SAT Initiative: Additional Monitoring Harriet Tubman Middle School (Portland, OR)

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 was initially conducted at Harriet Tubman Middle School from August 23, 2009 to November 3, 2009 to assess cadmium and other metals in particulate matter less than 10 microns (PM_{10}) in the air.
- This school was initially 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. The school is located in an urban area and is surrounded by several interstate and state highways.
- Although measurements of the key pollutants (manganese (PM_{10}), nickel (PM_{10}), acetaldehyde, acrolein, benzene, and 1,3-butadiene) were below levels of significant concern that had been suggested by the modeling information available prior to monitoring, EPA extended air toxics monitoring at this school because measurements of cadmium (PM_{10}) indicated an issue of potential concern depending on the location and characteristics of a nearby source or sources. EPA summarized the results of this initial sampling in the first technical report (http://www.epa.gov/schoolair/pdfs/HarrietTubmanTechReport.pdf).
- Additional air monitoring was conducted at this school from May 27, 2011 through July 17, 2011 for cadmium (PM_{10}) and other PM_{10} metals.
- The levels of cadmium (PM_{10}) measured in the outdoor air over this two-month period indicate influence of a key source although measurements are well below levels of significant concern. Results of all other PM_{10} metals monitored do not indicate levels of concern.
- Based on the analysis described here, EPA does not recommend further monitoring at this school. EPA remains concerned about emissions from sources of air toxics and continues to work to reduce these emissions across the country, through national rules and by providing information and suggestions to assist with reductions in local areas (http://www.epa.gov/ttn/atw/eparules.html).
- The Oregon Department of Environmental Quality (ODEQ) will continue to oversee industrial facilities in the area through air permits and other programs. ODEQ has also 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. Basis for Selecting this School and the Air Monitoring Conducted

In 2009, 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 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 conducted from August 23, 2009 through November 3, 2009 indicated potential issues with cadmium (PM_{10}) from nearby sources, and additional monitoring for a longer period of time was recommended.

Additional monitoring was conducted at this school from May 27, 2011 through July 17, 2011 for cadmium and other PM_{10} metals. During this period, 46 PM_{10} samples were collected and analyzed for the key pollutant and other air toxics at this school. All sampling methodologies are described in EPA's schools air toxics monitoring plan (http://www.epa.gov/schoolair/techinfo.html).[1]

III. Monitoring Results and Analysis

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

- The PM_{10} air sampling data collected over the 2-month sampling period indicate the influence of nearby source(s) of cadmium emissions. This pollutant can come from multiple industrial sources.
- Measured levels of cadmium (PM_{10}) do not indicate levels of concern.
- Results for other air toxics monitored do not indicate levels of concern.

A. Chemical Concentrations

Cadmium (PM_{10}), key pollutant:

- Do the monitoring data indicate influence from nearby sources?

[1] ODEQ staff operated the monitors and sent the canisters to the analytical laboratory under contract to EPA.

→ Emissions of cadmium may be associated with several different industrial sources. The monitoring data include multiple cadmium (PM_{10}) concentrations that are higher than concentrations commonly observed in other locations nationally.[2]

→ Concentrations of cadmium (PM_{10}) monitored at a nearby National Air Toxics Trends Station (Figure 2) indicate slightly lower but similar measurements of this pollutant over a 3-year period from 2008-2010 (Appendix C).

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

→ The monitoring data for cadmium (PM_{10}) do not indicate levels of significant health concern for long-term, continuous exposures.

  - The estimate of longer-term cadmium (PM_{10}) concentration (i.e., the upper bound of the 95 percent confidence interval on the mean of the dataset) is below the long-term comparison levels (Table 1 and Figure 3).[3] These comparison levels are based on consideration of continuous exposure concentrations (24 hours a day, all year, over a lifetime).

  - Further, the longer-term concentration estimate is less than 4% 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 a 1-in-1,000,000 additional cancer risk and 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 cadmium (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).[4]

→ 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 significant concern for long-term exposures.

<u>Other Air Toxics:</u>

- 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, in which the longer-term concentration estimates for these HAPs are below their long-term

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[2] For example, 18 of the 46 concentrations at this site (Table 2) were higher than 75 percent of samples collected at the National Air Toxics Trends Stations (NATTS) from 2003-2010 (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.

[3] The upper end of the interval is approximately 1.6 times the mean of the monitoring data and approximately 20% of the long-term noncancer-based comparison level.

[4] The development of long-term comparison levels, as well as of individual sample screening levels, is described in detail in *Schools Air Toxics Monitoring Activity (2009), Uses of Health Effects Information in Evaluating Sample Results.*

comparison levels (Appendix D). Additionally, each individual measurement for these pollutants is below the individual sample screening level[4] for that pollutant (Appendix E).

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 data collected for the key and other air toxics and the associated longer-term concentrations estimates do not pose significant concerns for cumulative health risk from these pollutants (Appendix D).[5]

B. 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 evaluated whether these data indicate that the general pattern of winds on our sampling dates was significantly different from those occurring across the full sampling period or from those expected over the longer term. Additionally, we noted, particularly for school sites where the measured chemical concentrations show little indication of influence from nearby sources, 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 May 31, 2011, continuing through the sampling period and ending on July 18, 2011. Data was not available from the first four sampling days (May 27, 2011 through May 30, 2011), and also on a few other days during sampling (see Table 2). Wind information from the NWS Station was used as a surrogate on all days when data was not available from the school location. The meteorological data collected at the school site on sampling days are presented in Figure 4 and Table 2.

The nearest NWS station is at Portland International Airport in Portland, OR. This station is approximately 4.77 miles southwest of the school. Measurements taken at that station include wind, temperature, and precipitation. These are presented in Table 2 and Appendix F.

[5] 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 key source was contributing to conditions at the school location.
- The wind patterns at the monitoring site on the sampling dates for cadmium (PM_{10}) are similar to those observed across the record of on-site meteorological data during the sampling period.
- The NWS station at Portland International Airport somewhat appears to represent the specific wind flow patterns at the school location. The historical data from the NWS station indicates that winds are predominantly from the northwest and southeast. During the two-month monitoring event, the wind was primarily from the northwest.

- What is the direction of the key source of cadmium emissions in relation to the school location?
  → The key source of cadmium was identified as a mix of industrial sources to the northwest of the school.
  → Using the boundaries of this general area (in lieu of information regarding the location of specific sources of cadmium emissions within the facilities), we have identified an approximate range of wind directions to use in considering the potential influence of the industrial sources on air concentrations at the school.
  → This general range of wind directions, from approximately 270 to 326 degrees, is referred to here as the expected zone of source influence (ZOI).

- On days the air samples were collected, how often did wind come from the direction of the key source?
  → There were 37 out of 46 sampling days in which the on-site wind data had a portion of the winds from the ZOI. (Figure 4, Table 2).

- 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 appear very similar to those observed over the record of on-site meteorological data during the sampling period, particularly with regard to the expected ZOI. We note that wind patterns at the nearest NWS station (at Portland International Airport) during the sampling period are somewhat similar to those recorded at the NWS station over the long-term (January 2002-July 2011 period; Appendix F). Winds in the area are usually predominantly from the northwesterly and southeasterly directions during the majority of the year. During the two-month monitoring event, the winds at this NWS station were primarily from the northwest.

- How do wind patterns at the school compare to those at the Portland International Airport NWS 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 two months), prevalent winds at the school site are predominantly from the northwest, which is the same as the NWS station. The windroses for the two sites during the sampling period (Figures 4a-4b and Appendix F) show similarities in wind flow patterns.

IV. Key Source Information

- Were the cadmium emission sources operating as usual during the monitoring period?
  - No cadmium emission sources were reported within two miles of this school in the 2002 NATA, 2005 NEI, 2008 NEI, and the 2005-2011 TRI emission inventories.

V. Integrated Summary and Next Steps

A. Summary of Key Findings

1. What is the key HAP for this school?
   → Cadmium (PM_{10}) is the key HAPs for this school, based on previous monitoring conducted August 2009 through November 2009. During the initial monitoring, the ambient air concentrations of cadmium (PM_{10}) on multiple days during the monitoring period indicated contributions from multiple sources. Similarly, the ambient air concentrations of cadmium (PM10) on multiple days during the monitoring period (May 27, 2011 through July 17, 2011) indicate contributions from multiple sources in the area.

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 additional monitoring?
   → Measured levels of cadmium (PM_{10}) and the associated longer-term concentration estimate for the outdoor air at this school are below levels of concern.
   → Results for other air toxics monitored do not indicate levels of concern.

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 have 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 somewhat representative of long-term wind flow at that site. The wind patterns seen over two months of sampling at the school are similar to those seen at the nearest NWS station.

B. Next Steps for Key Pollutants

1. Based on the analysis described here, EPA does not plan to extend air toxics monitoring at this school in the near future.
2. EPA remains concerned about emissions from sources of air toxics and continues to work to reduce these emissions across the country, through national rules and by providing information and suggestions to assist with reductions in local areas (http://www.epa.gov/ttn/atw/eparules.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 also 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.

VI. Figures and Tables

A. Tables

1. Harriet Tubman Middle School – Key Pollutant Analysis.
2. Harriet Tubman Middle School Key Pollutant Concentrations (Cadmium (PM_{10})) and Meteorological Data.

B. Figures

1. Harriet Tubman Middle School.
2. Harriet Tubman Middle School and the Portland NATTS Site.
3. Harriet Tubman Middle School – Key Pollutant (Cadmium (PM_{10})) Analysis.
4. Harriet Tubman Middle School (Portland, OR) Cadmium (PM_{10}) Concentration and Wind Information.

VII. Appendices

A. Summary Description of Long-term Comparison Levels.

B. National Air Toxics Trends Stations Measurements (2003-2010).

C. Portland, Oregon National Air Toxics Trends Station Measurements (2008-2010).

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

E. Harriet Tubman Middle School Pollutant Concentrations.

F. Windroses for Portland International Airport NWS Station.

Figure 1. Harriet Tubman Middle School (Portland, OR) and the Surrounding Area.

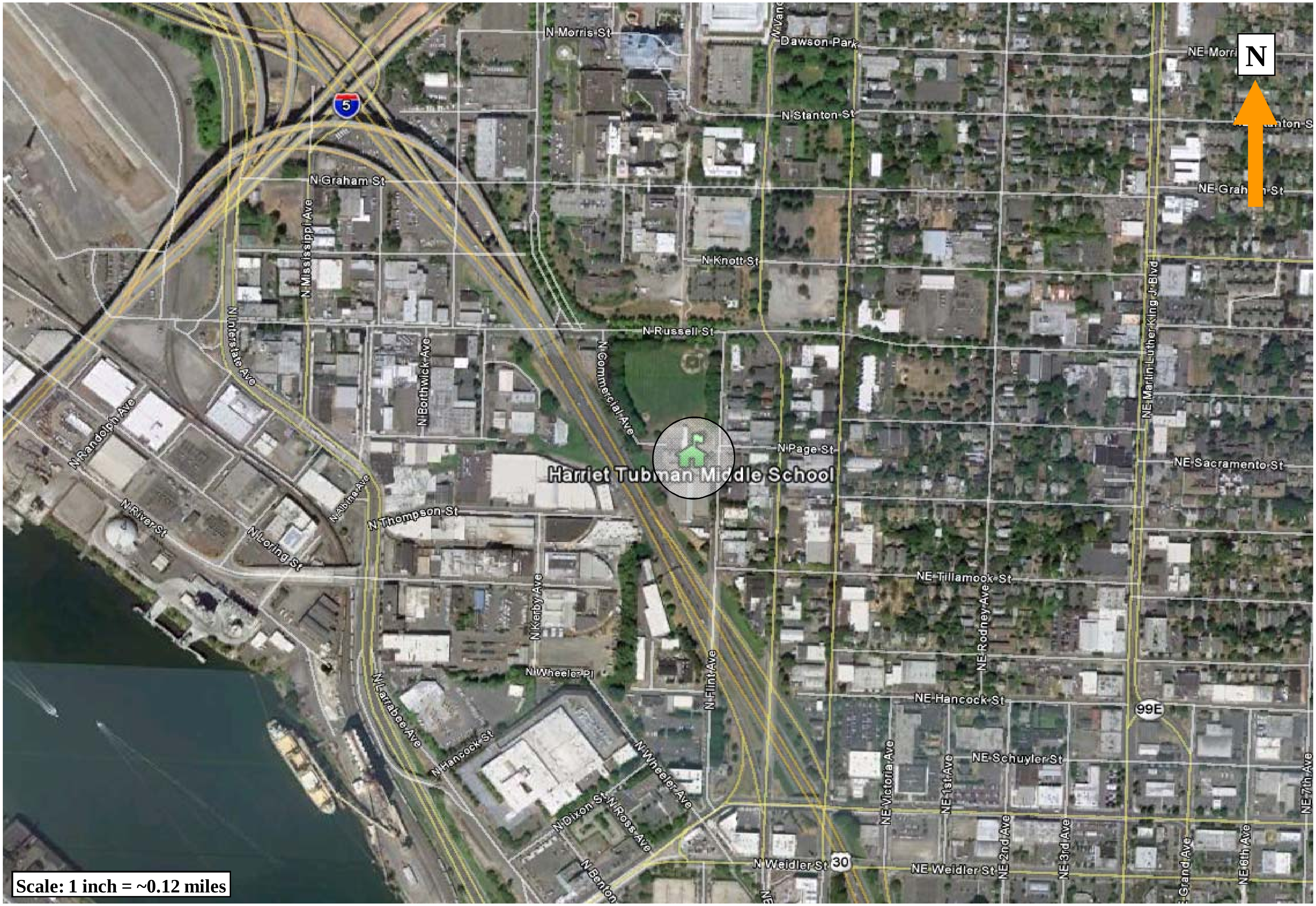


Figure 2. Harriet Tubman Middle School, Portland National Air Toxics Trends Station (NATTS) Site, and Portland International Airport.

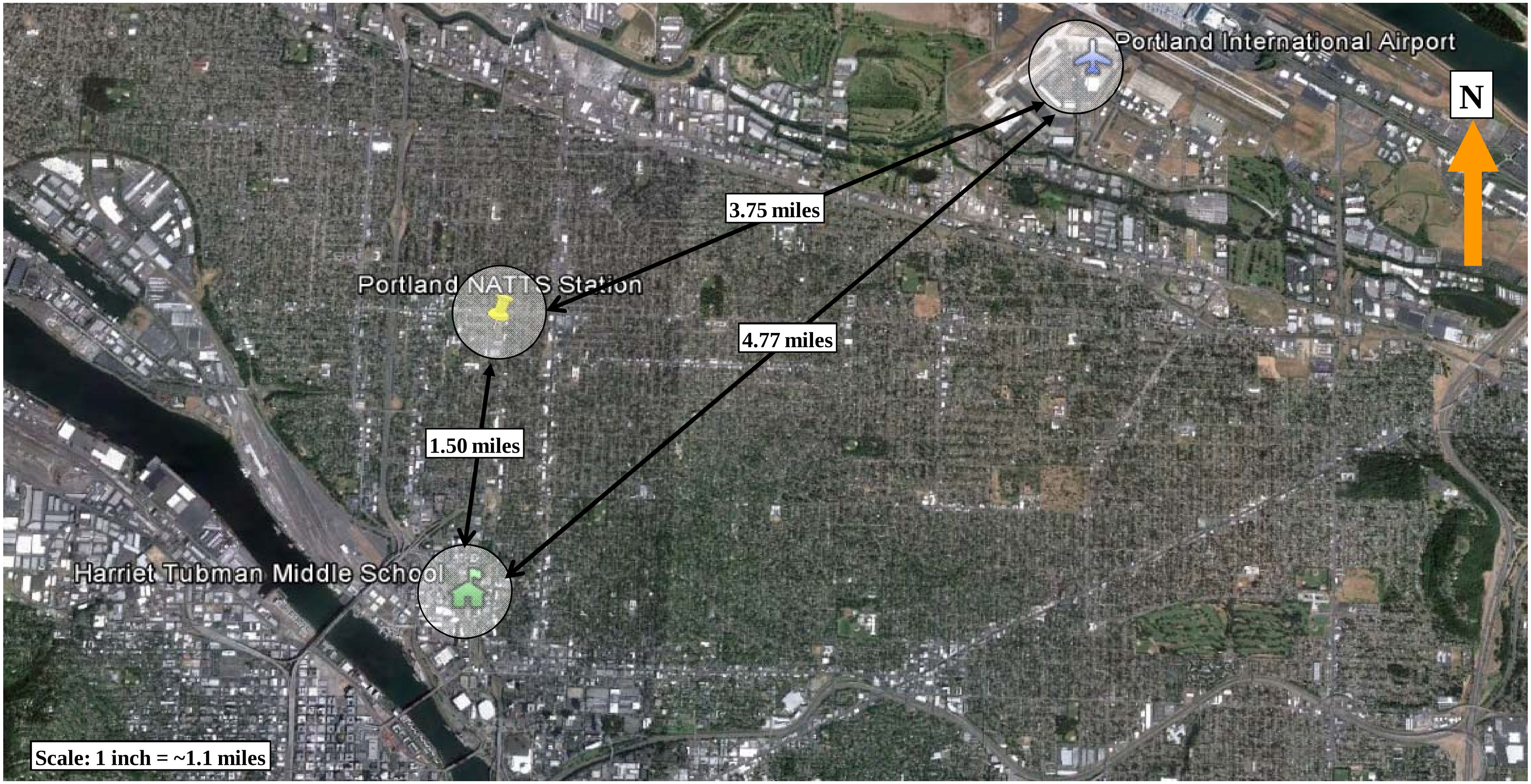


Table 1. Harriet Tubman Middle School - Key Pollutant Analysis.

Parameter	Units	Mean of Measurements	95% Confidence Interval on the Mean	Long-term Comparison Level[a]	
				Cancer-Based[b]	Noncancer-Based[c]
Cadmium (PM_{10})	ng/m^3	1.24 [d]	0.45 - 2.03	56	10

ng/m^3 nanograms per cubic meter
NA Not applicable

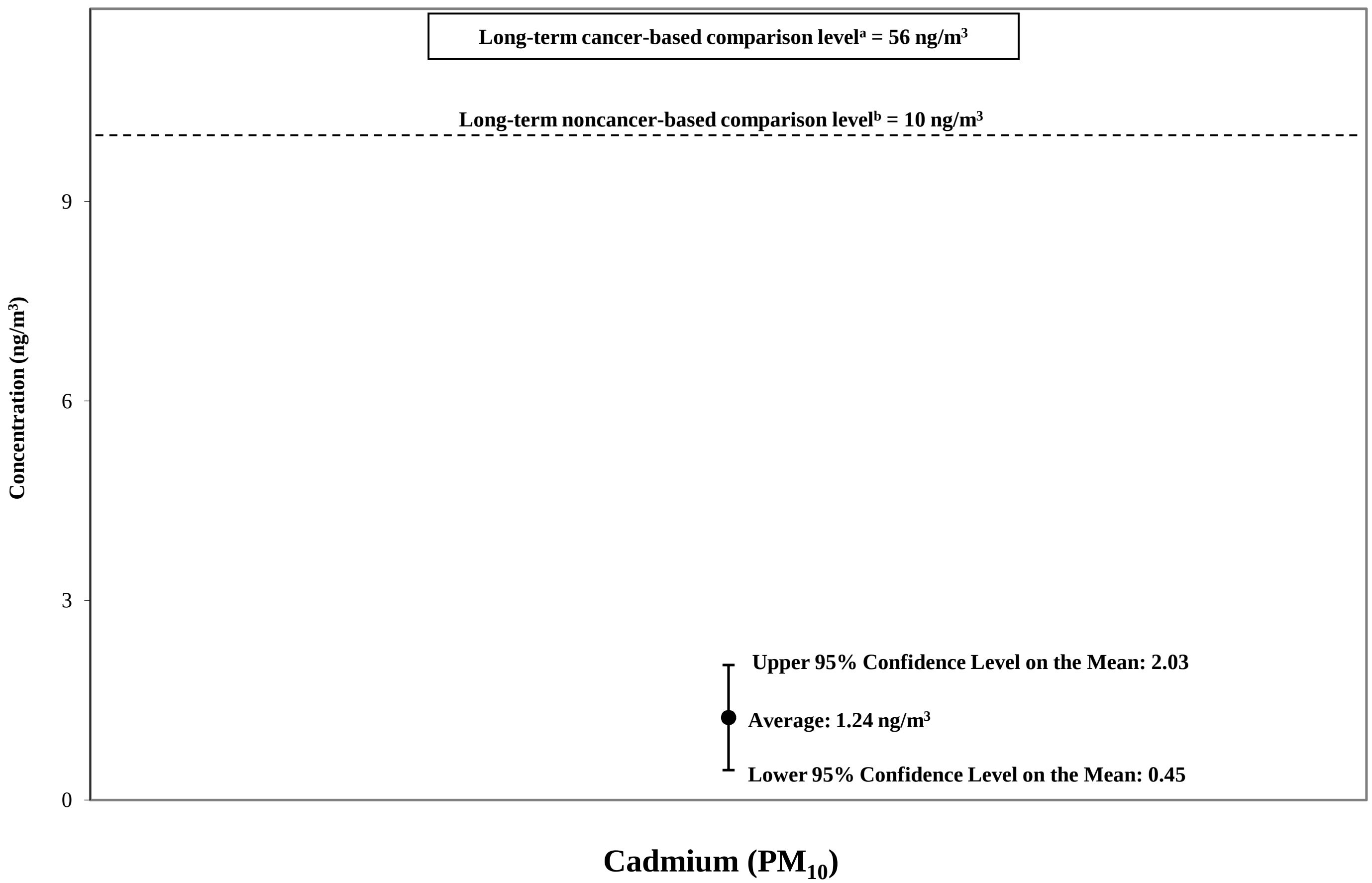
[a] Details regarding these values are in the technical report, Schools Air Toxics Monitoring Activity (2009) Uses of Health Effects Information.

[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 cadmium (PM_{10}) is the average of all sample results, which include 46 detections that ranged from 0.02 to 12.6 ng/m^3.

Figure 3. Harriet Middle Middle School - Key Pollutant (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 2. Harriet Tubman Middle School Key Pollutant Concentrations (Cadmium (PM_{10})) and Meteorological Data.

Parameter	Units	5/27/2011	5/28/2011	5/29/2011	5/30/2011	5/31/2011	6/1/2011	6/2/2011	6/3/2011	6/4/2011	6/5/2011	6/7/2011	6/8/2011	6/9/2011	6/10/2011	6/11/2011	6/12/2011	6/13/2011	6/14/2011	6/15/2011
Cadmium (PM_{10})	ng/m^3	0.88	0.10	0.19	11.6	1.44	1.27	5.14	12.6	0.08	0.11	0.65	0.16	0.04	0.05	0.04	0.29	0.33	0.07	0.04
% Hours w/Wind Direction from Expected ZOI[a]	%	0.0	29.2	4.2	8.3	16.7	12.5	0.0	16.7	41.7	37.5	12.5	8.3	25.0	25.0	12.5	16.7	4.2	16.7	50.0
Wind Speed (avg. of hourly speeds)	mph	7.3	4.9	3.1	4.5	2.4	2.2	3.0	3.2	3.8	2.3	2.5	2.8	3.8	3.0	3.2	2.1	4.3	3.5	2.4
Wind Direction (avg. of unitized vector)[b]	deg.	184.2	344.1	119.9	28.0	231.7	171.8	168.0	354.6	340.3	323.1	230.4	269.5	332.7	322.8	334.2	251.0	199.9	336.0	305.3
% of Hours with Speed below 2 knots	%	8.3	20.8	41.7	20.8	50.0	62.5	45.8	45.8	29.2	50.0	41.7	45.8	20.8	33.3	25.0	66.7	8.3	16.7	58.3
Daily Average Temperature	° F	50.5	51.9	51.6	55.9	54.5	53.9	53.7	62.3	69.8	68.4	58.3	57.7	61.5	58.4	60.5	58.7	61.3	58.5	56.5
Daily Precipitation	inches	0.26	0.16	0.04	0.02	0.08	0.38	0.10	0.01	0.00	0.02	0.03	0.02	0.00	0.01	0.00	0.04	0.04	0.00	0.07

Parameter	Units	6/16/2011	6/17/2011	6/18/2011	6/19/2011	6/20/2011	6/21/2011	6/22/2011	6/23/2011	6/24/2011	6/25/2011	6/26/2011	6/27/2011	6/29/2011	6/30/2011	7/1/2011	7/6/2011	7/7/2011	7/8/2011	7/9/2011
Cadmium (PM_{10})	ng/m^3	4.88	0.06	0.19	0.05	0.20	0.05	0.04	0.05	0.09	0.02	0.09	2.43	1.30	0.56	0.09	0.05	0.05	0.05	0.04
% Hours w/Wind Direction from Expected ZOI[a]	inches	8.3	8.3	20.8	33.3	33.3	20.8	4.2	41.7	29.2	0.0	29.2	25.0	0.0	16.7	8.3	0.0	8.3	8.3	8.3
Wind Speed (avg. of hourly speeds)	mph	2.1	3.1	2.6	2.2	2.0	2.7	3.7	2.8	3.1	3.9	2.0	1.9	2.7	2.6	3.8	0.0	0.1	0.2	0.4
Wind Direction (avg. of unitized vector)[b]	deg.	220.2	335.3	192.9	292.7	311.8	334.3	336.3	302.1	325.3	340.3	330.9	315.0	221.3	265.0	333.8	340.2	340.2	336.0	338.7
% of Hours with Speed below 2 knots	inches	62.5	33.3	58.3	58.3	62.5	41.7	12.5	37.5	50.0	16.7	66.7	79.2	41.7	54.2	16.7	0.0	0.0	20.8	12.5
Daily Average Temperature	mph	57.7	61.8	58.0	59.8	64.2	67.9	62.7	60.3	60.8	61.4	64.4	67.7	62.9	60.0	64.8	72.6	62.1	62.4	64.7
Daily Precipitation	deg.	0.00	0.00	0.21	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.01	0.04	0.01	0.00	0.00	0.00	0.00

Parameter	Units	7/10/2011	7/11/2011	7/12/2011	7/13/2011	7/14/2011	7/15/2011	7/16/2011	7/17/2011
Cadmium (PM_{10})	ng/m^3	0.07	1.21	2.86	4.51	0.97	1.75	0.05	0.32
% Hours w/Wind Direction from Expected ZOI[a]	inches	0.0	0.0	0.0	20.8	12.5	8.3	8.3	33.3
Wind Speed (avg. of hourly speeds)	mph	0.2	0.5	0.6	0.5	0.5	0.3	0.5	0.2
Wind Direction (avg. of unitized vector)[b]	deg.	353.5	164.4	175.7	204.0	275.3	174.5	188.3	325.1
% of Hours with Speed below 2 knots	inches	33.3	8.3	41.7	45.8	50.0	41.7	20.8	91.7
Daily Average Temperature	mph	67.0	64.3	62.7	62.8	63.3	66.9	65.3	61.5
Daily Precipitation	deg.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

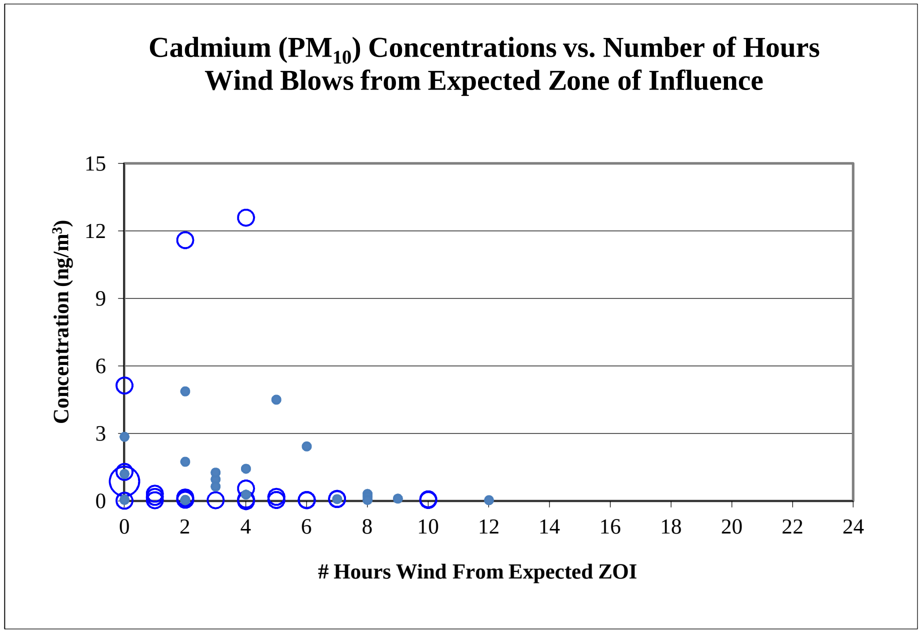
All precipitation and temperature data were from the Portland International Airport NWS Station.

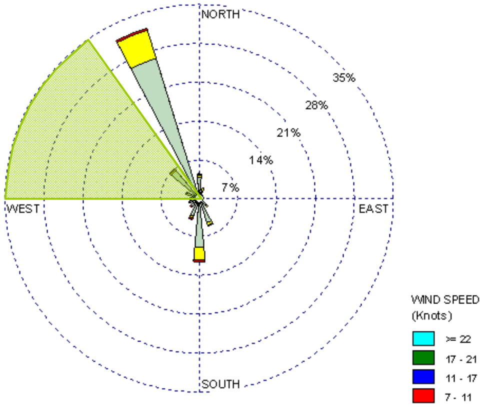
Wind information was not taken at the site from 5/27/11 to 5/30/11, and the NWS station data was used as a surrogate. Additionally, on 6/8/11 from 8:00am to 10:00am, wind information was not taken. Finally, wind information was not collected at 2pm on 6/9/11.

[a] Based on count of hours for which vector wind direction is from expected zone of influence.

[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).

Figure 4. Harriet Tubmen Middle School (Portland, OR) Cadmium (PM_{10}) Concentration and Wind Information.





Harriet Tubman Middle School Composite Hourly Windrose on Sample Days (May 27, 2011- July 17, 2011)

KEY

Pollutant: Cadmium (PM_{10})
Timeframe: May 27, 2011 - July 17, 2011

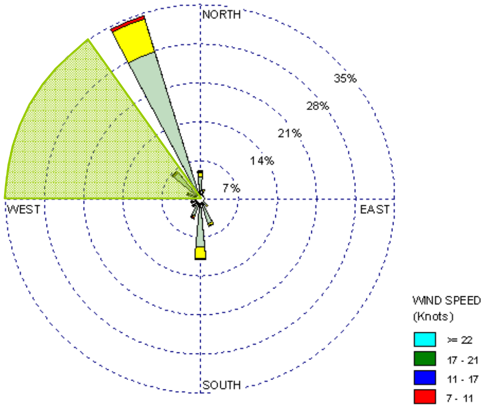
Wind Speed: 0.1-2.5 mph

Wind Speed: 2.5-5.0 mph

Wind Speed: > 5.0 mph

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 2). 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.



Harriet Tubman Middle School Composite Hourly Windrose Across Sampling Period (May 27, 2011- July 17, 2011)

Expected Zone of Source Influence

Appendix A. Summary Description of Long-term Comparison Levels

In addressing the primary objective identified above, we developed two types of long-term health risk-related comparison levels. These two types of levels are summarized below.[6]

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.[7] 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 D.

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

[7] 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 effects over a lifetime.[8] 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.

[8] 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 (2003-2010).[a]

Pollutant	Units	# Samples Analyzed	% Detections	Maximum	Arithmetic Mean[b]	Geometric Mean	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
Antimony (PM_{10})	ng/m^3	5,381	94%	43.30	1.55	1.07	ND	0.52	0.95	2.00	4.38
Arsenic (PM_{10})	ng/m^3	8,874	87%	44.10	0.96	0.68	ND	0.28	0.56	1.03	2.94
Beryllium (PM_{10})	ng/m^3	8,459	63%	1.97	0.05	0.01	ND	ND	<0.01	0.02	0.50
Cadmium (PM_{10})	ng/m^3	8,537	84%	30.58	0.26	0.15	ND	0.05	0.11	0.25	0.93
Chromium (PM_{10})	ng/m^3	8,189	92%	172.06	2.46	1.46	ND	0.80	1.79	2.57	6.61
Cobalt (PM_{10})	ng/m^3	5,508	91%	20.30	0.32	0.18	ND	0.07	0.14	0.32	1.00
Manganese (PM_{10})	ng/m^3	8,475	99%	734.00	9.57	4.65	0.96	2.19	4.05	8.66	30.22
Mercury (PM_{10})	ng/m^3	1,941	84%	2.07	0.05	0.02	ND	<0.01	0.02	0.04	0.24
Nickel (PM_{10})	ng/m^3	8,555	91%	135.88	1.93	1.36	ND	0.67	1.26	2.39	5.39
Selenium (PM_{10})	ng/m^3	4,968	95%	44.00	1.10	0.54	0.01	0.24	0.53	0.89	5.00

Key Pollutant

ng/m^3 nanograms per cubic meter

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 2003 through 2010. These data were extracted from AQS in December 2011. During the time period of interest, there were 30 sites measuring VOCs, carbonyls, metals, PAHs, 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 2003. 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. Portland, OR National Air Toxics Trends Station Measurements (2003-2010).

Analyte	Units	# AQS Records	% Detection	Average Concentration	Standard Deviation	Maximum Concentration	Percentile Value						
							5th	10th	25th	50th	75th	90th	95th
Acetaldehyde	μg/m^3	164	100%	1.33	0.63	4.00	0.54	0.65	0.92	1.23	1.54	2.19	2.47
Arsenic (PM_{10})	ng/m^3	171	100%	0.92	1.18	12.37	0.16	0.22	0.34	0.59	1.13	1.91	2.32
Benzene	μg/m^3	147	87%	1.05	1.37	11.50	ND	ND	0.38	0.64	1.25	2.15	2.98
Benzo(a)pyrene	ng/m^3	150	38%	0.14	0.24	1.23	ND	ND	ND	ND	0.27	0.51	0.62
Beryllium (PM_{10})	ng/m^3	172	98%	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Butadiene, 1,3-	μg/m^3	165	9%	0.03	0.13	1.33	ND	ND	ND	ND	ND	ND	0.22
Cadmium (PM_{10})	ng/m^3	171	99%	1.18	2.98	31.77	0.04	0.05	0.08	0.24	0.84	3.04	5.42
Carbon Tetrachloride	μg/m^3	157	28%	0.18	0.34	1.95	ND	ND	ND	ND	0.19	0.69	0.77
Chloroform	μg/m^3	165	8%	0.04	0.20	2.15	ND	ND	ND	ND	ND	ND	0.33
Formaldehyde	μg/m^3	169	100%	1.92	1.01	6.60	0.77	0.93	1.20	1.78	2.28	2.99	3.96
Hexavalent Chromium	ng/m^3	159	22%	0.02	0.03	0.23	ND	ND	ND	ND	ND	0.05	0.08
Lead (PM_{10})	ng/m^3	171	100%	4.82	5.21	44.21	1.24	1.48	2.13	3.47	5.99	8.30	10.87
Manganese (PM_{10})	ng/m^3	171	100%	9.88	14.68	108.31	1.09	1.38	2.60	5.91	9.83	20.42	35.66
Naphthalene	ng/m^3	145	99%	53.33	44.81	247.87	5.47	12.52	25.01	39.08	69.86	105.05	146.22
Nickel (PM_{10})	ng/m^3	172	99%	1.40	1.18	6.17	0.23	0.34	0.60	1.11	1.72	3.02	4.00
Tetrachloroethylene	μg/m^3	168	11%	0.13	0.58	6.24	ND	ND	ND	ND	ND	0.36	0.65
Trichloroethylene	μg/m^3	166	1%	0.01	0.05	0.54	ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	μg/m^3	164	1%	<0.01	0.03	0.26	ND	ND	ND	ND	ND	ND	ND

Key Pollutant

μg/m^3 micrograms per cubic meter

ng/m^3 nanograms per cubic meter

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

Appendix D. 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).[9] 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 D-1).

<u>Other Air Toxics (HAPs)</u>

- Do the monitoring data indicate elevated levels of any other air toxics or hazardous air pollutant (HAPs) that pose significant long-term health concerns?
  - → Longer term concentration estimates for the other HAPs monitored are below their long-term comparison levels.
    - Further, for pollutants with cancer-based comparison levels, the longer-term concentration estimates for all but one of these (chromium (PM_{10})) are more than 10-fold lower and all but three of these (chromium (PM_{10}), arsenic (PM_{10}), and nickel (PM_{10})) are more than 100-fold lower.[10]
  - → 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.[11]

<u>Additional Information on Three HAPs:</u>

- The first 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 below these very restrictive comparison values. The mean and 95 percent upper bound on the mean for chromium (PM_{10}) are approximately 60-74% of the lower (cancer-based) comparison level. Further, as Cr^{+6} is

[9] 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.
[10] 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.
[11] 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.*

commonly only a small fraction of the total chromium (PM_{10}),[12] 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 75th and 95th percentile of samples collected from 2003 to 2010 (the most recently compiled period) at the NATTS sites (Appendix B).

- The second HAP mentioned above is arsenic. The mean and 95 percent upper bound on the mean for arsenic (PM_{10}) are approximately 3-4% 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 50th and 75th percentile of samples collected from 2003 to 2010 (the most recently compiled period) at the NATTS sites (Appendix B).

- The third HAP mentioned above is nickel. The mean and 95 percent upper bound on the mean for arsenic (PM_{10}) are approximately 1% 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 75th and 95th percentile of samples collected from 2003 to 2010 (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.[13]

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)?

  → Although the multiple air toxics monitored at this location were below the levels of significant concern that had been suggested by the modeling information, EPA remains

[12] 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.
[13] General information on additional air pollutants is available at http://www.epa.gov/air/airpollutants.html.

concerned about emissions from sources of air toxics and continues to work to reduce these emissions across the country, through national rules and by providing information and suggestions to assist with reductions in local areas.

- In addition to the key pollutant, cadmium (PM_{10}), the only other HAPs monitored whose longer-term concentration estimates are more than ten percent of its lowest comparison level are chromium (PM_{10}) and manganese (PM_{10}).
    - The lowest comparison level for chromium is based on carcinogenic risk to the respiratory system posed by hexavalent chromium,[14] and, as noted above, hexavalent chromium is commonly a small fraction of the total chromium reported. The lowest comparison level for manganese and cadmium are based on non-carcinogenic effects to the nervous system and the kidney, respectively.

[14] 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 D-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 - all means are greater than 10% of the lowest comparison level					
Chromium (PM_{10})	ng/m^3	5.02	3.93 - 6.10	8.3 [e]	100 [e]
Manganese (PM_{10})	ng/m^3	12.5	10.1 - 14.9	NA	50
Non-Key HAPs - all means are lower than 10% of the lowest comparison level					
Arsenic (PM_{10})	ng/m^3	0.63	0.33 - 0.93	23	15
Nickel (PM_{10})	ng/m^3	3.00	1.76 - 4.24	420	90
Antimony (PM_{10})	ng/m^3	1.93	1.66 - 2.20	NA	200
Cobalt (PM_{10})	ng/m^3	0.29	0.21 - 0.36	NA	100
Beryllium (PM_{10})	ng/m^3	0.0047	0.003 - 0.006	42	20
Mercury (PM_{10})	ng/m^3	0.007	0.005 - 0.009	NA	300 [f]
Selenium (PM_{10})[g]	ng/m^3	0.80	0.26 - 1.34	NA	20000
No other HAPs were detected in any other samples.					

ng/m^3 nanograms per cubic meter
NA Not applicable
ND No detection of this chemical was registered by the laboratory analytical equipment.

[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] 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).

[g] Selenium (PM_{10}) was detected in 27 of 46 samples, ranging from 0.02 to 10.6 ng/m^3. The MDL range is between 0.01 and 0.02 ng/m^3.

Appendix E. Harriet Tubman Middle School Pollutant Concentrations.

Parameter	Units	5/27/2011	5/28/2011	5/29/2011	5/30/2011	5/31/2011	6/1/2011	6/2/2011	6/3/2011	6/4/2011	6/5/2011	6/7/2011	6/8/2011	6/9/2011	6/10/2011	6/11/2011	6/12/2011	6/13/2011	6/14/2011	6/15/2011	6/16/2011	6/17/2011	6/18/2011	6/19/2011
Cadmium (PM_{10})	ng/m^3	0.88	0.10	0.19	11.6	1.44	1.27	5.14	12.6	0.08	0.11	0.65	0.16	0.04	0.05	0.04	0.29	0.33	0.07	0.04	4.88	0.06	0.19	0.05
Chromium (PM_{10})	ng/m^3	ND	ND	ND	ND	ND	0.92	1.52	2.66	1.33	0.23	8.27	6.43	5.01	5.84	5.01	5.77	21.4	4.37	5.56	11.2	5.56	4.77	4.71
Manganese (PM_{10})	ng/m^3	4.98	3.09	5.92	3.14	7.16	7.80	8.15	8.67	7.94	9.48	15.5	14.7	11.6	17.5	5.36	6.08	22.5	11.7	19.10	26.2	18.70	7.84	4.03
Arsenic (PM_{10})	ng/m^3	0.39	0.71	1.40	1.10	1.31	0.54	1.10	1.81	0.58	0.84	0.00	0.25	ND	0.14	0.27	0.48	0.23	0.05	0.03	6.53	0.23	0.39	0.24
Nickel (PM_{10})	ng/m^3	2.03	1.90	2.54	1.21	2.45	1.61	1.65	2.62	2.37	2.91	2.45	1.58	1.27	2.06	1.22	2.00	28.5	1.92	3.22	4.08	1.99	5.94	1.00
Antimony (PM_{10})	ng/m^3	3.24	1.83	2.93	2.70	1.85	2.33	2.90	1.73	1.62	1.41	3.21	2.35	0.57	1.33	0.93	2.96	2.72	0.83	2.81	4.11	1.13	2.19	2.00
Cobalt (PM_{10})	ng/m^3	0.34	0.14	0.10	0.26	0.24	0.12	0.70	0.37	0.19	0.44	0.50	0.43	0.18	0.17	0.10	1.57	0.66	0.16	0.16	0.40	0.19	0.09	0.14
Beryllium (PM_{10})	ng/m^3	0.020	0.002	0.003	0.007	0.010	0.004	0.000	0.004	0.010	0.007	0.006	0.010	0.002	0.006	0.002	0.005	ND	0.005	0.003	0.020	0.010	0.006	0.005
Mercury (PM_{10})	ng/m^3	0.003	0.001	0.002	0.006	0.003	0.020	0.010	0.009	0.007	0.010	0.010	0.007	0.002	0.001	ND	0.002	0.001	0.002	0.003	0.010	0.020	0.007	0.001
Selenium (PM_{10})	ng/m^3	0.04	ND	ND	4.14	1.22	0.32	2.25	10.6	ND	ND	0.25	0.10	ND	0.05	ND	0.13	0.16	ND	ND	3.47	ND	ND	0.02

Parameter	Units	6/20/2011	6/21/2011	6/22/2011	6/23/2011	6/24/2011	6/25/2011	6/26/2011	6/27/2011	6/29/2011	6/30/2011	7/1/2011	7/6/2011	7/7/2011	7/8/2011	7/9/2011	7/10/2011	7/11/2011	7/12/2011	7/13/2011	7/14/2011	7/15/2011	7/16/2011	7/17/2011
Cadmium (PM_{10})	ng/m^3	0.20	0.05	0.04	0.05	0.09	0.02	0.09	2.43	1.30	0.56	0.09	0.05	0.05	0.05	0.04	0.07	1.21	2.86	4.51	0.97	1.75	0.05	0.32
Chromium (PM_{10})	ng/m^3	9.16	4.43	3.51	5.41	6.69	5.23	5.21	5.37	11.9	6.21	6.03	4.67	6.06	5.64	4.26	4.89	5.09	6.51	7.03	5.02	4.27	3.72	3.83
Manganese (PM_{10})	ng/m^3	38.7	29.2	11.2	25.8	14.4	4.80	12.6	30.0	19.9	10.0	11.8	13.4	11.3	12.3	5.23	5.74	9.93	9.81	19.30	17.20	8.31	3.01	3.61
Arsenic (PM_{10})	ng/m^3	0.39	0.55	0.13	0.15	0.19	0.42	0.55	1.36	0.28	ND	0.31	0.18	0.04	0.12	0.32	0.33	0.64	0.57	0.50	0.23	2.31	0.27	0.51
Nickel (PM_{10})	ng/m^3	4.88	3.36	1.28	2.70	2.15	1.28	3.73	5.25	9.03	1.56	2.55	1.93	0.92	1.46	0.89	1.17	1.41	1.97	7.09	1.88	1.28	0.58	1.14
Antimony (PM_{10})	ng/m^3	1.71	1.56	0.65	1.58	1.33	0.57	1.30	2.74	3.84	2.72	1.50	0.97	0.80	0.89	0.82	0.65	2.10	2.57	2.42	2.83	2.46	1.81	1.25
Cobalt (PM_{10})	ng/m^3	0.34	0.51	0.22	0.27	0.13	0.10	0.26	0.56	0.44	0.20	0.23	0.32	0.08	0.13	0.13	0.22	0.41	0.13	0.21	0.33	0.17	0.11	0.06
Beryllium (PM_{10})	ng/m^3	0.010	0.010	ND	0.002	0.002	ND	ND	0.009	0.003	ND	ND	0.002	ND	0.007	0.005	0.001	0.003	0.004	0.002	0.004	0.003	0.001	ND
Mercury (PM_{10})	ng/m^3	0.007	0.004	0.006	0.006	0.001	0.010	ND	0.010	0.005	ND	ND	ND	ND	0.030	0.020	0.010	0.007	0.020	0.009	0.010	0.010	0.001	0.010
Selenium (PM_{10})	ng/m^3	ND	ND	0.22	ND	ND	ND	ND	2.04	0.68	0.04	ND	ND	ND	0.18	0.14	0.10	1.49	2.76	1.92	0.57	3.38	0.09	0.31

Key Pollutant

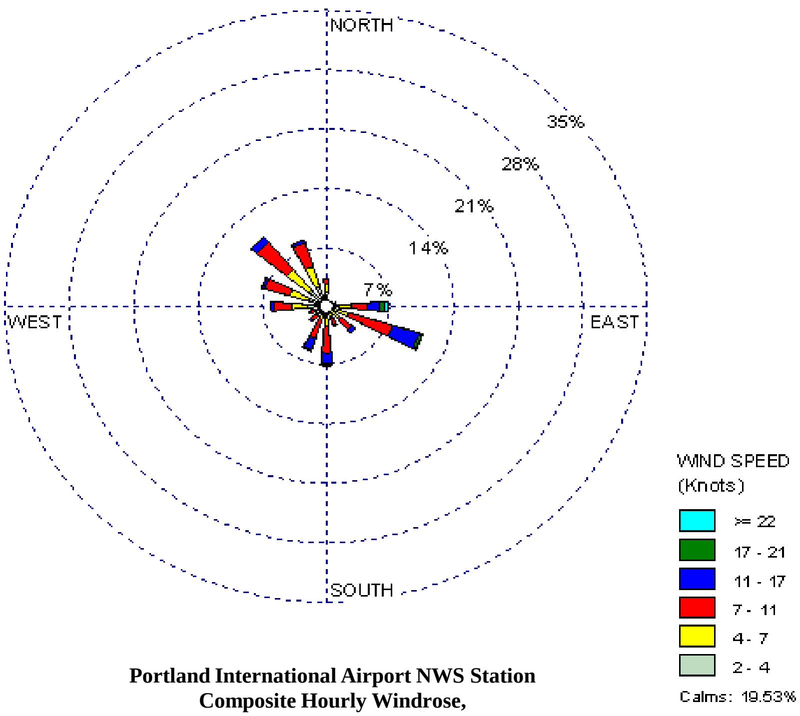
ng/m^3 nanograms per cubic meter

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

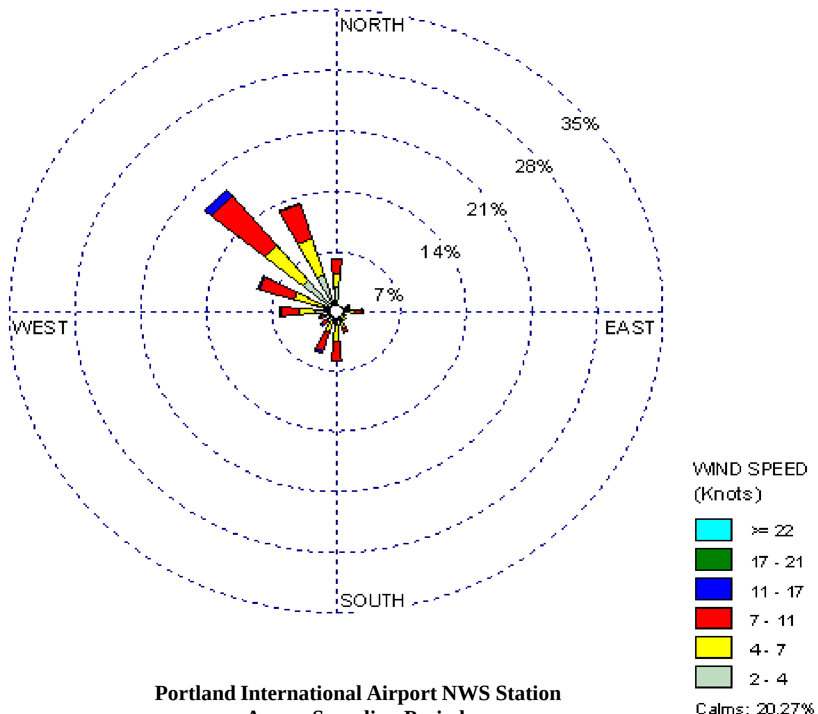
ND No results of this chemical were registered by the laboratory analytical equipment.

[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.

Appendix F. Windroses for Portland International Airport NWS Station.



Portland International Airport NWS Station
Composite Hourly Windrose,
1/1/2002-7/17/2011[1]



Portland International Airport NWS Station
Across Sampling Period
(May 27, 2011-July 17, 2011)[1]

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