non-cancer HQ at all sites for the 63 screened HAP compounds were largely similar with ELCRs ranging from 2 to 4.3 additional incidence of cancer per 100,000 population (2.0E-05 to 4.3E-05) and HQs no greater than 1.0. It is important to note, however, that data availability issues with toxics sampling, particularly carbonyl compounds, introduced uncertainty into the estimates. This screening and the associated risk/hazard estimates are only for the compounds for which the Department analyzed.

Given the limitations to the observed data and the uncertainty and assumptions associated with ambient air inhalation chronic lifetime risk/hazard assessment screening procedures described earlier, there does not appear to be a large difference in either the ELCR or HQ estimates between the four HAP sites in the affected study area and the single assumed unaffected study background site. The cumulative ELCR and HQ for all five study sites were also comparable to a historical Commonwealth HAP ambient air monitoring site located in Adams County, PA. This site is characterized as rural, largely agricultural with no oil and gas activities in the area and is representative of a lightly populated area minimally directly impacted by toxic pollutants.

Goal 2: *Identify and assess potential increases in ambient concentrations of criteria pollutants in the project area over the time period of the project and to compare observed ambient concentrations with historical data collected both in the project area and in other existing monitoring locations within the Commonwealth.*

For all criteria pollutants, the Meddings Road site reported values either in line with or lower than the four regional comparison sites. Ambient pollutant measurements reported at the Meddings Road site correlated well with the comparison sites for the more regionally distributed pollutants, Ozone and PM_{2.5}. Meddings Road measurements did not correlate with the comparison sites for the more localized pollutants, NO₂ and CO, indicating that site was primarily impacted by local sources. The Meddings Road site did not report NAAQS-related values for any of the criteria pollutants which exceeded the applicable NAAQS or indicated a probable future exceedance based on the data pattern. In addition, the Meddings site reported a lower number of days less than the AQI “Good” range than the four comparison sites.

Goal 3: *Assess and identify potential implications the observed results may have in other areas of the Commonwealth with varying populations and environmental conditions that may host similar facilities.*

As discussed previously, no exceedances of the NAAQS were observed at the Meddings Road site. In addition, the site data did not indicate that there was a localized source of NO₂ or CO that appeared to be influencing the site nor did the regionally distributed pollutants (Ozone, PM_{2.5}) appear to be trending noticeably higher than would be expected. However, it cannot be concluded that unconventional natural gas development operations and facilities collectively have no influence or affect ambient air criteria pollutant concentrations because no systematic monitoring for criteria pollutants occurred in the project area prior to unconventional gas development to provide a suitable baseline. Only a long term (greater than three years) collection and detailed analysis of ambient air data coupled with simultaneous detailed stationary, area and mobile source-specific emissions data and information examination might determine if the unconventional natural gas development sources contribute significantly more to ambient air criteria pollution than, for instance, vehicles or power plants in a study area or even pollution that was regionally transported from outside that area.

Prior to the commencement of the project, there were reports in western states of wintertime exceedances of the Ozone NAAQS likely attributed to unconventional oil and gas development. In addition to beginning to operate the Ozone monitors in unconventional drilling areas in Pennsylvania year-round, the project was designed to supplement the wintertime Ozone monitoring. During the course of the project, no Ozone concentrations were observed at the

Meddings Road site that showed or indicated a greater potential for wintertime Ozone formation in the project area. The Department believes that Pennsylvania's terrain, atmospheric conditions and meteorology are sufficiently dissimilar from these western states where winter Ozone concentrations resulting from natural gas development may be significantly increased to where winter exceedances may be of immediate concern. However, as the development in Pennsylvania increases as is anticipated, that industry's potentially increased contribution to ambient concentrations of criteria pollutants or their formation products (e.g., VOCs) must be examined as any other criteria pollutant source contributor. This is also best accomplished with continued long-term monitoring and close examination of emissions-related information and data from all source categories in an area of concern.

With regard to HAP concentrations, additional detailed analysis of both the project and statewide historical HAP canister and carbonyl data is needed to draw any conclusions with regard to applying observed air toxics concentrations to other locations with different populations or local environmental conditions within the Commonwealth. At a minimum, additional site data would be required to augment the existing data for further conclusions to be drawn from the project sites.

Recommendations

The following is a compilation of the Department's recommended actions based upon the findings of this project.

While the Department did not observe exceedances of the NAAQS for the pollutants monitored, as unconventional natural gas extraction, gathering and processing infrastructure develops to maturity, monitoring of criteria pollutants in the project area should continue. This will add important localized criteria pollutant information in the area. The Department has already redesignated the Meddings Road primary project site as the "Houston" Air Monitoring Station beginning in 2014 and will continue criteria pollutant monitoring for trend evaluation and NAAQS compliance.

Even though the project's observed toxic/HAP screening ambient inhalation risk/hazard concentrations were at levels within a one in one million to one in ten thousand ELCR range, and the chronic hazard was estimated to be below levels of concern for non-cancer hazard development, insufficient data collection led to reduced representativeness of the sample sets. The reduced representativeness of sampling at the project sites could underestimate the estimation of the screening values and thus underestimate risk and hazard. Additional systematic VOC sampling at the Meddings Road site (now known as the "Houston" site) and additional statistical analysis of the collected data, would help better characterize the toxic pollutant concentrations in the air and better assess future potential risk and hazard as gas development continues in the area.

The Department will continue to analyze the collected project toxic/HAP data with the goal of providing additional comparisons of that data to other monitored areas in the Commonwealth, other states and countries where unconventional natural gas development is occurring. In addition, the Department is considering future screening for certain chemicals that might contribute to the formation of ground-level Ozone.

While the conclusions of this project indicate that health impacts to ambient air from unconventional natural gas operations may be limited, particularly with chronic air toxic exposure, this project did not examine potential acute or chronic impacts to individuals working in, adjacent to, or in the immediate vicinity of natural gas extraction, gathering and/or processing facilities. Risk/hazard screening concentrations used for this project should not be used as a surrogate for a full inhalation pathway risk/hazard assessment. The Department may use this and future monitoring data to support any effort by the public health/industrial hygiene community to assess the potential localized risk.

Ambient Methane and Non-Methane Hydrocarbon analysis from the Meddings Road data collection was inconclusive due to equipment calibration issues and a lack of comparative data sets. The Department may partner with the EPA, other states and the academic community to assess where potential regional ambient air monitoring of Methane and Non-Methane Hydrocarbons might be of benefit to the public. Collected methane data is provided in the supplemental information.

Appendix A - Select Project Technical References and Guidance by Subject

Project Planning and Design

40 CFR Part 58, Appendix D - Network Design Criteria for Ambient Air Quality Monitoring

40 CFR Part 58, Appendix E - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring

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Appendix B - Glossary and List of Acronyms

Air Quality Index (AQI)	The AQI is an index for reporting daily air quality. It tells you how clean or polluted your air is, and what associated health effects might be a concern for you. The AQI focuses on health effects one may experience within a few hours or days after breathing polluted air. EPA calculates the AQI for five major air pollutants regulated by the Clean Air Act: ground-level Ozone, particle pollution (also known as Particulate Matter), Carbon Monoxide, Sulfur Dioxide, and Nitrogen Dioxide. For each of these pollutants, EPA has established national ambient air quality standards (NAAQS) to protect public health. The AQI can be expressed both numerically and as a color category. High-index values in the red category may indicate air quality is unhealthful for everyone, orange and yellow denoting unhealthful air for sensitive populations such as children and the elderly, and the green level (low-index values) indicating that the air pollution poses little or no risk.
Air Toxics	Also known as toxic air pollutants or hazardous air pollutants, air toxics are those pollutants known to or suspected of causing cancer or other serious health problems. Health concerns may be associated with both short- and long-term exposures to these pollutants. Many are known to have respiratory, neurological, immune or reproductive effects, particularly for more susceptible sensitive populations such as children. Five important air pollutants are not included in the list of air toxics (http://www.epa.gov/ttn/atw/187polls.html) because the Clean Air Act addresses them separately as "criteria pollutants": (http://epa.gov/air/criteria.html) Particulate Matter (PM), Nitrogen Oxides (NO _x), Sulfur Oxides (SO _x), Ozone, and Carbon Monoxide. Lead is listed as a criteria pollutant whereas Lead compounds are listed and regulated as an air toxic.
Aldehyde	An organic compound containing the formyl <i>functional group</i> , formed by the oxidation of alcohols. A formyl group is a functional group consisting of a double bonded Carbon-Oxygen center (Carbonyl) bonded to a Hydrogen. The formyl group is always at the end of a Carbon chain in an Aldehyde. Typical Aldehydes include Methanol (Formaldehyde) and Ethanol (Acetaldehyde).
Blank	A blank sample is one that has intentionally not been exposed to the pollutant of interest. Analysis of blank samples reveals possible contamination in the laboratory or during field handling or transportation.
Carbonyl	A compound containing a Carbonyl <i>functional group</i> . A Carbonyl group is composed of a Carbon atom double-bonded to an Oxygen atom. Carbonyls include <i>Aldehydes</i> and <i>Ketones</i> and other types of compounds. Common Carbonyl compounds are Acetone and Formaldehyde.

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Carcinogen	A chemical or physical agent capable of causing cancer.
Chemical Abstract Service Registry Number (CASRN)	(Also referred to as CAS RNs or CAS Numbers) Universally used to provide a unique, unmistakable identifier for chemical substances. A CAS Registry Number itself has no inherent chemical significance but provides an unambiguous way to identify a chemical substance or molecular structure when there are many possible systematic, generic, proprietary or trivial names.
Excess Lifetime Cancer Risk (ELCR)	The estimated increased risk (or probability) of developing cancer above the background rate (slightly less than 1 in 2 in men, and slightly more than 1 in 3 in women) as a result of lifetime exposure to a cancer-causing (or suspected cancer-causing) substance.
Functional Group	Specific groups of atoms or bonds within molecules that are responsible for the characteristic chemical reactions of those molecules. Combining the names of functional groups with the names of the parent straight-chained alkane is the basis of the systematic nomenclature for naming organic compounds.
Hazard Index (HI)	The sum of hazard quotients for substances that affect the same target organ or organ system.
Hazard Quotient (HQ)	The ratio of the potential exposure to the substance and the level at which no adverse effects are expected. If the Hazard Quotient is calculated to be less than 1, then no adverse health effects are expected as a result of exposure. If the Hazard Quotient is greater than 1, then adverse health effects are possible. The Hazard Quotient cannot be translated to a probability that adverse health effects will occur, and it is unlikely to be proportional to risk. It is especially important to note that a Hazard Quotient exceeding 1 does not necessarily mean that adverse effects will occur.
Hazardous Air Pollutant (HAP)	An air pollutant listed under Section 112(b) of the Federal Clean Air Act as particularly hazardous to health. Emission sources of hazardous air pollutants are identified by U.S. EPA, and emission standards are set accordingly.
Ketone	An organic <i>Carbonyl</i> compound with the structure $RC(=O)R'$, where R and R' can be a variety of Carbon-containing substituents. Ketones do not have a bonded Hydrogen as part of the Carbonyl group. Acetone is a very common Ketone.
Mean	A central value of a discreet set of numbers that is generally expressed as the arithmetic average of that set of numbers (e.g. $(2.2 + 2.6 + 4.8) / 3 = 3.2$); however, other mathematical methods can be used to estimate a "true" mean value when the data set is statistically representative of a larger population.

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Method Detection Limit (MDL)	The definition of MDL is “the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.” When concentrations are below the MDL, the result cannot be distinguished with statistical confidence from the background noise of the instrument. The MDLs are determined by a standard laboratory quality control procedure (40 CFR Part 136, Appendix B).
Microgram (µg)	A microgram is a unit of mass or weight equal to one millionth of a gram. (The symbol µg is commonly used for microgram.) One gram is about one twenty-eighth (1/28) of an ounce.
Microgram per cubic meter (µg/m ³)	Ambient air concentrations are commonly expressed in mass of pollutant per unit volume of air in units of micrograms per cubic meter (µg/m ³). Because air expands and contracts with changes in temperature and pressure, the cubic meter volume must be referenced to a specific temperature and pressure. Standard conditions for ambient air measurements are 25° C (77° F) and one atmosphere (29.92 inches of mercury).
Molecular Weight (MW)	Molecular weight (or molecular mass) refers to the mass of a molecule. It is calculated as the sum of the mass of each constituent atom multiplied by the number of atoms of that element in the molecular formula.
N in a Million Cancer Risk	A risk level of "N" in a million implies a likelihood that up to "N" people, out of one million equally exposed people, would contract cancer if exposed continuously (24 hours per day) to the specific concentration over 70 years (an assumed lifetime). This would be in addition to cancer cases that would normally occur in an unexposed population of one million people.
National Ambient Air Quality Standards (NAAQS)	Standards established by the U.S. EPA that apply for outdoor air throughout the country. There are two types of NAAQS. Primary standards set limits to protect public health, and secondary standards set limits to protect public welfare.
National Emissions Standards for Hazardous Air Pollutants (NESHAP)	Air quality standards set by the U.S. EPA for an air pollutant not covered by National Ambient Air Quality Standards that may cause an increase in fatalities or a serious, irreversible, or incapacitating illness.
Non-Methane Hydrocarbon (NMHC)	All Hydrocarbon air pollutants except Methane. NMHCs include compounds that can be significant precursors to ground-level Ozone formation. NMHCs can be reported as the sum of all Hydrocarbons in an air sample minus Methane.
Non-carcinogenic effects	Non-cancer health effects which may include birth defects, organ damage, morbidity and death.

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Organic Compounds	A large group of chemical compounds containing mainly Carbon, Hydrogen, Nitrogen and Oxygen. All living organisms are made up of organic compounds. Organic compounds are organized into classes based on their chemical properties and structure. These classes include <i>Alkanes</i> , Alcohols, <i>Ketones</i> , Amines, and Esters, among many others.
Ozone precursors	Chemicals such as Non-Methane Hydrocarbons (NMHC) and Oxides of Nitrogen, occurring either naturally or as a result of human activities, which contribute to the formation of Ozone, a major component of smog.
Percentile	Any one of the points dividing a distribution of values into parts each of which contain 1/100 of the values. For example, the 75 th percentile is a value such that 75 percent of the values are less than or equal to it.
Persistence	Refers to the length of time a compound stays in the atmosphere, once introduced. A compound may persist for less than a second or indefinitely.
Photochemical Reaction	A term referring to chemical reactions brought about by the light energy of the sun. The reaction of Nitrogen Oxides with Hydrocarbons in the presence of sunlight to form Ozone is an example of a photochemical reaction.
Pollutants	Unwanted chemicals or other materials found in the air. Pollutants can harm health, the environment and property. Many air pollutants occur as gases or vapors, but some are very tiny solid particles such as dust, smoke, or soot.
ppbv	Parts per billion by volume - The concentration units commonly used for gaseous pollutants in ambient air. These units are not used for non-gaseous pollutants.
ppm	Parts per million
Reference Air Concentration (RfC)	The RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups which include children, asthmatics and the elderly) that is likely to be without an appreciable risk of deleterious effects during a lifetime. It can be derived from various types of exposure data, from a "No" or "Lowest Observed Adverse Effect Level" (NOAEL to LOAEL) from human or animal exposures, to which uncertainty or "safety" factors are applied to reflect limitations of the data used. The inhalation reference concentration is for continuous inhalation exposures and is appropriately expressed in units of mg/m ³ ; however, for ambient air toxics studies, this value may be converted to the units µg/m ³ by multiplying the given RfC by 1000.
Reporting Limit (RL)	The RL of a compound is approximately ten times its <i>method detection limit (MDL)</i> . Concentrations at or above the RL are considered quantifiably accurate. If data is between the RL and the MDL, there is confidence that the compound is actually present but with less certainty in the accuracy of the reported concentration.

Risk and Hazard	The probability that damage to life, health, and/or the environment will occur as a result of a given hazard (such as exposure to a toxic chemical). Some risks can be estimated in numerical terms (e.g., one chance in a million). In risk assessment, "risk" can also refer specifically to probability of cancer-effects (e.g., lung cancer) as opposed to "hazard" referring to potential increased incidence of non-cancer effects (e.g., bronchitis in lungs).
Sensitive groups	Identifiable subsets of the general population that are at greater risk than the general population to the toxic effects of a specific air pollutant (e.g., infants, asthmatics, elderly).
Standard Deviation (SD)	A statistical measure that is used to quantify the amount of variation or dispersion of a set of data values. A standard deviation (SD) close to zero indicates that the data points tend to be very close to the <i>mean</i> of the set, while a high standard deviation indicates that the data points are spread out over a wider range of values. It is represented by the Greek letter sigma (σ). It is also commonly used as a measure of confidence in a statistical conclusion. In air quality monitoring, the SD is calculated from a data set as a standard deviation of a sample.
Toxic air pollutant	See <i>Air Toxics</i>
Unit Risk Factor (URF)	A measure of the probability of an individual developing cancer as a result of exposure to a specified unit concentration of a specific chemical. In air, the unit concentration is 1.0 $\mu\text{g}/\text{m}^3$. For example, an inhalation URF of 3.0E-04 implies that if 10,000 people breathe that chemical for 70 years at a concentration of 1.0 $\mu\text{g}/\text{m}^3$, an additional three people of a population of 10,000 could potentially develop cancer.
Upper Confidence Limit (UCL)	The Upper Confidence Limit is the upper bound of a confidence interval around any calculated statistic, most typically an average. For example, the 95 percent confidence interval for an average is the range of values that will contain the true average (i.e., the average of the full statistical population of all possible data) 95 percent of the time. In other words, we can say with 95 percent certainty that the "true" average will exceed the UCL only 2.5 percent of the time.
Vapor Pressure	The pressure exerted by a vapor in thermodynamic equilibrium with its condensed phases (solid or liquid) at a given temperature in a closed system. The vapor pressure is an indication of a liquid's evaporation rate. It relates to the tendency of particles to escape from the liquid (or a solid). A substance with a high vapor pressure at normal temperatures is often referred to as volatile.

Volatile Organic Compound (VOC)	A chemical compound containing carbon that can be present in the atmosphere as a vapor at normal temperatures. Generally, chemicals with <i>vapor pressures</i> greater than 0.1 mmHg at 20° C (0.0001316 atmospheres at 68° F) are classified as volatile, and chemicals with measurable vapor pressures that are less than 0.1 mmHg are classified as semi-volatile. In reference to ground-level Ozone formation and Ozone <i>NAAQS</i> compliance, the Federal Clean Air Act further defines a VOC as being photo reactive contributor to ground-level Ozone formation.
Weight of Evidence (WOE)	The extent to which the available information supports the hypothesis that a substance causes an effect in humans. For example, factors which determine the weight of evidence that a chemical poses a hazard to humans include the number of tissue sites affected by the agent; the number of animal species, strains, sexes, relationship, statistical significance in the occurrence of the adverse effect in treated subjects compared to untreated controls; and, the timing of the occurrence of adverse effect.

List of Acronyms

%ND	Percent Non-Detect (of sample set)
AADT	Annual Average Daily Traffic
APCA	Air Pollution Control Act
AQI	Air Quality Index
AQS	Air Quality System
ATSDR	Agency for Toxic Substances and Disease Registry
BAM	Beta Attenuation Monitor
CAA	Federal Clean Air Act
CASN or CASRN	Chemical Abstract Service Registry Number
CBSA	Core-based statistical area
CDC	Centers for Disease Control
CFR	Code of Federal Regulations
CO	Carbon Monoxide
COPAMS	Commonwealth of Pennsylvania Air Monitoring System
CSA	Combined Statistical Area
CV	Coefficient of Variance
DQO	Data Quality Objective
ELCR	Excess Lifetime Cancer Risk
EPA	U. S. Environmental Protection Agency
FDMS	Filter Dynamics Measurement System
FEM	Federal Equivalent Method
FR	Federal Register
FRM	Federal Reference Method
g/mol	grams per mole
GC / MS	Gas Chromatograph / Mass Spectrometer
H ₂ S	Hydrogen Sulfide
HAP	Hazardous Air Pollutant
HI	Hazard Index
HQ	Hazard Quotient
M/NMHC	Methane / Non-Methane Hydrocarbon
MDL	Method Detection Limit
MQO	Measurement Quality Objective
MW	Molecular Weight
NAAQS	National Ambient Air Quality Standards
NATTS	National Air Toxics Trend Station
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NIOSH	National Institutes of Occupational Safety and Health

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NMHC	Non-Methane Hydrocarbon
NO	The gaseous pollutant Nitrogen Oxide
NO ₂	The gaseous pollutant Nitrogen Dioxide
NO _x	Oxides of Nitrogen
O ₃	The gaseous pollutant Ozone
PA DEP	Pennsylvania Department of Environmental Protection
PA DOH	Pennsylvania Department of Health
PM ₁₀	Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers
PM _{2.5}	Particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers
ppb	parts per billion
ppbv	parts per billion by volume
ppm	parts per million
QA	Quality Assurance
QC	Quality Control
R&P	Rupprecht & Patashnick (manufacturer of air monitoring equipment)
RfC	Reference Air Concentration (Inhalation)
RL	Reporting Limit
SLAMS	State or Local Air Monitoring Stations
SO ₂	The gaseous pollutant Sulfur Dioxide
SPM	Special Purpose Monitor
TAPI	Teledyne Advanced Pollution Instrumentation
UCL	Upper Confidence Limit
ug/m ³	micrograms per cubic meter
URF	Unit Risk Factor
UV	Ultraviolet
VOC	Volatile Organic Compound
VSCC	Very Sharp Cut Cyclone (a particulate sampler separator device for PM _{2.5})
WINS	Well Impactor Ninety-Six (a particulate sampler separator device for PM _{2.5})
WOE	Weight of Evidence

Appendix C - Project HAP Analyte List with Reporting Limit (RL) and Method Detection Limits (MDL)

Compared to criteria pollutants, concentrations of Hazardous Air Pollutants (HAP) in ambient air, on a volume-pollutant-per-volume-air-sampled basis, are generally significantly less. For ambient air monitoring purposes, most screened HAP compounds are at concentrations below which current HAP monitoring methods can reliably, accurately and precisely quantify their presence in the air. However, the absence of a “detect” using these methods does not preclude the possibility that any given “non-detected” compound in any given sample could be chronically present at concentrations below the ability of the analytical instrument to detect.

In order for accredited laboratories to report their HAP compound results consistently, precisely and accurately, calibration and quality assurance methods are employed to give certainty (or quantify uncertainty) to measurements of air pollutants. These are detailed in federal regulations and EPA-required analysis methods.

A prime indicator of data accuracy and precision for any given sample is the “qualifier flag” associated with any compound concentration result. Data with no qualifier is considered to be accurate and precise to the reported value with a reliable certainty. The minimum value that is reported for a specific compound that still retains an acceptable degree of accuracy and precision is called the lab Reporting Limit or RL.

However, the RL for a lab is not just a reflection of the chemical analysis method alone but a reflection of all inherent measurement uncertainty through the lab’s handling, processing, analysis and reporting of a value.

Fortunately, for most HAP compounds with the largest concerns for widespread human health effects, based on current toxicological and epidemiological knowledge of those compounds, the limits of detection for the analysis are well below the typical levels seen in ambient air. This means that for some pervasive ambient air HAP compounds (e.g. benzene, carbon tetrachloride, various chlorofluorocarbons), reliable measurements over time, with few to no samples with non-detected data, can lead to statistically reliable estimates of mean concentrations. These durational concentration estimates can then help inform air managers and inhalation risk/hazard assessment practitioners, depending on the length and frequency of sampling, as to the short-term (acute), intermediate or long-term (chronic) concentrations in the air to which a human population could be exposed.

When presented with situations where the ambient air concentration of a HAP compound is infrequently or intermittently detected over a sampling duration, the overall duration of the sampling must be sufficient to ascertain the nature of the detection over time. An analyst must examine if the detection is potentially an outlier as the result of some random, localized event (e.g. short-term road repair using asphalt) or possibly an indication of a constant concentration near the limits of detection for the compound where only higher levels are detected. This is important for the consideration of health effects from exposure as the effects of a low concentration constant exposure over a long period of time may differ from occasional or intermittent short-term exposures over the same time period.

The Method Detection Limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. The procedure for the determination of the MDL, as described in 40 CFR Part 136, Appendix B, consists of a minimum of seven aliquots of low-level standard carried through the entire analytical process. The following equation is used to calculate the MDL:

$$\text{MDL} = t_{(n-1, 1-\alpha=0.99)}(S)$$

$t_{(n-1, 1-\alpha=0.99)}$ = the students' t value for 99 percent confidence and a standard deviation estimate with n-1 degrees of freedom, where n = number of aliquots analyzed.

S = standard deviation of the analytical results.

The Reporting Limit (RL) is the minimum concentration that can be reported, with a reasonable degree of accuracy and precision, as a quantitated value for a target analyte in a sample following analysis. This defined concentration can be no lower than the concentration of the lowest calibration standard for that analyte, and it can only be used if acceptable quality control criteria for the analyte at this concentration are met.

MDL vs. RL

The main difference between the MDL and the RL is that the MDL is the lowest level at which an instrument signal is **detected** and distinguishable from instrument noise, whereas the RL is the lowest level at which the instrument signal is **quantified**.

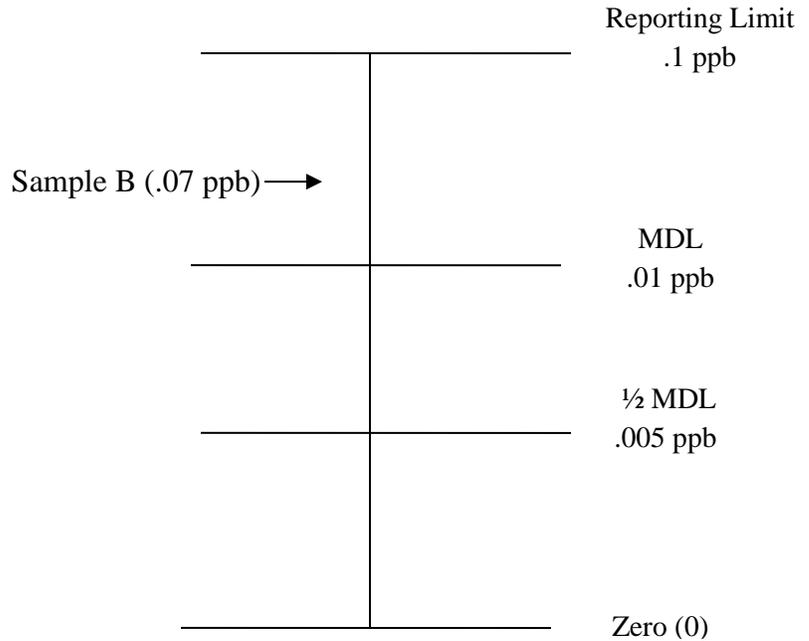
Reporting Results and Use of MDL

When samples are analyzed and the concentration of the target analyte is greater than the established RL, the observed concentration can be reported as is. When samples are analyzed and the target analyte concentration is below the established RL, the concentration is reported as < RL. The concentration of the target analyte is essentially zero since the observed value is below the lowest calibration point. In an effort to be more conservative with the annual averages calculated for target analytes, one-half the MDL is used, rather than zero, whenever a target analyte was not detected in a sample.

An example of the use of the MDL and reporting results can be found in Figure 1.

Figure C-1- Example of the Use of the MDL and Reporting Results

Sample A (.5 ppb)



Sample A and Sample B are analyzed and found to have concentrations of .5 ppb and .07 ppb of analyte X, respectively. Sample A, having a concentration above the RL, is reported as having a concentration of .5 ppb of analyte X. Sample B, however, has a concentration of .07, which is below the RL. Since the concentration of Sample B is below the reporting, and thus below the lowest calibration standard, the actual concentration cannot be known or reported with certainty. Instead, a value of <.1 ppb is reported for Sample B.

A list of MDLs is presented in Table 1. Note that the MDLs in the table only reflect the MDLs in effect at the beginning of the project. Changes in MDLs over the course of the project are shown in the project HAP data presentation and risk/hazard screening summary tables in Sections III and IV.

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Table C-1 – List of MDLs Used in the Project

Target Pollutant List								
CAS#	Analyte	MDL (ppbv)	CAS#	Analyte	MDL (ppbv)	CAS#	Analyte	MDL (ppbv)
74-82-8	Methane/Non-Methane Compound	0.1 ppm / 5 ppb	622-96-8	1-Ethyl-4-methylbenzene	0.043	1634-04-4	2-Methoxy-2-methylpropane (MTBE)	0.030
10028-15-6	Ozone	<0.6 ppb	591-78-6	2-Hexanone	0.030	75-09-2	Methylene chloride	0.078
10102-44-0	Nitrogen Oxides	0.4 ppb	67-64-1	Acetone (2-Propanone)	0.076	108-10-1	4-Methyl-2-pentanone (MBK)	0.040
630-08-0	Carbon Monoxide	<0.05 ppm	107-02-8	Acrolein*	0.057	142-82-5	n-Heptane	0.040
6/4/7783	Hydrogen Sulfide (API / Jerome)	0.4 ppb / 3 ppb	71-43-2	Benzene	0.030	110-54-3	n-Hexane	0.038
n/a	Particulate Matter (<2.5 microns)	n/a	75-27-4	Bromodichloromethane	0.017	95-47-6	o-Xylene	0.043
71-55-6	1,1,1-Trichloroethane	0.017	75-25-2	Bromoform	0.019	115-07-1	Propene	0.030
79-34-5	1,1,1,2,2-Tetrachloroethane	0.019	74-83-9	Bromomethane	0.046	100-42-5	Styrene	0.041
79-00-5	1,1,2-Trichloroethane	0.018	75-15-0	Carbon disulfide	0.064	127-18-4	Tetrachloroethene (PERC)	0.030
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	0.061	56-23-5	Carbon tetrachloride	0.015	109-99-9	Tetrahydrofuran (THF)	0.027
75-34-3	1,1-Dichloroethane	0.021	108-90-7	Chlorobenzene	0.029	108-88-3	Toluene	0.028
75-35-4	1,1-Dichloroethene	0.059	75-00-3	Chloroethane	0.056	156-60-5	trans-1,2-Dichloroethene	0.025
120-82-1	1,2,4-Trichlorobenzene	0.048	75-01-4	Chloroethene	0.072	10061-02-6	trans-1,3-Dichloro-1-propene	0.021
95-63-6	1,2,4-Trimethylbenzene	0.043	67-66-3	Chloroform	0.019	79-01-6	Trichloroethylene (TCE)	0.025
106-93-4	1,2-Dibromoethane	0.025	74-87-3	Chloromethane	0.055	75-69-4	Trichlorofluoromethane	0.064
95-50-1	1,2-Dichlorobenzene	0.035	156-59-2	cis-1,2-Dichloroethene	0.028	75-07-0	Acetaldehyde (Ethanal)	0.035
107-06-2	1,2-Dichloroethane	0.026	10061-01-5	cis-1,3-Dichloro-1-propene	0.026	67-64-1	Acetone (2-Propanone)	0.054
78-87-5	1,2-Dichloropropane	0.021	110-82-7	Cyclohexane	0.027	100-52-7	Benzaldehyde	0.017
76-14-2	1,2-Dichloro-1,1,2,2-tetrafluoroethane	0.034	124-48-1	Dibromochloromethane	0.024	123-72-8	Butyraldehyde (Butanal)	0.024
108-67-8	1,3,5-Trimethylbenzene	0.045	75-71-8	Dichlorodifluoromethane	0.021	50-00-0	Formaldehyde	0.060
106-99-0	1,3-Butadiene	0.065	100-41-4	Ethylbenzene	0.040	590-86-3	Isovaleraldehyde (3-methyl-Butanal)	0.039
541-73-1	1,3-Dichlorobenzene	0.033	87-68-3	Hexachloro-1,3-butadiene	0.027	123-38-6	Propionaldehyde (Propanal)	0.026
106-46-7	1,4-Dichlorobenzene	0.030	108-38-3	m&p-Xylene	0.087	123-73-9	Crotonaldehyde (trans-2-Butenal)	0.029
106-94-5	1-Bromopropane	0.028	78-93-3	2-Butanone (Methyl Ethyl Ketone)	0.032			
	MDL	Minimum Detection Limit (by unit) for continuous monitors; Method Detection Limit (by unit-volume) for Canister/Carbonyl						
		Continuous Measurement Compounds						
		TO-11A Compound (Carbonyl) - DNPH Cartridge						
		TO-15 Compound - Canister						
Compounds in bold are analytes potentially associated with permanent shale gas facilities through natural gas combustion, or direct/fugitive emissions of "w et" gas.								
* While Acrolein (propenal) is being sampled, there exist high uncertainty in reported results due to sampling and analytical limitations. Because of this uncertainty, results for Acrolein may not be used for final risk analysis.								

Appendix D - Summary of Risk Factor/Reference Concentration Values Used for Project

The following table contains a summary of the risk factor and reference concentration values used for the project.

Note that the absence of a value in the table does not imply that an inhalation risk or hazard does not exist. It shows that insufficient information exists on the screened compound for the source of these values to make a scientifically-based examination thus providing a reliable chronic risk factor or reference concentration. The detailed examination of potential chronic risk/hazard for screened pollutants for which limited toxicological and epidemiological factors exist is beyond the scope of this project.

The sources of the values used for this project (indicated in the “Source” columns in the table) are as follows:

IRIS	Integrated Risk Information System (U.S. EPA)
Cal EPA	California Environmental Protection Agency
ATSDR	Agency for Toxic Substances and Disease Registry (part of U.S. Centers for Disease Control)
PPRTV	Provisional Peer-Reviewed Toxicity Values (U.S. Dept. of Energy - Oak Ridge National Laboratory)
HEAST	Health Effects Assessment Summary Tables (U.S. EPA)

Compounds that are classified as photochemically reactive volatile organic compounds (VOC) or have been shown to act as a mutagen⁴¹ are indicated.

Also note that Acetaldehyde (CAS 75-07-0), Formaldehyde (CAS 50-00-0), and Propionaldehyde (123-38-6) and their respective values are not listed. However, they can be found in various tables in the document as well as at the website: <https://rais.ornl.gov/>.

⁴¹ A *mutagen* is a compound that can change the genetic material in an organism. This change, in turn, increases the probability of a future mutation above the background probability of a mutation.

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Table D-1 – Summary of Risk Factor/Reference Concentration Values

Compound & Analysis Information		RAIS Risk / Hazard				EPA Risk/Hazard				Compound Information	
Chemical Name	CASN ^A	Cancer Risk Factors		Non-Cancer Reference Conc.		Cancer Risk Factors		Non-Cancer Reference Conc.		VOC	Mutagen
		URF (m ³ /ug)	Source URF	RfC (ug/m ³)	Source RfC	IUR (ug/m ³)-1	Source IUR	RfCi (ug/m ³)	Source RfCi		
Ethylbenzene	100-41-4	2.50E-06	Cal EPA	1000	IRIS	2.50E-06	Cal EPA	1000	IRIS	V	
Styrene	100-42-5			1000	IRIS			1000	IRIS	V	
cis-1,3-Dichloro-1-propene	10061-01-5										
trans-1,3-Dichloro-1-propene	10061-02-6										
1,4-Dichlorobenzene	106-46-7	1.10E-05	Cal EPA	800	IRIS	1.10E-05	Cal EPA	800	IRIS	V	
1,2-Dibromoethane	106-93-4	6.00E-04	IRIS	9.0	IRIS	6.00E-04	IRIS	9.0	IRIS	V	
1-Bromopropane	106-94-5										
1,3-Butadiene	106-99-0	3.00E-05	IRIS	2.0	IRIS	3.00E-05	IRIS	2.0	IRIS	V	
1,2-Dichloroethane	107-06-2	2.60E-05	IRIS	7.0	PPRTV	2.60E-05	IRIS	7.0	PPRTV	V	
4-Methyl-2-pentanone (MIBK)	108-10-1			3000	IRIS			3000	IRIS	V	
m & p-Xylene	108-38-3			100	IRIS			100	S	V	
1,3,5-Trimethylbenzene	108-67-8			6.0	PPRTV (A)					V	
Toluene	108-88-3			5000	IRIS			5000	IRIS	V	
Chlorobenzene	108-90-7			50	PPRTV			50	PPRTV	V	
Tetrahydrofuran (THF)	109-99-9			2000	IRIS			2000	IRIS	V	
n-Hexane	110-54-3			700	IRIS			700	IRIS	V	
Cyclohexane	110-82-7			6000	IRIS			6000	IRIS	V	
Propene	115-07-1			3000	Cal EPA			3000	Cal EPA	V	
1,2,4-Trichlorobenzene	120-82-1			2.0	PPRTV			2.0	PPRTV	V	
Dibromochloroethane	124-48-1	2.70E-05	Cal EPA			2.70E-05	Cal EPA			V	
Tetrachloroethene (PERC)	127-18-4	2.60E-07	IRIS	40	IRIS	2.60E-07	IRIS	40	IRIS	V	
n-Heptane	142-82-5										
cis-1,2-Dichloroethene	156-59-2									V	
trans-1,2-Dichloroethene	156-60-5			60	PPRTV (A)					V	
2-Methoxy-2-methylpropane (MTBE)	1634-04-4	2.60E-07	Cal EPA	3000	IRIS	2.60E-07	Cal EPA	3000	IRIS	V	
1,3-Dichlorobenzene	541-73-1										
Carbon tetrachloride	56-23-5	6.00E-06	IRIS	100	IRIS	6.00E-06	IRIS	100	IRIS	V	
2-Hexanone	591-78-6			30	IRIS			30	IRIS	V	
1-Ethyl-4-methylbenzene	622-96-8										
Acetone	67-64-1			30881	ATSDR			31000	ATSDR	V	
Chloroform	67-66-3	2.30E-05	IRIS	98	ATSDR	2.30E-05	IRIS	98	ATSDR	V	
Benzene	71-43-2	7.80E-06	IRIS	30	IRIS	7.80E-06	IRIS	30	IRIS	V	
1,1,1-Trichloroethane	71-55-6			5000	IRIS			5000	IRIS	V	
Bromomethane	74-83-9			5	IRIS			5	IRIS	V	
Chloromethane	74-87-3	1.80E-06	HEAST	90	IRIS			90	IRIS	V	
Chloroethane	75-00-3			10000	IRIS			10000	IRIS	V	
Chloroethene	75-01-4	4.40E-06	IRIS	100	IRIS	4.40E-06	IRIS	100	IRIS	V	M
Methylene chloride	75-09-2	1.00E-08	IRIS	600	IRIS	1.00E-08	IRIS	600	IRIS	V	M
Carbon disulfide	75-15-0			700	IRIS			700	IRIS	V	
Bromoforn	75-25-2	1.10E-06	IRIS			1.10E-06	IRIS				
Bromodichloromethane	75-27-4	3.70E-05	Cal EPA			3.70E-05	Cal EPA			V	
1,1-Dichloroethane	75-34-3	1.60E-06	Cal EPA	500	HEAST	1.60E-06	Cal EPA			V	
1,1-Dichloroethene	75-35-4			200	IRIS			200	IRIS	V	
Trichlorofluoromethane	75-69-4			700	HEAST			700	HEAST	V	
Dichlorodifluoromethane	75-71-8			100	PPRTV (S)			100	PPRTV (S)	V	
1,1,2-Trichloro-1,1,2,2-trifluoroethane	76-13-1			30000	HEAST			30000	HEAST	V	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	76-14-2										
1,2-Dichloropropane	78-87-5	1.00E-05	Cal EPA	4.0	IRIS	1.00E-05	Cal EPA	4.0	IRIS	V	
2-Butanone (MEK)	78-93-3			5000	IRIS			5000	IRIS	V	
1,1,2-Trichloroethane	79-00-5	1.60E-05	IRIS	0.2	PPRTV (S)	1.60E-05	IRIS	0.2	PPRTV (S)	V	
Trichloroethylene (TCE)	79-01-6	4.10E-06	IRIS	2.0	IRIS	4.10E-06	IRIS	2.0	IRIS	V	M
1,1,2,2-Tetrachloroethane	79-34-5	5.80E-05	Cal EPA			5.80E-05	Cal EPA			V	
Hexachloro-1,3-butadiene	87-68-3	2.20E-05	IRIS			2.20E-05	IRIS				
o-Xylene	95-47-6			100	IRIS			100	S	V	
1,2-Dichlorobenzene	95-50-1			200	HEAST			200	HEAST	V	
1,2,4-Trimethylbenzene	95-63-6			7.0	PPRTV			7.0	PPRTV	V	