# SAT Initiative: Harriet Tubman Middle School (Portland, Oregon)

This document describes the analysis of air monitoring and other data collected under EPA's initiative to assess potentially elevated air toxics levels at some of our nation's schools. The document has been prepared for technical audiences (e.g., risk assessors, meteorologists) and their management. It is intended to describe the technical analysis of data collected for this school in clear, but generally technical, terms. A summary of this analysis is presented on the page focused on this school on EPA's website (www.epa.gov/schoolair).

## I. Executive Summary

- Air monitoring has been conducted at Harriet Tubman Middle School as part of the EPA initiative to monitor specific air toxics in the outdoor air around priority schools in 22 states and 2 tribal areas.
- This school was selected for monitoring based on information indicating the potential for elevated ambient concentrations of manganese, nickel, acetaldehyde, acrolein, benzene, and 1,3-butadiene in air outside the school. That information included EPA's 2002 National-Scale Air Toxics Assessment (NATA) which indicated elevated levels of manganese and nickel from a mix of industrial sources and elevated levels of acetaldehyde, acrolein, benzene, and 1,3-butadiene from nearby mobile sources. This school is located in an urban area and is surrounded by several interstate and state highways.
- Air monitoring was performed from August 23, 2009 through November 3, 2009 for acetaldehyde and other carbonyl compounds; manganese, nickel, and other metals in particulate matter less than 10 microns ($PM_{10}$); and acrolein, benzene, 1,3-butadiene, and other volatile organic compounds (VOCs).
- Measured levels of manganese ($PM_{10}$) and nickel ($PM_{10}$) and associated longer-term concentration estimates are below levels of concern.
- Measured levels of acetaldehyde, benzene, and 1,3-butadiene and associated longer-term concentration estimates at this school were not as high as suggested by the modeling information available prior to monitoring. Although they were below the levels of significant concern that had been suggested by the modeling information, these results indicate the influence of mobile source pollutants of concern that are the focus of EPA actions nationwide.
- Acetaldehyde, benzene, and 1,3-butadiene are common in the outdoor air in urban areas where many sources are located near one another, particularly mobile sources such as cars and other motor vehicles and off-road machinery. Levels of acetaldehyde, benzene, 1,3-butadiene and other mobile source pollutants can be elevated in many urban areas. EPA remains concerned about mobile source emissions and continues to work to reduce those emissions across the country, through national rules and by providing information and suggestions to assist with reductions in local areas (http://www.epa.gov/schoolair/mobile.html).
- Results of a recent short-term laboratory study have raised questions about the consistency and reliability of monitoring results of acrolein. As a result, EPA will not

use these acrolein data in evaluating the potential for health concerns from exposure to air toxics in outdoor air as part of the School Air Toxics (SAT) monitoring project (http://www.epa.gov/schoolair/acrolein.html).

- Measured levels of an additional pollutant, cadmium ($PM_{10}$), also indicate influence from a nearby source(s) and the longer-term concentration estimate is higher than that suggested by the information available prior to monitoring. The elevated level of cadmium, while not indicating a level of significant concern for health effects at this location, indicates an issue of potential concern depending on the location and characteristics of the source(s).
- EPA recommends additional monitoring for cadmium in this area to better understand the elevated levels of cadmium observed in this study, identify the source(s) of cadmium and further characterize any potential exposure to the community.
- The Oregon Department of Environmental Quality (ODEQ) will continue to oversee industrial facilities in the area through air permits and other programs. ODEQ has developed state-specific ambient benchmark concentrations, which are used with either monitoring or modeling studies, for these key pollutants. They may be found at http://www.deq.state.or.us/aq/toxics/benchmark.htm. The ODEQ will also continue to implement reductions in mobile sources through implementation of national programs and its own programs.

## II. Background on this Initiative

As part of an EPA initiative to implement Administrator Lisa Jackson's commitment to assess potentially elevated air toxics levels at some of our nation's schools, EPA and state and local air pollution control agencies monitored specific (key) air toxics in the outdoor air around priority schools in 22 states and 2 tribal areas (http://www.epa.gov/schoolair/schools.html).

- The schools selected for monitoring included some schools that are near large industries that are sources of air toxics, and some schools that are in urban areas, where emissions of air toxics come from a mix of large and small industries, cars, trucks, buses and other sources.
- EPA selected schools based on information available to us about air pollution in the vicinity of the school, including results of the 2002 NATA, results from a 2008 USA Today analysis on air toxics at schools, and information from state and local air agencies. The analysis by USA Today involved use of EPA's Risk Screening Environmental Indicators tool and Toxics Release Inventory (TRI) for 2005.
  - Available information had raised some questions about air quality near these schools that EPA concluded merited investigation. In many cases, the information indicated that estimated long-term average concentrations of one or more air toxics were above the upper end of the range that EPA generally considers as acceptable (e.g., above 1-in-10,000 cancer risk for carcinogens).

- Monitors were placed at each school for approximately 60 days, and took air samples on at least 10 different days during that time. The samples were analyzed for specific air toxics identified for monitoring at the school (i.e., key pollutants).[1]
- These monitoring results and other information collected at each school during this initiative allow us to:
  - assess specific air toxics levels occurring at these sites and associated estimates of longer-term concentrations in light of health risk-based criteria for long-term exposures,
  - better understand, in many cases, potential contributions from nearby sources to key air toxics concentrations at the schools,
  - consider what next steps might be appropriate to better understand and address air toxics at the school, and
  - improve the information and methods we will use in the future (e.g., NATA) for estimating air toxics concentrations in communities across the U.S.

Assessment of air quality under this initiative is specific to the air toxics identified for monitoring at each school. This initiative is being implemented in addition to ongoing state, local and national air quality monitoring and assessment activities, including those focused on criteria pollutants (e.g., ozone and particulate matter) or existing, more extensive, air toxics programs.

Several technical documents prepared for this project provide further details on aspects of monitoring and data interpretation and are available on the EPA website (e.g., www.epa.gov/schoolair/techinfo.html). The full titles of these documents are provided here:

- *School Air Toxics Ambient Monitoring Plan*
- *Quality Assurance Project Plan For the EPA School Air Toxics Monitoring Program*
- *Schools Air Toxics Monitoring Activity (2009), Uses of Health Effects Information in Evaluating Sample Results*

Information on health effects of air toxics being monitored[2] and educational materials describing risk concepts[3] are also available from EPA's website.

## III. Basis for Selecting this School and the Air Monitoring Conducted

This school was selected for monitoring in consultation with the state air agency, the Oregon Department of Environmental Quality (ODEQ). We were interested in evaluating the ambient concentrations of manganese and nickel in air outside the school because EPA's 2002 NATA analysis indicated the potential for levels of concern of these key HAPs due to a mix of industrial sources in the area. We were also interested in evaluating the ambient concentrations of acetaldehyde, acrolein, benzene, and 1,3-butadiene in air outside this school because EPA's 2002 NATA analysis indicated the potential for levels of concern of these key HAPs due to nearby

[1] In analyzing air samples for these key pollutants, samples are also being analyzed for some additional pollutants that are routinely included in the analytical methods for the key pollutants.
[2] For example, http://www.epa.gov/schoolair/pollutants.html, http://www.epa.gov/ttn/fera/risk_atoxic.html.
[3] For example, http://www.epa.gov/ttn/atw/3_90_022.html, http://www.epa.gov/ttn/atw/3_90_024.html.

mobile sources. This school is located near an urban industrial area, as well as several interstate and state highways (Figure 1). More information on mobile sources of air toxics can be found on EPA's website (http://www.epa.gov/schoolair/mobile.html).

Monitoring commenced at this school on August 23, 2009 and continued through November 3, 2009. During this period, 13 $PM_{10}$ metal samples,[4] 13 carbonyl samples, and 12 VOC samples of airborne particles were collected and analyzed for the key pollutants and other air toxics at this school. The samples were analyzed for manganese, nickel, acetaldehyde, benzene, and 1,3-butadiene (the key pollutants at this school) and for a standardized set of additional $PM_{10}$ metals, carbonyls, and VOCs that are routinely included in the analytical methods for the key pollutants.

All VOC results with the exception of acrolein were evaluated for health concerns. Results of a recent short-term laboratory study have raised questions about the consistency and reliability of monitoring results of acrolein. As a result, EPA will not use these acrolein data in evaluating the potential for health concerns from exposure to air toxics in outdoor air as part of the SAT monitoring project (http://www.epa.gov/schoolair/acrolein.html). All sampling methodologies are described in EPA's schools air toxics monitoring plan (http://www.epa.gov/schoolair/techinfo.html).[5]

## IV. Monitoring Results and Analysis

### A. Background for the SAT Analysis

The majority of schools being monitored in this initiative were selected based on modeling analyses that indicated the potential for annual average air concentrations of some specific (key) hazardous air pollutants (HAPs or air toxics)[6] to be of particular concern based on approaches that are commonly used in the air toxics program for considering potential for long-term risk. For example, such analyses suggested annual average concentrations of some air toxics were greater than long-term risk-based concentrations associated with an additional cancer risk greater than 10-in-10,000 or a hazard index on the order of or above 10. To make projections of air concentrations, the modeling analyses combined estimates of air toxics emissions from industrial, motor vehicle and other sources, with past measurements of winds, and other meteorological factors that can influence air concentrations, from a weather station in the general area. In some cases, the weather station was very close (within a few miles), but in other cases, it was much further away (e.g., up to 60 miles), which may contribute to quite different conditions being modeled than actually exist at the school. The modeling analyses are intended to be used to prioritize locations for further investigation.

[4] In general, this sampler collects airborne particles with a diameter of 10 microns or smaller, more of which would be considered to be in the respirable range which are what the health-based comparison levels for manganese and nickel are based on.

[5] ODEQ staff operated the monitors and sent the sample filters, cartridges, and canisters to the analytical laboratory under contract to EPA.

[6] The term hazardous air pollutants (commonly called HAPs or air toxics) refers to pollutants identified in section 112(b) of the Clean Air Act which are the focus of regulatory actions involving stationary sources described by CAA section 112 and are distinguished from the six pollutants for which criteria and national ambient air quality standards (NAAQS) are developed as described in section 108. One of the criteria pollutants, lead, is also represented, as lead compounds, on the HAP list.

The primary objective of this initiative is to investigate - through monitoring air concentrations of key air toxics at each school over a 2-3 month period - whether levels measured and associated longer-term concentration estimates are of a magnitude, in light of health risk-based criteria, for which follow-up activities may need to be considered. To evaluate the monitoring results consistent with this objective, we developed health risk-based air concentrations (the long-term comparison levels summarized in Appendix A) for the monitored air toxics using established EPA methodology and practices for health risk assessment[7] and, in the case of cancer risk, consistent with the implied level of risk considered in identifying schools for monitoring. Consistent with the long-term or chronic focus of the modeling analyses, based on which these schools were selected for monitoring, we have analyzed the full record of concentrations of air toxics measured at this school, using routine statistical tools, to derive a 95 percent confidence interval[8] for the estimate of the longer-term average concentration of each of these pollutants. In this project, we are reporting all actual numerical values for pollutant concentrations including any values below method detection limit (MDL).[9] Additionally, a value of 0.0 is used when a measured pollutant has no value detected (ND). The projected range for the longer-term concentration estimate for each chemical (most particularly the upper end of the range) is compared to the long-term comparison levels. These long-term comparison levels conservatively presume continuous (all-day, all-year) exposure over a lifetime. The analysis of the air concentrations also includes a consideration of the potential for cumulative multiple pollutant impacts.[10] In general, where the monitoring results indicate estimates of longer-term average concentrations that are above the comparison levels - i.e., above the cancer-based comparison levels or notably above the noncancer-based comparison levels - we will consider the need for follow-up actions such as:

→ Additional monitoring of air concentrations and/or meteorology in the area,

[7] While this EPA initiative will rely on EPA methodology, practices, assessments and risk policy considerations, we recognize that individual state methods, practices and policies may differ and subsequent analyses of the monitoring data by state agencies may draw additional or varying conclusions.

[8] When data are available for only a portion of the period of interest (e.g., samples not collected on every day during this period), statisticians commonly calculate the 95% confidence interval around the dataset mean (or average) in order to have a conservative idea of how high or low the "true" mean may be. More specifically, this interval is the range in which the mean for the complete period of interest is expected to fall 95% of the time (95% probability is commonly used by statisticians). The interval includes an equal amount of quantities above and below the sample dataset mean. The interval that includes these quantities is calculated using a formula that takes into account the size of the dataset (i.e., the 'n') as well as the amount by which the individual data values vary from the dataset mean (i.e., the "standard deviation"). This calculation yields larger confidence intervals for smaller datasets as well as ones with more variable data points. For example, a dataset including {1.0, 3.0, and 5.0}, results in a mean of 3.0 and a 95% confidence interval of 3.0 +/- ~5 (or -2.0 to 8.0). For comparison purposes, a dataset including {2.5, 3 and 3.5} results in a mean of 3.0 and a 95% confidence interval of 3.0 +/- ~1.2 (or 1.8 to 4.2). The smaller variation within the data in the second set of values causes the second confidence interval to be smaller.

[9] Method detection limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99% confidence that the pollutant concentration is greater than zero and is determined from the analysis of a sample in a given matrix containing the pollutant.

[10] As this analysis of a 2-3 month monitoring dataset is not intended to be a full risk assessment, consideration of potential multiple pollutant impacts may differ among sites. For example, in instances where no individual pollutant appears to be present above its comparison level, we will also check for the presence of multiple pollutants at levels just below their respective comparison levels (giving a higher priority to such instances).

- → Evaluation of potentially contributing sources to help us confirm their emissions and identify what options (regulatory and otherwise) may be available to us to achieve emissions reductions, and
- → Evaluation of actions being taken or planned nationally, regionally or locally that may achieve emission and/or exposure reductions. An example of this would be actions taken to address the type of ubiquitous emissions that came from mobile sources.

We have further analyzed the dataset to describe what it indicates in light of some other criteria and information commonly used in prioritizing state, local and national air toxics program activities. State, local and national programs often develop long-term monitoring datasets in order to better characterize pollutants near particular sources. The 2-3 month dataset developed under this initiative will be helpful to those programs in setting priorities for longer-term monitoring projects. The intent of this analysis is to make this 2-3 month monitoring dataset as useful as possible to state, local and national air toxics programs in their longer-term efforts to improve air quality nationally. To that end, this analysis:

- → Describes the air toxics measurements in terms of potential longer-term concentrations, and, as available, compares the measurements at this school to monitoring data from national monitoring programs.
- → Describes the meteorological data by considering conditions on sampling days as compared to those over all the days within the 2-3 month monitoring period and what conditions might be expected over the longer-term (as indicated, for example, by information from a nearby weather station).
- → Describes available information regarding activities and emissions at the nearby source(s) of interest, such as that obtained from public databases such as TRI and/or consultation with the local air pollution authority.

### B. Chemical Concentrations

We developed two types of long-term health risk-related comparison levels (summarized in Appendix A below) to address our primary objective. The primary objective is to investigate through the monitoring data collected for key pollutants at the school, whether pollutant levels measured and associated longer-term concentration estimates are elevated enough in comparison with health risk-based criteria to indicate that follow-up activities be considered. These comparison levels conservatively presume continuous (all-day, all-year) exposure over a lifetime.

In developing or identifying these comparison levels, we have given priority to use of relevant and appropriate air standards and EPA risk assessment guidance and precedents.[11] These levels are based upon health effects information, exposure concentrations and risk estimates developed and assessed by EPA, the U.S. Agency for Toxic Substances and Disease Registry, and the California EPA. These agencies recognize the need to account for potential differences in sensitivity or susceptibility of different groups (e.g., asthmatics) or lifestages/ages (e.g., young

[11] This is described in detail in *Schools Air Toxics Monitoring Activity (2009), Uses of Health Effects Information in Evaluating Sample Results*

children or the elderly) to a particular pollutant's effects so that the resulting comparison levels are relevant for these potentially sensitive groups as well as the broader population.

In addition to evaluating individual pollutants with regard to their corresponding comparison levels, we also considered the potential for cumulative impacts from multiple pollutants in cases where individual pollutant levels fall below the comparison levels but where multiple pollutant mean concentrations are within an order of magnitude of their comparison levels.

Using the analysis approach described above, we analyzed the chemical concentration data (Table 1 and Figures 2a-2f) with regard to areas of interest identified below.

**Key findings** drawn from the information on chemical concentrations and the considerations discussed below include:

- The air sampling data collected over the 3-month sampling period and the related longer-term concentration estimates, while indicating influence from nearby source(s) of manganese and nickel, are below concentrations of concern.
- Acetaldehyde, benzene, and 1,3-butadiene levels measured over the 3-month sampling period and associated longer-term concentration estimates at this school were not as high as suggested by the modeling information available prior to monitoring. Although they were below the levels of significant concern that had been suggested by the modeling information, these results indicate the influence of mobile source pollutants of concern that are the focus of EPA actions nationwide.
- EPA recommends additional monitoring for cadmium in this area to better understand the elevated levels of cadmium observed in this study, identify the source(s) of cadmium and further characterize any potential exposure to the community.

<u>Manganese, key pollutant:</u>

- Do the monitoring data indicate influence from a nearby source?

  → The monitoring data include several manganese ($PM_{10}$) concentrations that are higher than concentrations commonly observed in other locations nationally.[12]

- Do the monitoring data indicate elevated levels that pose significant long-term health concerns?

  → The monitoring data for manganese do not indicate levels of health concern for long-term exposures.

[12] For example, seven of the concentrations at this site (Table 2a) were higher than 75 percent of samples collected at the National Air Toxics Trends Stations (NATTS) from 2004-2008 (Appendix B). Because these NATTS sites are generally sited so as to not be influenced by specific nearby sources, EPA is using the 75$^{th}$ percentile point of concentrations at these sites as a benchmark of indicating potential influence from a source nearby to the school.

- The estimate of longer-term manganese concentration (i.e., the upper bound of the 95 percent confidence interval on the mean of the dataset) is below the noncancer-based long-term comparison level (Table 1).[13] This comparison level is a continuous exposure concentration (24 hours a day, all year, over a lifetime) associated with little risk of adverse effect; it is not an exposure concentration at which effects have been observed or are predicted to occur.[14]
- As manganese has not been found to be carcinogenic, it has no cancer-based comparison level.[15]

→ Additionally, we did not identify any concerns regarding short-term exposures as each individual measurement is below the individual sample screening level for manganese (which is based on consideration of exposure all day, every day over a period ranging from a couple of weeks to longer for some pollutants).[11]

→ In summary, the individual measurements do not indicate concentrations of concern for short-term exposures and the combined contributions of all individual measurements in the estimate of longer-term concentration do not indicate a level of concern for long-term exposure.

Nickel, key pollutant:

- Do the monitoring data indicate influence from a nearby source?

  → The monitoring data include several nickel ($PM_{10}$) concentrations that are higher than concentrations commonly observed in other locations nationally.[16]

- Do the monitoring data indicate elevated levels that pose significant long-term health concerns?

  → The monitoring data for nickel do not indicate levels of health concern for long-term exposures.

  - The estimate of longer-term nickel concentration (i.e., the upper bound of the 95 percent confidence interval on the mean of the dataset) is well below both of the long-term comparison levels (Table 1).[17] These comparison levels are continuous exposure concentrations (24 hours a day, all year, over a lifetime).
  - Further, the longer-term concentration estimate is more than 100-fold lower than the cancer-based comparison level, indicating the longer-term estimate is

[13] The upper end of the interval is less than 1.5 times the mean of the monitoring data and less than 40 percent of the long-term noncancer-based comparison level.
[14] The comparison level for manganese is based on the RfC. Manganese concentrations at which health effects have been observed are higher than the RfC (http://www.atsdr.cdc.gov/tfacts151.html, http://www.epa.gov/ttn/atw/hlthef/manganes.html#conversion)
[15] www.epa.gov/iris
[16] For example, three of the concentrations at this site (Table 2a) were higher than 75 percent of samples collected at the National Air Toxics Trends Stations (NATTS) from 2004-2008 (Appendix B). Because these NATTS sites are generally sited so as to not be influenced by specific nearby sources, EPA is using the 75th percentile point of concentrations at these sites as a benchmark of indicating potential influence from a source nearby to the school.
[17] The upper end of the interval is nearly 1.4 times the mean of the monitoring data and approximately 3 percent of the long-term noncancer-based comparison level.

below a continuous (24 hours a day, 7 days a week) lifetime exposure concentration associated with 1-in-1 million additional cancer risk.

→ Additionally, we did not identify any concerns regarding short-term exposures as each individual measurement is below the individual sample screening level for nickel (which is based on consideration of exposure all day, every day over a period ranging up from a couple of weeks to longer for some pollutants).[12]

→ In summary, the individual measurements do not indicate concentrations of concern for short-term exposures and the combined contributions of all individual measurements in the estimate of longer-term concentration do not indicate a level of concern for long-term exposure.

Acetaldehyde, key pollutant:

Acetaldehyde is one of several air toxics that EPA recognizes as a key pollutant nationally. A large number of people live in areas across the U.S. with elevated ambient concentrations of this pollutant due to mobile sources.[18]

- Do the monitoring data indicate elevated levels that pose significant long-term health concerns?

  → Measured acetaldehyde levels and associated longer-term concentration estimates at this school were not as high as suggested by the modeling information available prior to monitoring. Although they were below the levels of significant concern that had been suggested by the modeling information, these results indicate the ubiquitous nature and influence of mobile source pollutants of concern that are the focus of EPA actions nationwide.

    - The estimate of longer-term acetaldehyde concentration (i.e., the upper bound of the 95 percent confidence interval on the mean of the dataset) is below both of the long-term comparison levels (Table 1).[19] These comparison levels are continuous exposure concentrations (24 hours a day, all year, over a lifetime).
    - Further, the longer-term concentration estimate is more than tenfold lower than the cancer-based comparison level, indicating the longer-term estimate is below a continuous (24 hours a day, 7 days a week) lifetime exposure concentration associated with 1-in-100,000 additional cancer risk.

  → Additionally, we did not identify any concerns regarding short-term exposures as each individual measurement is below the individual sample screening level for acetaldehyde (which is based on consideration of exposure all day, every day over a period ranging from a couple of weeks to longer for some pollutants).[12]

[18] Additional information on mobile sources of air toxics is available at http://www.epa.gov/schoolair/mobile.html
[19] The upper end of the interval is nearly 1.2 times the mean of the monitoring data and less than 20 percent of the long-term noncancer-based comparison level.

Benzene, key pollutant:

Benzene is one of several air toxics that EPA recognizes as a key pollutant nationally. A large number of people live in areas across the U.S. with elevated ambient concentrations of this pollutant due to mobile sources.[18]

- Do the monitoring data indicate elevated levels that pose significant long-term health concerns?

  → Measured benzene levels and associated longer-term concentration estimates at this school were not as high as suggested by the modeling information available prior to monitoring. Although they were below the levels of significant concern that had been suggested by the modeling information, these results indicate the ubiquitous nature and influence of mobile source pollutants of concern that are the focus of EPA actions nationwide.

    - The estimate of longer-term benzene concentration (i.e., the upper bound of the 95 percent confidence interval on the mean of the dataset) is below both of the long-term comparison levels (Table 1).[20] These comparison levels are continuous exposure concentrations (24 hours a day, all year, over a lifetime).
    - Further, the longer-term concentration estimate is 11% of the cancer-based comparison level, indicating the longer-term estimate falls between continuous (24 hours a day, 7 days a week) lifetime exposure concentrations associated with 1-in-100,000 and 1-in-10,000 additional cancer risk.

  → Additionally, we did not identify any concerns regarding short-term exposures as each individual measurement is below the individual sample screening level for benzene (which is based on consideration of exposure all day, every day over a period ranging from a couple of weeks to longer for some pollutants).[12]

1,3-Butadiene, key pollutant:

1,3-Butadiene is one of several air toxics that EPA recognizes as a key pollutant nationally. A large number of people live in areas across the U.S. with elevated ambient concentrations of this pollutant due to mobile sources.[18]

- Do the monitoring data indicate elevated levels that pose significant long-term health concerns?

  → Measured 1,3-butadiene levels and associated longer-term concentration estimates at this school were not as high as suggested by the modeling information available prior to monitoring. Although they were below the levels of significant concern that had been suggested by the modeling information, these results indicate the ubiquitous nature and influence of mobile source pollutants of concern that are the focus of EPA actions nationwide.

    - The estimate of longer-term 1,3-butadiene concentration (i.e., the upper bound of the 95 percent confidence interval on the mean of the dataset) is below both

[20] The upper end of the interval is less than 1.4 times the mean of the monitoring data and less than 12 percent of the long-term cancer-based comparison level.

of the long-term comparison levels (Table 1).[21] These comparison levels are continuous exposure concentrations (24 hours a day, all year, over a lifetime).

- Further, the longer-term concentration estimate is more than tenfold lower than the cancer-based comparison level, indicating the longer-term estimate is below a continuous (24 hours a day, 7 days a week) lifetime exposure concentration associated with 1-in-100,000 additional cancer risk.

→ Additionally, we did not identify any concerns regarding short-term exposures as each individual measurement is below the individual sample screening level for 1,3-butadiene (which is based on consideration of exposure all day, every day over a period ranging from a couple of weeks to longer for some pollutants).[12]

Other Air Toxics:

- Do the monitoring data indicate elevated levels of any other air toxics (or HAPs) that pose significant long-term health concerns?

  → The monitoring data show low levels of the other HAPs monitored, with longer-term concentration estimates for these HAPs, with the exception of cadmium, below their long-term comparison levels (Appendix C). Additionally, each individual measurement for these pollutants is below the individual sample screening level[11] for that pollutant (Appendix D).

  - The longer-term concentration estimate for cadmium is slightly above the long-term noncancer-based comparison level for continuous, long-term exposures (Figure 2f, Appendix C). Contributing to this were results for four of the 13 individual samples which, while below the individual sample screening level, were each above the long-term comparison level concentration (Appendix D). This comparison level is a continuous exposure concentration (24 hours a day, all year, over a lifetime) associated with little risk of adverse effect; it is an exposure concentration appreciably below levels at which effects have been observed.[22] The slightly elevated levels at this location, however, indicate an issue of potential concern depending on the location and characteristics of the source(s). Further investigation is recommended to characterize the contributing source(s) as well as to characterize concentrations in areas of the community closest to the source(s) of cadmium emissions.

[21] The upper end of the interval is nearly 1.5 times the mean of the monitoring data and less than 11 percent of the long-term noncancer-based comparison level.

[22] The comparison level for cadmium is based on the RfC. Cadmium concentrations at which health effects have been observed are higher than the RfC (http://www.atsdr.cdc.gov/tfacts5.pdf, http://www.epa.gov/ttn/atw/hlthef/cadmium.html).

Multiple Pollutants:

- Do the data collected for the air toxics monitored indicate the potential for other monitored pollutants to be present at levels that in combination with the key pollutant levels indicate an increased potential for cumulative impacts of significant concern (e.g., that might warrant further investigation)?

  → The multiple air toxics monitored at this site were below the levels of particularly significant concern for multi-pollutant cumulative risk that had been suggested by the modeling information available prior to monitoring. However, these results do indicate the influence of multiple mobile source pollutants of concern that are the focus of EPA actions nationwide, and of the non-mobile source HAP, cadmium, discussed above, for which additional activities are recommended (Appendix C).[23]

### C. Wind and Other Meteorological Data

At each school monitored as part of this initiative, we collected meteorological data, minimally for wind speed and direction, during the sampling period. Additionally, we identified the nearest National Weather Service (NWS) station at which a longer record is available.

In reviewing these data at each school in this initiative, we are considering if these data indicate that the general pattern of winds on our sampling dates are significantly different from those occurring across the full sampling period or from those expected over the longer term. Additionally, we are noting, particularly for school sites where the measured chemical concentrations show little indication of influence from a nearby source, whether wind conditions on some portion of the sampling dates were indicative of a potential to capture contributions from the nearby "key" source in the air sample collected.

The meteorological station at Harriet Tubman Middle School collected wind speed and wind direction measurements beginning on August 11, 2009, continuing through the sampling period (August 23, 2009-November 3, 2009), and ending on May 10, 2010. As a result, on-site data for these meteorological parameters are available for all dates of sample collection, and also for a period before and after the sampling period, producing a continuous record of approximately nine months of on-site meteorological data. The meteorological data collected on sampling days are presented in Figures 3a-3c and Tables 2a-2b.

The nearest NWS station is at Portland International Airport in Portland, Oregon. This station is approximately 4.77 miles northeast of the school. Measurements taken at that station include wind, temperature, and precipitation. Wind speed and direction data collected at the Portland International Airport NWS station have been summarized in Tables 2a-2b and Appendix E.

[23] We note that this initiative is focused on investigation for a school-specific set of key pollutants indicated by previous analyses (and a small set of others for which measurements are obtained in the same analysis). Combined impacts of pollutants or stressors other than those monitored in this project is a broader area of consideration in other EPA activities. General information on additional air pollutants is available at http://www.epa.gov/air/airpollutants.html.

**Key findings** drawn from this information and the considerations discussed below include:

- Both the sampling results and the on-site wind data indicate that some of the air samples were collected on days when the nearby source(s) were contributing to conditions at the school location.

- The wind patterns at the monitoring site across sampling dates are generally similar to those observed across the record of on-site meteorological data during the sampling period.

- Although we lack long-term wind data at the monitoring site, the wind pattern at the NWS station during the sampling period is very similar to the historical long-term wind flow pattern at that same NWS station. This, and the 9-month wind data at the school suggest that, on a regional scale, the sampling period is representative of year-round wind patterns.

- What is the direction of the key source of manganese, nickel, acetaldehyde, benzene, and 1,3-butadiene emissions in relation to the school location?
  → The key sources of manganese and nickel was identified as a mix of industrial sources; therefore no ZOI was identified.
  → A roadway located to the south and west of the school was identified as the key source for mobile source emissions. Therefore winds from the south and west may be considered as from this source.
  → Considering the boundaries of the sources of interest (in lieu of information regarding the location of specific sources of, acetaldehyde, benzene, and 1,3-butadiene emissions), we have determined the range of wind directions to use in considering potential influence of the mobile sources on air concentrations at the school.
  → These general ranges of wind directions, from approximately 146-326 degrees are referred to here as the expected zone of source influence for the roadway mobile sources (ZOI).

- On days the air samples were collected, how often did wind come from direction of the key source?
  → For acetaldehyde, there were twelve out of thirteen sampling days in which a portion of the winds were from the expected ZOI B (Figure 3a, Table 2b).
  → For benzene and 1,3-butadiene, there were eleven out of twelve sampling days in which a portion of the winds were from the expected ZOI B (Figures 3c-3d, Table 2b).

- How do wind patterns on the air monitoring days compare to those across the complete monitoring period and what might be expected over the longer-term at the school location?
  → Wind patterns across the air monitoring days appear similar to those observed over the record of on-site meteorological data during the sampling period.
  → We note that wind patterns at the nearest NWS station (at Portland International Airport) during the sampling period are very similar to those recorded at the NWS station over the long-term (2002-2007 period; Appendix E), supporting the idea that regional meteorological patterns in the area during the sampling period were

consistent with long-term patterns. There is some uncertainty as to whether the general wind patterns at the school location for longer periods would be similar to the general wind patterns at the Portland International Airport (see below).

- How do wind patterns at the school compare to those at the Portland International Airport station, particularly with regard to prevalent wind directions and the direction of the key source?
  → During the sampling period for which data are available both at the school site and at the reference NWS station (approximately 3 months), prevalent winds at the school site are predominantly from the north-northwest to north, while those at the NWS station are more from the northwestern quadrant and east to east-southeast. The windroses for the two sites during the sampling period (Figure 2 and Appendix E) show some similarities in wind flow patterns.

- Are there other meteorological patterns that may influence the measured concentrations at the school monitoring site?
  → No. We did not observe other meteorological patterns that may influence the measured concentrations at the school monitoring site.

## V. Key Source Information

- Were the industrial sources operating as usual and was mobile source activity typical during the monitoring period?
  – The most recently available county-level acetaldehyde, benzene and 1,3-butadiene emissions for on-road mobile sources (2005 NATA) are lower than those relied upon previous modeling analysis for this area (2002 NATA).

## VI. Integrated Summary and Next Steps

### A. Summary of Key Findings

1. What are the key HAPs for this school?
   → Manganese, nickel, acetaldehyde, benzene, and 1,3-butadiene are the key HAPs for this school, identified based on emissions information considered in identifying the school for monitoring. The ambient air measurements during the monitoring period also identified another HAP, cadmium, for additional consideration.
2. Do the data collected at this school indicate an elevated level of concern, as implied by information that led to identifying this school for monitoring?
   → Measured manganese and nickel levels and associated longer-term concentration estimates are not as high as those suggested by the information available prior to monitoring and are well below levels of concern for long-term exposures.
   → Measured benzene, 1,3-butadiene, and acetaldehyde levels and associated longer-term concentration estimates at this school were not as high as was suggested by the modeling information available prior to monitoring.

Although they were below the levels of significant concern that had been suggested by the modeling information, these results (and those for formaldehyde) indicate the influence of mobile source pollutants of concern that are the focus of EPA actions nationwide.

→ Additionally, the slightly elevated longer-term concentration estimate for cadmium indicates an issue of potential concern depending on the location and characteristics of the source(s).

3. Are there indications, e.g., from the meteorological or other data, that the sample set may not be indicative of longer-term air concentrations? Would we expect higher (or lower) concentrations at other times of year?

→ The data we collected appear to reflect air concentrations during the entire monitoring period, with no indications from the on-site meteorological data that the sampling day conditions were inconsistent with conditions overall during this period.

→ Among the data collected for this site, we have none that would indicate generally higher (or lower) concentrations during other times of year. The wind flow patterns at the nearest NWS station during the sampling period appear to be representative of long-term wind flow at that site. The lack of long-term meteorological data at the school location, along with our finding that the wind patterns from the nearest NWS station are only somewhat similar to those at the school, however, limit somewhat our ability to confidently predict longer-term wind patterns at the school (which might provide further evidence relevant to concentrations during other times).

## B. Next Steps for Key Pollutants

1. Based on the analysis described here, EPA recommends additional monitoring for cadmium in this area to better understand the elevated levels of cadmium observed in this study, identify the source(s) of cadmium and further characterize any potential exposure to the community.
2. EPA's ongoing research and national air toxics monitoring programs will continue to collect information on mobile source impacts on outdoor air nationally. EPA will also continue to work toward reductions in mobile source emissions nationally and to facilitate reductions in local areas (http://www.epa.gov/schoolair/mobile.html).
3. The Oregon Department of Environmental Quality (ODEQ) will continue to oversee industrial facilities in the area through air permits and other programs. ODEQ has developed state-specific ambient benchmark concentrations, which are used with either monitoring or modeling studies, for these key pollutants. They may be found at http://www.deq.state.or.us/aq/toxics/benchmark.htm. The ODEQ will also continue to implement reductions in mobile sources through implementation of national programs and its own programs.

## VII. Figures and Tables

### A. Tables

1. Harriet Tubman Middle School – Key Pollutant Analysis.

2a. Harriet Tubman Middle School Key Pollutant Concentrations (Manganese ($PM_{10}$), Nickel ($PM_{10}$), and Cadmium ($PM_{10}$)) and Meteorological Data.

2b. Harriet Tubman Middle School Key Pollutant Concentrations (Acetaldehyde, Benzene, and 1,3-Butadiene) and Meteorological Data.

### B. Figures

1. Harriet Tubman Middle School and Sources of Interest.

2a. Harriet Tubman Middle School – Key Pollutant (Manganese ($PM_{10}$)) Analysis.

2b. Harriet Tubman Middle School – Key Pollutant (Nickel ($PM_{10}$)) Analysis.

2c. Harriet Tubman Middle School – Key Pollutant (Acetaldehyde) Analysis.

2d. Harriet Tubman Middle School – Key Pollutant (Benzene) Analysis.

2e. Harriet Tubman Middle School – Key Pollutant (1,3-Butadiene) Analysis.

2f. Harriet Tubman Middle School – Cadmium ($PM_{10}$) Analysis.

3a. Harriet Tubman Middle School (Portland, OR) Acetaldehyde Concentration and Wind Information.

3b. Harriet Tubman Middle School (Portland, OR) Benzene Concentration and Wind Information.

3c. Harriet Tubman Middle School (Portland, OR) 1,3-Butadiene Concentration and Wind Information.

## VIII. Appendices

A. Summary Description of Long-term Comparison Levels.

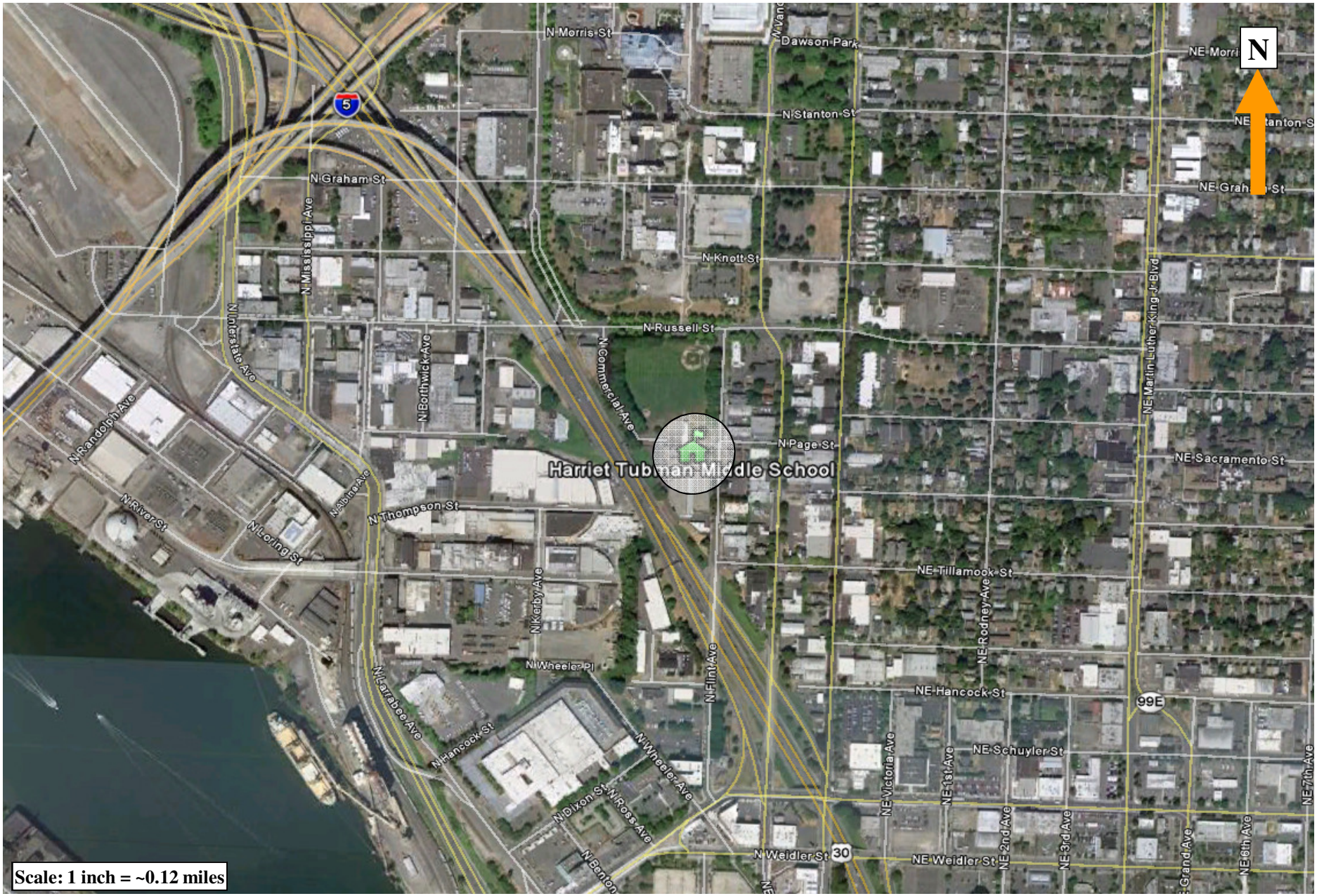
B. National Air Toxics Trends Stations Measurements (2004-2008).

C. Analysis of Other (non-key) Air Toxics Monitored at the School and Multiple-pollutant Considerations.

D. Harriet Tubman Middle School Pollutant Concentrations.

E. Windroses for Portland International Airport NWS Station.

**Figure 1. Harriet Tubman Middle School and Sources of Interest.**




| Source | Distance from School (miles) |
|---|---|
| Interstate-5 | 0.03 |

## Table 1. Harriet Tubman Middle School - Key Pollutant Analysis.

| Parameter | Units | Mean of Measurements | 95% Confidence Interval on the Mean | Long-term Comparison Level[a] | |
|---|---|---|---|---|---|
| | | | | Cancer-Based[b] | Noncancer-Based[c] |
| Manganese ($PM_{10}$) | $ng/m^3$ | 13.9 [d] | 8.04 - 19.7 | NA | 50 |
| Nickel ($PM_{10}$) | $ng/m^3$ | 2.00 [e] | 1.20 - 2.79 | 420 | 90 |
| Acetaldehyde | $\mu g/m^3$ | 1.56 [f] | 1.29 - 1.83 | 45 | 9 |
| Benzene | $\mu g/m^3$ | 1.07 [g] | 0.69 - 1.46 | 13 | 30 |
| Butadiene, 1,3- | $\mu g/m^3$ | 0.12 [h] | 0.06 - 0.18 | 3.3 | 2 |
| Cadmium ($PM_{10}$)[i] | $ng/m^3$ | 7.29 [j] | 1.90 - 12.7 | 56 | 10 |

$ng/m^3$ nanograms per cubic meter

$\mu g/m^3$ micrograms per cubic meter

NA Not applicable

[a] Details regarding these values are in the technical report, Schools Air Toxics Monitoring Activity (2009) Uses of Health Effects Information.

[b] Air toxics for which the upper 95% confidence limit on the mean concentration is above this level will be fully discussed in the text and may be considered a priority for potential follow-up activities, if indicated in light of the full set of information available for the site. Findings of the upper 95% confidence limit below 1% of the comparison level (i.e., where the upper 95% confidence limit is below the corresponding 1-in-1-million cancer risk based concentration) are generally considered a low priority for follow-up activity. Situations where the summary statistics for a pollutant are below this comparison level but above 1% of this level are fully discussed in the text of the report.

[c] Air toxics for which the upper 95% confidence limit on the mean concentration are near or below the noncancer-based comparison level are generally of low concern and will generally be considered a low priority for follow-up activity. Pollutants for which the 95% confidence limits extend appreciably above the noncancer-based comparison level are fully discussed in the school-specific report and may be considered a priority for follow-up activity, if indicated in light of the full set of information available for the site.

[d] The mean of measurements for manganese ($PM_{10}$) is the average of all sample results, which include thirteen detections that ranged from 3.79 to 38.6 $ng/m^3$.

[e] The mean of measurements for nickel ($PM_{10}$) is the average of all sample results, which include thirteen detections that ranged from 0.30 to 5.10 $ng/m^3$.

[f] The mean of measurements for acetaldehyde is the average of all sample results, which include thirteen detections that ranged from 1.08 to 2.45 $\mu g/m^3$.

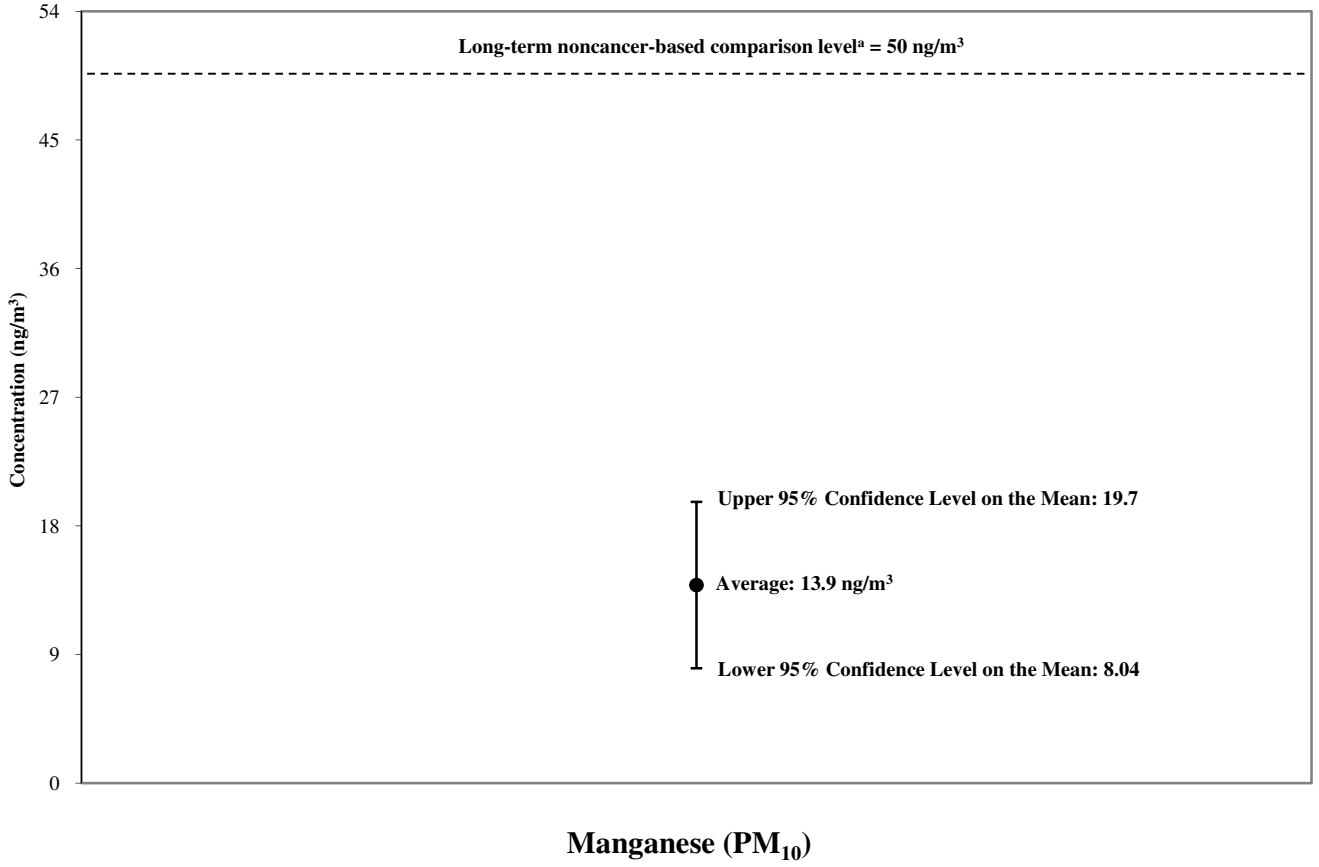
[g] The mean of measurements for benzene is the average of all sample results, which include twelve detections that ranged from 0.43 to 2.25 $\mu g/m^3$.

[h] The mean of measurements for 1,3-butadiene is the average of all sample results, which include eleven detections that ranged from 0.029 to 0.272 $\mu g/m^3$. There was, as well, one sample in which no chemical was registered by the laboratory analytical equipment. For this sample, a value of zero was used when calculating the mean.

[i] Not originally identified as a key pollutant.

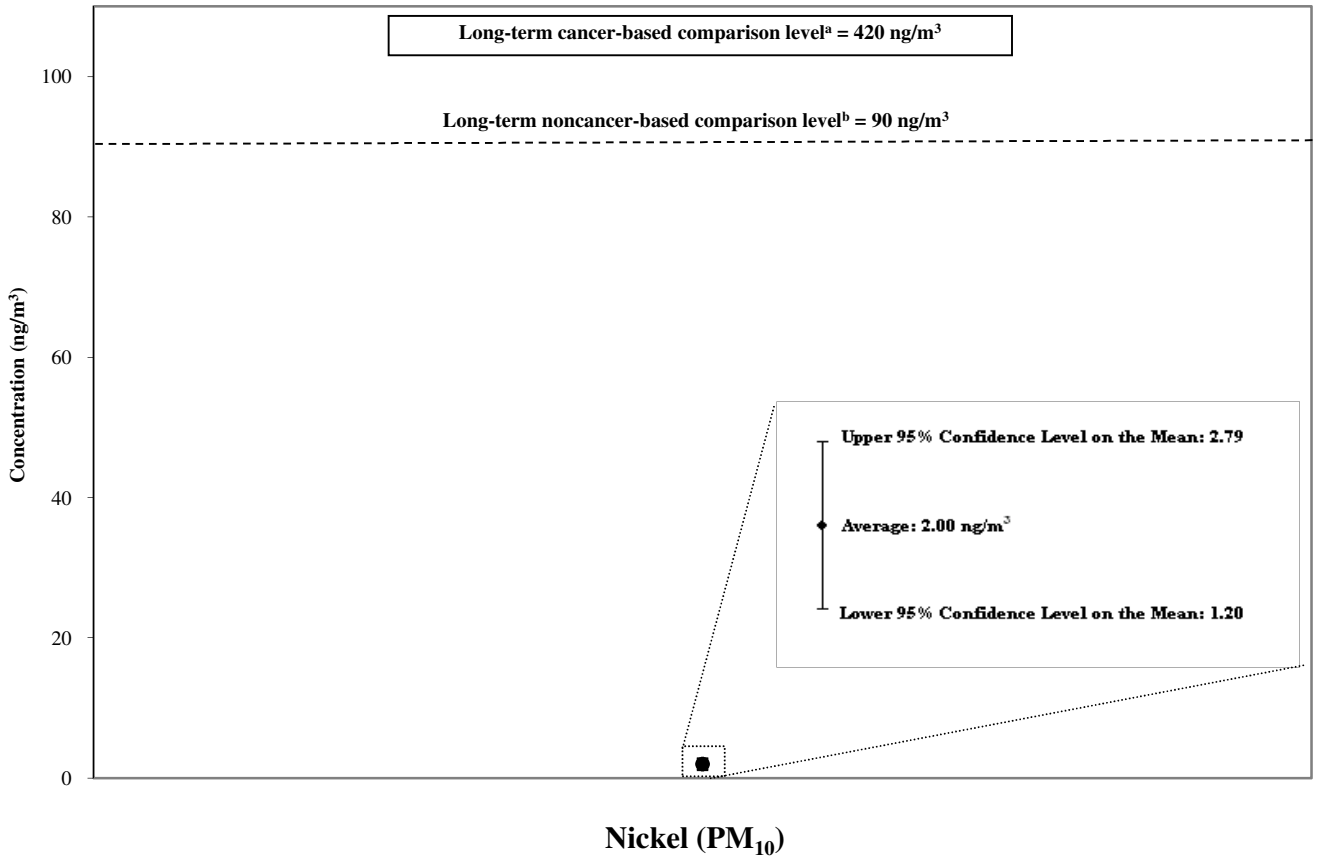
[j] The mean of measurements for cadmium ($PM_{10}$) is the average of all sample results, which include thirteen detections that ranged from 0.05 to 23.1 $ng/m^3$.

**Figure 2a. Harriet Tubman Middle School - Key Pollutant (Manganese ($PM_{10}$)) Analysis.**




[a] Air toxics for which the upper 95% confidence limit on the mean concentration are near or below the noncancer-based comparison level are generally of low concern and will generally be considered a low priority for follow-up activity. Pollutants for which the 95% confidence limits extend appreciably above the noncancer-based comparison level are fully discussed in the school-specific report and may be considered a priority for follow-up activity, if indicated in light of the full set of information available for the site.

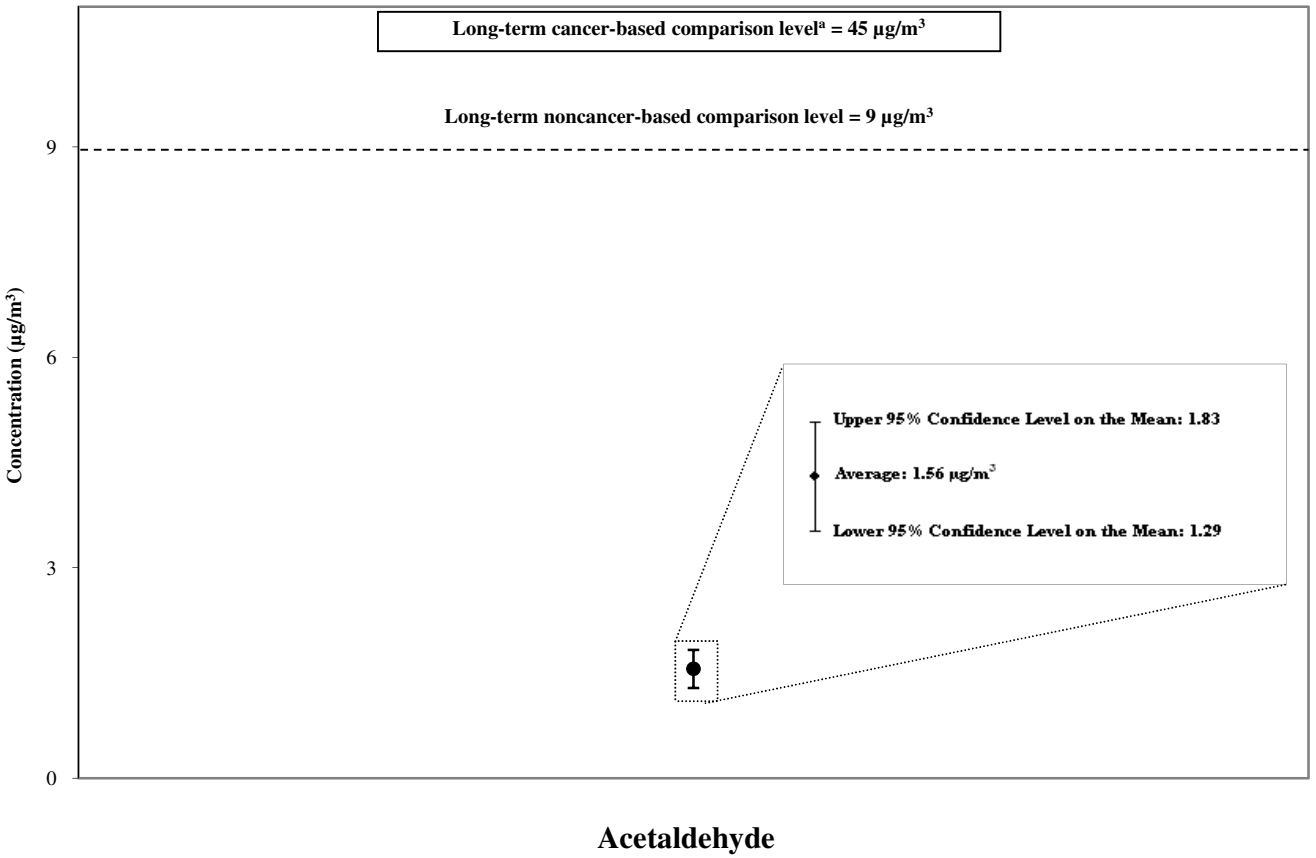
## Figure 2b. Harriet Tubman Middle School - Key Pollutant (Nickel ($PM_{10}$)) Analysis.




[a] Air toxics for which the upper 95% confidence limit on the mean concentration is above this cancer-based comparison level will be fully discussed in the text and may be considered a priority for potential follow-up activities, if indicated in light of the full set of information available for the site. Findings of the upper 95% confidence limit below 1% of the comparison level (i.e., where the upper 95% confidence limit is below the corresponding 1-in-1-million cancer risk based concentration) are generally considered a low priority for follow-up activity. Situations where the summary statistics for a pollutant are below this comparison level but above 1% of this level are fully discussed in the text of the report.

[b] Air toxics for which the upper 95% confidence limit on the mean concentration are near or below the noncancer-based comparison level are generally of low concern and will generally be considered a low priority for follow-up activity. Pollutants for which the 95% confidence limits extend appreciably above the noncancer-based comparison level are fully discussed in the school-specific report and may be considered a priority for follow-up activity, if indicated in light of the full set of information available for the site.

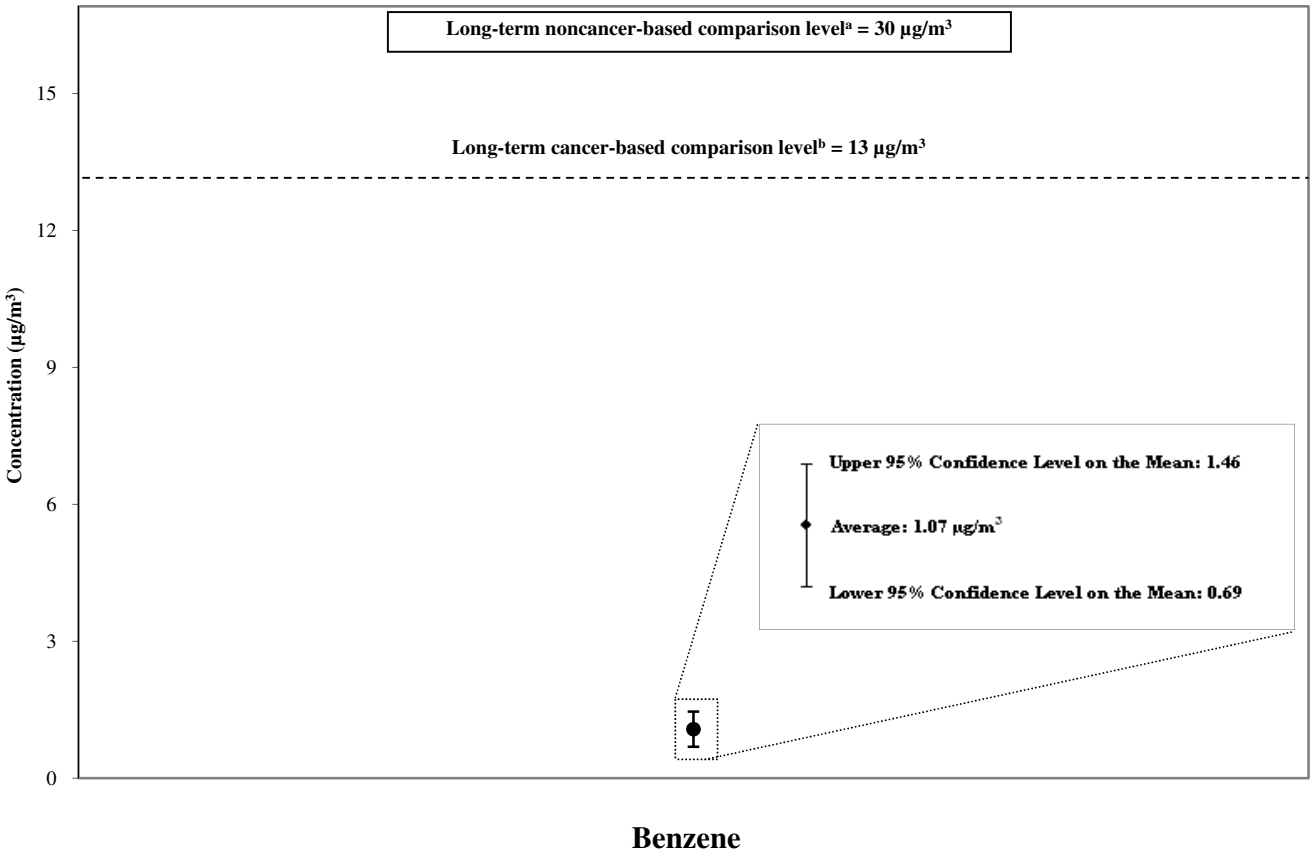
## Figure 2c. Harriet Tubman Middle School - Key Pollutant (Acetaldehyde) Analysis.




[a] Air toxics for which the upper 95% confidence limit on the mean concentration is above this cancer-based comparison level will be fully discussed in the text and may be considered a priority for potential follow-up activities, if indicated in light of the full set of information available for the site. Findings of the upper 95% confidence limit below 1% of the comparison level (i.e., where the upper 95% confidence limit is below the corresponding 1-in-1-million cancer risk based concentration) are generally considered a low priority for follow-up activity. Situations where the summary statistics for a pollutant are below this comparison level but above 1% of this level are fully discussed in the text of the report.

[b] Air toxics for which the upper 95% confidence limit on the mean concentration are near or below the noncancer-based comparison level are generally of low concern and will generally be considered a low priority for follow-up activity. Pollutants for which the 95% confidence limits extend appreciably above the noncancer-based comparison level are fully discussed in the school-specific report and may be considered a priority for follow-up activity, if indicated in light of the full set of information available for the site.

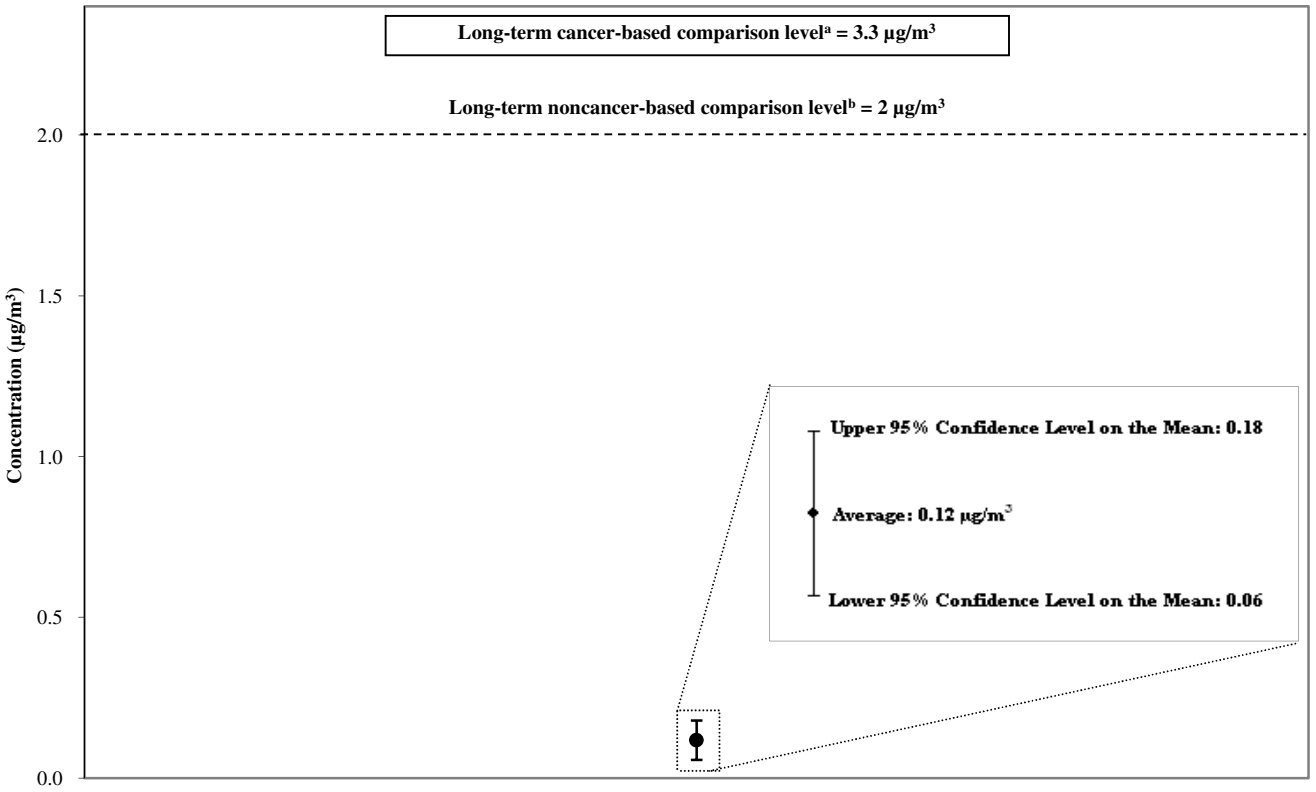
## Figure 2d. Harriet Tubman Middle School - Key Pollutant (Benzene) Analysis.




[a] Air toxics for which the upper 95% confidence limit on the mean concentration are near or below the noncancer-based comparison level are generally of low concern and will generally be considered a low priority for follow-up activity. Pollutants for which the 95% confidence limits extend appreciably above the noncancer-based comparison level are fully discussed in the school-specific report and may be considered a priority for follow-up activity, if indicated in light of the full set of information available for the site.

[b] Air toxics for which the upper 95% confidence limit on the mean concentration is above this cancer-based comparison level will be fully discussed in the text and may be considered a priority for potential follow-up activities, if indicated in light of the full set of information available for the site. Findings of the upper 95% confidence limit below 1% of the comparison level (i.e., where the upper 95% confidence limit is below the corresponding 1-in-1-million cancer risk based concentration) are generally considered a low priority for follow-up activity. Situations where the summary statistics for a pollutant are below this comparison level but above 1% of this level are fully discussed in the text of the report.

## Figure 2e. Harriet Tubman Middle School - Key Pollutant (1,3-Butadiene) Analysis.

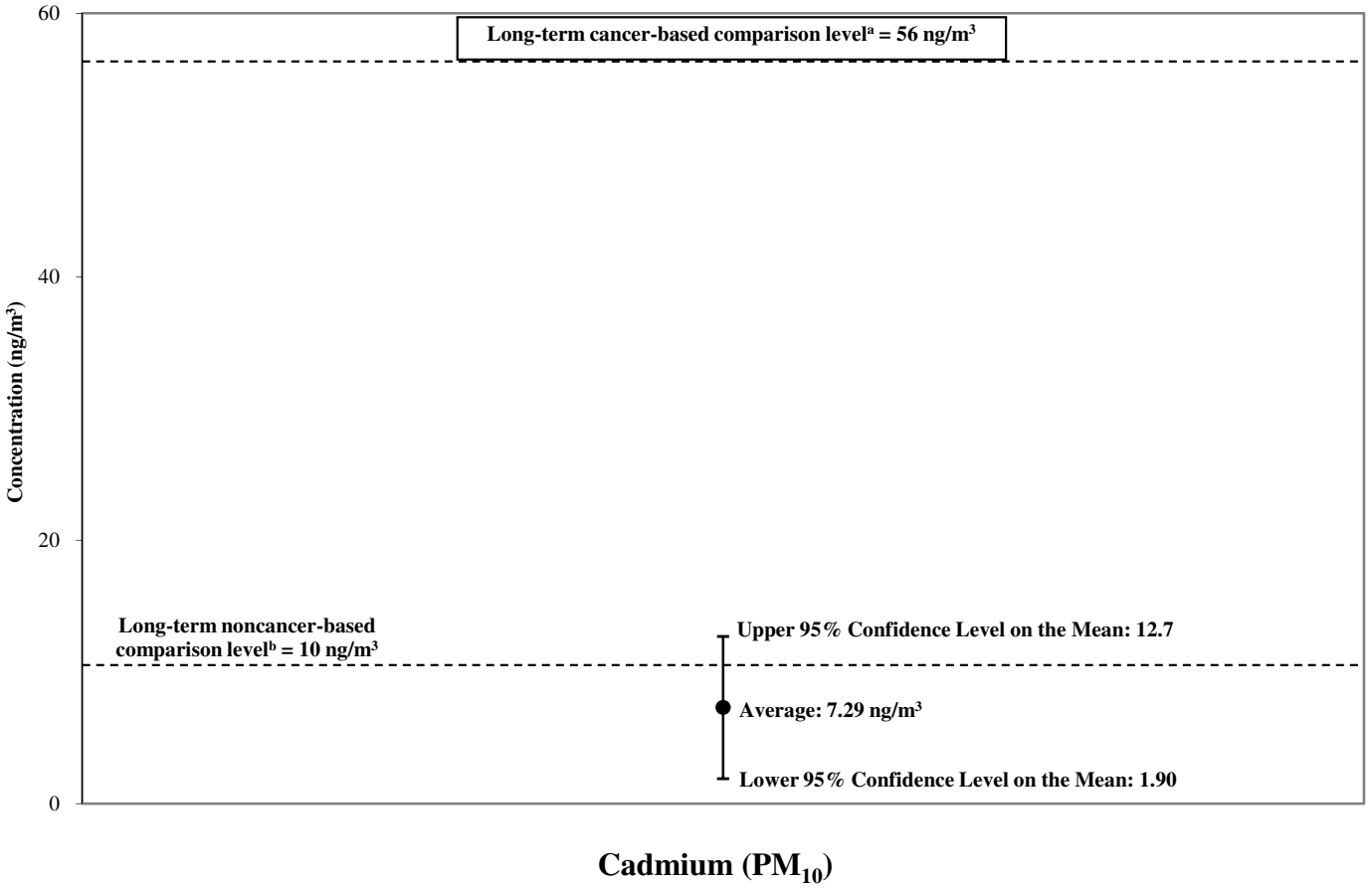



**1,3-Butadiene**

[a] Air toxics for which the upper 95% confidence limit on the mean concentration is above this cancer-based comparison level will be fully discussed in the text and may be considered a priority for potential follow-up activities, if indicated in light of the full set of information available for the site. Findings of the upper 95% confidence limit below 1% of the comparison level (i.e., where the upper 95% confidence limit is below the corresponding 1-in-1-million cancer risk based concentration) are generally considered a low priority for follow-up activity. Situations where the summary statistics for a pollutant are below this comparison level but above 1% of this level are fully discussed in the text of the report.

[b] Air toxics for which the upper 95% confidence limit on the mean concentration are near or below the noncancer-based comparison level are generally of low concern and will generally be considered a low priority for follow-up activity. Pollutants for which the 95% confidence limits extend appreciably above the noncancer-based comparison level are fully discussed in the school-specific report and may be considered a priority for follow-up activity, if indicated in light of the full set of information available for the site.

## Figure 2f. Harriet Tubman Middle School - Cadmium ($PM_{10}$) Analysis.




[a] Air toxics for which the upper 95% confidence limit on the mean concentration is above this cancer-based comparison level will be fully discussed in the text and may be considered a priority for potential follow-up activities, if indicated in light of the full set of information available for the site. Findings of the upper 95% confidence limit below 1% of the comparison level (i.e., where the upper 95% confidence limit is below the corresponding 1-in-1-million cancer risk based concentration) are generally considered a low priority for follow-up activity. Situations where the summary statistics for a pollutant are below this comparison level but above 1% of this level are fully discussed in the text of the report.

[b] Air toxics for which the upper 95% confidence limit on the mean concentration are near or below the noncancer-based comparison level are generally of low concern and will generally be considered a low priority for follow-up activity. Pollutants for which the 95% confidence limits extend appreciably above the noncancer-based comparison level are fully discussed in the school-specific report and may be considered a priority for follow-up activity, if indicated in light of the full set of information available for the site.

**Table 2a. Harriet Tubman Middle School Key Pollutant Concentrations (Manganese ($PM_{10}$), Nickel ($PM_{10}$), and Cadmium ($PM_{10}$)) and Meteorological Data.**

| Parameter | Units | 8/23/2009 | 8/29/2009 | 9/4/2009 | 9/10/2009 | 9/16/2009 | 9/22/2009 | 9/28/2009 | 10/4/2009 | 10/10/2009 | 10/16/2009 | 10/22/2009 | 10/28/2009 | 11/3/2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Manganese ($PM_{10}$) | $ng/m^3$ | 5.1 | 6.4 | 17.6 | 9.09 | 10.3 | 17.7 | 13.2 | 3.79 | 8.92 | 26.3 | 38.6 | 7.40 | 15.9 |
| Nickel ($PM_{10}$) | $ng/m^3$ | 0.84 | 2.08 | 3.25 | 1.55 | 1.13 | 0.97 | 2.08 | 1.17 | 0.30 | 3.62 | 5.10 | 1.39 | 2.46 |
| Cadmium ($PM_{10}$) | $ng/m^3$ | 0.05 | 0.22 | 0.07 | 23.1 | 4.81 | 2.41 | 15.7 | 22.6 | 0.12 | 5.45 | 2.40 | 17.6 | 0.29 |
| % Hours w/Wind Direction from Expected ZOI A (270°-326°)[a] | % | 0.0 | 4.2 | 8.3 | 4.2 | 4.2 | 16.7 | 4.2 | 16.7 | 4.2 | 16.7 | 20.8 | 0.0 | 0.0 |
| Wind Speed (avg. of hourly speeds) | mph | 3.4 | 3.9 | 3.1 | 4.2 | 2.4 | 2.7 | 3.3 | 2.4 | 4.4 | 2.1 | 2.0 | 2.1 | 3.8 |
| Wind Direction (avg. of unitized vector)[b] | deg. | 352.4 | 351.2 | 347.4 | 342.4 | 171.6 | 25.2 | 192.3 | 310.3 | 54.6 | 200.3 | 341.2 | 151.2 | 24.6 |
| % of Hours with Speed below 2 knots | % | 16.7 | 29.2 | 29.2 | 12.5 | 62.5 | 54.2 | 12.5 | 50.0 | 29.2 | 66.7 | 66.7 | 70.8 | 16.7 |
| Daily Average Temperature | ° F | 64.0 | 67.9 | 66.9 | 68.5 | 66.5 | 72.9 | 58.0 | 52.8 | 53.0 | 62.0 | 52.3 | 46.6 | 48.0 |
| Daily Precipitation | inches | 0.00 | 0.00 | 0.1 | 0.00 | 0.10 | 0.02 | 0.04 | 0.07 | 0.02 | 0.03 | 0.01 | 0.06 | 0.01 |

All precipitation and temperature data were from the PORTLAND INTERNATIONAL AIRPORT NWS Station.

[a] Based on count of hours for which vector wind direction is from expected zone of influence (270°-326°).

[b] Wind direction for each day is represented by values derived by scalar averaging of hourly estimates that were produced (by wind instrumentation's logger) as unitized vectors (specified as degrees from due north).

-- No sample was collected for this pollutant on this day or the result was invalidated.

## Table 2b. Harriet Tubman Middle School Key Pollutant Concentrations (Acetaldehyde, Benzene, and 1,3-Butadiene) and Meteorological Data.

| Parameter | Units | 8/23/2009 | 8/29/2009 | 9/4/2009 | 9/10/2009 | 9/16/2009 | 9/22/2009 | 9/28/2009 | 10/4/2009 | 10/10/2009 | 10/16/2009 | 10/22/2009 | 10/28/2009 | 11/3/2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Acetaldehyde | µg/m$^3$ | 1 | 1.91 | 1.78 | 1.39 | 1.15 | 2.05 | 1.40 | 1.30 | 1.19 | 2.45 | 2.14 | 1.18 | 1.25 |
| Benzene | µg/m$^3$ | 0.432 | 0.806 | 0.432 | 0.684 | 1.09 | 0.716 | 0.738 | -- | 0.604 | 2.25 | 1.67 | 1.81 | 1.65 |
| Butadiene, 1,3- | µg/m$^3$ | 0.029 | 0.058 | 0.069 | 0.071 | 0.104 | ND | 0.064 | -- | 0.062 | 0.249 | 0.272 | 0.270 | 0.18 |
| % Hours w/Wind Direction from Expected ZOI B (146°-326°)[a] | % | 8.3 | 4.2 | 8.3 | 4.2 | 66.7 | 16.7 | 75.0 | 45.8 | 4.2 | 70.8 | 29.2 | 58.3 | 0.0 |
| Wind Speed (avg. of hourly speeds) | mph | 3.4 | 3.9 | 3.1 | 4.2 | 2.4 | 2.7 | 3.3 | 2.4 | 4.4 | 2.1 | 2.0 | 2.1 | 3.8 |
| Wind Direction (avg. of unitized vector)[b] | deg. | 352.4 | 351.2 | 347.4 | 342.4 | 171.6 | 25.2 | 192.3 | 310.3 | 54.6 | 200.3 | 341.2 | 151.2 | 24.6 |
| % of Hours with Speed below 2 knots | % | 16.7 | 29.2 | 29.2 | 12.5 | 62.5 | 54.2 | 12.5 | 50.0 | 29.2 | 66.7 | 66.7 | 70.8 | 16.7 |
| Daily Average Temperature | ° F | 64.0 | 67.9 | 66.9 | 68.5 | 66.5 | 72.9 | 58.0 | 52.8 | 53.0 | 62.0 | 52.3 | 46.6 | 48.0 |
| Daily Precipitation | inches | 0.00 | 0.00 | 0.05 | 0.00 | 0.10 | 0.02 | 0.04 | 0.07 | 0.02 | 0.03 | 0.01 | 0.06 | 0.01 |

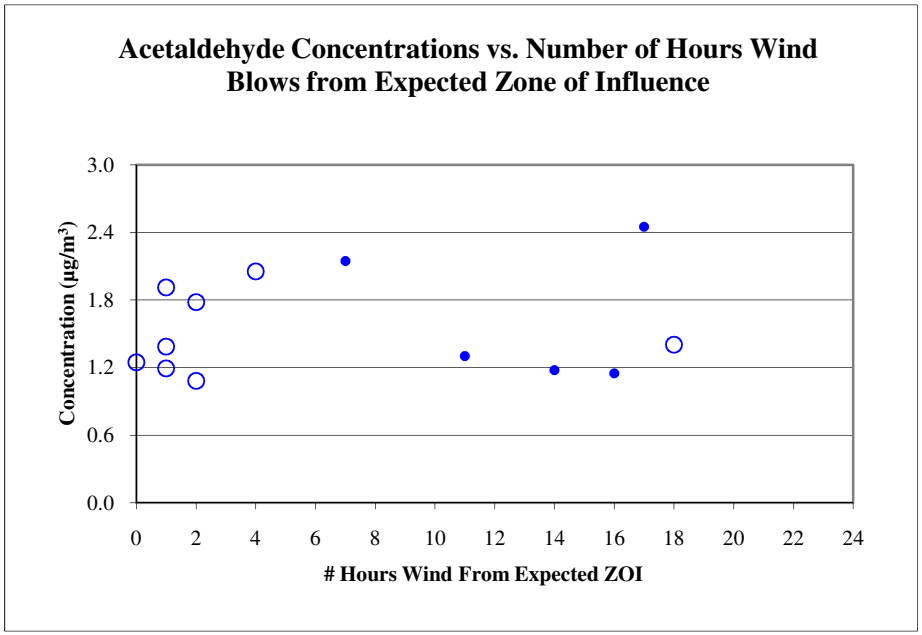
All precipitation and temperature data were from the PORTLAND INTERNATIONAL AIRPORT NWS Station.

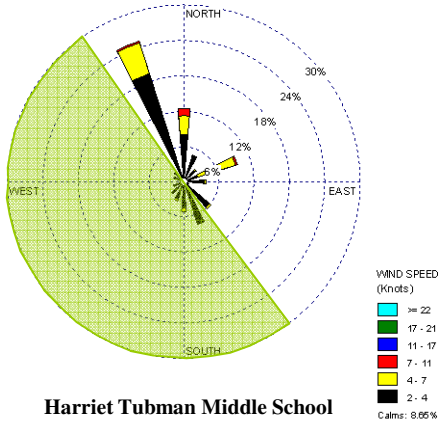
[a] Based on count of hours for which vector wind direction is from expected zone of influence (146°-326°).

[b] Wind direction for each day is represented by values derived by scalar averaging of hourly estimates that were produced (by wind instrumentation's logger) as unitized vectors (specified as degrees from due north).

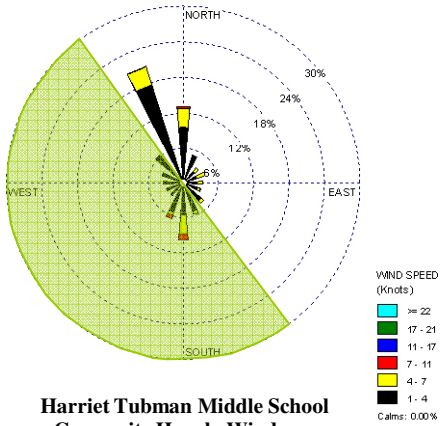
-- No sample was collected for this pollutant on this day or the result was invalidated.

# Figure 3a. Harriet Tubman Middle School (Portland, OR) Acetaldehyde Concentration and Wind Information.




**Harriet Tubman Middle School Composite Hourly Windrose on Sample Days (Aug. 23, 2009-Nov. 3 2009)**




**Harriet Tubman Middle School Composite Hourly Windrose Across Sampling Period (Aug. 23, 2009-Nov. 3, 2009)**

## KEY

**Pollutant: Acetaldehyde**
**Timeframe: August 23, 2009 - November 3, 2009**

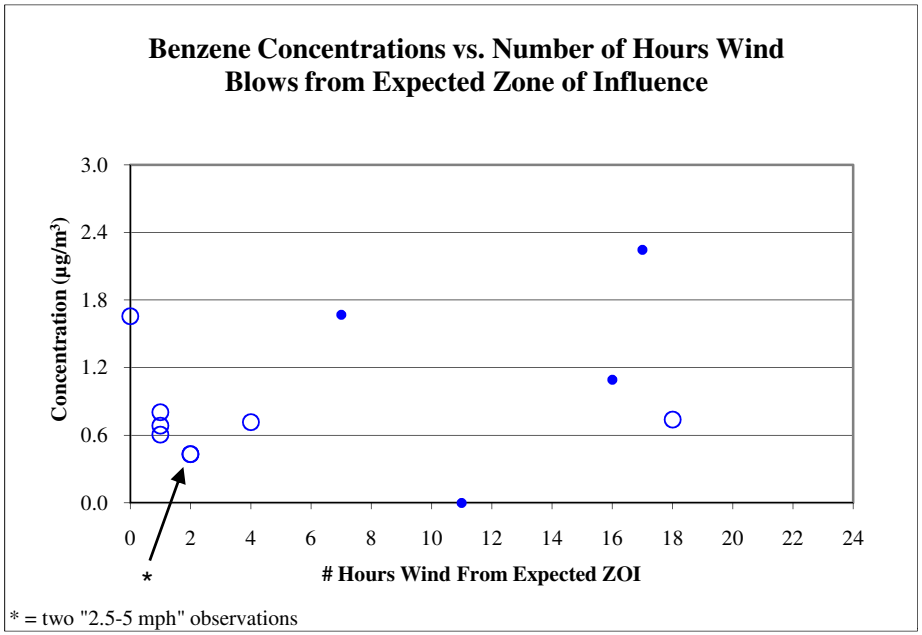
Note

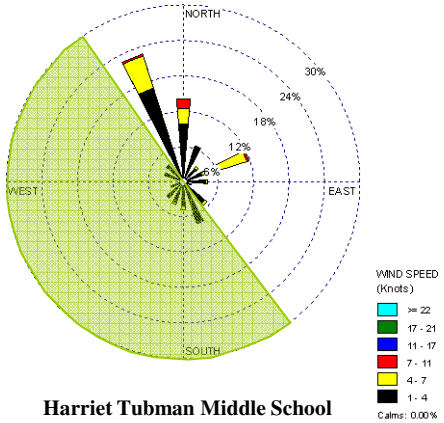
Each circle denotes a 24-hour collection of air for chemical analysis. The size of the circle indicates the magnitude of the wind speed for that day (wind data shown in Table 2b). The expected zone of source influence is a rough approximation of the range of directions from which winds carrying chemicals emitted by the key source may originate.

- Wind Speed: 0.1-2.5 mph
- Wind Speed: 2.5-5.0 mph
- Wind Speed: > 5.0 mph

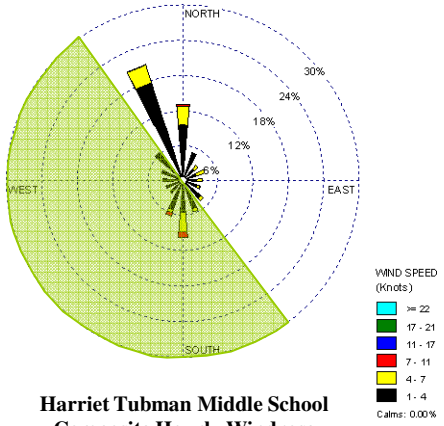
Expected Zone of Source Influence B

# Figure 3b. Harriet Tubman Middle School (Portland, OR) Benzene Concentration and Wind Information.




**Harriet Tubman Middle School Composite Hourly Windrose on Sample Days (Aug. 23, 2009-Nov. 3 2009)**




**Harriet Tubman Middle School Composite Hourly Windrose Across Sampling Period (Aug. 23, 2009-Nov. 3, 2009)**

## KEY

**Pollutant: Benzene**
**Timeframe: August 23, 2009 - November 3, 2009**

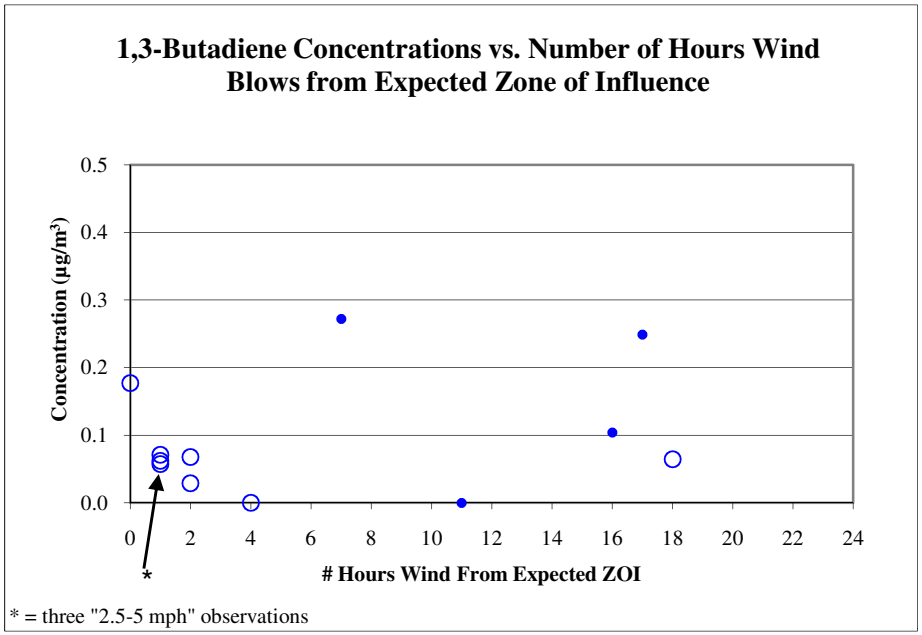
Note

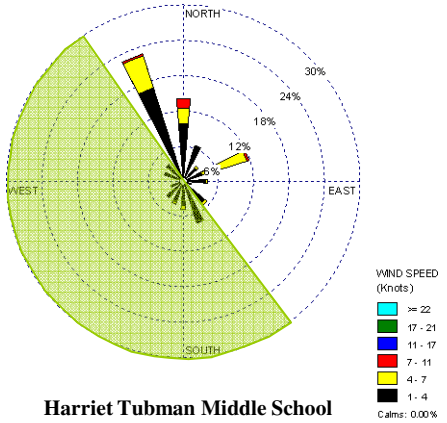
Each circle denotes a 24-hour collection of air for chemical analysis. The size of the circle indicates the magnitude of the wind speed for that day (wind data shown in Table 2b). The expected zone of source influence is a rough approximation of the range of directions from which winds carrying chemicals emitted by the key source may originate.

- Wind Speed: 0.1-2.5 mph
- Wind Speed: 2.5-5.0 mph
- Wind Speed: > 5.0 mph

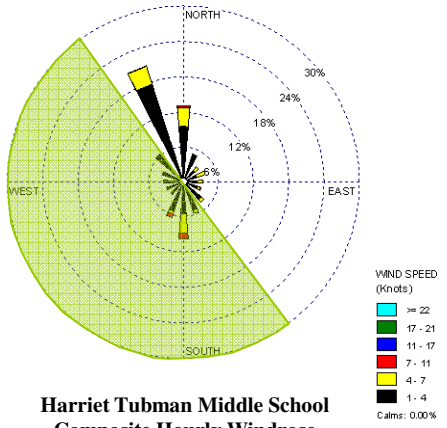
Expected Zone of Source Influence B

# Figure 3c. Harriet Tubman Middle School (Portland, OR) 1,3-Butadiene Concentration and Wind Information.




**Harriet Tubman Middle School Composite Hourly Windrose on Sample Days (Aug. 23, 2009-Nov. 3 2009)**




**Harriet Tubman Middle School Composite Hourly Windrose Across Sampling Period (Aug. 23, 2009-Nov. 3, 2009)**

## KEY

**Pollutant: 1,3-Butadiene**
**Timeframe: August 23, 2009 - November 3, 2009**

Note

Each circle denotes a 24-hour collection of air for chemical analysis. The size of the circle indicates the magnitude of the wind speed for that day (wind data shown in Table 2b). The expected zone of source influence is a rough approximation of the range of directions from which winds carrying chemicals emitted by the key source may originate.

- Wind Speed: 0.1-2.5 mph
- Wind Speed: 2.5-5.0 mph
- Wind Speed: > 5.0 mph

Expected Zone of Source Influence B

## Appendix A. Summary Description of Long-term Comparison Levels

In addressing the primary objective identified above, to investigate through the monitoring data collected for key pollutants at the school whether levels are of a magnitude, in light of health risk-based criteria, to indicate that follow-up activities be considered, we developed two types of long-term health risk-related comparison levels. These two types of levels are summarized below.[24]

Cancer-based Comparison Levels

- For air toxics where applicable, we developed cancer risk-based comparison levels to help us consider whether the monitoring data collected at the school indicate the potential for concentrations to pose incremental cancer risk above the range that EPA generally considers acceptable in regulatory decision-making to someone exposed to those concentrations continuously (24 hours a day, 7 days a week) over an entire lifetime.[25] This general range is from 1 to 100 in a million.
- Air toxics with long-term mean concentrations below one one-hundredth of this comparison level would be below a comparably developed level for 1-in-a-million risk (which is the lower bound of EPA's traditional acceptable risk range). Such pollutants, with long-term mean concentrations below the Agency's traditional acceptable risk range, are generally considered to pose negligible risk.
- Air toxics with long-term mean concentrations above the acceptable risk range would generally be a priority for follow-up activities. In this evaluation, we compare the upper 95% confidence limit on the mean concentration to the comparison level. Pollutants for which this upper limit falls above the comparison level are fully discussed in the school monitoring report and may be considered a priority for potential follow-up activities in light of the full set of information available for that site.
- Situations where the summary statistics for a pollutant are below the cancer-based comparison level but above 1% of that level are fully discussed in Appendix C.

[24] The comparison levels are described in more detail *Schools Air Toxics Monitoring Activity (2009), Uses of Health Effects Information in Evaluating Sample Results*.

[25] While no one would be exposed at a school for 24 hours a day, every day for an entire lifetime, we chose this worst-case exposure period as a simplification for the basis of the comparison level in recognition of other uncertainties in the analysis. Use of continuous lifetime exposure yields a lower, more conservative, comparison level than would use of a characterization more specific to the school population (e.g., 5 days a week, 8-10 hours a day for a limited number of years).

Noncancer-based Comparison Levels

- To consider concentrations of air toxics other than lead (for which we have a national ambient air quality standard) with regard to potential for health effects other than cancer, we derived noncancer-based comparison levels using EPA chronic reference concentrations (or similar values). A chronic reference concentration (RfC) is an estimate of a long-term continuous exposure concentration (24 hours a day, every day) without appreciable risk of adverse effect over a lifetime.[26] This differs from the cancer risk-based comparison level in that it represents a concentration without appreciable risk *vs* a risk-based concentration.
- In using this comparison level in this initiative, the upper end of the 95% confidence limit on the mean is compared to the comparison level. Air toxics for which this upper confidence limit is near or below the noncancer-based comparison level (i.e., those for which longer-term average concentration estimates are below a long-term health-related reference concentration) are generally of low concern and will generally be considered a low priority for follow-up activity. Pollutants for which the 95% confidence limits extend appreciably above the noncancer-based comparison level are fully discussed below and may be considered a priority for follow-up activity if indicated in light of the full set of information available for the pollutant and the site.
- For lead, we set the noncancer-based comparison level equal to the level of the recently revised national ambient air quality standard (NAAQS). It is important to note that the NAAQS for lead is a 3-month rolling average of lead in total suspended particles. Mean levels for the monitoring data collected in this initiative that indicate the potential for a 3-month average above the level of the standard will be considered a priority for consideration of follow-up actions such as siting of a NAAQS monitor in the area.

In developing or identifying these comparison levels, we have given priority to use of relevant and appropriate air standards and EPA risk assessment guidance and precedents. These levels are based upon health effects information, exposure concentrations and risk estimates developed and assessed by EPA, the U.S. Agency for Toxic Substances and Disease Registry, and the California EPA. These agencies recognize the need to account for potential differences in sensitivity or susceptibility of different groups (e.g., asthmatics) or lifestages/ages (e.g., young children or the elderly) to a particular pollutant's effects so that the resulting comparison levels are relevant for these potentially sensitive groups as well as the broader population.

[26] EPA defines the RfC as "an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. It can be derived from a NOAEL, LOAEL, or benchmark concentration, with uncertainty factors generally applied to reflect limitations of the data used. Generally used in EPA's noncancer health assessments." http://www.epa.gov/ncea/iris/help_gloss.htm#r

## Appendix B. National Air Toxics Trends Stations Measurements (2004-2008).[a]

| Pollutant | Units | # Samples Analyzed | % Detections | Maximum | Arithmetic Mean[b] | Geometric Mean | 5th Percentile | 25th Percentile | 50th Percentile | 75th Percentile | 95th Percentile |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acetaldehyde | µg/m$^3$ | 6,401 | 100% | 92.78 | 1.87 | 1.40 | 0.41 | 0.86 | 1.42 | 2.34 | 4.48 |
| Formaldehyde | µg/m$^3$ | 6,403 | 100% | 91.50 | 3.09 | 2.22 | 0.51 | 1.35 | 2.32 | 3.92 | 7.65 |
| Propionaldehyde | µg/m$^3$ | 4,330 | 93% | 5.53 | 0.28 | 0.22 | ND | 0.13 | 0.21 | 0.35 | 0.77 |
| Antimony ($PM_{10}$) | ng/m$^3$ | 2,372 | 94% | 43.30 | 1.71 | 1.21 | ND | 0.60 | 1.13 | 2.17 | 4.33 |
| Arsenic ($PM_{10}$) | ng/m$^3$ | 5,076 | 86% | 47.70 | 0.93 | 0.70 | ND | 0.29 | 0.56 | 1.02 | 2.89 |
| Beryllium ($PM_{10}$) | ng/m$^3$ | 4,771 | 64% | 1.97 | 0.05 | 0.02 | ND | ND | <0.01 | 0.02 | 0.50 |
| Cadmium ($PM_{10}$) | ng/m$^3$ | 4,793 | 85% | 15.30 | 0.27 | 0.17 | ND | 0.05 | 0.13 | 0.29 | 0.94 |
| Chromium ($PM_{10}$) | ng/m$^3$ | 5,094 | 92% | 172.06 | 2.71 | 1.66 | ND | 0.93 | 1.98 | 2.85 | 7.10 |
| Cobalt ($PM_{10}$) | ng/m$^3$ | 2,614 | 91% | 20.30 | 0.28 | 0.18 | ND | 0.08 | 0.15 | 0.27 | 1.00 |
| Manganese ($PM_{10}$) | ng/m$^3$ | 4,793 | 99% | 734.00 | 10.39 | 5.20 | <0.01 | 2.41 | 4.49 | 9.96 | 33.78 |
| Mercury ($PM_{10}$) | ng/m$^3$ | 1,167 | 81% | 2.07 | 0.07 | 0.04 | ND | 0.01 | 0.02 | 0.06 | 0.32 |
| Nickel ($PM_{10}$) | ng/m$^3$ | 4,815 | 90% | 110.10 | 2.05 | 1.49 | ND | 0.74 | 1.44 | 2.50 | 5.74 |
| Selenium ($PM_{10}$) | ng/m$^3$ | 2,382 | 96% | 13.00 | 1.10 | 0.53 | <0.01 | 0.24 | 0.53 | 1.07 | 5.50 |
| Acetonitrile | µg/m$^3$ | 1,804 | 69% | 542.30 | 3.55 | 0.72 | ND | ND | 0.27 | 0.76 | 8.60 |
| Acrylonitrile | µg/m$^3$ | 3,673 | 31% | 5.51 | 0.06 | 0.10 | ND | ND | ND | 0.03 | 0.33 |
| Benzene | µg/m$^3$ | 6,313 | 94% | 10.19 | 1.03 | 0.84 | ND | 0.48 | 0.80 | 1.31 | 2.81 |
| Benzyl chloride | µg/m$^3$ | 3,046 | 9% | 2.49 | 0.01 | 0.05 | ND | ND | ND | ND | 0.05 |
| Bromoform | µg/m$^3$ | 2,946 | 4% | 1.18 | 0.01 | 0.16 | ND | ND | ND | ND | ND |
| Bromomethane | µg/m$^3$ | 5,376 | 61% | 120.76 | 0.11 | 0.05 | ND | ND | 0.03 | 0.05 | 0.12 |
| Butadiene, 1,3- | µg/m$^3$ | 6,427 | 67% | 15.55 | 0.10 | 0.09 | ND | ND | 0.05 | 0.13 | 0.38 |
| Carbon disulfide | µg/m$^3$ | 1,925 | 91% | 46.71 | 2.32 | 0.25 | ND | 0.03 | 0.09 | 0.96 | 12.65 |
| Carbon tetrachloride | µg/m$^3$ | 6,218 | 86% | 1.76 | 0.52 | 0.58 | ND | 0.47 | 0.57 | 0.65 | 0.87 |
| Chlorobenzene | µg/m$^3$ | 5,763 | 30% | 1.10 | 0.02 | 0.04 | ND | ND | ND | 0.01 | 0.11 |
| Chloroethane | µg/m$^3$ | 4,625 | 37% | 0.58 | 0.02 | 0.04 | ND | ND | ND | 0.03 | 0.08 |
| Chloroform | µg/m$^3$ | 6,432 | 73% | 48.05 | 0.17 | 0.14 | ND | ND | 0.10 | 0.17 | 0.61 |
| Chloromethane | µg/m$^3$ | 5,573 | 95% | 19.70 | 1.17 | 1.20 | ND | 1.03 | 1.18 | 1.36 | 1.68 |
| Chloroprene | µg/m$^3$ | 2,341 | 11% | 0.17 | <0.01 | 0.03 | ND | ND | ND | ND | 0.02 |
| Dichlorobenzene, *p*- | µg/m$^3$ | 5,409 | 60% | 13.65 | 0.19 | 0.16 | ND | ND | ND | 0.18 | 0.90 |
| Dichloroethane, 1,1- | µg/m$^3$ | 5,670 | 16% | 0.36 | 0.01 | 0.02 | ND | ND | ND | ND | 0.02 |
| Dichloroethylene, 1,1- | µg/m$^3$ | 5,480 | 19% | 0.44 | 0.01 | 0.02 | ND | ND | ND | ND | 0.04 |
| Dichloromethane | µg/m$^3$ | 6,206 | 82% | 214.67 | 0.59 | 0.34 | ND | 0.14 | 0.28 | 0.49 | 1.35 |

## Appendix B. National Air Toxics Trends Stations Measurements (2004-2008).[a]

| Pollutant | Units | # Samples Analyzed | % Detections | Maximum | Arithmetic Mean[b] | Geometric Mean | 5th Percentile | 25th Percentile | 50th Percentile | 75th Percentile | 95th Percentile |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dichloropropane,1,2- | µg/m$^3$ | 6,225 | 17% | 1.80 | 0.01 | 0.03 | ND | ND | ND | ND | 0.04 |
| Dichloropropylene, c*is* -1,3- | µg/m$^3$ | 4,705 | 18% | 0.80 | 0.01 | 0.05 | ND | ND | ND | ND | 0.11 |
| Dichloropropylene, *trans* -1,3- | µg/m$^3$ | 4,678 | 18% | 1.13 | 0.02 | 0.05 | ND | ND | ND | ND | 0.11 |
| Ethyl acrylate | µg/m$^3$ | 1,917 | 1% | 0.08 | <0.01 | 0.04 | ND | ND | ND | ND | ND |
| Ethylbenzene | µg/m$^3$ | 6,120 | 84% | 8.84 | 0.42 | 0.32 | ND | 0.10 | 0.29 | 0.53 | 1.33 |
| Ethylene dibromide | µg/m$^3$ | 5,646 | 19% | 4.15 | 0.01 | 0.05 | ND | ND | ND | ND | 0.05 |
| Ethylene dichloride | µg/m$^3$ | 6,143 | 38% | 4.49 | 0.03 | 0.05 | ND | ND | ND | 0.04 | 0.09 |
| Hexachlorobutadiene | µg/m$^3$ | 3,727 | 20% | 0.97 | 0.03 | 0.10 | ND | ND | ND | ND | 0.18 |
| Methyl chloroform | µg/m$^3$ | 5,944 | 73% | 3.17 | 0.09 | 0.10 | ND | ND | 0.08 | 0.11 | 0.20 |
| Methyl isobutyl ketone | µg/m$^3$ | 2,936 | 60% | 2.95 | 0.11 | 0.09 | ND | ND | 0.02 | 0.12 | 0.49 |
| Methyl methacrylate | µg/m$^3$ | 1,917 | 9% | 14.05 | 0.13 | 0.49 | ND | ND | ND | ND | 0.53 |
| Methyl *tert*- butyl ether | µg/m$^3$ | 4,370 | 41% | 20.50 | 0.28 | 0.12 | ND | ND | ND | 0.04 | 1.53 |
| Styrene | µg/m$^3$ | 6,080 | 70% | 27.22 | 0.16 | 0.11 | ND | ND | 0.05 | 0.16 | 0.60 |
| Tetrachloroethane, 1,1,2,2- | µg/m$^3$ | 5,952 | 20% | 2.47 | 0.02 | 0.04 | ND | ND | ND | ND | 0.07 |
| Tetrachloroethylene | µg/m$^3$ | 6,423 | 71% | 42.12 | 0.28 | 0.20 | ND | ND | 0.13 | 0.27 | 0.88 |
| Toluene | µg/m$^3$ | 5,947 | 95% | 482.53 | 2.46 | 1.54 | 0.01 | 0.70 | 1.51 | 3.05 | 7.42 |
| Trichlorobenzene, 1,2,4- | µg/m$^3$ | 4,301 | 21% | 45.27 | 0.07 | 0.10 | ND | ND | ND | ND | 0.16 |
| Trichloroethane,1,1,2- | µg/m$^3$ | 5,210 | 19% | 5.89 | 0.01 | 0.04 | ND | ND | ND | ND | 0.05 |
| Trichloroethylene | µg/m$^3$ | 6,410 | 46% | 6.50 | 0.05 | 0.07 | ND | ND | ND | 0.05 | 0.22 |
| Vinyl chloride | µg/m$^3$ | 6,284 | 18% | 1.61 | 0.01 | 0.02 | ND | ND | ND | ND | 0.03 |
| Xylene, *m/p*- | µg/m$^3$ | 4,260 | 90% | 21.41 | 1.12 | 0.71 | ND | 0.26 | 0.69 | 1.43 | 3.65 |
| Xylene, *o*- | µg/m$^3$ | 6,108 | 83% | 9.21 | 0.41 | 0.30 | ND | 0.09 | 0.24 | 0.52 | 1.39 |

Key Pollutant

ND No results of this chemical were registered by the laboratory analytical equipment.

[a] The summary statistics in this table represent the range of actual daily HAP measurement values taken at NATTS sites from 2004 through 2008. These data were extracted from AQS in summer 2008 and 2009. During the time period of interest, there were 28 sites measuring VOCs, carbonyls, metals, and hexavalent chromium. We note that some sites did not sample for particular pollutant types during the initial year of the NATTS Program, which was 2004. Most of the monitoring stations in the NATTS network are located such that they are not expected to be impacted by single industrial sources. The concentrations typically measured at NATTS sites can thus provide a comparison point useful to considering whether concentrations measured at a school are likely to have been influenced by a significant nearby industrial source, or are more likely to be attributable to emissions from many small sources or to transported pollution from another area. For example, concentrations at a school above the 75th percentile may suggest that a nearby industrial source is affecting air quality at the school.

[b] In calculations involving non-detects (ND), a value of zero is used.

**Appendix C. Analysis of Other (non-key) Air Toxics Monitored at the School and Multiple-pollutant Considerations.**

At each school, monitoring has been targeted to get information on a limited set of key hazardous air pollutants (HAPs).[27] These pollutants are the primary focus of the monitoring activities at a school and a priority for us based on our emissions, modeling and other information. In analyzing air samples for these key pollutants, we have also obtained results for some other pollutants that are routinely included with the same test method. Our consideration of the data collected for these additional HAPs is described in the first section below. In addition to evaluating monitoring results for individual pollutants, we also considered the potential for cumulative impacts from multiple pollutants as described in the second section below (see Table C-1).

Other Air Toxics (HAPs)

- Do the monitoring data indicate elevated levels of any other air toxics or hazardous air pollutant (HAPs) that pose significant long-term health concerns?

  → With the exception of cadmium, the longer-term concentration estimates for all other HAPs monitored are below their long-term comparison levels.

    - The longer-term concentration estimate for cadmium is slightly above the long-term noncancer-based comparison level for cadmium. This comparison level is a continuous exposure concentration (24 hours a day, all year, over a lifetime) associated with little risk of adverse effect; it is an exposure concentration appreciably below levels at which effects have been observed. [28]

  → For pollutants with cancer-based comparison levels, longer-term concentration estimates for all but four of these (cadmium, chromium, formaldehyde, and arsenic) are more than 10-fold lower and all but seven (also carbon tetrachloride, tetrachloroethylene, and ethylbenzene) are more than 100-fold lower.[29]

  → Additionally, each individual measurement for these pollutants is below the individual sample (short-term) screening level developed for considering potential short-term exposures for that pollutant.[30]

[27] Section 112(b) of the Clean Air Act identifies 189 hazardous air pollutants, three of which have subsequently been removed from this list. These pollutants are the focus of regulatory actions involving stationary sources described by CAA section 112 and are distinguished from the six pollutants for which criteria and national ambient air quality standards (NAAQS) are developed as described in section 108. One of the criteria pollutants, lead, is also represented, as lead compounds, on the HAP list.

[28] The comparison level for cadmium is based on the current draft ATSDR minimal risk level, which is an estimate of chronic exposure considered likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure. The MRL is intended to serve as a screening level and is below concentrations at which health effects have been observed (http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=47&tid=15, http://www.atsdr.cdc.gov/mrls/index.html)

[29] For pollutants with cancer-based comparison levels, this would indicate longer-term estimates below continuous (24 hours a day, 7 days a week) lifetime exposure concentrations associated with $10^{-5}$ and $10^{-6}$ excess cancer risk, respectively.

[30] The individual sample screening levels and their use is summarized on the website and described in detail in *Schools Air Toxics Monitoring Activity (2009), Uses of Health Effects Information in Evaluating Sample Results*.

Additional Information on Seven Other HAPs:

- The first HAP mentioned above is cadmium. The mean and 95 percent upper bound on the mean for cadmium are approximately 13-23% of the cancer-based comparison level. A review of information available at other sites nationally shows that the mean concentration of cadmium at this site is higher than the 95$^{th}$ percentile of samples collected from 2004 to 2008 (the most recently compiled period) at the NATTS sites (Appendix B).

- The second HAP mentioned is chromium. The comparison values for chromium are conservatively based on the most toxic form of chromium (hexavalent chromium, $Cr^{+6}$), which is only a fraction of the chromium in the ambient air. Nonetheless, the longer-term concentration estimate for chromium ($PM_{10}$) is well below these very restrictive comparison values. The mean and 95 percent upper bound on the mean for chromium ($PM_{10}$) are approximately 45-57% of the lower (cancer-based) comparison level. Further, as $Cr^{+6}$ is commonly only a small fraction of the total chromium ($PM_{10}$),[31] the levels of $Cr^{+6}$ in these samples would be expected to be appreciably lower than this. A review of information available at other sites nationally shows that the mean concentration of chromium ($PM_{10}$) at this site is between the 75$^{th}$ and 95$^{th}$ percentile of samples collected from 2004 to 2008 (the most recently compiled period) at the NATTS sites (Appendix B).

- The third HAP mentioned above is formaldehyde. The mean and 95 percent upper bound on the mean for formaldehyde are approximately 35-42% of the cancer-based comparison level. A review of information available at other sites nationally shows that the mean concentration of formaldehyde at this site is between the 50$^{th}$ and 75$^{th}$ percentile of samples collected from 2004 to 2008 (the most recently compiled period) at the NATTS sites (Appendix B). This pollutant may occur in the air at this school as a result of several different industrial sources, as well as cars and trucks and the exhaust of other gasoline-powered engines.

- The fourth HAP mentioned above is arsenic. The mean and 95 percent upper bound on the mean for arsenic ($PM_{10}$) are approximately 6-12% of the cancer-based comparison level. A review of information available at other sites nationally shows that the mean concentration of arsenic ($PM_{10}$) at this site is between the 75$^{th}$ and 95$^{th}$ percentile of samples collected from 2004 to 2008 (the most recently compiled period) at the NATTS sites (Appendix B).

- The fifth HAP mentioned above is carbon tetrachloride. The mean and 95 percent upper bound on the mean for carbon tetrachloride are approximately 4% of the cancer-based comparison level. A review of information available at other sites nationally shows that the mean concentration of carbon tetrachloride at this site is between the 75$^{th}$ and 95$^{th}$ percentile of samples collected from 2004 to 2008 (the most recently compiled period) at the NATTS sites (Appendix B). Carbon tetrachloride is found globally as a result of its

[31] Data in EPA's Air Quality System for locations that are not near a facility emitting hexavalent chromium indicate that hexavalent chromium concentrations comprise less than approximately 10% of total chromium concentrations.

significant past uses in refrigerants and propellants for aerosol cans and its chemical persistence. Virtually all uses have been discontinued. However, it is still measured throughout the world as a result of its slow rate of degradation in the environment and global distribution in the atmosphere.

- The sixth HAP mentioned above is tetrachloroethylene. The mean and 95 percent upper bound on the mean for tetrachloroethylene are approximately 1-2% of the cancer-based comparison level. A review of information available at other sites nationally shows that the mean concentration of tetrachloroethylene at this site is between the 50$^{th}$ and 75$^{th}$ percentile of samples collected from 2004 to 2008 (the most recently compiled period) at the NATTS sites (Appendix B).

- The seventh HAP mentioned above is ethylbenzene. The mean and 95 percent upper bound on the mean for ethylbenzene are approximately 1-2% of the cancer-based comparison level. A review of information available at other sites nationally shows that the mean concentration of ethylbenzene at this site is between the 50$^{th}$ and 75$^{th}$ percentile of samples collected from 2004 to 2008 (the most recently compiled period) at the NATTS sites (Appendix B).

**Multiple Pollutants**

As described in the main body of the report and background materials, this initiative and the associated analyses are focused on investigation of key pollutants for each school that were identified by previous analyses. This focused design does not provide for the consideration of combined impacts of pollutants or stressors other than those monitored in this project. Broader analyses and those involving other pollutants may be the focus of other EPA activities.[32]

In our consideration of the potential for impacts from key pollutants at the monitored schools, we have also considered the potential for other monitored pollutants to be present at levels that in combination with the key pollutant levels contribute to an increased potential for cumulative impacts. This was done in cases where estimates of longer-term concentrations for any non-key HAPs are within an order of magnitude of their comparison levels even if these pollutant levels fall below the comparison levels. This analysis is summarized below.

- Do the data collected for the air toxics monitored indicate the potential for other monitored pollutants to be present at levels that in combination with the key pollutant levels indicate an increased potential for cumulative impacts of significant concern (e.g., that might warrant further investigation)?

  → The multiple air toxics monitored at this site were below the levels of particularly significant concern for multi-pollutant cumulative risk that had been suggested by the modeling information available prior to monitoring. However, these results do indicate the influence of multiple mobile source pollutants of concern (e.g., acetaldehyde, formaldehyde and benzene, as well as 1,3-butadiene) that are the focus of EPA actions nationwide.

[32] General information on additional air pollutants is available at http://www.epa.gov/air/airpollutants.html.

→ Additionally, non-mobile source HAPs that were within an order of magnitude of their comparison levels included manganese, cadmium, chromium and arsenic. These various HAPs pose risk to differing targets in the body, reducing the potential for cumulative impact. The lowest comparison level for chromium is based on carcinogenic risk to the respiratory system posed by hexavalent chromium,[33] and, as noted above, hexavalent chromium is commonly a small fraction of the total chromium reported. The lowest comparison levels for manganese and cadmium are based on non-carcinogenic effects to the nervous system and the kidney, respectively. The lowest comparison level for arsenic is based on non-carcinogenic effects considering several endpoints including development.

[33] The noncancer-based comparison level for chromium is much higher than the cancer-based level and is based on risk of other effects posed to the respiratory system by hexavalent chromium in particulate form.

## Table C-1. Harriet Tubman Middle School - Other Monitored Pollutant Analysis.

| Parameter | Units | Mean of Measurements[a] | 95% Confidence Interval on the Mean | Long-term Comparison Level[b] | |
|---|---|---|---|---|---|
| | | | | Cancer-Based[c] | Noncancer-Based[d] |
| ***Non-Key HAPs with mean greater than 10% of the lowest comparison level*** | | | | | |
| Chromium ($PM_{10}$) | $ng/m^3$ | 3.76 | 2.79 - 4.74 | 8.3 [e] | 100 [e] |
| Formaldehyde | $\mu g/m^3$ | 2.79 | 2.19 - 3.39 | 8 | 9.8 |
| Arsenic ($PM_{10}$) | $ng/m^3$ | 1.45 | 0.12 - 2.77 | 23 | 15 |
| ***Non-Key HAPs with mean lower than 10% of the lowest comparison level*** | | | | | |
| Carbon Tetrachloride | $\mu g/m^3$ | 0.67 | 0.62 - 0.71 | 17 | 100 |
| Propionaldehyde | $\mu g/m^3$ | 0.25 | 0.21 - 0.29 | NA | 8 |
| Antimony ($PM_{10}$) | $ng/m^3$ | 2.90 | 1.61 - 4.19 | NA | 200 |
| Chloromethane | $\mu g/m^3$ | 1.27 | 1.19 - 1.34 | NA | 90 |
| Tetrachloroethylene | $\mu g/m^3$ | 0.24 | 0.10 - 0.37 | 17 | 270 |
| Xylene, *m/p-* | $\mu g/m^3$ | 1.31 | 0.83 - 1.80 | NA | 100 |
| Ethylbenzene | $\mu g/m^3$ | 0.49 | 0.33 - 0.65 | 40 | 1000 |
| Bromomethane | $\mu g/m^3$ | 0.05 | 0.04 - 0.07 | NA | 5 |
| Dichlorobenzene, *p-* | $\mu g/m^3$ | 0.06 | 0.04 - 0.07 | 9.1 | 800 |
| Dichloromethane | $\mu g/m^3$ | 1.09 | 0.64 - 1.54 | 210 | 1000 |
| Xylene, *o-* | $\mu g/m^3$ | 0.50 | 0.33 - 0.67 | NA | 100 |
| Cobalt ($PM_{10}$) | $ng/m^3$ | 0.41 | 0.25 - 0.57 | NA | 100 |
| Chloroform | $\mu g/m^3$ | 0.17 | 0.15 - 0.19 | NA | 98 |
| Beryllium ($PM_{10}$) | $ng/m^3$ | 0.01 | 0.004 - 0.02 | 42 | 20 |
| Toluene | $\mu g/m^3$ | 2.63 | 1.59 - 3.67 | NA | 5000 |
| Styrene | $\mu g/m^3$ | 0.40 | 0.30 - 0.50 | NA | 1000 |
| Carbon Disulfide | $\mu g/m^3$ | 0.17 | 0.10 - 0.23 | NA | 700 |
| Methyl isobutyl ketone | $\mu g/m^3$ | 0.54 | 0.35 - 0.73 | NA | 3000 |
| Selenium ($PM_{10}$) | $ng/m^3$ | 3.09 | 1.14 - 5.05 | NA | 20000 |
| Methyl Chloroform | $\mu g/m^3$ | 0.06 | 0.05 - 0.08 | NA | 5000 |
| Chloroethane | $\mu g/m^3$ | 0.03 | 0.02 - 0.04 | NA | 10000 |
| Trichloroethylene | $\mu g/m^3$ | 0.05 [f] | 0.002 - 0.09 [f] | 50 | 600 |
| Mercury ($PM_{10}$) | $ng/m^3$ | 0.02 [g] | 0.005 - 0.03 [g] | NA | 300 [h] |
| ***Non-Key HAPs with more than 50% ND Results*** | | | | | |
| Acrylonitrile | $\mu g/m^3$ | 83% of results were ND[i] | | 1.5 | 2 |
| Ethylene dichloride | $\mu g/m^3$ | 92% of results were ND[j] | | 3.8 | 2400 |
| Hexachloro-1,3-butadiene | $\mu g/m^3$ | 92% of results were ND[k] | | 4.5 | 90 |
| Vinyl chloride | $\mu g/m^3$ | 67% of results were ND[l] | | 11 | 100 |
| Methyl Methacrylate | $\mu g/m^3$ | 92% of results were ND[m] | | NA | 700 |
| ***No other HAPs were detected in any other samples*** | | | | | |

$ng/m^3$ nanograms per cubic meter

$\mu g/m^3$ micrograms per cubic meter

NA Not available

ND No detection of this chemical was registered by the laboratory analytical equipment.

## Table C-1. Harriet Tubman Middle School - Other Monitored Pollutant Analysis.

[a] Mean of measurements is the average of all sample results which include actual measured values. If no chemical was registered, then a value of zero is used when calculating the mean

[b] Details regarding these values are in the technical report, Schools Air Toxics Monitoring Activity (2009) Uses of Health Effects Information in Evaluating Sample Results.

[c] Air toxics for which the upper 95% confidence limit on the mean concentration is above this level will be fully discussed in the text and may be considered a priority for potential follow-up activities, if indicated in light of the full set of information available for the site. Findings of the upper 95% confidence limit below 1% of the comparison level (i.e., where the upper 95% confidence limit is below the corresponding 1-in-1-million cancer risk based concentration) are generally considered a low priority for follow-up activity. Situations where the summary statistics for a pollutant are below this comparison level but above 1% of this level are fully discussed in the text of the report.

[d] Air toxics for which the upper 95% confidence limit on the mean concentration are near or below the noncancer-based comparison level are generally of low concern and will generally be considered a low priority for follow-up activity. Pollutants for which the 95% confidence limits extend appreciably above the noncancer-based comparison level are fully discussed in the school-specific report and may be considered a priority for follow-up activity, if indicated in light of the full set of information available for the site.

[e] The comparison levels are specific to hexavalent chromium (recognized as the most toxic form) which is a fraction of the total chromium reported.

[f] Trichlorothylene was detected in 6 of 12 samples, ranging from 0.032 to 0.23 $\mu g/m^3$. The MDL is 0.008 $\mu g/m^3$.

[g] Mercury ($PM_{10}$) was detected in 9 of 13 samples, ranging from 0.004 to 0.06 $ng/m^3$. The MDL range was 1.08 to 1.25 $ng/m^3$.

[h] The comparison level is specific to elemental mercury, which is more readily and completely absorbed into the body than mercury conveyed on particles (e.g., divalent species).

[i] Acrylonitrile was detected in only 2 of 12 samples, ranging from 0.085 to 0.20 $\mu g/m^3$. The MDL is 0.011 $\mu g/m^3$.

[j] Ethylene dichloride was detected in only 1 of 12 samples, equal to 0.065 $\mu g/m^3$. The MDL is 0.008 $\mu g/m^3$.

[k] Hexachloro-1,3-butadiene was detected in only 1 of 12 samples, equal to 0.04 $\mu g/m^3$. The MDL is 0.128 $\mu g/m^3$.

[l] Vinyl chloride was detected in only 4 of 12 samples, ranging from 0.005 to 0.01 $\mu g/m^3$. The MDL is 0.005 $\mu g/m^3$.

[m] Methyl Methacrylate was detected in only 1 of 12 samples, equal to 0.03 $\mu g/m^3$. The MDL is 0.115 $\mu g/m^3$.

## Appendix D. Harriet Tubman Middle School Pollutant Concentrations.

| Parameter | Units | 8/23/2009 | 8/29/2009 | 9/4/2009 | 9/10/2009 | 9/16/2009 | 9/22/2009 | 9/28/2009 | 10/4/2009 | 10/10/2009 | 10/16/2009 | 10/22/2009 | 10/28/2009 | 11/3/2009 | Sample Screening Level[a] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Manganese ($PM_{10}$) | $ng/m^3$ | 5.1 | 6.4 | 17.6 | 9.09 | 10.3 | 17.7 | 13.2 | 3.79 | 8.92 | 26.3 | 38.6 | 7.40 | 15.9 | 500 |
| Acetaldehyde | $\mu g/m^3$ | 1 | 1.91 | 1.78 | 1.39 | 1.15 | 2.05 | 1.40 | 1.30 | 1.19 | 2.45 | 2.14 | 1.18 | 1.25 | 90 |
| Benzene | $\mu g/m^3$ | 0.432 | 0.806 | 0.432 | 0.684 | 1.09 | 0.716 | 0.738 | -- | 0.604 | 2.25 | 1.67 | 1.81 | 1.65 | 30 |
| Butadiene, 1,3- | $\mu g/m^3$ | 0.029 | 0.058 | 0.069 | 0.071 | 0.10 | ND | 0.064 | -- | 0.062 | 0.249 | 0.272 | 0.270 | 0.18 | 20 |
| Nickel ($PM_{10}$) | $ng/m^3$ | 0.84 | 2.08 | 3.25 | 1.55 | 1.13 | 0.97 | 2.08 | 1.17 | 0.30 | 3.62 | 5.10 | 1.39 | 2.46 | 200 |
| Cadmium ($PM_{10}$) | $ng/m^3$ | 0.05 | 0.22 | 0.07 | 23.1 | 4.81 | 2.41 | 15.7 | 22.6 | 0.12 | 5.45 | 2.40 | 17.6 | 0.29 | 30 |
| Chromium ($PM_{10}$) | $ng/m^3$ | 2.21 | 2.85 | 4.52 | 2.60 | 3.95 | 3.18 | 3.58 | 2.97 | 1.45 | 6.84 | 6.61 | 5.16 | 3.01 | 580 [b] |
| Formaldehyde | $\mu g/m^3$ | 3.43 | 3.23 | 3.08 | 2.92 | 1.83 | 5.32 | 3.22 | 2.00 | 3.03 | 2.82 | 2.05 | 1.61 | 1.74 | 50 |
| Arsenic ($PM_{10}$) | $ng/m^3$ | 0.16 | 0.25 | 0.28 | 0.54 | 1.15 | ND | ND | 1.03 | 0.61 | 2.93 | 2.54 | 8.13 | 1.19 | 150 |
| Carbon Tetrachloride | $\mu g/m^3$ | 0.656 | 0.661 | 0.723 | 0.629 | 0.58 | 0.751 | 0.683 | -- | 0.57 | 0.723 | 0.60 | 0.807 | 0.635 | 200 |
| Propionaldehyde | $\mu g/m^3$ | 0.20 | 0.328 | 0.318 | 0.264 | 0.19 | 0.375 | 0.254 | 0.19 | 0.20 | 0.337 | 0.261 | 0.16 | 0.18 | 80 |
| Antimony ($PM_{10}$) | $ng/m^3$ | 0.86 | 0.83 | 1.21 | 2.66 | 2.78 | 1.28 | 3.12 | 2.96 | 1.80 | 5.47 | 7.47 | 6.03 | 1.24 | 2,000 |
| Chloromethane | $\mu g/m^3$ | 1.37 | 1.48 | 1.26 | 1.22 | 1.22 | 1.36 | 1.27 | -- | 1.20 | 1.34 | 1.28 | 1.21 | 1.01 | 1,000 |
| Tetrachloroethylene | $\mu g/m^3$ | 0.068 | 0.13 | 0.10 | 0.13 | 0.23 | 0.095 | 0.12 | -- | 0.11 | 0.821 | 0.26 | 0.45 | 0.31 | 1,400 |
| Xylene, *m/p-* | $\mu g/m^3$ | 0.84 | 1.39 | 0.56 | 0.99 | 1.79 | 0.50 | 0.48 | -- | 0.88 | 2.71 | 2.67 | 1.46 | 1.49 | 9,000 |
| Ethylbenzene | $\mu g/m^3$ | 0.36 | 0.487 | 0.24 | 0.42 | 0.630 | 0.20 | 0.20 | -- | 0.32 | 0.934 | 0.908 | 0.495 | 0.665 | 40,000 |
| Bromomethane | $\mu g/m^3$ | 0.093 | 0.082 | 0.074 | 0.062 | 0.050 | ND | 0.045 | -- | 0.039 | 0.043 | 0.058 | 0.03 | 0.039 | 200 |
| Dichlorobenzene, *p-* | $\mu g/m^3$ | 0.04 | 0.060 | 0.04 | 0.084 | 0.060 | ND | 0.04 | -- | 0.084 | 0.078 | 0.060 | 0.05 | 0.066 | 10,000 |
| Dichloromethane | $\mu g/m^3$ | 0.77 | 0.64 | 1.01 | 0.46 | 1.79 | 0.57 | 0.75 | -- | 0.52 | 2.98 | 1.08 | 1.47 | 1.04 | 2,000 |
| Xylene, *o-* | $\mu g/m^3$ | 0.39 | 0.591 | 0.23 | 0.40 | 0.651 | 0.21 | 0.17 | -- | 0.34 | 0.929 | 0.981 | 0.538 | 0.565 | 9,000 |
| Cobalt ($PM_{10}$) | $ng/m^3$ | ND | 0.52 | 0.56 | 0.18 | 0.24 | 0.41 | 0.43 | 0.35 | 0.25 | 0.37 | 0.76 | 0.21 | 1.03 | 100 |
| Chloroform | $\mu g/m^3$ | 0.19 | 0.21 | 0.15 | 0.16 | 0.21 | 0.15 | 0.17 | -- | 0.13 | 0.22 | 0.15 | 0.17 | 0.17 | 500 |
| Beryllium ($PM_{10}$) | $ng/m^3$ | ND | 0.002 | 0.05 | 0.006 | 0.008 | 0.0003 | 0.002 | 0.009 | 0.04 | ND | 0.04 | 0.02 | 0.01 | 20 |
| Toluene | $\mu g/m^3$ | 0.893 | 1.86 | 1.42 | 2.76 | 2.39 | 1.15 | 0.984 | -- | 1.89 | 5.31 | 5.80 | 3.06 | 4.03 | 4,000 |
| Styrene | $\mu g/m^3$ | 0.509 | 0.537 | 0.34 | 0.618 | 0.37 | 0.25 | 0.15 | -- | 0.443 | 0.575 | 0.507 | 0.31 | 0.20 | 9,000 |
| Carbon Disulfide | $\mu g/m^3$ | 0.23 | 0.23 | 0.19 | 0.11 | 0.29 | 0.361 | 0.091 | -- | 0.072 | 0.14 | 0.100 | 0.069 | 0.087 | 7,000 |
| Methyl isobutyl ketone | $\mu g/m^3$ | 0.606 | 1.11 | 0.941 | 0.717 | 0.31 | 0.31 | 0.11 | -- | 0.545 | 0.463 | 0.733 | 0.438 | 0.16 | 30,000 |
| Selenium ($PM_{10}$) | $ng/m^3$ | 0.14 | 0.4 | 0.41 | 0.28 | 5.39 | 2.56 | 5.87 | 5.06 | 0.42 | 9.32 | 2.01 | 8.04 | 0.32 | 20,000 |
| Methyl Chloroform | $\mu g/m^3$ | 0.071 | 0.066 | 0.066 | 0.066 | 0.071 | ND | 0.071 | -- | 0.055 | 0.082 | 0.071 | 0.076 | 0.076 | 10,000 |
| Chloroethane | $\mu g/m^3$ | 0.02 | 0.034 | 0.026 | 0.02 | 0.029 | ND | 0.038 | -- | ND | 0.042 | 0.034 | 0.01 | 0.063 | 40,000 |
| Trichloroethylene | $\mu g/m^3$ | 0.04 | ND | ND | 0.03 | 0.064 | ND | ND | -- | ND | 0.23 | 0.070 | 0.12 | ND | 10,000 |
| Mercury ($PM_{10}$) | $ng/m^3$ | ND | ND | 0.04 | 0.01 | 0.004 | ND | 0.004 | 0.005 | 0.03 | 0.06 | 0.05 | 0.02 | ND | 3,000 [c] |
| Acrylonitrile | $\mu g/m^3$ | 0.20 | ND | ND | ND | ND | ND | ND | -- | ND | ND | 0.085 | ND | ND | 200 |
| Ethylene dichloride | $\mu g/m^3$ | ND | ND | ND | ND | ND | ND | ND | -- | ND | ND | ND | 0.065 | ND | 270 |
| Hexachloro-1,3-butadiene | $\mu g/m^3$ | ND | ND | ND | ND | ND | ND | ND | -- | ND | ND | ND | 0.04 | ND | 320 |
| Vinyl chloride | $\mu g/m^3$ | ND | ND | 0.01 | 0.01 | ND | ND | ND | -- | ND | ND | 0.008 | 0.005 | ND | 1,000 |
| Methyl Methacrylate | $\mu g/m^3$ | ND | ND | ND | ND | ND | ND | ND | -- | ND | ND | ND | 0.03 | ND | 7,000 |
| Benzyl Chloride | $\mu g/m^3$ | ND | ND | ND | ND | ND | ND | ND | -- | ND | ND | ND | ND | ND | 140 |
| Bromoform | $\mu g/m^3$ | ND | ND | ND | ND | ND | ND | ND | -- | ND | ND | ND | ND | ND | 6,400 |
| Chlorobenzene | $\mu g/m^3$ | ND | ND | ND | ND | ND | ND | ND | -- | ND | ND | ND | ND | ND | 10,000 |
| Chloroprene | $\mu g/m^3$ | ND | ND | ND | ND | ND | ND | ND | -- | ND | ND | ND | ND | ND | 200 |
| Dichloroethane, 1,1- | $\mu g/m^3$ | ND | ND | ND | ND | ND | ND | ND | -- | ND | ND | ND | ND | ND | 4,400 |
| Dichloroethylene, 1,1- | $\mu g/m^3$ | ND | ND | ND | ND | ND | ND | ND | -- | ND | ND | ND | ND | ND | 80 |
| Dichloropropane, 1,2- | $\mu g/m^3$ | ND | ND | ND | ND | ND | ND | ND | -- | ND | ND | ND | ND | ND | 200 |
| Dichloropropylene, *cis* -1,3- | $\mu g/m^3$ | ND | ND | ND | ND | ND | ND | ND | -- | ND | ND | ND | ND | ND | 40 |
| Dichloropropylene, *trans* -1,3- | $\mu g/m^3$ | ND | ND | ND | ND | ND | ND | ND | -- | ND | ND | ND | ND | ND | 40 |
| Ethyl Acrylate | $\mu g/m^3$ | ND | ND | ND | ND | ND | ND | ND | -- | ND | ND | ND | ND | ND | 7,000 |

## Appendix D. Harriet Tubman Middle School Pollutant Concentrations.

| Parameter | Units | 8/23/2009 | 8/29/2009 | 9/4/2009 | 9/10/2009 | 9/16/2009 | 9/22/2009 | 9/28/2009 | 10/4/2009 | 10/10/2009 | 10/16/2009 | 10/22/2009 | 10/28/2009 | 11/3/2009 | Sample Screening Level[a] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ethylene dibromide | µg/m$^3$ | ND | ND | ND | ND | ND | ND | ND | -- | ND | ND | ND | ND | ND | 12 |
| Methyl *tert*-Butyl Ether | µg/m$^3$ | ND | ND | ND | ND | ND | ND | ND | -- | ND | ND | ND | ND | ND | 7,000 |
| Tetrachloroethane, 1,1,2,2- | µg/m$^3$ | ND | ND | ND | ND | ND | ND | ND | -- | ND | ND | ND | ND | ND | 120 |
| Trichlorobenzene, 1,2,4- | µg/m$^3$ | ND | ND | ND | ND | ND | ND | ND | -- | ND | ND | ND | ND | ND | 2,000 |
| Trichloroethane, 1,1,2- | µg/m$^3$ | ND | ND | ND | ND | ND | ND | ND | -- | ND | ND | ND | ND | ND | 440 |
| Acetonitrile | µg/m$^3$ | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 600 |

Key Pollutant

ng/m$^3$ nanograms per cubic meter

µg/m$^3$ micrograms per cubic meter

-- No sample was conducted for this pollutant on this day or the sample was invalid.

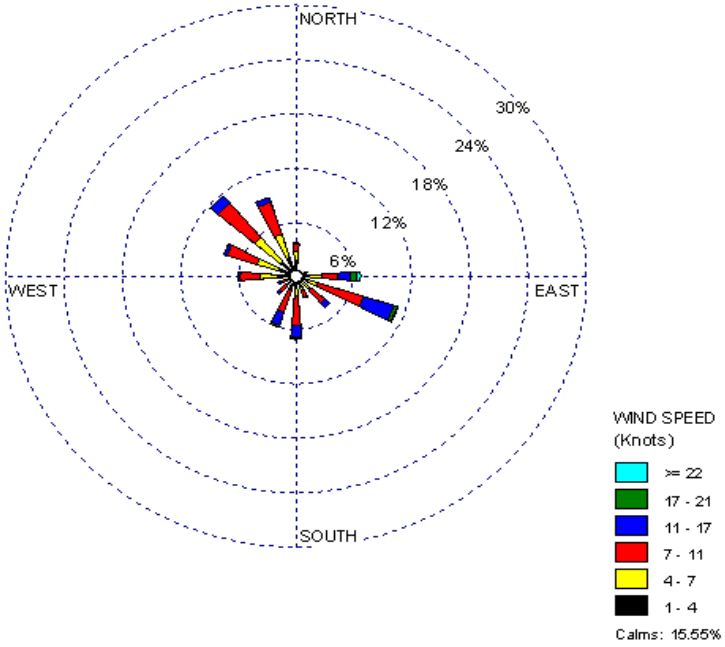
ND No detection of this chemical was registered by the laboratory analytical equipment.

[a] The individual sample screening levels and their use is summarized on the web site and described in detail in Schools Air Toxics Monitoring Activity (2009), "Uses of Health Effects Information in Evaluating Sample Results", see http://www.epa.gov/schoolair/pdfs/UsesOfHealthEffectsInfoinEvalSampleResults.pdf. These screening levels are based on consideration of exposure all day, every day over a period ranging up to at least a couple of weeks, and longer for some pollutants.

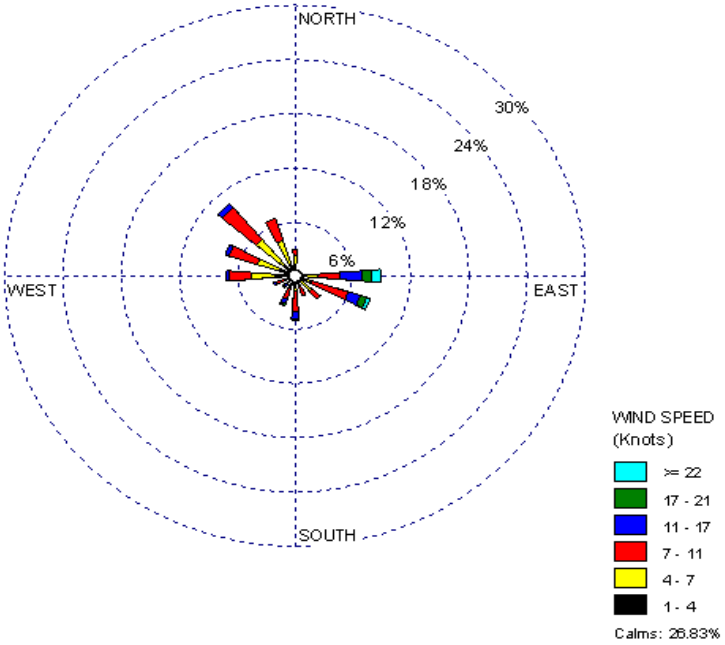
[b] The sample screening levels are specific to hexavalent chromium (recognized as the most toxic form) which is a fraction of the total chromium reported.

[c] The sample screening level is specific to elemental mercury, which is more readily and completely absorbed into the body than mercury conveyed on particles (e.g., divalent species).

# Appendix E. Windroses for Portland International Airport NWS Station.




**Portland International Airport NWS Station 2002-2007[1]**




**Portland International Airport NWS Station Across Sampling Period (Aug. 23, 2009-Nov. 3, 2009)[1]**

**[1] Portland International Airport NWS Station (WBAN 24229) is 4.77 miles from Harriet Tubman Middle School.**