

2013

Air Quality Data Summary

August 2014

Working Together for Clean Air

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The 2013 Air Quality Data Summary is available
for viewing or download on the internet at:

www.pscleanair.org

Links to additional documents for download are also available at the web site.



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Executive Summary

The Puget Sound Clean Air Agency (the Agency) reports air quality data every year. The purpose is to summarize regional air quality by presenting air quality monitoring results for six criteria air pollutants and air toxics. The U.S. Environmental Protection Agency (EPA) sets national ambient air quality standards (NAAQS) for the criteria pollutants. The criteria pollutants are:

- Particulate Matter (particles 10 micrometers and 2.5 micrometers in diameter)
- Ozone
- Nitrogen Dioxide
- Carbon Monoxide
- Sulfur Dioxide

Air toxics are defined by Washington State and the Agency to include hundreds of chemicals and compounds that are associated with a broad range of adverse health effects, including cancer.¹ Many air toxics are a component of either particulate matter or volatile organic compounds (a precursor to ozone). The Air Quality Index (AQI) is a nationwide reporting standard for the criteria pollutants. The AQI is used to relate air quality levels to health effects in a simplified way. “Good” AQI days continued to dominate our air quality in 2013. However, air quality degrades into “moderate” or “unhealthy for sensitive groups” for brief periods.

The Agency and the Washington State Department of Ecology (Ecology) work together to monitor air quality within the Puget Sound region.² The Agency’s jurisdiction includes King, Snohomish, Pierce, and Kitsap counties. Real-time air monitoring data are available for pollutants at pscleanair.org/airquality/ourairquality/Pages/currentaq.aspx. To receive the Agency's most updated news and stay current on air quality issues in King, Kitsap, Pierce and Snohomish counties, visit pscleanair.org/contact/Pages/connect.aspx and select your favorite news feed method. Friends and subscribers receive the latest on air quality news and updates on projects in the Puget Sound region. You can also find us on Facebook and Twitter.

Data included in this report are for our “fixed” (relatively stable) monitoring network. We also undertake local, seasonal monitoring studies – you can see these study results on our website at <http://www.pscleanair.org/>.

The Agency and Ecology continued to monitor the region’s air quality in 2013. Over the last two decades, many pollutant levels have declined and air quality has improved. While air quality is improving, we face new challenges. The Environmental Protection Agency (EPA) regularly revises national ambient air quality standards as directed by the Clean Air Act to protect public health.

¹Washington Administrative Code 173-460. See Table of Toxic Air Pollutants, WAC 173-425-150.
apps.leg.wa.gov/WAC/default.aspx?cite=173-460-150

²The Agency’s jurisdiction covers King, Kitsap, Pierce, and Snohomish Counties in Washington State.

Elevated fine particle levels pose the greatest air quality challenge in our jurisdiction. While fine particle levels met EPA's health-based standard of 35 micrograms per cubic meter in 2013, sites in three of four counties (King, Pierce and Snohomish) continued to exceed the Agency's more stringent local PM_{2.5} health goal of 25 micrograms per cubic meter. In 2013, our Kitsap County monitor met the Agency's local PM_{2.5} health goal.

Ozone levels remain a concern in our region. Over the last decade, ozone concentrations have not decreased as significantly as other pollutants. The Enumclaw Mud Mountain monitor has the highest regional ozone concentrations. EPA is expected to propose a more protective health-based standard in 2014.

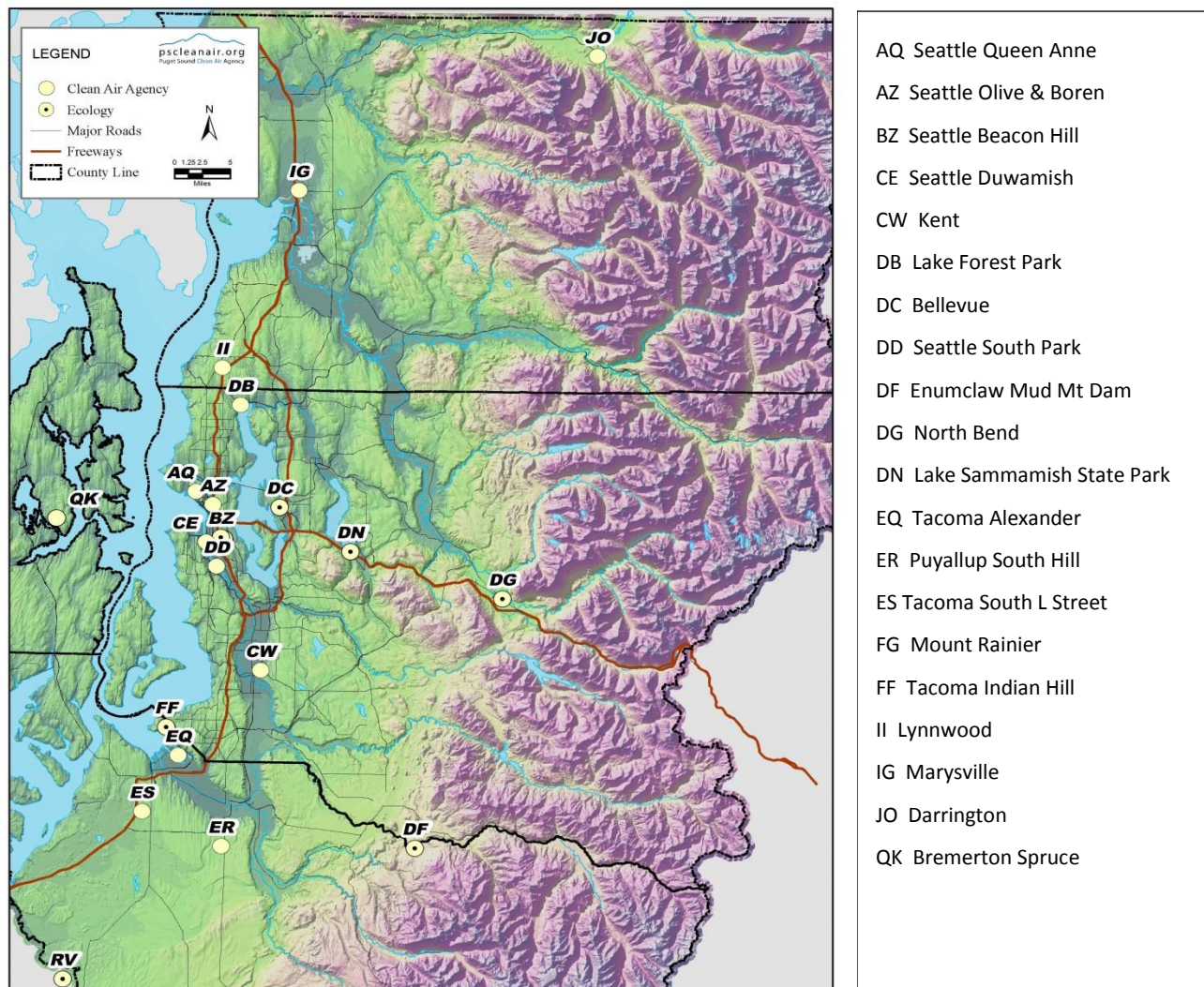
Air toxics were present in our air at levels that posed adverse health effects. These health effects include, but are not limited to, increased cancer risk and respiratory effects.

The Agency's jurisdiction is currently in attainment for carbon monoxide, ozone, lead, sulfur dioxide, and PM₁₀. In 2013, we have one nonattainment area (the Tacoma-Pierce County PM_{2.5} area).

Monitoring Network

The Agency and Ecology operated the Puget Sound region's monitoring network in 2013. The network is comprised of meteorological, pollutant-specific equipment, and equipment for special studies. Data from the network are normally collected automatically via the Ecology data network, or in some cases, collected manually by field staff. Monitoring stations are located in a variety of geographic locations in the Puget Sound region. Monitors are sited according to EPA criteria to ensure a consistent and representative picture of air quality.

King, Pierce, Snohomish, and Kitsap County monitoring sites used in 2013 are shown in Map 1 and Table 1, Monitoring Network for 2013. A more interactive map is available at <http://www.pscleanair.org/airquality/ourairquality/Pages/currentaq.aspx>.



The Ozone site (FG) located in Mount Rainier National Park is not shown on this map.

Table 1: Air Quality Monitoring Network Parameters 2013

| Station ID | Location | PM _{2.5} ref | PM _{2.5} Spec | PM _{2.5} FEM | PM _{2.5} Is | PM _{2.5} bc | O ₃ | SO ₂ | NO _y | CO | b _{sp} | Wind | Temp | AT | Vsby | Location |
|------------|---|-----------------------|------------------------|-----------------------|----------------------|----------------------|----------------|-----------------|-----------------|----|-----------------|------|------|----|------|----------|
| AQ | Queen Anne Hill, 400 W Garfield St, Seattle (photo/visibility included) | | | | ● | | | | | | ● | ● | ● | | ● | a, d, f |
| AZ | Olive Way & Boren Ave, 1624 Boren Ave, Seattle | | | | ● | | | | | | ● | ● | ● | | ● | a, d |
| BW ☉ | Beacon Hill, 4103 Beacon Ave S, Seattle | ● | ● | ● | | | ● | ● | ● | ● | | ● | ● | ● | | b, d, f |
| CE | Duwamish, 4401 E Marginal Way S, Seattle | | | ● | ● | ● | | | | | ● | ● | ● | | ● | a, e |
| CW | James St & Central Ave, Kent | | | ● | ● | ● | | | | | ● | ● | ● | | ● | b, d |
| DB | 17171 Bothell Way NE, Lake Forest Park | | | | ● | | | | | | ● | ● | | | ● | b, d, f |
| DC ☉ | 305 Bellevue Way NE, Bellevue | | | | ● | | | | | | ● | | | | ● | a, d |
| DD | South Park, 8201 10 th Ave S, Seattle | | | | ● | | | | | | ● | | | | ● | b, e, f |
| DF ☉ | 30525 SE Mud Mountain Road, Enumclaw | | | | | | ● | | | | | ● | ● | | | c |
| DG ☉ | 42404 SE North Bend Way, North Bend | | | | ● | | ● | | | | ● | ● | ● | | ● | c, d, f |
| DN ☉ | 20050 SE 56 th , Lake Sammamish State Park, Issaquah | | | | | | ● | | | | | | | | | b, d |
| EQ | Tacoma Tideflats, 2301 Alexander Ave, Tacoma | | | | ● | ● | | | | | ● | ● | | | ● | a, e |
| ER | South Hill, 9616 128 th St E, Puyallup | | | | ● | ● | | | | | ● | ● | ● | | ● | b, f |
| ES | 7802 South L St, Tacoma | ● | ● | ● | ● | ● | | | | | ● | ● | ● | | ● | b, f |
| FF ☉ | Tacoma Indian Hill, 5225 Tower Drive NE, northeast Tacoma | | | | | | | | | | | ● | ● | | | b, f |
| FG ☉ | Mt Rainier National Park, Jackson Visitor Center | | | | | | ● | | | | | | | | | c |
| IG | Marysville JHS, 1605 7 th St, Marysville | | ● | ● | ● | ● | | | | | ● | ● | ● | | ● | b, d |
| II | 6120 212 th St SW, Lynnwood | | | ● | ● | | | | | | ● | ● | ● | | ● | b, d |
| JO | Darrington High School, Darrington 1085 Fir St | | | ● | ● | | | | | | ● | ● | ● | | ● | d, f |
| QK | Spruce, 3250 Spruce Ave, Bremerton | | | ● | ● | | | | | | ● | ● | ● | | ● | b, f |

| | | | |
|------------------------|--|-----------------|---|
| ⊙ | Station operated by Ecology | SO ₂ | Sulfur Dioxide |
| ● | Indicates parameter currently monitored | NO _y | Nitrogen Oxides |
| PM _{2.5} ref | Particulate matter <2.5 micrometers (reference) | CO | Carbon Monoxide |
| PM _{2.5} Spec | Speciation | b _{sp} | Light scattering by atmospheric particles (nephelometer) |
| PM _{2.5} FEM | Particulate matter <2.5 micrometers (teom-fdms continuous) | Wind | Wind direction and speed |
| PM _{2.5} ls | Particulate matter <2.5 micrometers (light scattering nephelometer continuous) | Temp | Air temperature (relative humidity also measured at BW, IG, ES) |
| PM _{2.5} bc | Particulate matter <2.5 micrometers black carbon (light absorption aethalometer) | AT | Air Toxics |
| O ₃ | Ozone (May through September except Beacon Hill and Mt Rainier) | VSBY | Visual range (light scattering by atmospheric particles) |
| Location | | PHOTO | Visibility (camera) |
| a | Urban Center | | |
| b | Suburban | | |
| c | Rural | | |
| d | Commercial | | |
| e | Industrial | | |
| f | Residential | | |

The Agency conducted monitoring as early as 1965. A summary of the monitoring stations and parameters used over the history of the program is on page A-6 of the Appendix. The network changes periodically because the Agency and Ecology regularly re-evaluate monitoring objectives, resources and logistics.

A list of the methods used for monitoring the criteria pollutants is shown on page A-9 of the Appendix. Additional information on these methods is available at EPA's website at epa.gov/ttn/amtic/. Information on air toxics monitoring methods is available at epa.gov/ttn/amtic/airtox.html.

Air Quality Index

EPA established the air quality index (AQI) as a simplified index for reporting daily air quality. It tells you how clean or polluted your air is and what associated health effects might be a concern for you. The AQI focuses on health effects that you may experience within a few hours or days after breathing polluted air. EPA calculates the AQI for five major air pollutants regulated by the Clean Air Act: ground-level ozone, particle pollution (also known as particulate matter), carbon monoxide, sulfur dioxide and nitrogen dioxide.

Think of the AQI as a yardstick that runs from 0 to 500. As the AQI increases, the level of air pollution and the health concern increases. An AQI value of 100 generally corresponds to the national air quality standard for the pollutant, which is the level EPA has set to protect public health. AQI values below 100 are generally thought of as satisfactory. When AQI values are above 100, air quality is considered unhealthy first for certain sensitive groups of people, then for everyone as AQI values get higher.

The purpose of the AQI is to help people understand what local air quality means to health. To make it easier to understand, the AQI is divided into six categories:

| Air Quality Index (AQI) Values | Levels of Health Concern | Colors |
|--------------------------------|---------------------------------------|--------------------------------|
| <i>When the AQI is:</i> | <i>...air quality condition is:</i> | <i>...look for this color:</i> |
| 0 – 50 | Good | Green |
| 51 – 100 | Moderate | Yellow |
| 101 – 150 | Unhealthy for Sensitive Groups | Orange |
| 151 – 200 | Unhealthy | Red |
| 201 – 300 | Very Unhealthy | Purple |
| 301 - 500 | Hazardous | Maroon |

GOOD AQI is 0 – 50: Air pollution poses little or no risk.

MODERATE AQI is 51 – 100: Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people. For example, people who are unusually sensitive to ozone may experience respiratory symptoms.

UNHEALTHY FOR SENSITIVE GROUPS AQI is 101 – 150: Although the general public is not likely to be affected at this AQI range, people with lung disease, older adults and children are at a greater risk from exposure to ozone, whereas persons with heart and lung disease, older adults and children are at greater risk from the presence of particles in the air. .

UNHEALTHY AQI is 151 – 200: Everyone may begin to experience some adverse health effects, and members of the sensitive groups may experience more serious effects.

VERY UNHEALTHY AQI is 201 – 300: This would trigger a health alert signifying that everyone may experience more serious health effects.

HAZARDOUS is AQI greater than 300: This would trigger a health warning of emergency conditions. The entire population is more likely to be affected.

Table 2 shows the AQI breakdown by percentage in each category for 2013. King County registered the highest daily AQI value of 152 on November 28th, which was PM_{2.5}. PM_{2.5} normally determines the AQI in the Puget Sound area on days considered unhealthy for sensitive groups.

Table 2: AQI Ratings for 2013

| County | AQI Rating (% of year) | | | | Highest AQI |
|-----------|------------------------|----------|--------------------------------|-----------|-------------|
| | Good | Moderate | Unhealthy for Sensitive Groups | Unhealthy | |
| Snohomish | 74% | 25% | 1% | 0% | 115 |
| King | 61% | 38% | 1% | 0% | 152 |
| Pierce | 79% | 19% | 2% | 0% | 116 |
| Kitsap | 96% | 4% | 0% | 0% | 75 |

EPA's main intent with development of the AQI is that it is used as a daily indicator or forecast of air quality – it's most useful when used this way. This local, almost-real-time information can be found here: pscleanair.org/airquality/ourairquality.

Most days in the Puget Sound region are in the "Good" category, but local meteorological conditions, along with polluting sources, cause levels to rise into "Moderate" or above. See the appendix for more information on the AQI.

Figure 1: Number of Days Air Quality Rated As "Good" Per AQI

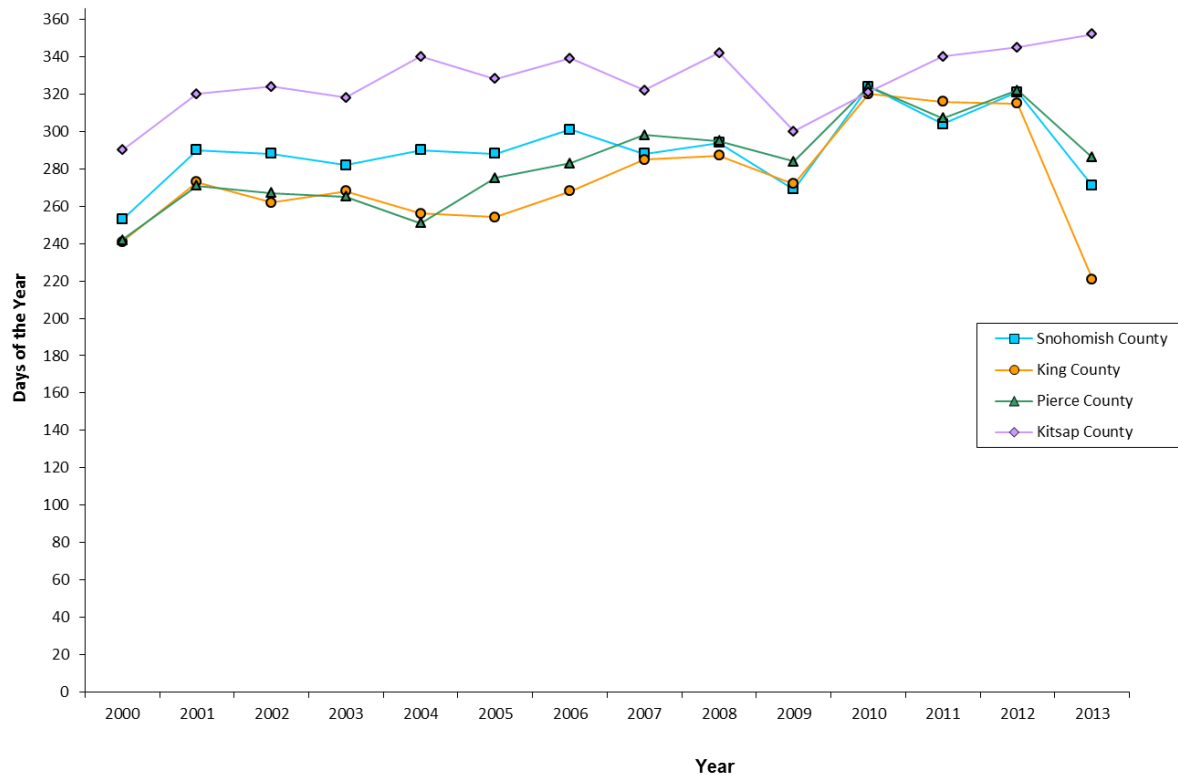


Figure 1 (above) shows the number of days that the AQI fell into the Good category for each of the four counties of our jurisdiction. In 2012 the EPA tightened PM_{2.5} NAAQS, therefore the AQI calculation changed. The drop in number of “Good” AQI days is a result of the AQI calculation change, not a degradation of regional air quality.

Pages A-1 through A-8 of the Appendix present summaries for each county which include “good”, “moderate”, “unhealthy for sensitive groups”, and “unhealthy” days from 1990 to 2013.

Particulate Matter

"Particulate matter," also known as particle pollution or PM, is a complex mixture of extremely small particles and liquid droplets. Particle pollution consists of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles.

EPA groups particle pollution into two categories. "Inhalable coarse particles," such as those found near roadways and dusty industries, are larger than 2.5 micrometers and smaller than 10 micrometers in diameter. "Fine particles," such as those found in smoke and haze, are 2.5 micrometers in diameter and smaller.

PM₁₀

The Agency ceased direct PM₁₀ monitoring in 2006 and focused its efforts on PM_{2.5} monitoring. For a historic look at Puget Sound area PM₁₀ levels, please see pages 32-35 of the 2007 data summary which is available upon request.

PM_{2.5} Health and Environmental Effects

An extensive body of scientific evidence shows that exposure to particle pollution is linked to a variety of significant health problems, such as increased hospital admissions and emergency department visits for cardiovascular and respiratory problems, including non-fatal heart attacks and premature death. Older adults, children, pregnant women, and those with pre-existing health conditions are more at risk from exposure to particle pollution. Particle pollution also contributes to haze in cities and some of our nation's most treasured national parks.

Fine particles are emitted directly from a variety of sources, including wood burning (both outside, and in wood stoves and fireplaces), vehicles and industry. They also form when gases from some of these same sources react in the atmosphere.

PM_{2.5}– Federal Reference Method and Continuous Methods

Fine particulate matter (PM_{2.5}) is measured using a variety of methods to ensure quality and consistency. EPA defined the federal reference method (FRM) to be the method used to determine PM_{2.5} concentrations. The reference method is a filter-based method. EPA further defined several federal equivalent methods (FEM), which are continuous instruments operated under specific standard operating procedures. The continuous FEM's advantage is that it provides highly time resolved data (hourly averages).

The Agency uses the FRM, the FEM and a Nephelometer estimation method to provide data. These methods determine fine particulate matter concentration differently:

- The FRM method involves pulling in air (at a given flow rate) for a 24-hour period and collecting particles of a certain size (in this case PM_{2.5}) on a filter. The filter is weighed and the

mass is divided by air volume (determined from flow rate and amount of time) to provide concentration. Particles on the filter can later be analyzed for more information about the types of particulate matter.

- The tapered element oscillating microbalance (TEOM-FDMS) method measures mass and uses a filter dynamic measurement system to eliminate moisture measurements from the sample, allowing the mass to be converted. This is a Federal Equivalent Method (FEM) for PM_{2.5}.
- The nephelometer uses scattering of light in a photomultiplier tube, which is then compared to Reference and Equivalent method data to produce an estimate of PM_{2.5}. While light scattering has been proven to correlate well with PM_{2.5}, this is an “unofficial” method using a surrogate.

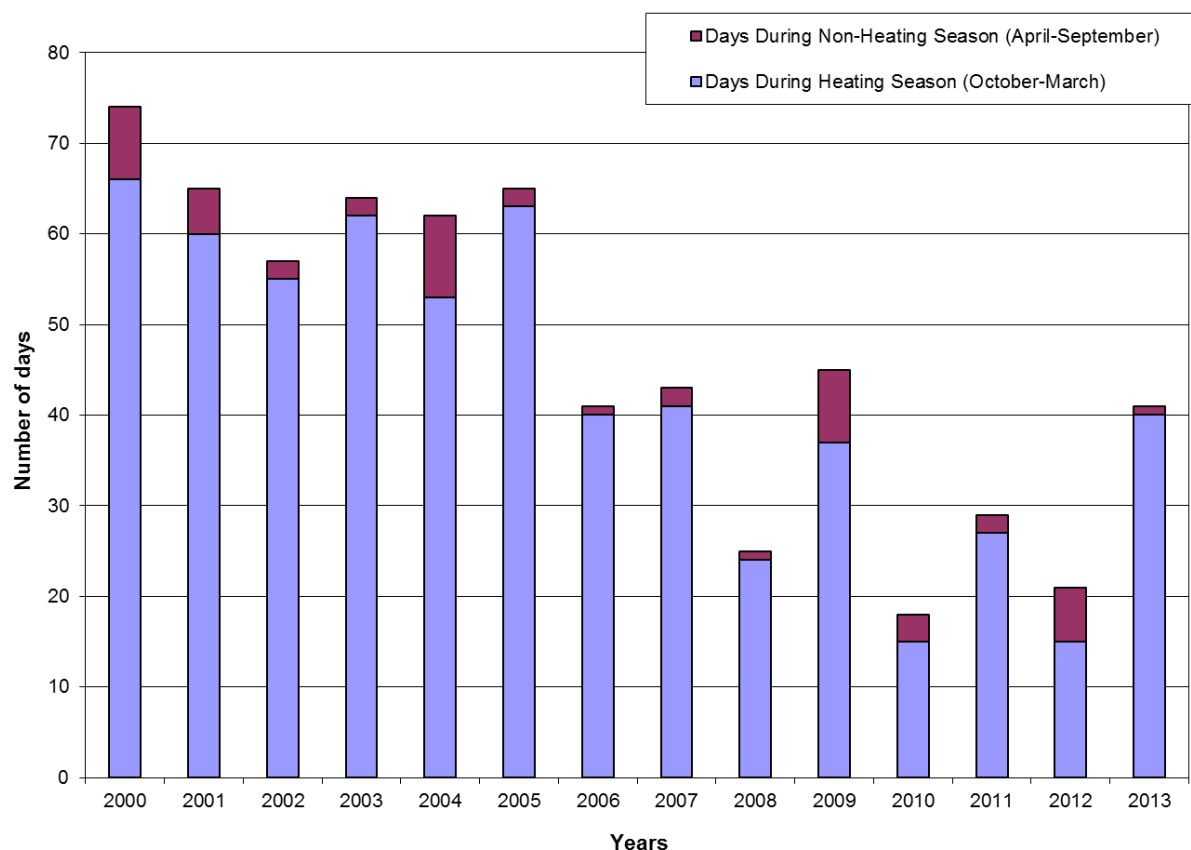
The Agency and Ecology work together to evaluate the TEOM-FDMS technology as compared to the reference method. Ecology reports the data to EPA as full equivalent method data.

PM_{2.5} Daily Federal Standard and Health Goal

The EPA set a daily health-based fine particle standard of 35 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$). Monitors in all four counties met this standard in 2013. In addition to the federal standard, our Board of Directors adopted a more stringent health goal based on recommendations from our Particulate Matter Health Committee. Monitors in King, Pierce and Snohomish exceeded the local health goal of 25 $\mu\text{g}/\text{m}^3$ during the 2013 winter season. Our monitor in Kitsap County achieved the local health goal.

Figure 2 shows the number of days the health goal was exceeded annually in the region, from 2000 to 2013. The shading demonstrates that our highest fine particulate days overwhelmingly take place during the winter wood heating months. While the graph indicates that we have made progress reducing the number of days we exceed the health goal, it also shows that we are falling short of our goal of having zero days exceeding the health goal, especially during winter months.

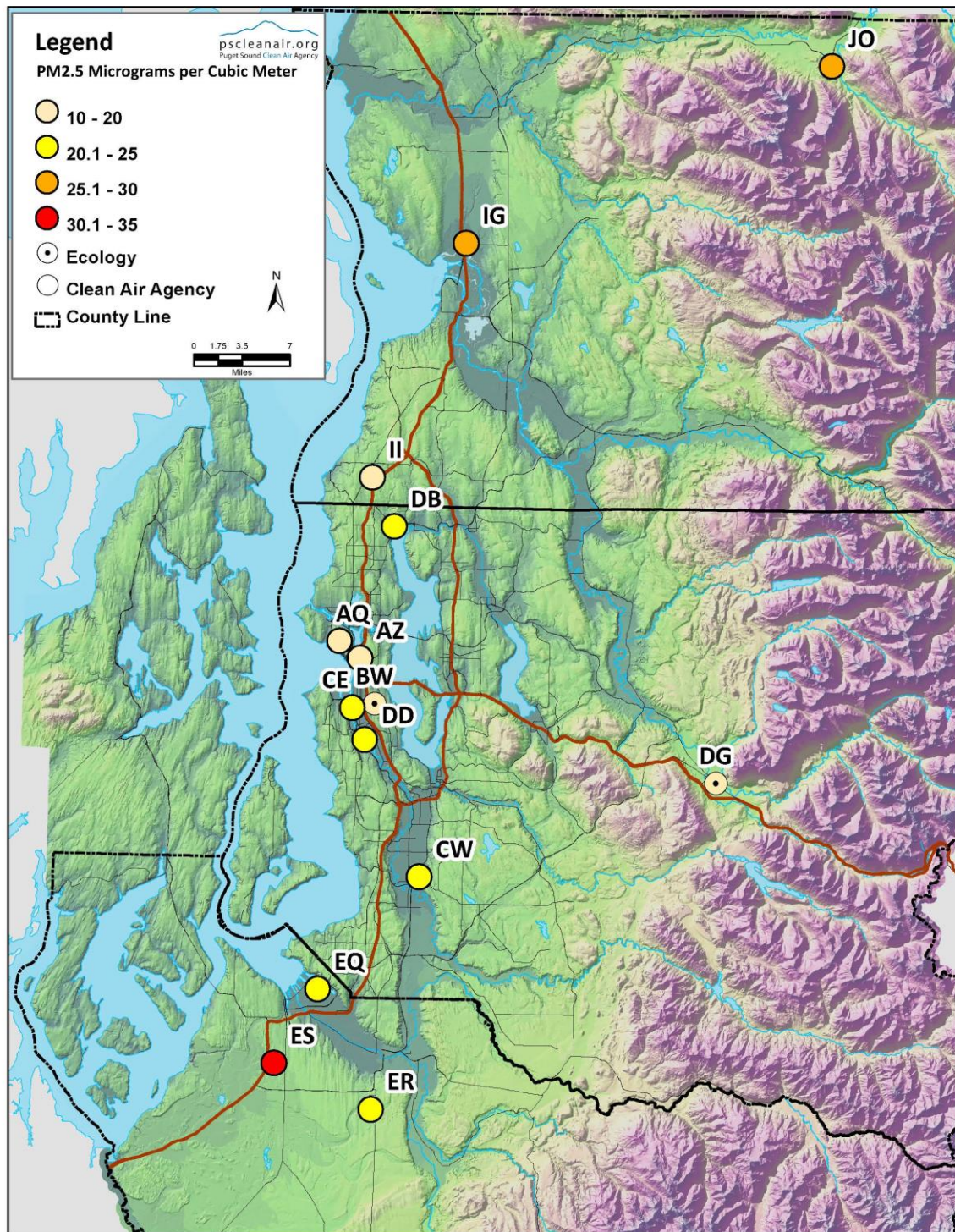
Figure 2: Days Exceeding the PM_{2.5} Health Goal at One or More Monitoring Sites



Includes data from all sites in King, Kitsap, Pierce, and Snohomish counties, both daily and continuous methods. The Darrington monitor was added in 2004.

Map 2 shows the 98th percentile of the 3-year average of daily PM_{2.5} concentrations. The map includes only those monitoring sites with three years of complete data from 2010 to 2013. This map incorporates data collected from federal reference, federal equivalent, and nephelometer estimate methods.

Map 2: The 98th Percentile 3-Year Average Daily PM_{2.5} Concentrations for 2013

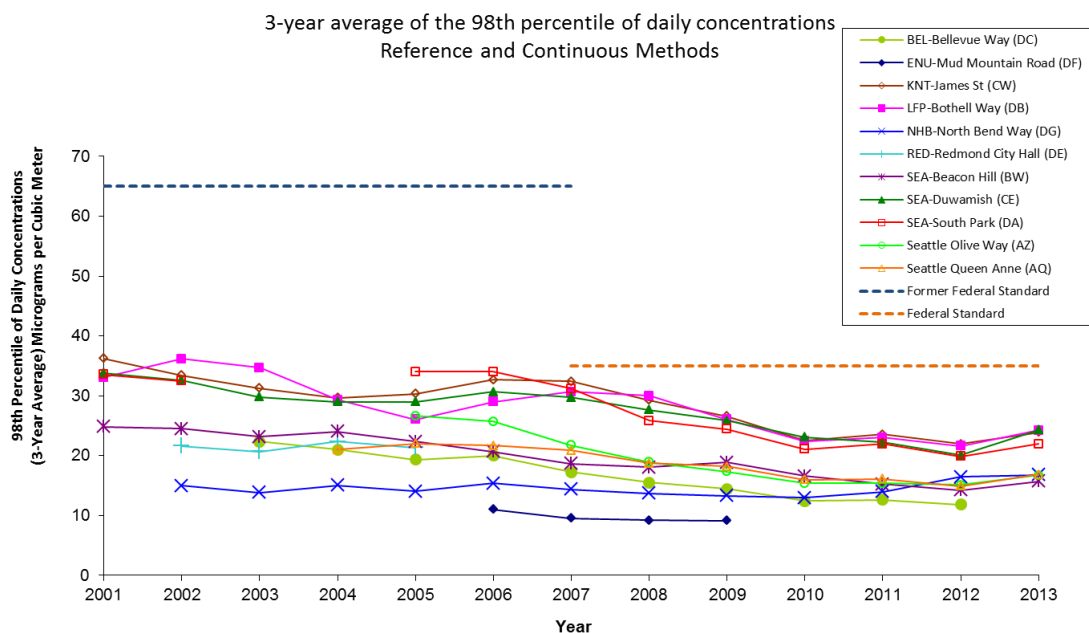


Figures 3 through 6 show daily 98th percentile 3-year averages at each monitoring station in King, Kitsap, Pierce, and Snohomish Counties compared to the current daily federal standard – all are below the standard in 2013. Points on the graphs represent averages for three consecutive years. For example, the value for 2013 is the average of the 98th percentile daily concentration for 2011, 2012, and 2013. These figures incorporate data collected from federal reference, federal equivalent, and nephelometer estimate methods.

Figure 4 does not include a three-year average for Kitsap County in 2008-2010, 2012-2013 because the monitor did not meet data completeness criteria or the monitoring site was moved. Kitsap County data shows that PM_{2.5} levels are below the federal standard.

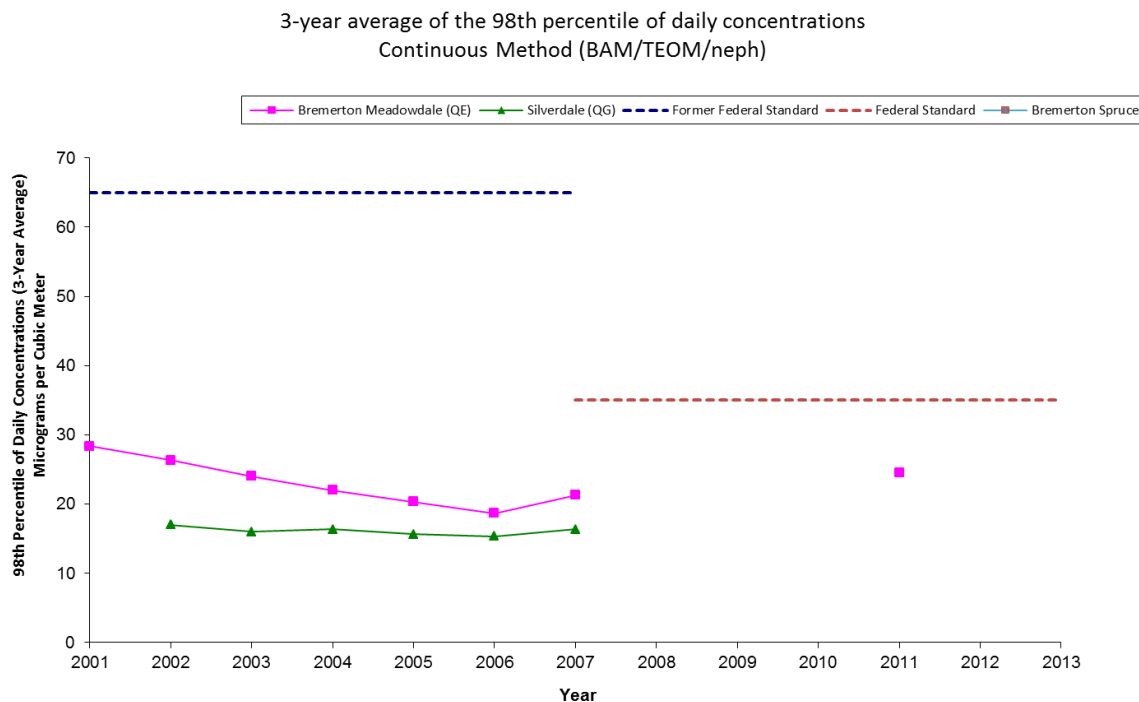
Statistical summaries for 98th percentile daily concentrations for 2013 data are provided on page A-15 through A-17 of the Appendix.

Figure 3: Daily PM_{2.5} for King County



Note: Duwamish (CE) data are FRM from 1999-2009, nephelometer 2010, TEOM-FEM 2011-2013. Beacon Hill (BW) data are FRM from 1999-2013. Lake Forest Park (DB) data are FRM from 1999-2007, neph in 2008-2013. South Park (DA) data are FRM from 1999-2002, (3 yr avg 2004-06 was FRM in 2004, neph in 2005-2013). Bellevue Way (DC) data are FRM from 2001-2004, neph 2005-12. Redmond (DE) data are FRM from 2000-2002, neph from 2003-2005. Queen Anne (AQ) data are neph from 2002-2013. Olive Way (AZ) data are neph from 2003-2013. North Bend (DG) data are FRM from 2000-2004, neph in 2005-2013. Kent (CW) data are FRM from 1999-2004, neph in 2005-2010, TEOM-FEM 2011-2013. Enumclaw (DF) data are from neph in 2000-2009.

Figure 4: Daily PM_{2.5} for Kitsap County



75% of data is required to calculate 98th percentile. Insufficient data available for 2008 so 3 year calculation not available for 2008-2010. 2011-2013 data are TEOM-FEM. Meadowdale site ended 4/30/12, Spruce site began 5/1/2012, 3 year calculation not available.

Figure 5: Daily PM_{2.5} for Pierce County

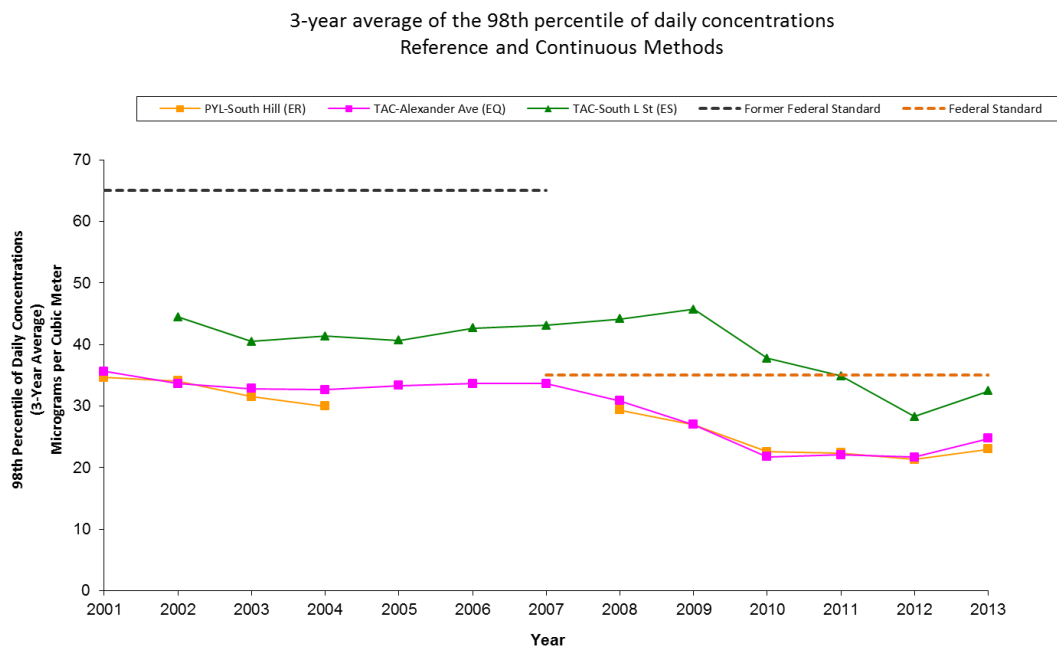
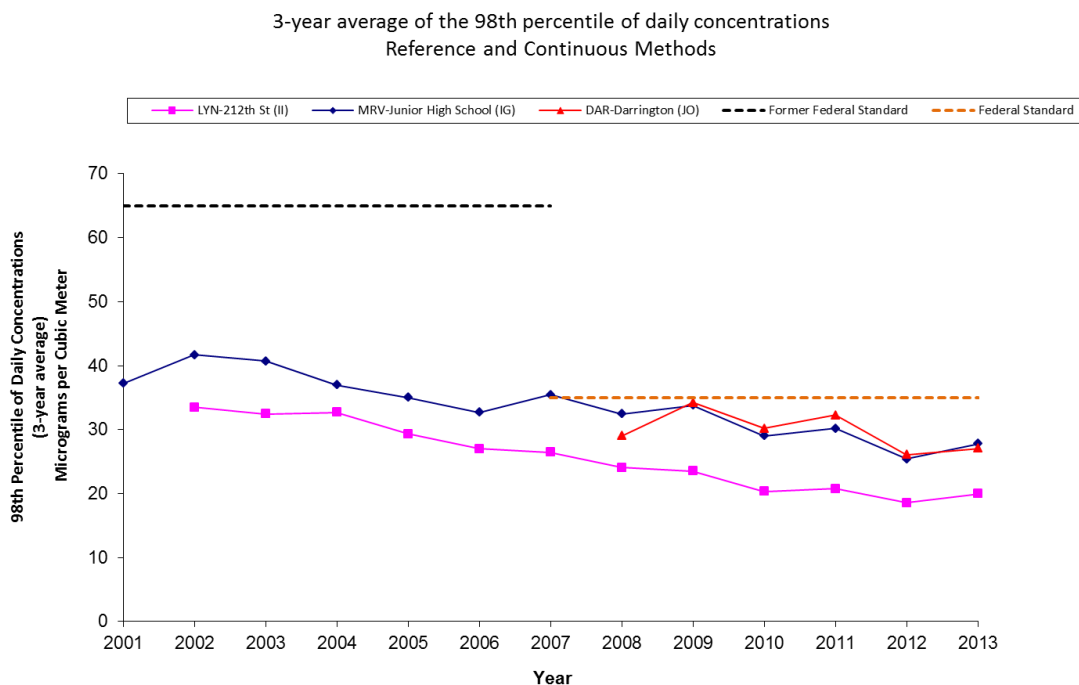


Figure 6: Daily PM_{2.5} for Snohomish County

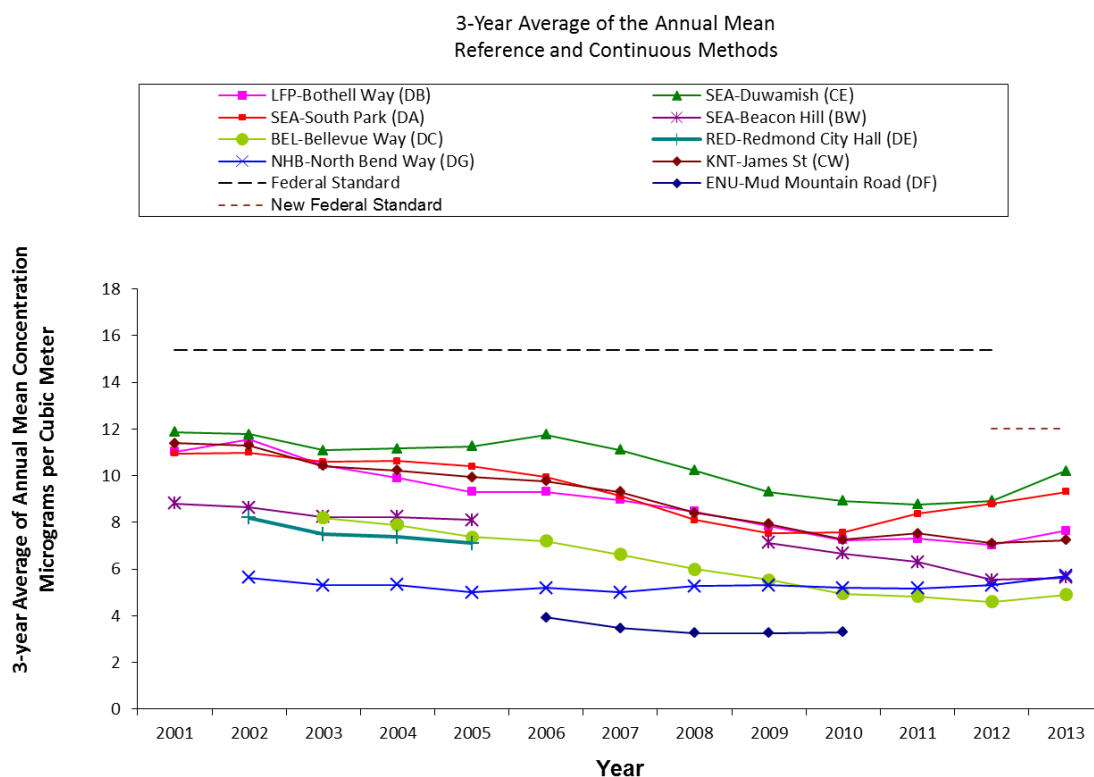


PM_{2.5} Annual Federal Standard

Figures 7 through 10 show 3-year annual averages at each monitoring station for King, Kitsap, Pierce and Snohomish Counties. In 2012, the EPA strengthened the annual standard from 15 micrograms per cubic meter to 12 micrograms per cubic meter. All counties have levels below the annual standard of 12 micrograms per cubic meter and all counties are in attainment for the annual standard. Figure 8 does not show any 2008, 2009, 2010, 2012 or 2013 data for Kitsap County because the monitor did not achieve data completeness criteria or the monitoring site was relocated.

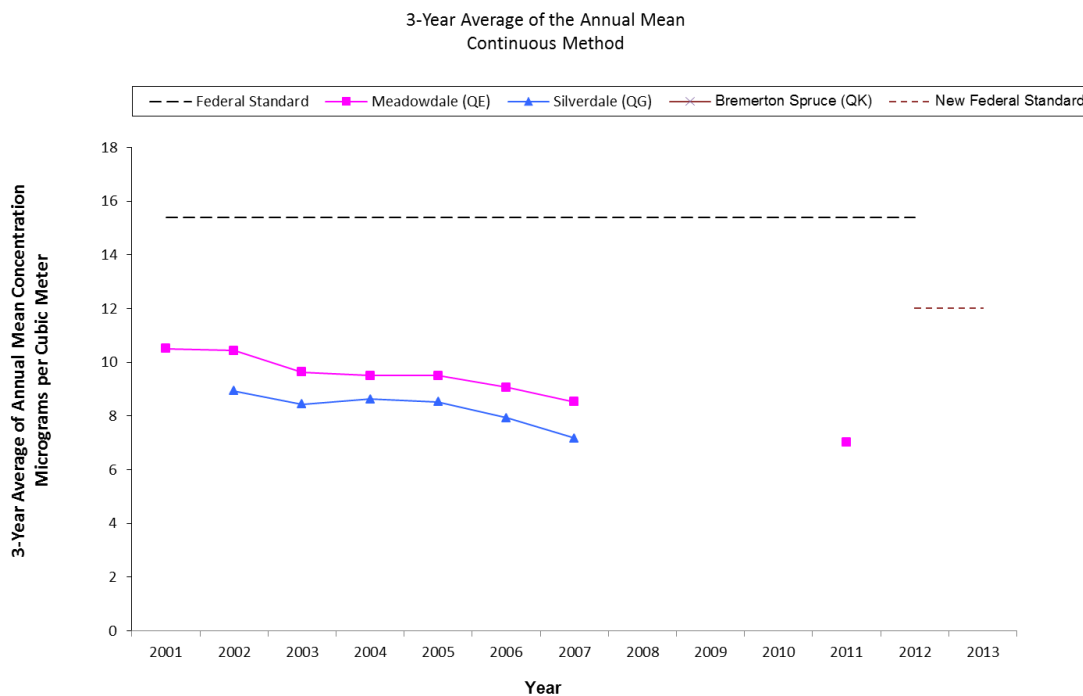
Figures 7 through 10 show data from the federal reference method (FRM) and continuous method monitors. The federal standard is based on a 3-year average, so each value on the graph is an average for three consecutive years. For example, the value shown for 2013 is the average of the annual averages for 2011, 2012, and 2013.

Figure 7: Annual PM_{2.5} for King County



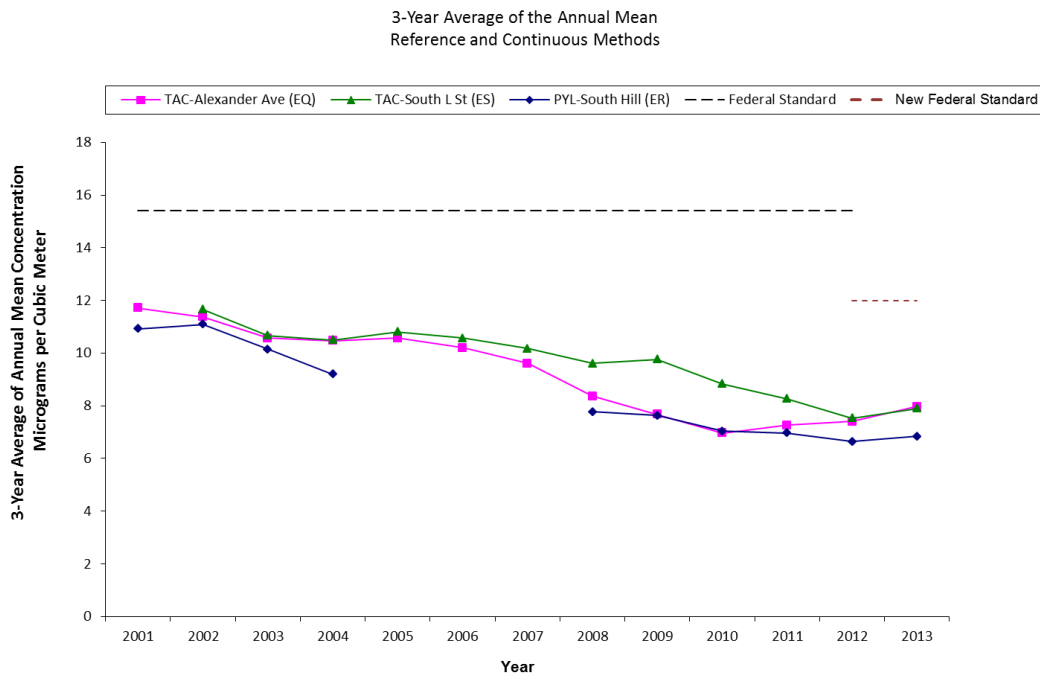
Note: Lake Forest Park (DB) data are FRM from 1999-2007, nephelometer in 2008-2013. Beacon Hill (BW) data are FRM from 1999-2013. Duwamish (CE) data are FRM from 1999-2009, nephelometer 2010, TEOM-FEM 2011-2013. South Park (DA) data are FRM from 1999-2002, nephelometer from 2003-2013. Redmond (DE) data are FRM from 2000-2002, nephelometer from 2003-2005. Bellevue Way (DC) data are FRM from 2001-2003, nephelometer from 2004-2013. Kent (CW) data are FRM from 1999-2003, nephelometer 2004-2010, TEOM-FEM 2011-2013. North Bend (DG) data are FRM 2000-2004, nephelometer in 2005. Enumclaw data are FRM in 2004, nephelometer in 2005-2013.

Figure 8: Annual PM_{2.5} for Kitsap County



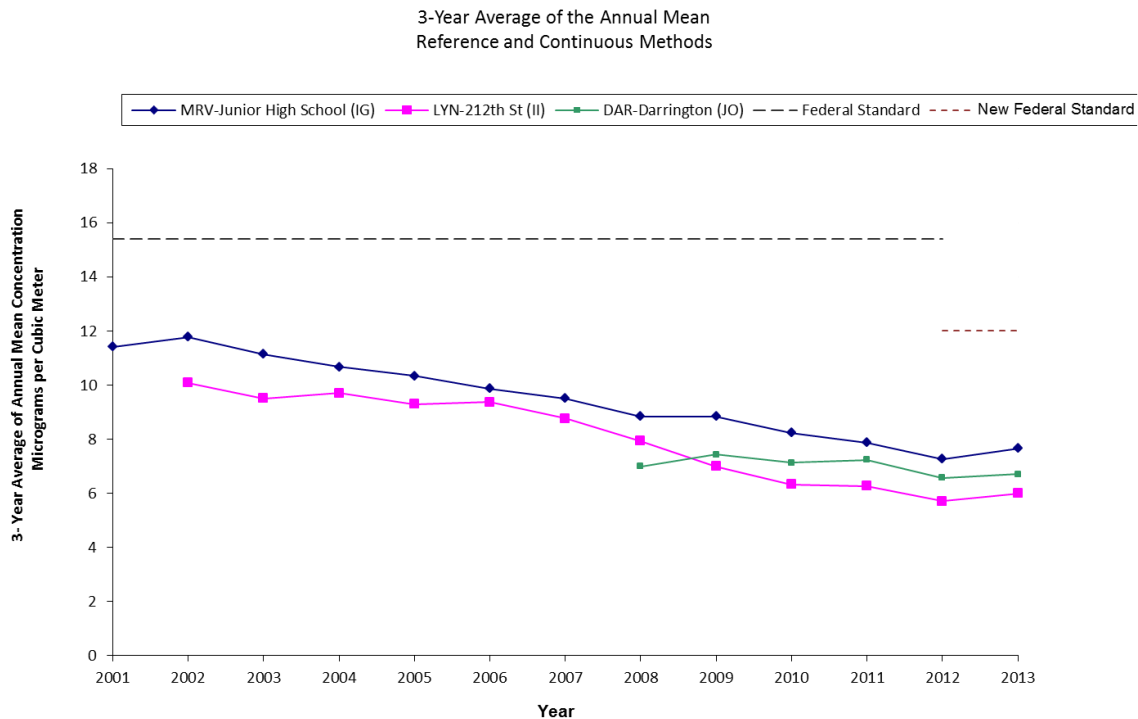
Note: Meadowdale and Silverdale data are BAM (Beta Attenuation Monitor) 1999-2005, nephelometer 2006-2010, TEOM-FEM 2011-2013. Insufficient data in 2008 resulted in the inability to calculate a 3 year average for 2008, 2009, 2010. The Spruce site began in 2012 and insufficient data is available to calculate a 3 year average.

Figure 9: Annual PM_{2.5} for Pierce County



Note: South L St. (ES) data are FRM. South Hill (ER) data are FRM from 1999-2002. South Hill (ER) data 2003, 2004, 2008-2013 was measured with a nephelometer. Alexander Ave (EQ) data are FRM from 1999-2002, nephelometer from 2003-2010, and TEOM-FEM 2011-2013.

Figure 10: Annual PM_{2.5} for Snohomish County



Note: Marysville (IG) data are FRM from 1999-2011, TEOM-FEM 2013. Lynnwood (II) data are FRM except 2004, 2007-2011, TEOM-FEM 2012-2013. The 2004, 2007-2011 values for Lynnwood were measured with a nephelometer. Darrington (JO) data are neph in 2006, FRM in 2007 - 2011, TEOM-FEM 2012-2013.

PM_{2.5} Continuous Data and Seasonal Variability

Continuous monitoring data provide information on how concentration levels vary throughout the year. For example, many sites have elevated PM_{2.5} levels during the winter when residential burning and air stagnations are at their peak, but have low levels of PM_{2.5} during the summer. For more detailed information on continuous data, please see the Airgraphing tool at <http://airgraphing.pscleanair.org/> to plot the sites and timeframes of interest.

Particulate Matter – PM_{2.5} Speciation and Aethalometers

Although there are no regulatory requirements to go beyond measuring the total mass of fine particulate matter, it is important to know the chemical makeup of particulate matter in addition to its mass. Knowledge about the composition of fine particulate can help to guide emission reduction strategies. Information on fine particulate composition helped guide the Agency's commitment to reduce wood smoke and diesel particulate emissions.^{3,4,5}

Speciation Monitoring and Source Apportionment

Speciation monitoring involves determining the individual fractions of metals and organics in fine particulate matter on different types of filters. Speciation filters are analyzed to determine the makeup of fine particulate at that site. Over 40 species are measured at speciation monitors in the area. These data are used in source apportionment models to estimate contributing sources to PM_{2.5}. Source apportionment models use statistical patterns in data to identify likely pollution sources and then estimate how much each source is contributing at each site.

Ecology conducted speciation monitoring at three monitoring sites in the Puget Sound region in 2013:

- Seattle Beacon Hill – typical urban impacts, mixture of sources (speciation samples collected every third day, operated by Ecology)
- Tacoma South L – urban residential area, impacts from residential wood combustion (speciation samples collected every sixth day, operated by Ecology)
- Marysville – residential area, impacts from wood combustion (speciation samples collected every sixth day, operated by Ecology)

Scientific and health researchers have analyzed speciation data from these sites. In addition to using speciation data for concentrations of specific species or source apportionment modeling, the Agency uses them to qualitatively look at the makeup of fine particulate at our monitoring sites. For a list of PM_{2.5} analytes measured at these sites, please see Appendix A-18.

Aethalometer Data

Aethalometers provide information about the carbon fraction of fine particulate matter. Aethalometers continuously measure light absorption to estimate carbon concentrations using two channels, black carbon (BC) and ultraviolet (UV). Concentrations from the black carbon channel correlate well with elemental carbon (EC) speciation data. Qualitatively, the difference between the UV and BC channel (UV-BC) correlates well with organic carbon (OC) speciation data. Elemental and organic carbons are related to diesel particulate, wood smoke particulate and particulate from other

³Puget Sound Air Toxics Evaluation, October 2003.

⁴Tacoma and Seattle Air Toxics Evaluation, October 2010:
epa.gov/ttn/amtic/files/20072008csatam/PSCAA_CommunityAssessment_FR.pdf.

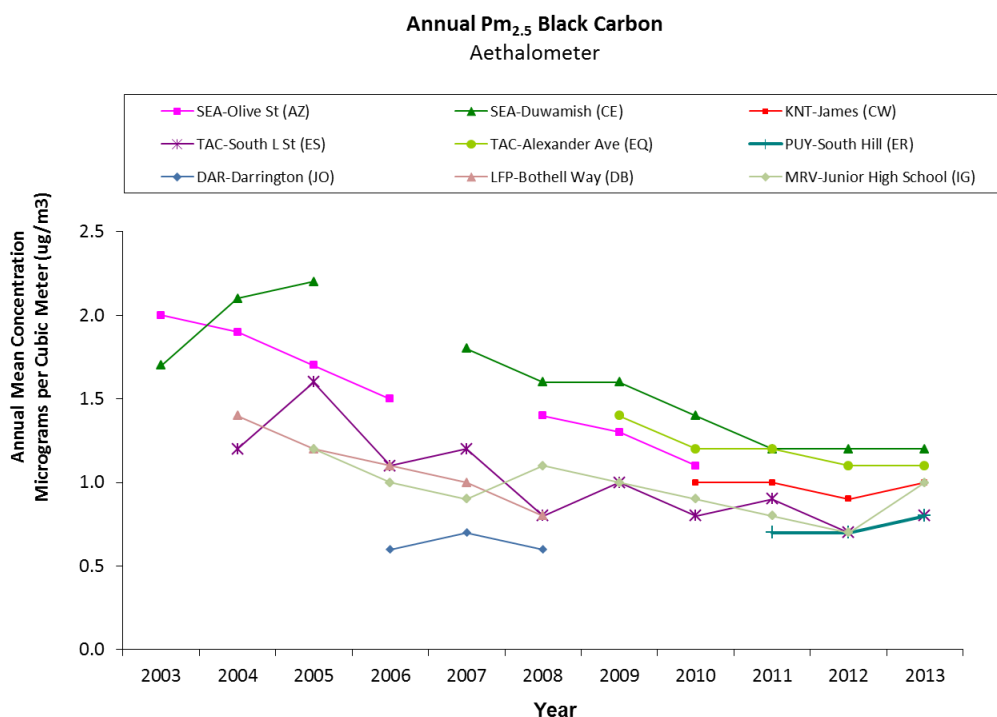
⁵Ogulei, D. WA State Dept of Ecology (2010). "Sources of Fine Particles in the Wapato Hills-Puyallup River Valley PM_{2.5} Nonattainment Area". Publication Number 10-02-009.

combustion sources.⁶ Unfortunately, neither is uniquely attributed to a particular combustion type – so the information gained from aethalometer data is largely qualitative.

The Agency maintains aethalometers at monitoring sites with high particulate matter concentrations, as well as sites with speciation data, so that the different methods to measure carbon may be compared. For more information on aethalometers, refer to our aethalometer monitoring paper which is available upon request.

Figure 11 shows annual average trending of black carbon concentrations. Since 2003, the general trend shows reducing BC levels. A statistical summary of aethalometer black carbon data is presented on page A-19 of the Appendix.

Figure 11: Annual PM_{2.5} Black Carbon



⁶Urban Air Monitoring Strategy – Preliminary Results Using Aethalometer™ Carbon Measurements for the Seattle Metropolitan Area

Ozone

Ozone is a summertime air pollution problem in our region and is not directly emitted by pollutant sources. Ozone forms when photochemical pollutants react with sunlight. These pollutants are called ozone precursors and include volatile organic compounds (VOC) and nitrogen oxides (NO_x), with some influence by carbon monoxide (CO). These precursors come from anthropogenic sources such as mobile sources and industrial and commercial solvent use, as well as natural sources (biogenic). Ozone levels are usually highest in the afternoon because of the intense sunlight and the time required for ozone to form in the atmosphere. The Washington State Department of Ecology conducts the ozone monitoring in our counties.

People sometimes confuse upper atmosphere ozone with ground-level ozone. Stratospheric ozone helps to protect the earth from the sun's harmful ultraviolet rays. In contrast, ozone formed at ground level is unhealthy. Elevated concentrations of ground-level ozone can cause reduced lung function and respiratory irritation, and can aggravate asthma.⁷ Ozone has also been linked to immune system impairment.⁸ People with respiratory conditions should limit outdoor exertion if ozone levels are elevated. Even healthy individuals may experience respiratory symptoms on a high-ozone day. Ground-level ozone can also damage forests and agricultural crops, interfering with their ability to grow and produce food.⁹

Most ozone monitoring stations are located in rural areas of the Puget Sound region, although the precursor chemicals that react with sunlight to produce ozone are generated primarily in large metropolitan areas (mostly by cars and trucks). The photochemical formation of ozone takes several hours. Thus, the highest concentrations of ozone are measured in the communities downwind of these large urban areas. In the Puget Sound region, the hot sunny days favorable for ozone formation also tend to have light north-to-northwest winds. Precursors are transported downwind from their source by the time the highest ozone concentrations have formed in the afternoon and early evening. As shown on Map 3, the highest ozone concentrations occur at the Enumclaw monitor southeast of the urban area.

⁷EPA, Air Quality Index: A Guide to Air Quality and Your Health; epa.gov/airnow/aqi_brochure_02-14.pdf.

⁸EPA Health and Environmental Effects of Ground Level Ozone; epa.gov/ttn/oarpg/naaqsfm/o3health.html.

⁹EPA Health and Environmental Effects of Ground Level Ozone; epa.gov/ttn/oarpg/naaqsfm/o3health.html.

Map 3: Ozone 3-year Average of 4th Highest 8-hr Value for 2013

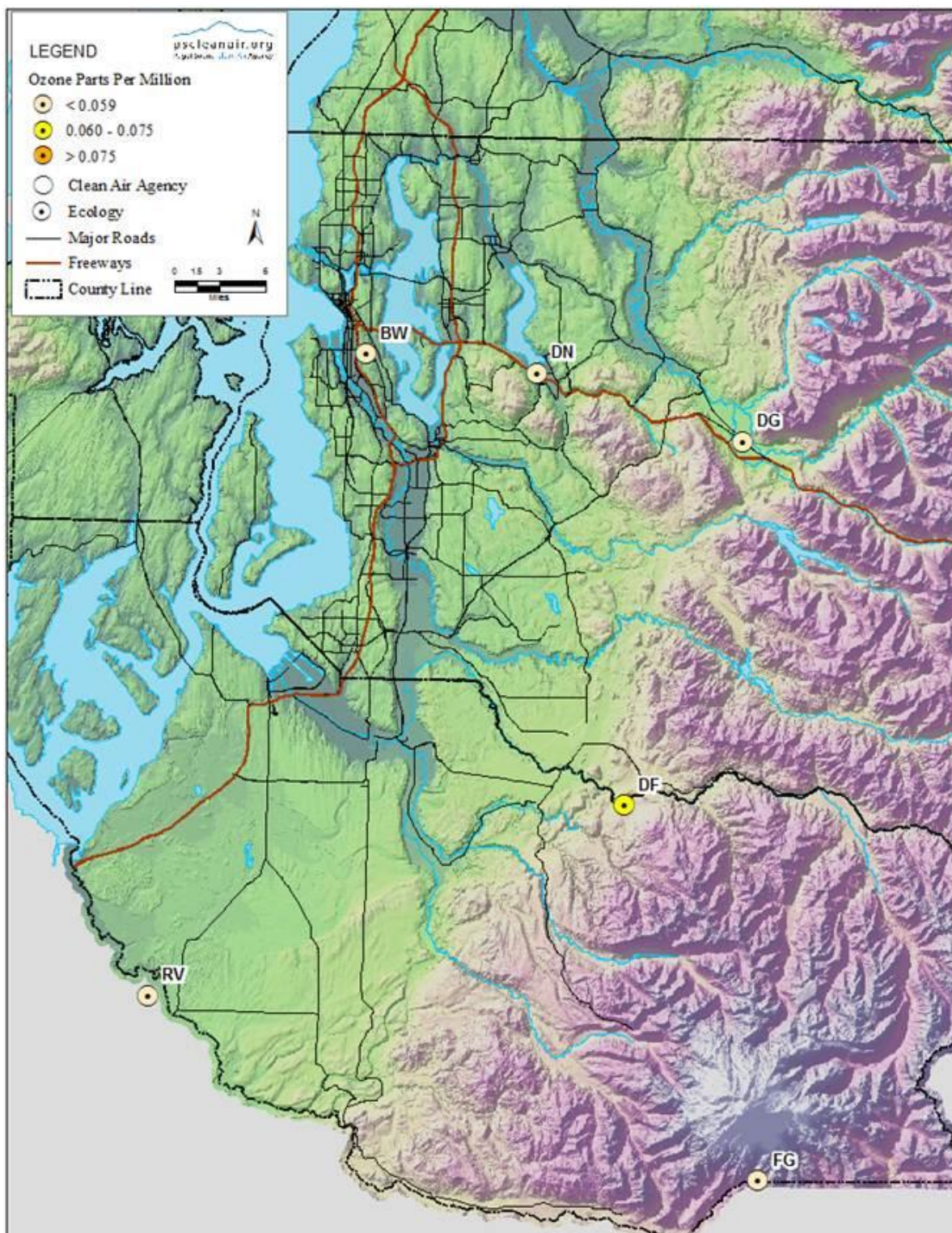


Figure 12 presents data for each monitoring station and the 8-hour federal standard. EPA revised its 8-hour standard from 0.08 parts per million (ppm) to 0.075 ppm in March 2008. The federal standard is based on the 3-year average of the 4th highest 8-hour concentration, called the “design value”. The year on the x-axis represents the last year averaged. For example, concentrations shown for 2008 are an average of 2006, 2007 and 2008 4th highest concentrations. The highest 2013 site design value is 0.062 ppm at the Enumclaw site, which does not violate the 2008 standard. The highest 2013 8-hour ozone concentration of 0.073 ppm was recorded at the Enumclaw Mud Mountain monitor.

For 2013, the Puget Sound area is below EPA’s 0.075 ppm 8-hour standard.

Figure 13 presents 8-hour average data for the months of May through September, the months when ozone levels are greatest in the Puget Sound.

Statistical summaries for 8-hour average ozone data are provided on page A-20 of the Appendix.

For additional information on ozone, visit epa.gov/air/ozonepollution.

Figure 12: Ozone for Puget Sound Region

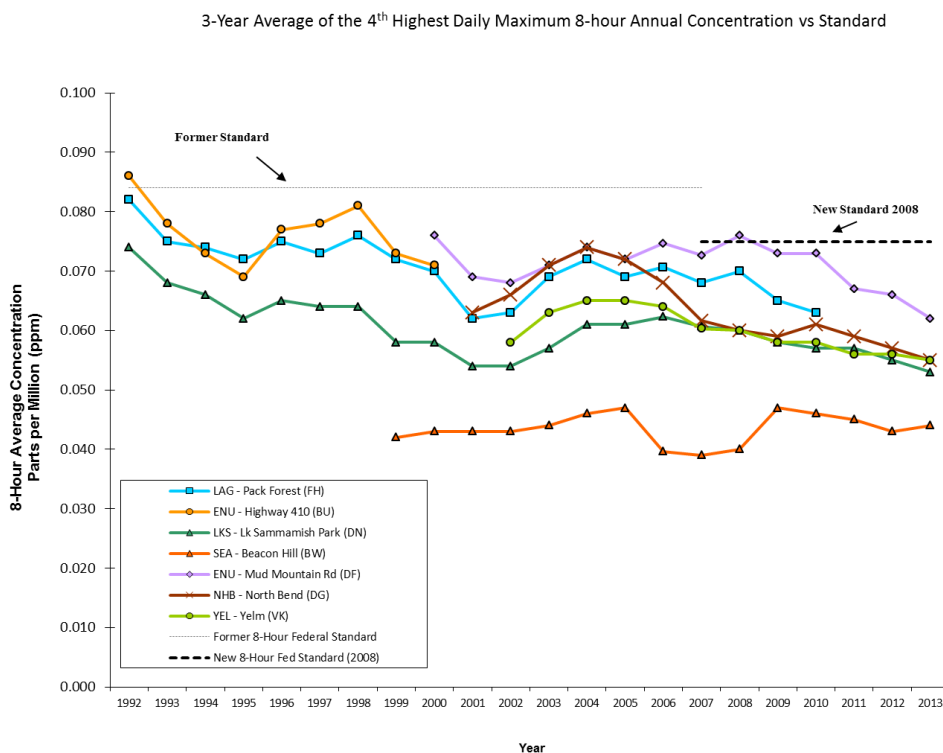
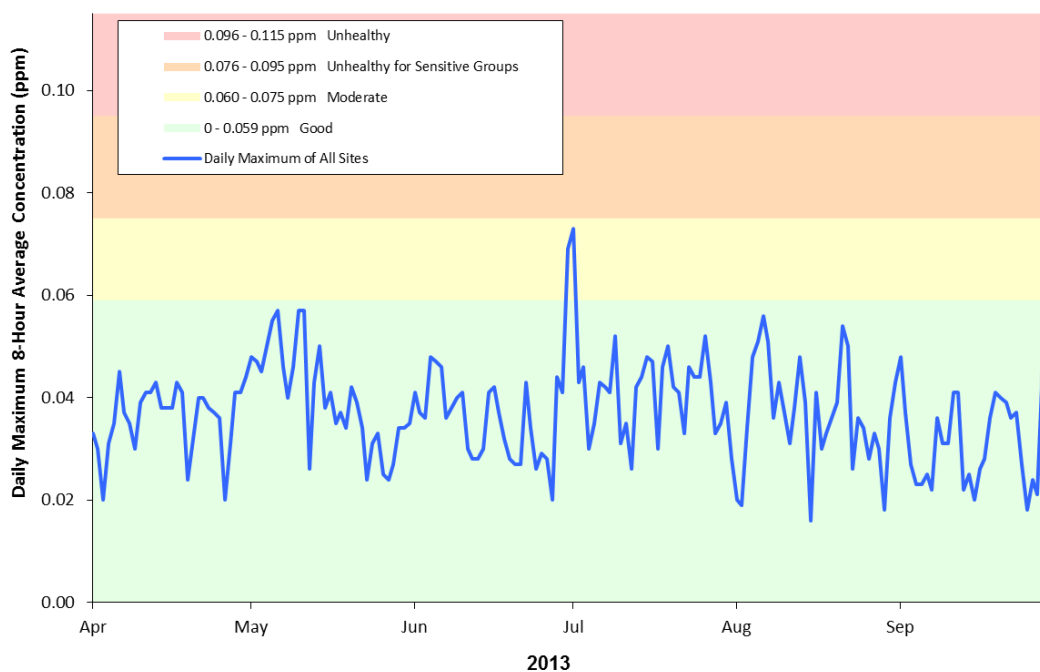


Figure 13: Ozone (O_3) for Puget Sound Region April-September 2013



Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a reddish brown, highly reactive gas that forms from the reaction of nitrogen oxide (NO) and hydroperoxy (HO_2) and alkylperoxy (RO_2) free radicals in the atmosphere. NO_2 can cause coughing, wheezing and shortness of breath in people with respiratory diseases such as asthma.¹⁰ Long-term exposure can lead to respiratory infections.

The term NO_x is defined as $\text{NO} + \text{NO}_2$. NO_x participates in a complex chemical cycle with volatile organic compounds (VOCs) which can result in the production of ozone. NO_x can also be oxidized to form nitrates, which are an important component of fine particulate matter. On-road vehicles such as trucks and automobiles and off-road vehicles such as construction equipment, marine vessels and port cargo-handling equipment are the major sources of NO_x . Industrial boilers and processes, home heaters and gas stoves also produce NO_x .

Motor vehicle and non-road engine manufacturers have been required by EPA to reduce NO_x emissions from cars, trucks and non-road equipment. As a result, emissions have been reduced dramatically since the 1970s.

Ecology maintains one monitoring site for nitrogen dioxide at the Beacon Hill station. In 2007, the monitoring technique and equipment changed to record NO_y instead of NO_x , in order to observe all reactive nitrogen compounds. NO_y is NO_x plus all other reactive nitrogen oxides present in the atmosphere. NO_y components such as nitric acid (HNO_3) and peroxyacetyl nitrate (PAN) can be important contributors to the formation of ozone and fine particulate matter. The additional nitroxy compounds are generally present in much lower concentrations than NO_2 (or NO_x).

Figure 14 shows NO_2 concentrations through 2005. In 2006, no data were recorded due to the relocation of the Beacon Hill monitor to a different location on the same property. From 2007 onward, the concentration of NO_2 is represented as $\text{NO}_y - \text{NO}$, since NO_2 is no longer directly recorded, and $\text{NO}_y = \text{NO} + \text{NO}_2 + \text{other nitroxy compounds}$. The annual average for each year has consistently been less than half of the federal standard, as shown in Figure 14 and in the statistical summary on page A-21 of the Appendix.

The maximum 1-hour average of $\text{NO}_y - \text{NO}$, measured in 2013, was 0.058 ppm on April 25. Visit epa.gov/air/nitrogenoxides/ for additional information on NO_2 .

EPA promulgated a 1-hour national ambient air quality standard for nitrogen dioxide on January 22, 2010.¹¹ The new 1-hour standard is 100 ppb. The design value is calculated by following the procedures in the Federal Register. EPA retained the current annual health-based standard for nitrogen dioxide of 53 ppb (0.053 ppm). Nitrogen dioxide levels in the Puget Sound region, as currently monitored by Ecology, are typically below (cleaner than) the levels in the new standard. The new standard is depicted in Figure 15 with historical data since 1998. The years prior to 2010 have been included on the graphs for historical comparison; the new air quality standard applies to 2010 and subsequent years.

¹⁰EPA, Airnow, NO_x Chief Causes for Concern; epa.gov/air/nitrogenoxides/

¹¹EPA. New 1-hour National Ambient Air Quality Standards for Nitrogen Dioxide; epa.gov/air/nitrogenoxides/actions.html#jan10, accessed September, 2010.

Figure 14: Annual Nitrogen Dioxide (NO₂) (1995-2005) and Reactive Nitrogen (NO_y – NO) (2007-Present)

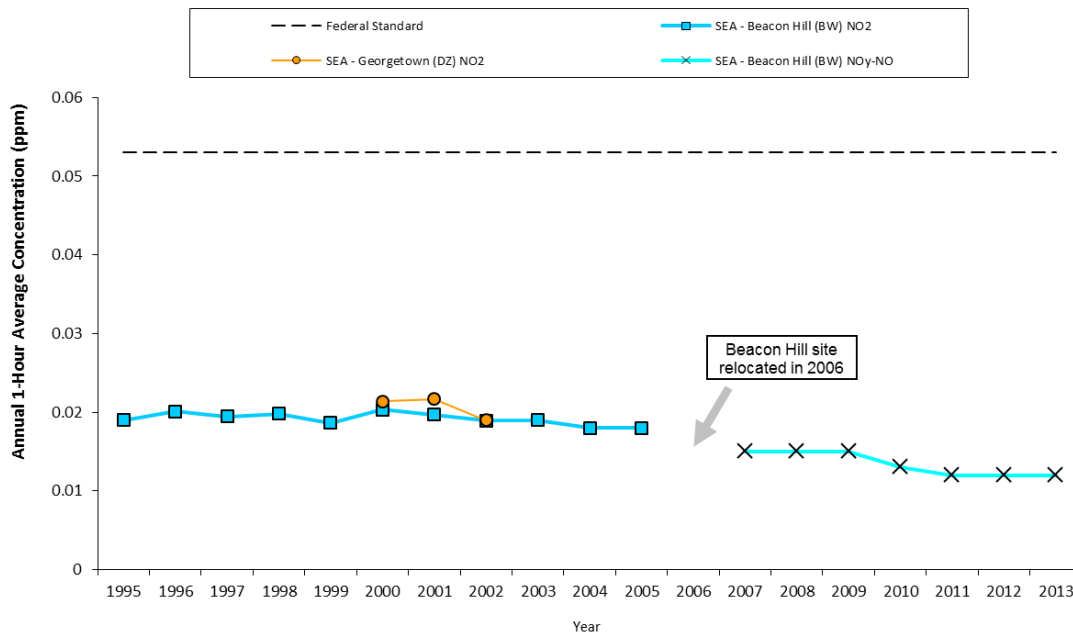
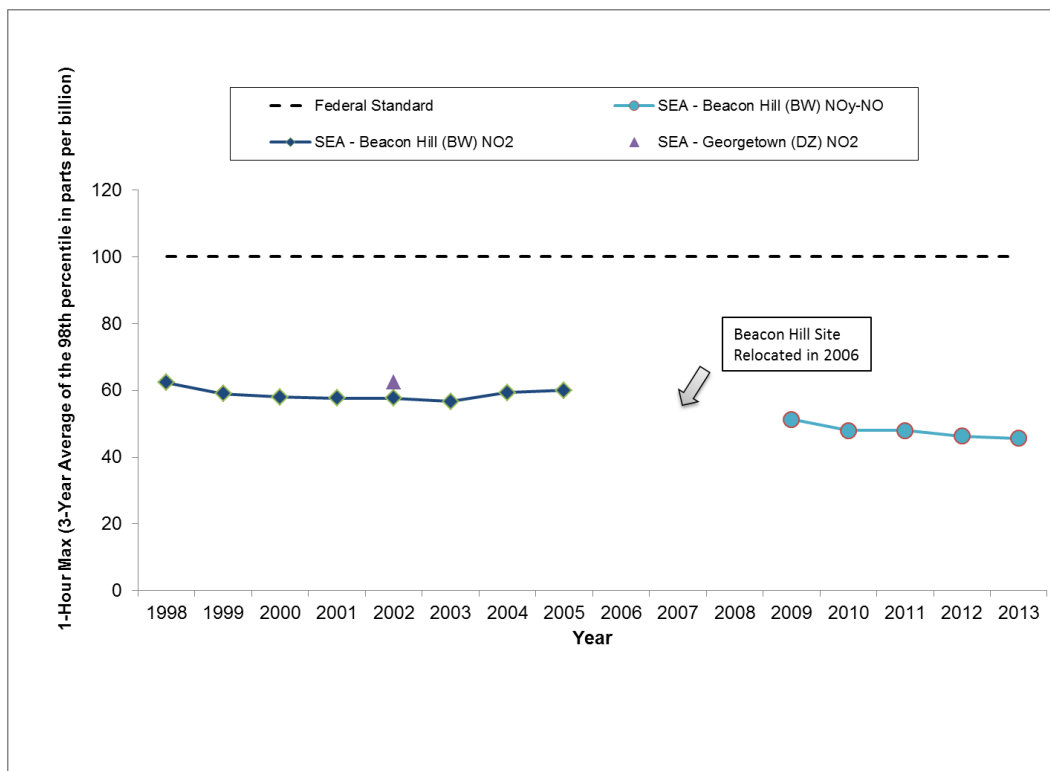


Figure 15: 2010 1-Hour Maximum Standard for Nitrogen Dioxide (NO₂) (1995-2005) and Reactive Nitrogen (NO_y – NO) (2007-Present)



Carbon Monoxide

Carbon monoxide (CO) is an odorless, colorless gas that can enter the bloodstream through the lungs and reduce the amount of oxygen that reaches organs and tissues. Carbon monoxide forms when the carbon in fuels does not burn completely. The vast majority of CO emissions come from motor vehicles.

Elevated levels of CO in ambient air occur more frequently in areas with heavy traffic and during the colder months of the year when temperature inversions are more common. People with cardiovascular disease or respiratory problems may experience chest pain and increased cardiovascular symptoms, particularly while exercising, if CO levels are high. High levels of CO can affect alertness and vision even in healthy individuals.

Although urban portions of the Puget Sound region historically violated the CO standard, CO levels have decreased significantly primarily due to emissions controls on car engines. EPA designated the Puget Sound region as a CO attainment area in 1996. Ecology has substantially reduced its CO monitoring network, and only the Beacon Hill site operated during 2013.

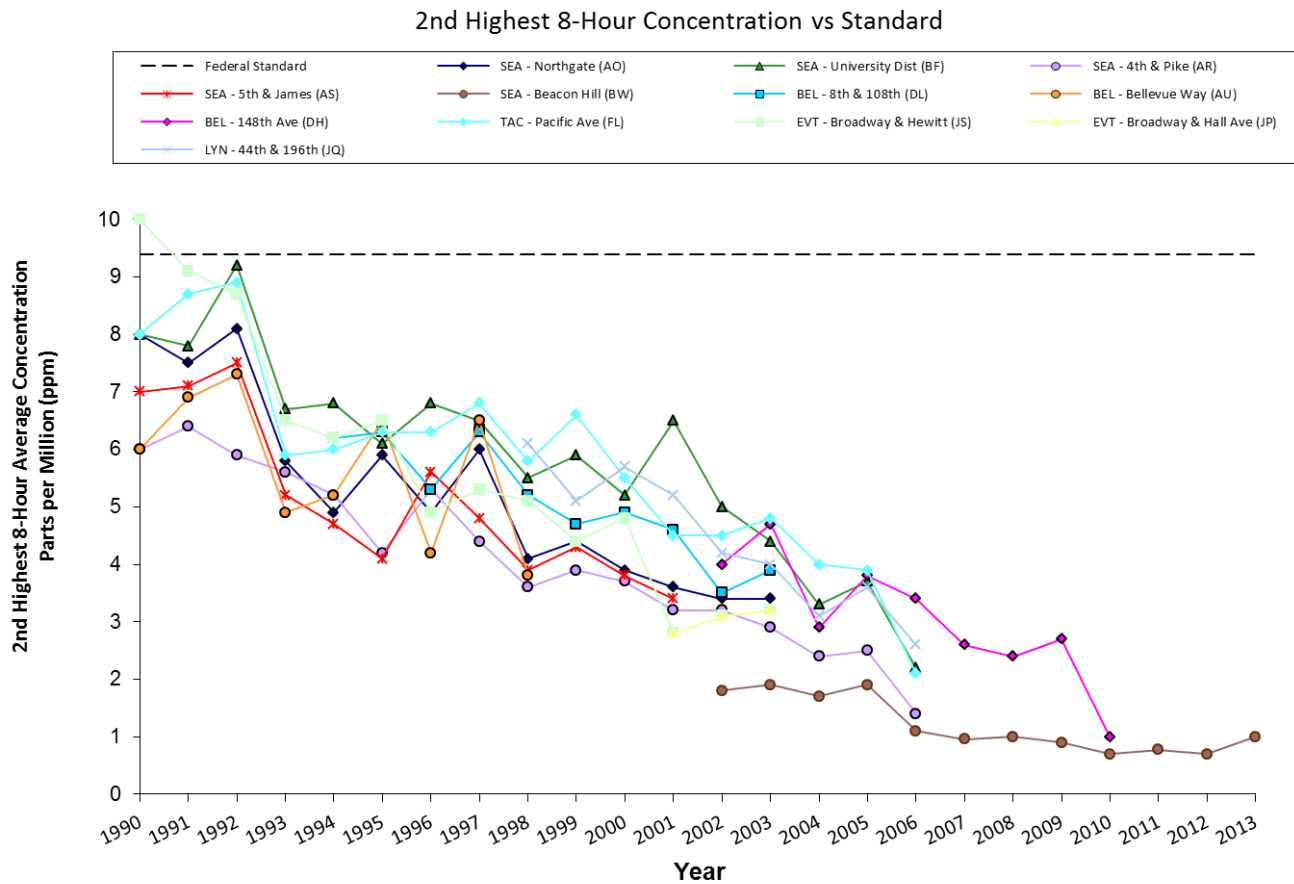
The CO national ambient air quality standard is based on the 2nd highest 8-hour average. Figure 16 shows the 2nd highest 8-hour concentrations and the federal standard (9 ppm) for the Puget Sound region. There currently are no CO monitoring stations in Kitsap, Pierce, or Snohomish Counties.

The maximum 8-hour concentration for CO in 2013 was 1.0 parts per million (ppm) and occurred on January 22 at the Seattle Beacon Hill site.

The EPA federal standards also include a 1-hour standard for CO of 35 ppm, not to be exceeded more than once a year. Measured 1-hour concentrations in the Puget Sound area are historically much lower than the 35 ppm standard.

Statistical summaries for 8-hour average CO data are provided on page A-22 of the Appendix. For additional information on CO, visit epa.gov/air/urbanair/co/index.html.

Figure 16: Carbon Monoxide (CO): 2nd Highest Annual 8-hour Value for Puget Sound Region



Sulfur Dioxide

Sulfur dioxide (SO₂) is a colorless, reactive gas produced by burning fuels containing sulfur, such as coal and oil, and by industrial processes. Historically, the greatest sources of SO₂ were industrial facilities that derived their products from raw materials such as metallic ore, coal and crude oil, or that burned coal or oil to produce process heat (petroleum refineries, cement manufacturing and metal processing facilities). Marine vessels, on-road vehicles and diesel construction equipment are the main contributors to SO₂ emissions today.

SO₂ may cause people with asthma who are active outdoors to experience bronchial constriction, where symptoms include wheezing, shortness of breath and tightening of the chest. People should limit outdoor exertion if SO₂ levels are high. SO₂ can also form sulfates in the atmosphere, a component of fine particulate matter.

The Puget Sound area has experienced a significant decrease in SO₂ from sources such as pulp mills, cement plants and smelters in the last two decades. Additionally, levels of sulfur in diesel and gasoline fuels have decreased due to EPA regulations. The Puget Sound Clean Air Agency stopped monitoring for SO₂ in 1999 because of these decreases. Monitoring sites for SO₂ were historically sited in or near industrial areas. Ecology monitored SO₂ at the Beacon Hill site from 2000-2005. In 2006, the SO₂ monitor was relocated to a different location on the same property. The monitor was not operating most of 2006 so no data are reported for that year.

EPA changed the SO₂ standard in June of 2010 to a more short-term (1-hour) standard and revoked the annual and daily average standards. Historic comparisons to federal and Washington State standards can be seen in our 2009 data summary which is available upon request.

The new standard is a 3-year average of the 99th percentile of the daily 1-hour maximum concentrations. Levels must be below 0.075 ppm. Demonstration of attainment is determined from the 2008-2010 data. The Seattle Beacon Hill site is below the new standard.

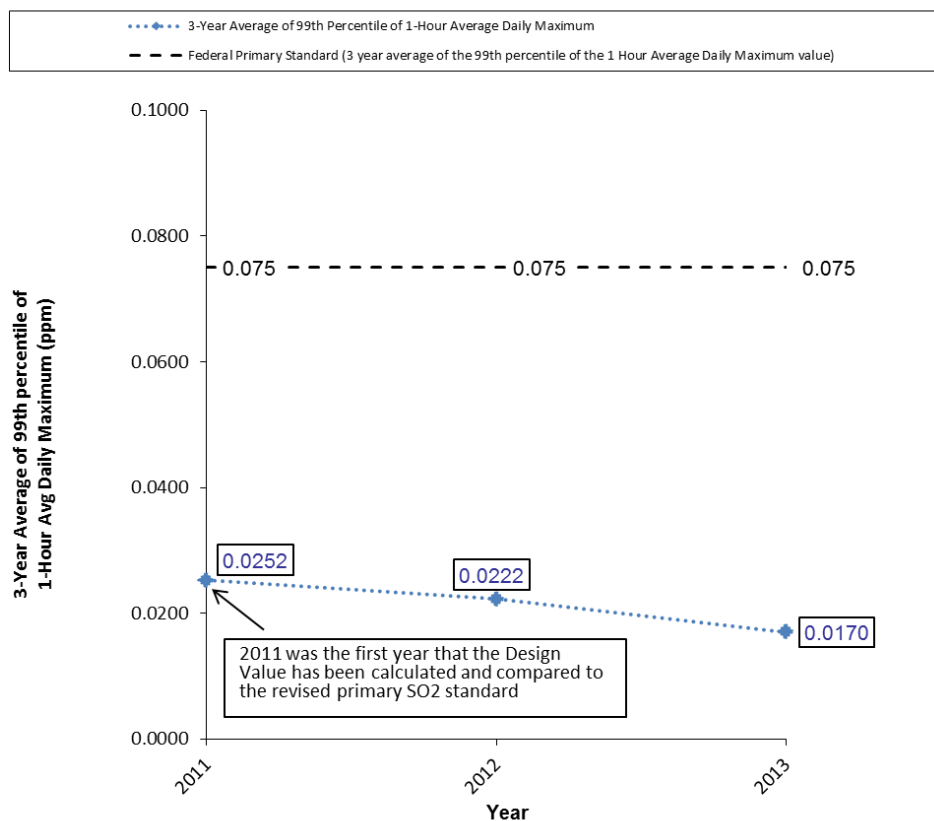
Figure 17 shows the maximum 3-year average of the 99th percentile of 1-hour maximum concentrations at Beacon Hill. The maximum measured SO₂ concentrations in 2013 were below standards.

Statistical summaries for SO₂ data from the Beacon Hill site are available on page A-23 of the Appendix.

Additional information on SO₂ is available at epa.gov/air/sulfurdioxide/.

Figure 17: Sulfur Dioxide (SO₂) 1-Hour Maximum Concentrations (3-Year Average of the 99th Percentile) for the Puget Sound Region

3-Year Average of 99th Percentile of 1-Hour Average Daily Maximum vs Primary Standard
Measured at Beacon Hill - Seattle



Lead

Lead is a highly toxic metal that was used for many years in household products (e.g. paints), automobile fuel and industrial chemicals. Nationally, industrial processes, particularly primary and secondary lead smelters and battery manufacturers, are now responsible for most of the remaining lead emissions. Lead from aviation gasoline used in small aircraft is also of concern nationally.

People, animals and fish are mainly exposed to lead by breathing and ingesting it in food, water, soil or dust. Lead accumulates in the blood, bones, muscles and fat. Infants and young children are especially sensitive to even low levels of lead. Lead can have health effects ranging from behavioral problems and learning disabilities to seizures and death.

According to EPA, the primary sources of lead exposure are lead-based paint, lead-contaminated dust and lead-contaminated residual soils. See the EPA website at epa.gov/ttnatw01/hlthef/lead.html for ways to limit your exposure to these lead sources.

Since the phase-out of lead in fuel and the closure of the Harbor Island secondary lead smelter, levels of lead in ambient air have decreased substantially. For a historic look at the Puget Sound region's lead levels, please see page 87 of the 2007 Air Quality Data Summary which is available upon request.

In October 2008, EPA strengthened the lead standard from 1.5 $\mu\text{g}/\text{m}^3$ to 0.15 $\mu\text{g}/\text{m}^3$ (rolling three-month average).¹² As part of this rulemaking, EPA initiated a pilot lead monitoring program that focuses on lead from aviation gasoline at small airports, including two in our region. For additional information on lead, visit epa.gov/air/lead.

Washington Department of Ecology conducted monitoring of lead at two airports as part of a national EPA study. Results of the study are available at <https://fortress.wa.gov/ecy/publications/SummaryPages/1302040.html>

¹²US EPA, National Ambient Air Quality Standard for Lead, Final Rule. Federal Register, November 12, 2008; <http://www.gpo.gov/fdsys/pkg/FR-2008-11-12/pdf/E8-25654.pdf>

Visibility

Visibility data is presented as an indicator of air quality. Visibility is explained in terms of visual range and light extinction. *Visual range* is the maximum distance, usually miles or kilometers, that you can see a black object against the horizon. *Light extinction* is the sum of light scattering and light absorption by fine particles and gases in the atmosphere. The more light extinction, the shorter the visual range. Visual range as measured by nephelometer instruments using light-scattering methodology provides one approach to measuring visibility at a specific location.

Reduced visibility is caused by weather such as clouds, fog, rain and air pollution, including fine particles and gases. The major contributor to reduced visual range is fine particulate matter (PM_{2.5}), which is present near the ground, can be transported aloft and may remain suspended for a week or longer. Figures 18 through 22 show visibility for the overall Puget Sound area, as well as King, Kitsap, Pierce and Snohomish Counties. Visibility on these graphs, in units of miles, is determined by continuous nephelometer monitoring. The nephelometer measures light scattering due to particulate matter (b_{sp}), and this value is converted into estimates of visibility in miles. Nephelometer data are shown on page A-17 of the Appendix.

The red line represents the monthly average visibility. The large fluctuations are due to seasonal variability. The blue line shows the average of the previous 12-months. This moving average reduces seasonal variation and allows longer-term trends to be observed. The moving average shows that the visibility for the Puget Sound area has steadily increased (improved) over the last decade with some year-to-year variability. For the 23-year period from December 1990 through December 2013, the 12-month moving average increased from 47 miles to 78 miles.

For additional information on visibility, visit epa.gov/air/visibility/index.html.

Figure 18: Puget Sound Visibility

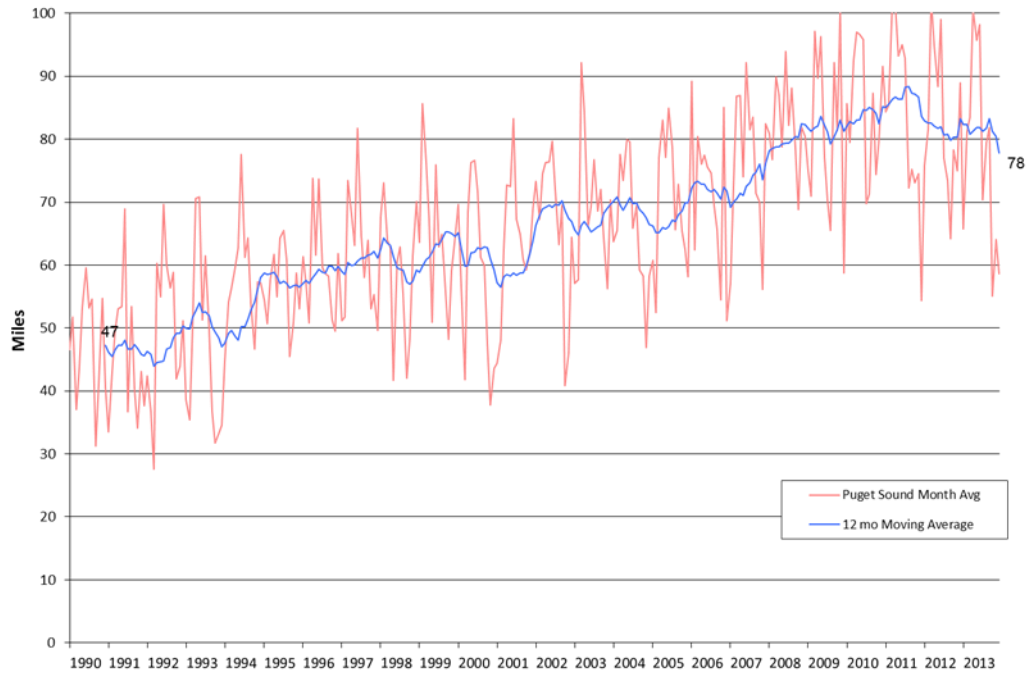


Figure 19: King County Visibility

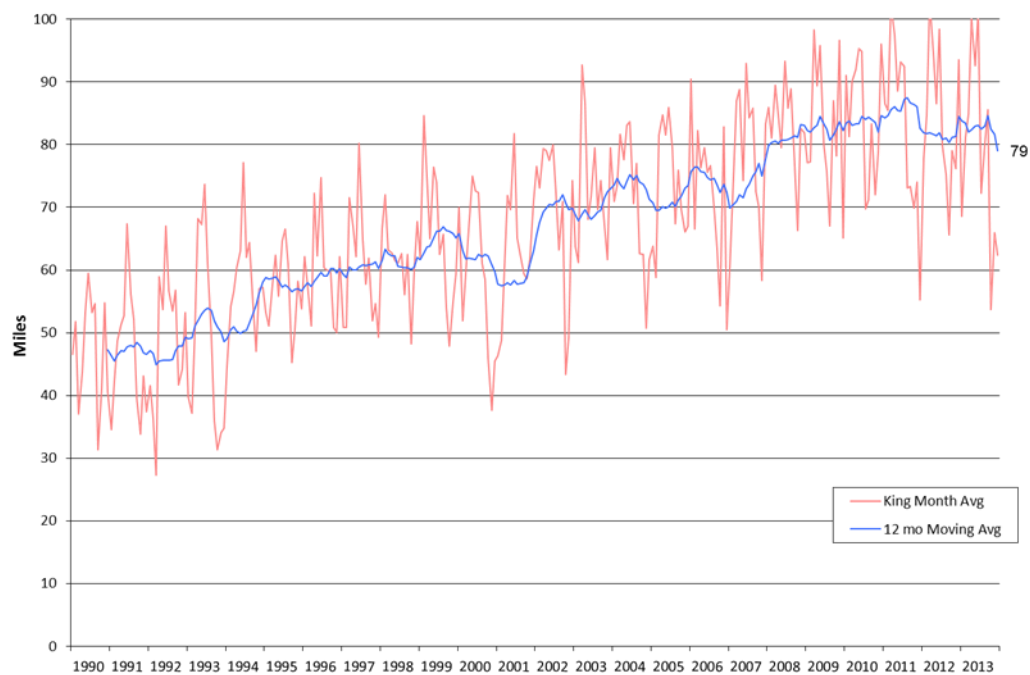


Figure 20: Kitsap County Visibility

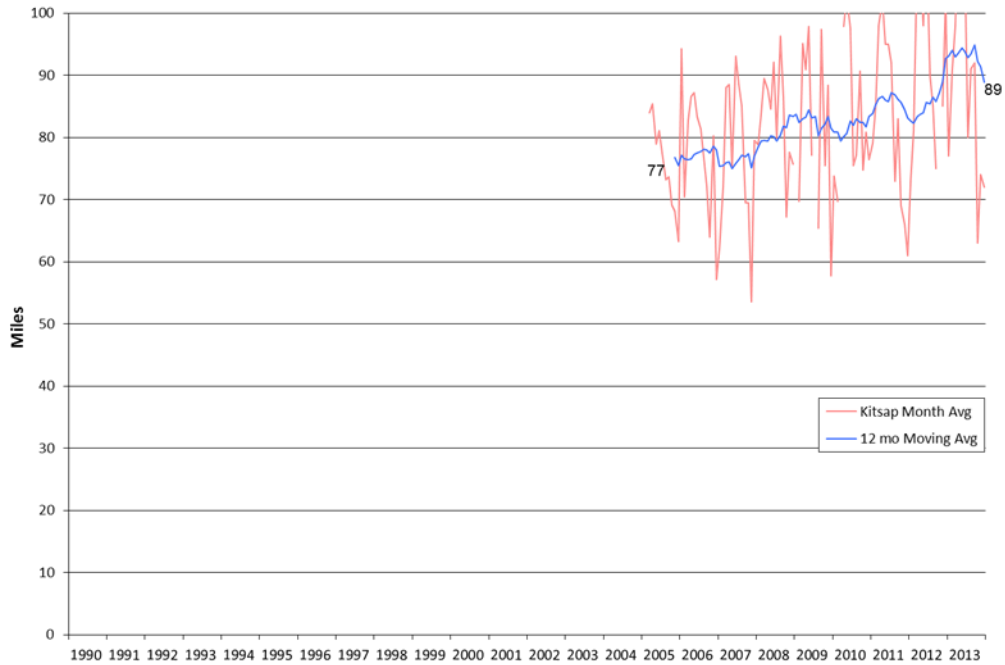


Figure 21: Pierce County Visibility

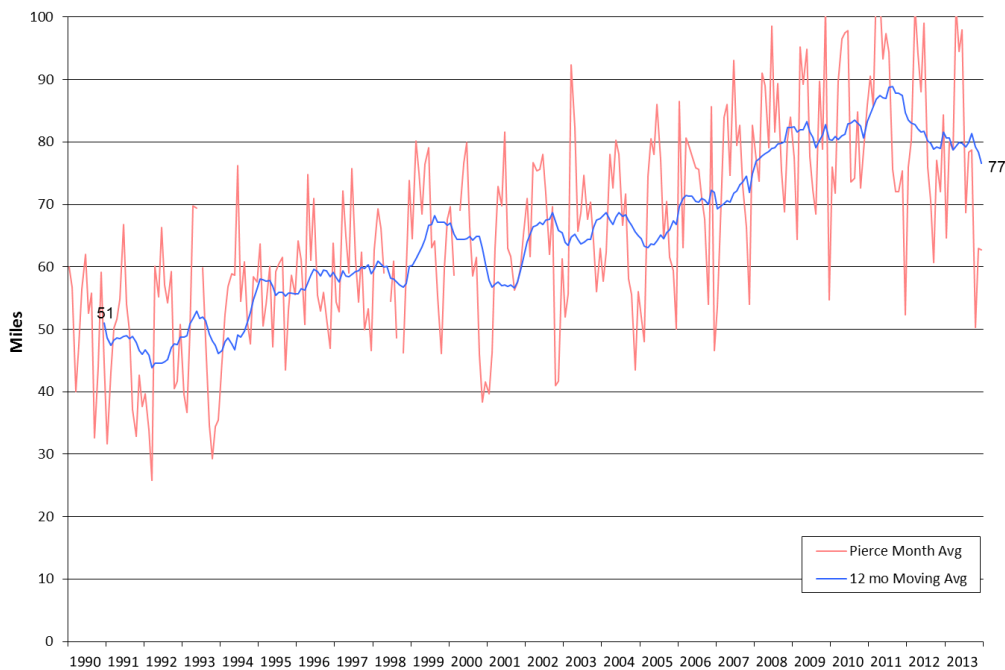
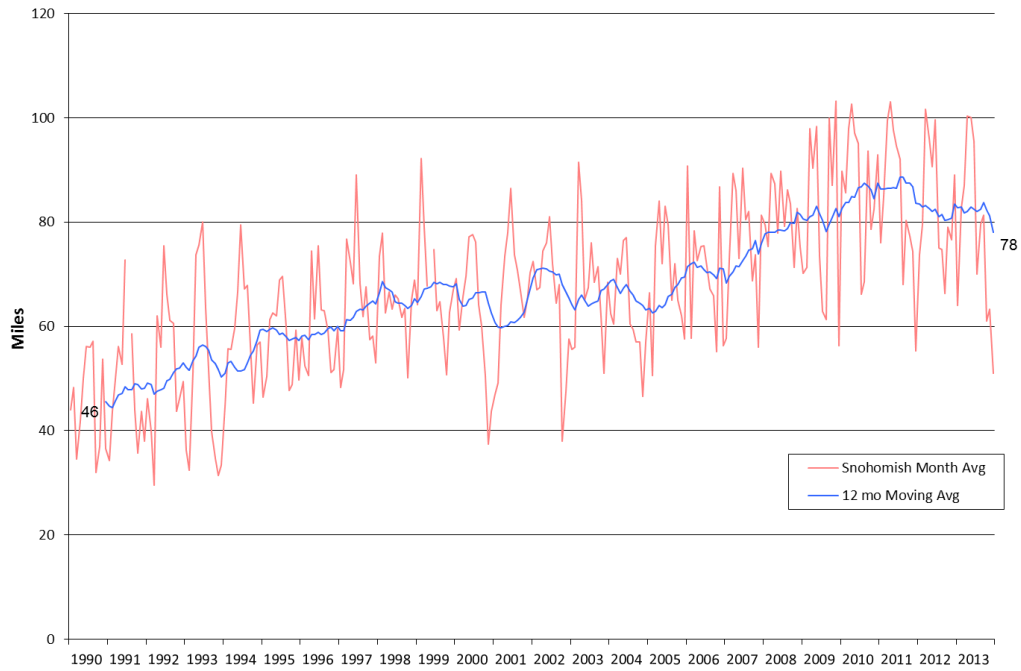


Figure 22: Snohomish County Visibility



Air Toxics

“Air toxics” are air pollutants known or suspected to cause health problems. Potential health effects include cancer, birth defects, lung damage, immune system damage, and nerve damage.¹³ The Agency considers over 400 different air pollutants as air toxics.

This section presents a relative ranking of these toxics based on potential cancer health risks, as well as trends over time. We provide a short description of each air toxic of concern, including their health effects and sources.

The Washington State Department of Ecology (Ecology) monitors for air toxics annually at the Seattle Beacon Hill site. The Beacon Hill site is one of 30 EPA-sponsored National Air Toxic Trends Sites. As in previous years, Ecology monitored toxics every six days. The 2006 dataset is incomplete due to relocation of the Beacon Hill site that year. For general information on air toxics, see pscleanair.org/airquality/airqualitybasics/airtoxics/Pages/default.aspx. Air toxics statistical summaries are provided starting on page A-24 of the Appendix.

Relative ranking based on cancer risk & unit risk factors

Table 3 below ranks 2013 air toxics from the Beacon Hill monitoring site according to mean potential cancer risk per million. It shows monitored pollutants ranked from highest concern (#1) to lowest, based on ambient concentrations multiplied by unit risk factors. A unit risk factor takes into account how toxic a pollutant is. Potential cancer risk estimates are shown here to provide a meaningful basis of comparison between pollutants and are not intended to represent any one community or individual exposure.

Potential cancer risk is an estimate of the number of potential additional cancers (out of a population of one million) that may develop from exposure to air toxics over a lifetime (set at 70 years). A risk level of one in a million is commonly used as a screening value, and is used here.¹⁴

For details on how air toxics were ranked, please see pages A-25 and A-26 in the Appendix.

Risks presented in this table are based on annual average ambient (outside) concentrations. Risks based on 95th percentile concentrations (a more protective statistic than presented in Table 3) are presented on page A-26 of the Appendix. Page A-26 also lists the frequency (percentage) of samples that were over the cancer screening level of one in a million risk.

¹³ US EPA, About Air Toxics, Health, and Ecological Effects, <http://www.epa.gov/air/toxicair/newtoxics.html>.

¹⁴ US EPA, A Preliminary Risk-Based Screening Approach for Air Toxics Monitoring Datasets. EPA-904-B-06-001, February 2006; epa.gov/region4/air/airtoxic/Screening_111610_KMEL.pdf

Table 3: 2013 Beacon Hill Air Toxics Ranking
(Average Potential Cancer Risk Estimate per 1,000,000)

| Air Toxic | Rank | Average Potential Cancer Risk ^a |
|--|------|--|
| Carbon Tetrachloride | 1 | 29 |
| Benzene | 2 | 16 |
| 1,3-Butadiene | 3 | 13 |
| Cadmium (PM ₁₀) ^b | 4 | 9 ^b |
| Arsenic (PM ₁₀) | 5 | 3 |
| Chloroform | 5 | 3 |
| Chromium VI (TSP) ^c | 5 | 3 ^c |
| Formaldehyde | 5 | 3 |
| Acetaldehyde | 9 | 2 |
| Ethylene Dichloride | 9 | 2 |
| Naphthalene | 9 | 2 |
| Acrylonitrile ^d | 10 | 1 ^d |
| Dichloromethane | 10 | 1 |
| Nickel (PM ₁₀) | 10 | 1 |

^a Risk based on unit risk factors as adopted in Washington State Acceptable Source Impact Level (WAC 173-460-150)¹⁵

^b For cadmium, an outlier sampled on 11/18/13 was included in this estimate. On that day, no other metal concentrations were statistical outliers compared to their annual variability. With the outlier excluded, the estimated annual potential cancer risk for cadmium would be < 1.

^c Chromium VI monitoring was discontinued on June 30th and this reflects only the concentrations from the first half of 2013.

^d For acrylonitrile, an outlier sampled on 8/2/13 was included in this estimate and it accounts for all the risk in this annual average. All the other samples were below detection and well below the risk threshold of one per million.

PM₁₀ = fine particles less than 10 micrometers in diameter

TSP = total suspended particulate

The two air toxics that present the majority of potential health risk in the Puget Sound area, diesel particulate matter and wood smoke particulate, are not included in the table. No direct monitoring method currently exists for these toxics. Modeling for these air toxics was not conducted for this report.

¹⁵ Washington State Administrative Code WAC 173-460-150, apps.leg.wa.gov/WAC/default.aspx?cite=173-460-150

Health effects other than cancer

Air toxics can also have chronic non-cancer health effects. These include respiratory, cardiac, immunological, nervous system and reproductive system effects.

In order to determine non-cancer health risks, we compared each air toxic to its reference concentration, as established by California EPA (the most comprehensive dataset available). A reference concentration (RfC) is considered a safe level for toxics for non-cancer health effects.

Only one air toxic, acrolein, failed the screen for non-cancer health effects, with measured concentrations consistently exceeding the reference concentration. Acrolein irritates the lungs, eyes, and nose, and is a combustion by-product.¹⁶ Unfortunately, acrolein measurements have large uncertainty and is one of the most difficult pollutants to measure.¹⁷ Therefore, for acrolein, we did not explore a trend analysis as the results are likely all within the uncertainty of the measurement.

Reference concentrations and hazard indices are shown for each air toxic on page A-27 of the Appendix. A hazard index is the concentration of a pollutant (either mean or other statistic) divided by the reference concentration. Typically, no adverse non-cancer health effects for that pollutant are associated with a hazard index less than 1, although it is important to consider that people are exposed to many pollutants at the same time.

We did not explore acute non-cancer health effects, because the Beacon Hill air toxics concentrations are based on 24-hour samples.

Air toxics trends

Annual average potential cancer risks are shown on the following pages for air toxics collected from 2000 to 2013 at Beacon Hill. For many air toxics, our analysis of the trends shows a statistically significant decrease in annual average concentrations.

EPA has not set ambient air standards for air toxics, so graphs do not include reference lines for federal standards. The statistical results can be found on page A-28 of the Appendix.

¹⁶EPA, Acrolein Hazard Summary; epa.gov/ttn/atw/hlthef/acrolein.html.

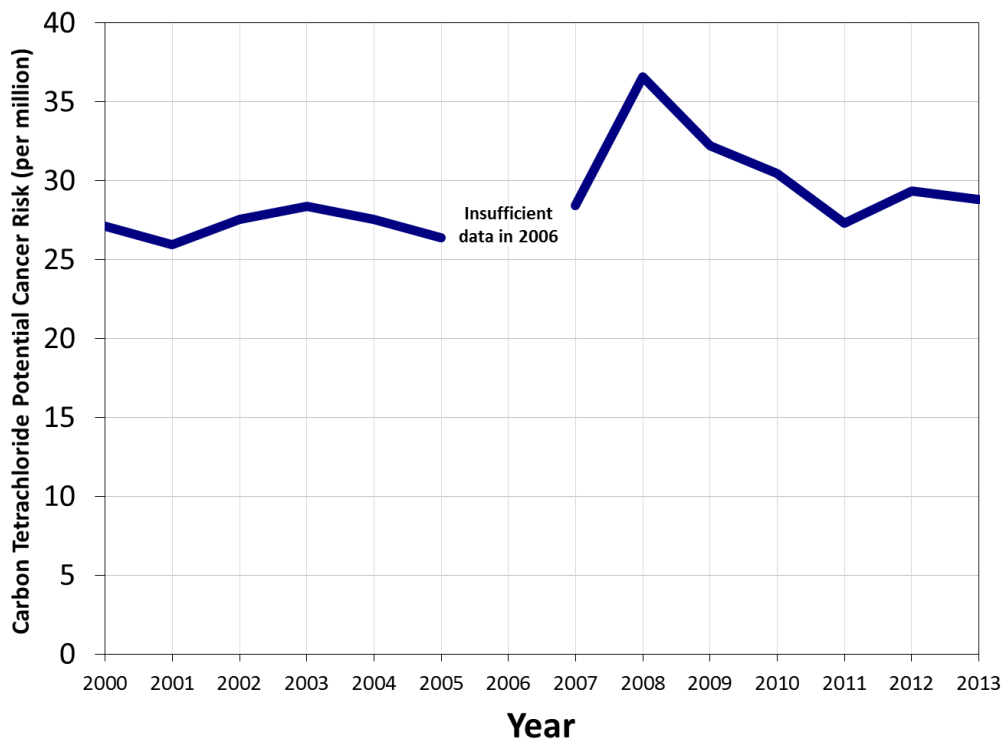
¹⁷EPA, Schools Monitoring Initiative Acrolein Update, <http://www.epa.gov/schoolair/pdfs/acroleinupdate.pdf>.

Carbon Tetrachloride

The EPA lists carbon tetrachloride as a probable human carcinogen. Carbon tetrachloride inhalation is also associated with liver and kidney damage.¹⁸ It was widely used as a solvent for both industry and consumer users and was banned from consumer use in 1995. Trace amounts are still emitted by local sewage treatment plants. Carbon tetrachloride is relatively ubiquitous and has a long half-life and concentrations are similar in urban and rural areas. Carbon tetrachloride's 2013 average potential cancer risk estimate at Beacon Hill was 29 in a million.

The Agency does not target efforts at reducing carbon tetrachloride emissions, as carbon tetrachloride has already been banned. We did not find a statistically significant trend in carbon tetrachloride levels over time.

Figure 23: Carbon Tetrachloride Annual Average Potential Cancer Risk at Beacon Hill, 2000-2013



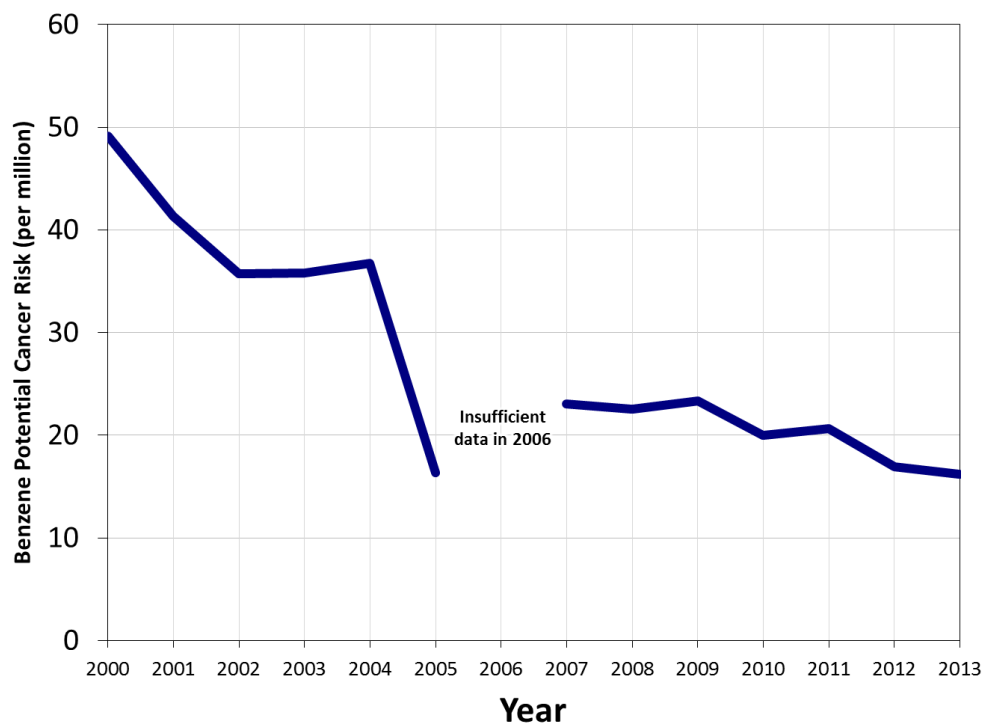
¹⁸EPA Hazard Summary; epa.gov/ttn/atw/hlthef/carbonte.html.

Benzene

The EPA lists benzene as a known human carcinogen. Benzene inhalation is also linked with blood, immune and nervous system disorders.¹⁹ This air toxic comes from a variety of sources, including car/truck exhaust, wood burning, evaporation of industrial solvent and other combustion. Benzene's 2013 average potential cancer risk range estimate at Beacon Hill was 16 in a million.

Benzene levels are likely decreasing in our area due to factors including: less automobile pollution with cleaner vehicles coming into the fleet, better fuels and fewer gas station emissions due to better compliance (vapor recovery at the pump and during filling of gas station tanks). We found a statistically significant drop in risk from benzene at a rate of about two per million per year since 2000.

Figure 24: Benzene Annual Average Potential Cancer Risk at Beacon Hill, 2000-2013



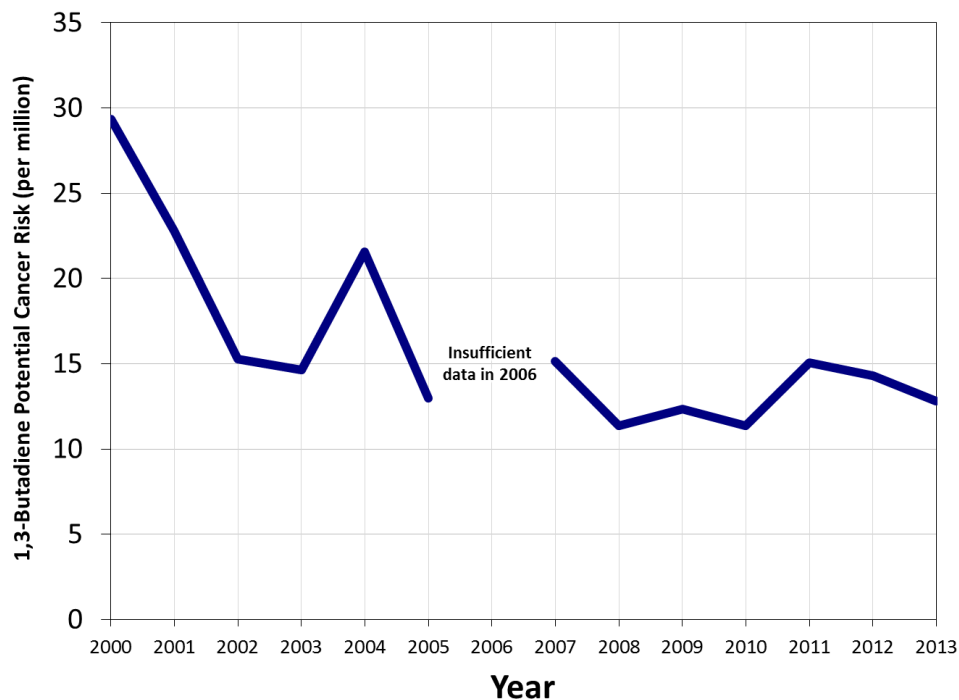
¹⁹EPA Hazard Summary; epa.gov/ttn/atw/hlthef/benzene.html.

1,3-Butadiene

The EPA lists 1,3-butadiene as a known human carcinogen. 1,3-butadiene inhalation is also associated with neurological effects.²⁰ Primary sources of 1,3-butadiene include cars, trucks, buses and wood burning. 1,3-butadiene's 2013 average potential cancer risk estimate at Beacon Hill was 13 in a million.

Agency efforts that target vehicle exhaust and wood stove emission reductions also reduce 1,3-butadiene emissions. Since 2000, we found a statistically significant drop in risk from 1,3-butadiene at a rate of about one per million per year.

Figure 25: 1,3-butadiene Annual Average Potential Cancer Risk at Beacon Hill, 2000-2013



²⁰EPA Hazard Summary; epa.gov/ttnatw01/hlthef/butadien.html.

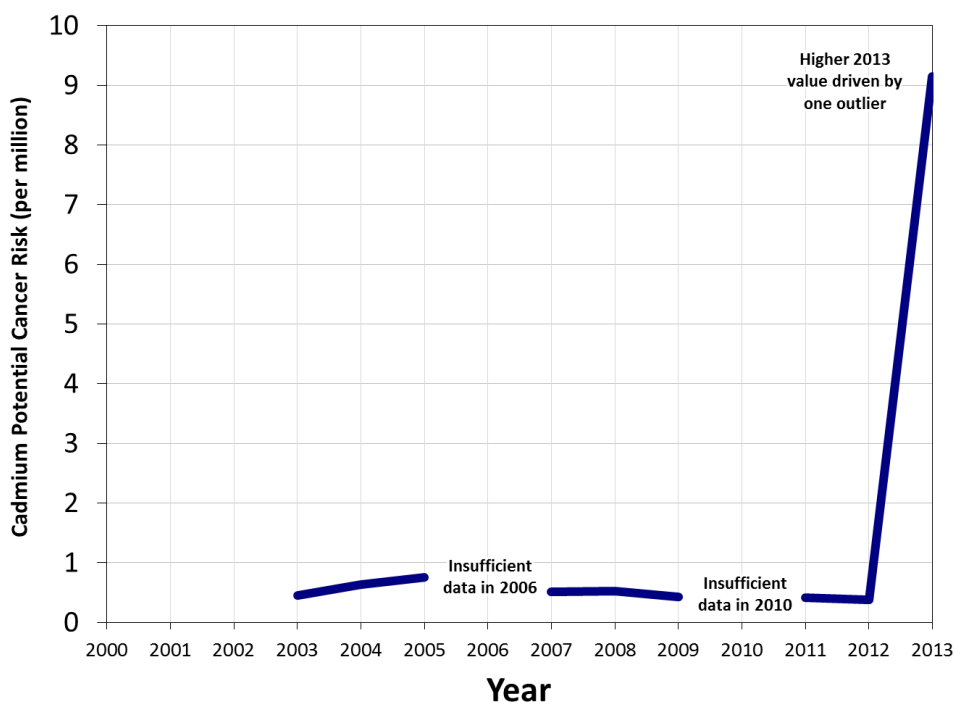
Cadmium

EPA lists cadmium as a probable human carcinogen. Cadmium exposures are also associated with kidney damage.²¹ Combustion of distillate oil is a main source of cadmium in the Puget Sound area.

Cadmium's 2013 average potential cancer risk estimate at Beacon Hill was 9 in a million. A sampled outlier on 11/18/13 was included in this estimate. On that day, no other metal concentrations were statistical outliers compared to their respective annual variability. With the outlier excluded, the estimated annual potential cancer risk for cadmium would be < 1 as in the historical trend below. With or without the outlier included, we found no statistically significant trend for cadmium. Over half the samples in 2010 were below the detection limits and did not have sufficient data to make a comparable average.

The Agency's permitting program works with and regulates industrial producers of cadmium to reduce emissions.

Figure 26: Cadmium Annual Average Potential Cancer Risk at Beacon Hill, 2003-2013



²¹EPA Hazard Summary; epa.gov/ttn/atw/hlthef/cadmium.html.

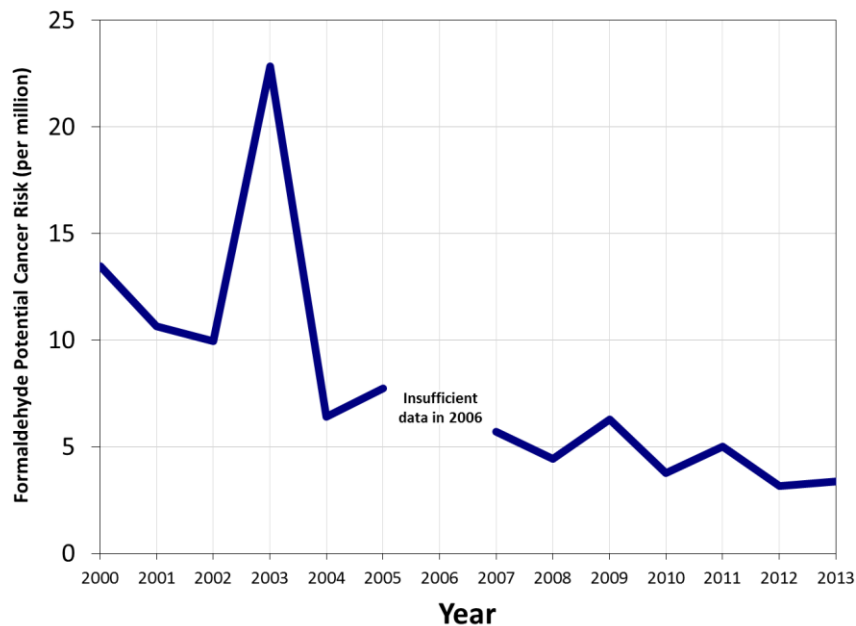
Formaldehyde

The EPA lists formaldehyde as a probable human carcinogen. Formaldehyde inhalation is also associated with eye, nose, throat and lung irritation.²² Sources of ambient formaldehyde include automobiles, trucks, wood burning and other combustion. Formaldehyde's 2013 average potential cancer risk range estimate at Beacon Hill was 3 in a million.

The increase in formaldehyde 2003 concentrations is due to 9 anomalous sampling days in July 2003 when levels were roughly ten times the normal levels. It is possible that a local formaldehyde source was present at the Beacon Hill reservoir during this month and inadvertently affected the monitors.

Agency efforts that target vehicle exhaust and wood stove emission reductions also reduce formaldehyde emissions. Since 2000, we found a statistically significant drop in risk from formaldehyde at a rate of about one per million per year.

Figure 27: Formaldehyde Annual Average Potential Cancer Risk at Beacon Hill, 2000-2013



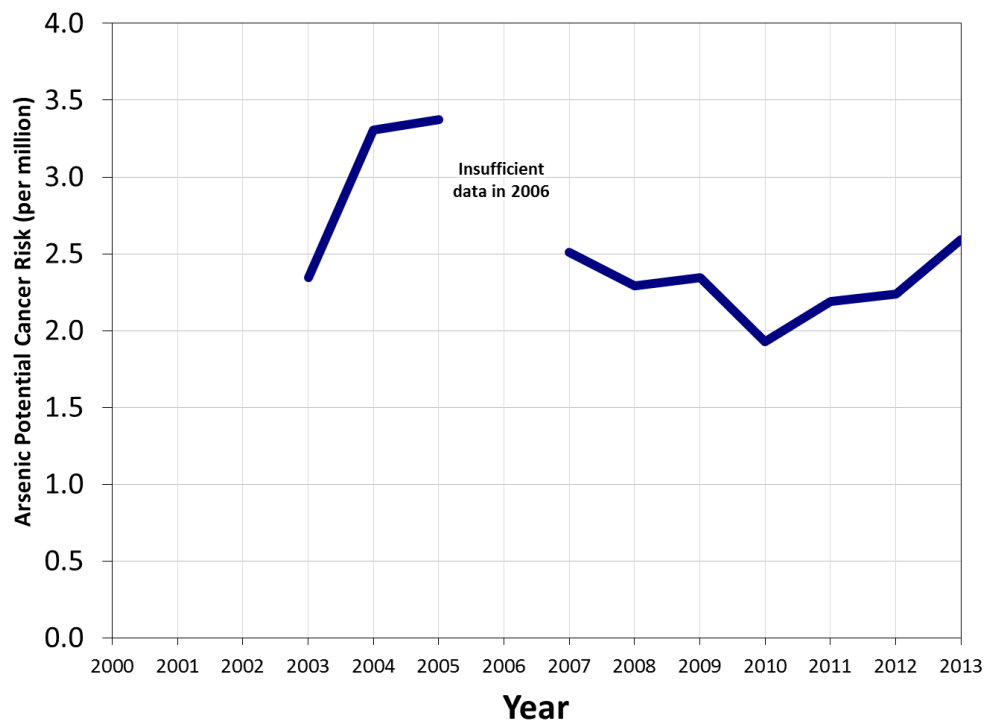
²²EPA Hazard Summary; epa.gov/ttn/atw/hlthef/formalde.html.

Arsenic

EPA lists arsenic as a known carcinogen. Exposure to arsenic is also associated with skin irritation and liver and kidney damage.²³ Arsenic is used to treat wood. Combustion of distillate oil is also a source of arsenic in the Puget Sound area. Arsenic's 2013 average potential cancer risk range estimate at Beacon Hill was 3 in a million. We did not find a statistically significant trend in arsenic levels over time.

We enforce illegal burning practices to limit arsenic emissions in Puget Sound. The Agency's permitting program also works with and regulates industrial producers of arsenic to reduce emissions.

Figure 28: Arsenic Annual Average Potential Cancer Risk at Beacon Hill, 2003-2013



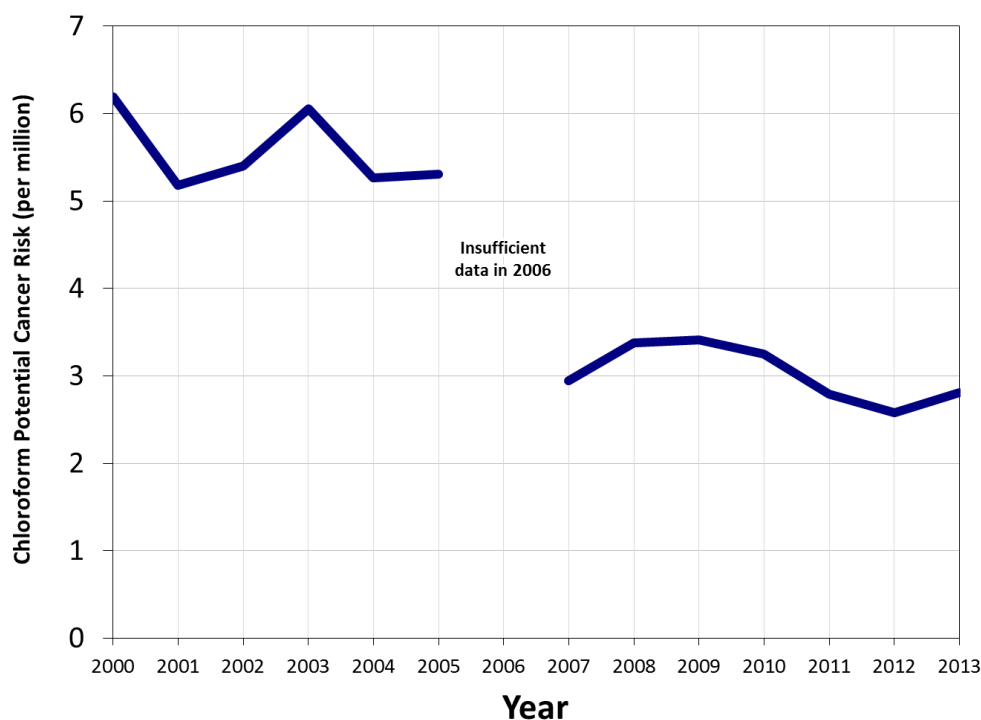
²³EPA Hazard Summary; epa.gov/ttn/atw/hlthef/arsenic.html.

Chloroform

The EPA lists chloroform as a probable human carcinogen. Chloroform inhalation is associated with central nervous system effects and liver damage.²⁴ Main sources of chloroform are water treatment plants and reservoirs. Since the Beacon Hill monitoring site is located at the Beacon Hill reservoir, the chloroform data may be biased high. However, it is still useful to calculate and assess the long-term trend and potential risk. Chloroform's 2013 average potential cancer risk range estimate at Beacon Hill was 3 in a million.

The Agency does not prioritize efforts to reduce chloroform emissions, as it does not likely present risk in areas other than those directly adjacent to reservoirs.²⁵ Since 2000, we found a statistically significant drop in risk from chloroform at a rate of about 0.3 per million per year.

Figure 29: Chloroform Annual Average Potential Cancer Risk at Beacon Hill, 2000-2013



²⁴EPA Hazard Summary; epa.gov/ttn/atw/hlthef/chlorofo.html.

²⁵Seattle Public Utilities. 2011Water Quality Analysis shows detectable levels of trihalomethanes; http://www.seattle.gov/util/groups/public/@spu/@water/documents/webcontent/02_016357.pdf. Trihalomethanes include chloroform, dichlorobromomethane, dibromochloromethane, and bromoform.

Hexavalent Chromium

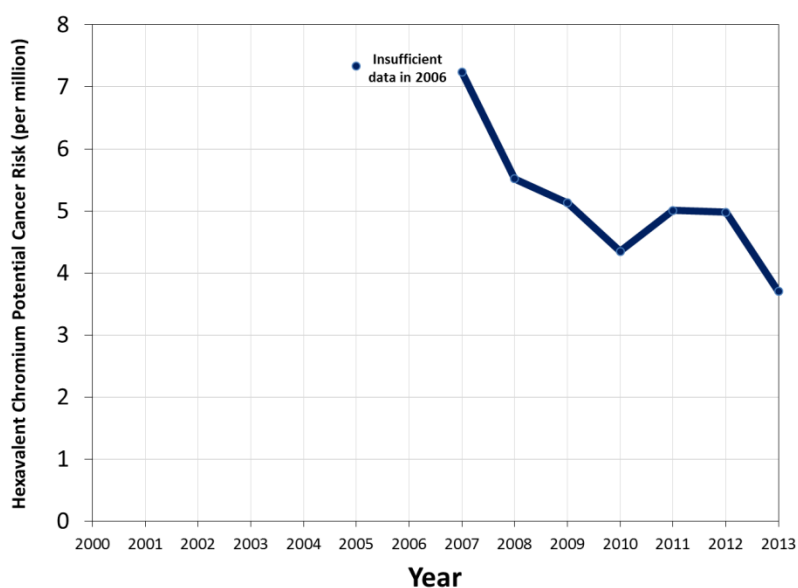
Chromium is present in two chemical states (trivalent and hexavalent) in our air. Trivalent chromium occurs naturally, while hexavalent comes from human activities and is much more toxic. EPA lists hexavalent chromium as a known carcinogen, associated primarily with lung cancer. Hexavalent chromium is often abbreviated as chromium +6 or chromium VI.

Exposure to hexavalent chromium is also associated with adverse respiratory, liver, and kidney effects.²⁶ Sources of hexavalent chromium include chrome electroplaters, as well as combustion of distillate oil, and combustion of gasoline and diesel fuels (car, truck and bus exhaust).

In recent years, the monitoring method for total suspended particulate (TSP) hexavalent chromium has improved. The 2013 estimated average potential cancer risk range for hexavalent chromium at Beacon Hill was 3 in a million. Sampling has been discontinued for hexavalent chromium and the last sample was collected on June 30th, 2013. This estimate only includes the first half of 2013.

In some years, up to 20% of the samples were below method detection limits. For the trend below, we used the Kaplan-Meier method to estimate the mean to better account for potential left-censored data biases for each year and changes in detection limits. Since 2000, we found a statistically significant drop in risk from hexavalent chromium at a rate of about 0.4 per million per year. The Agency's permitting program works with and regulates industrial chromium plating operations to reduce hexavalent chromium emissions.

Figure 30: Hexavalent Annual Average Potential Cancer Risk at Beacon Hill, 2005-2013



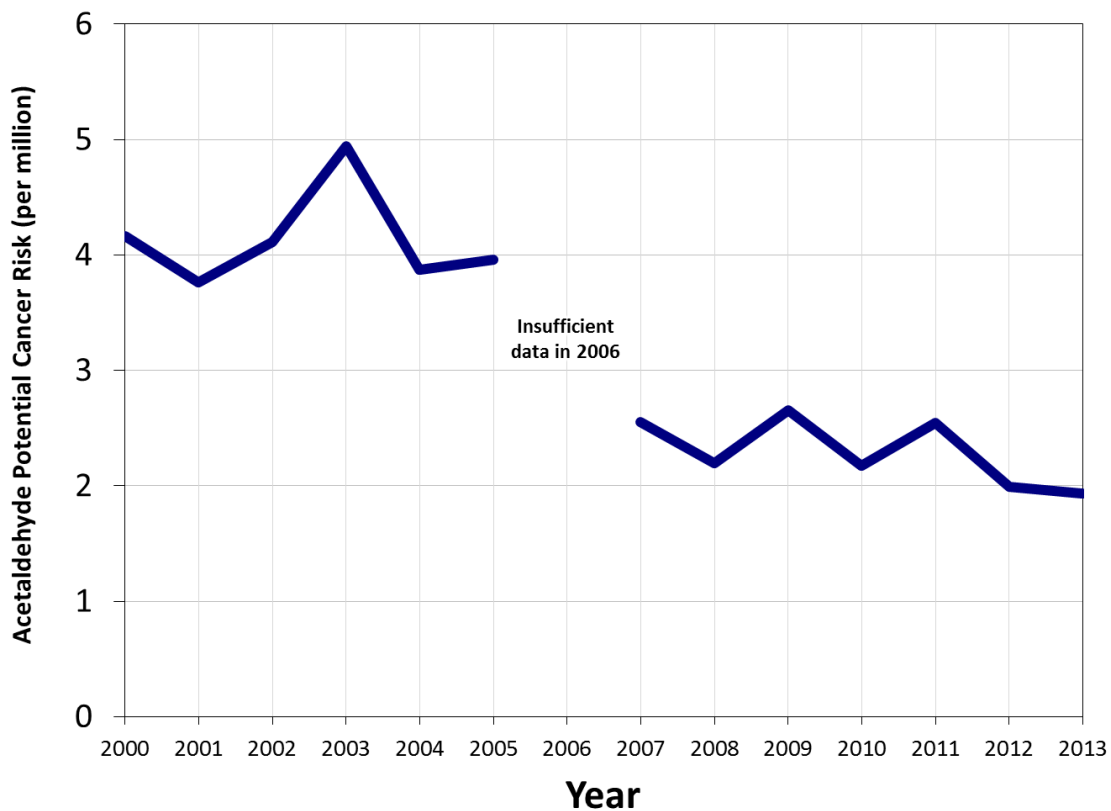
²⁶EPA Hazard Summary; epa.gov/ttn/atw/hlthef/chromium.html.

Acetaldehyde

The EPA lists acetaldehyde as a probable human carcinogen. Acetaldehyde inhalation is also associated with irritation of eyes, throat and lungs, and effects similar to alcoholism.²⁷ Main sources of acetaldehyde include wood burning and car/truck exhaust. Acetaldehyde's 2013 average potential cancer risk estimate at Beacon Hill was 2 in a million.

Agency efforts that target vehicle exhaust and wood stove emission reductions also reduce acetaldehyde emissions. Since 2000, we found a statistically significant drop in risk from acetaldehyde at a rate of about 0.2 per million per year.

Figure 31: Acetaldehyde Annual Average Potential Cancer Risk at Beacon Hill, 2000-2013



²⁷EPA Hazard Summary; epa.gov/ttn/atw/hlthef/acetalde.html.

Ethylene Dichloride

EPA lists ethylene dichloride as a probable human carcinogen. It is primarily used as a solvent in the production of other chemicals like vinyl chloride. It is also added to leaded gas.²⁸

We estimated ethylene dichloride's 2013 average potential cancer risk estimate at Beacon Hill at 2 in a million.

There is no useful trend information for this air toxic since this estimate includes samples near the practical quantitation limit of the measurement method. That is, all of the samples in 2013 were within twice the method detection limit. Additionally, in prior years, most of the samples were below the method detection limits. Through the years, the detection limits for this air toxic is near the one in a million potential cancer risk level.

The Agency's permitting program works with and regulates industrial producers of ethylene dichloride to reduce emissions.

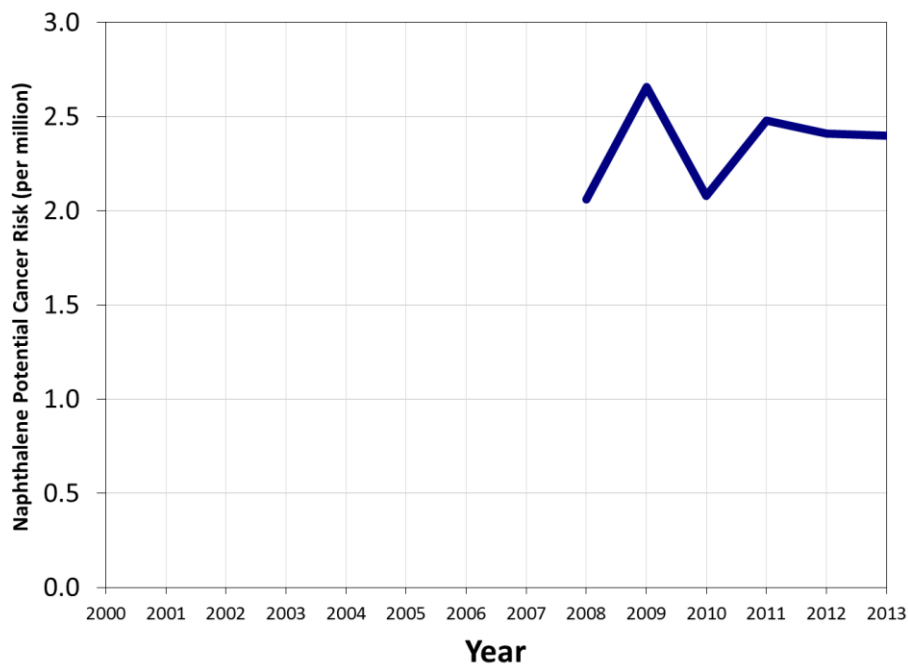
²⁸ EPA Hazard Summary, <http://www.epa.gov/ttnatw01/hlthef/di-ethan.html>.

Naphthalene

EPA lists naphthalene as a possible human carcinogen. Naphthalene is similarly associated with respiratory effects and retina damage.²⁹ Local sources of naphthalene include combustion of wood and heavy fuels. Naphthalene's 2013 average potential cancer risk estimate at Beacon Hill was at one in a million.

The Agency works with and regulates wood burning through burn bans and wood stove replacement programs to reduce naphthalene emissions. We did not find a statistically significant trend in naphthalene levels over time. Monitoring for naphthalene and other polycyclic aromatic hydrocarbons started in 2008.

Figure 32: Naphthalene Annual Average Potential Cancer Risk at Beacon Hill, 2008-2013



²⁹EPA Hazard Summary; epa.gov/ttn/atw/hlthef/naphthal.html.

Acrylonitrile

EPA lists acrylonitrile as a probable human carcinogen. Acrylonitrile is associated with headaches, fatigue, and nausea. The main source of acrylonitrile is from the production of plastics.³⁰

Acrylonitrile's 2013 average potential cancer risk estimate at Beacon Hill was at one in million. A sampled outlier on August 2, 2013 was included in this estimate and is the source for all the risk for the year. All the other samples in 2013 were below the detection limit and well below the potential cancer risk screen of one in a million. There is no useful trend information for this air toxic since all the prior years had samples below detection. Through the years, the detection limits for this air toxic has been near or below the one in a million potential cancer risk level. On August 2, 2013, no other volatile organic compounds were statistical outliers when compared to their annual variability.

The Agency's permitting program works with and regulates industrial producers of acrylonitrile to reduce emissions.

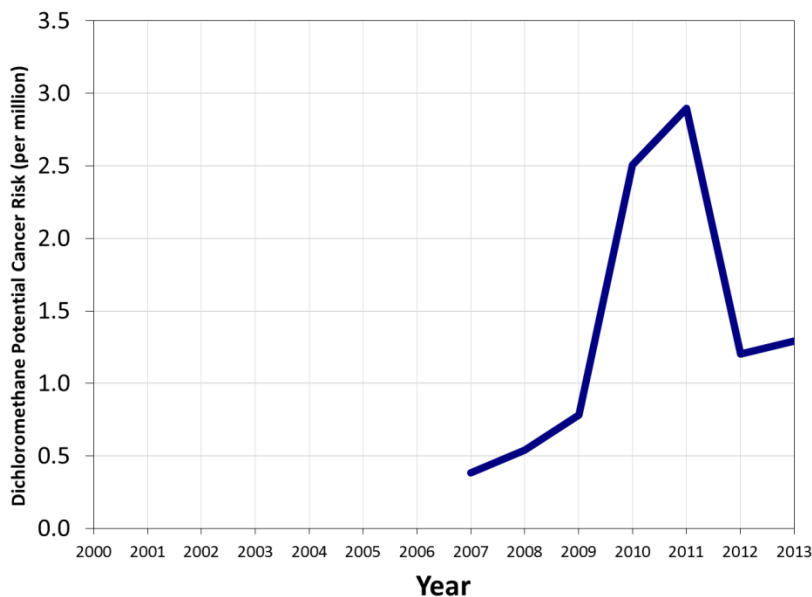
³⁰ EPA Hazard Summary, <http://www.epa.gov/ttnatw01/hlthef/acryloni.html>.

Dichloromethane

EPA lists dichloromethane as a probable human carcinogen. Dichloromethane is also known as methylene chloride. Dichloromethane is a common solvent used for paint, extraction, and cleaning processes.³¹ Dichloromethane's 2013 average potential cancer risk estimate at Beacon Hill was one in a million. We did not find a statistically significant trend in dichloromethane levels over this time frame.

The Agency's permitting program works with and regulates industrial producers of dichloromethane to reduce emissions. We do not have a program that addresses emissions from household products like paint strippers that may contain dichloromethane.

Figure 33: Dichloromethane Annual Average Potential Cancer Risk at Beacon Hill, 2007-2013

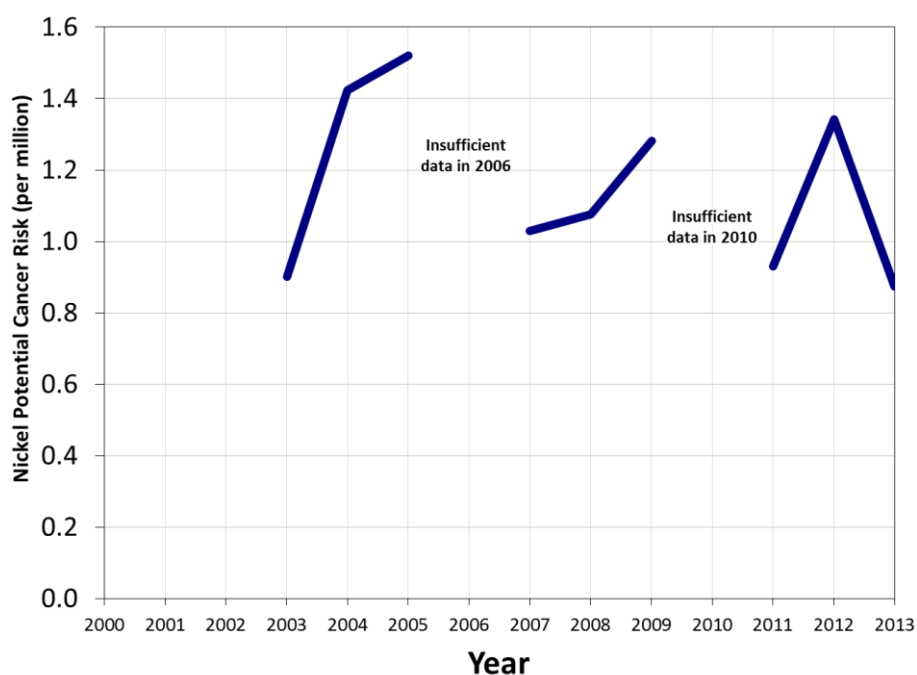


³¹ EPA Hazard Summary, <http://www.epa.gov/ttnatw01/hlthef/methylen.html>.

Nickel

EPA lists nickel as a known human carcinogen. Nickel is also associated with dermatitis and respiratory effects.³² Combustion of gasoline and diesel fuels (car, truck and bus exhaust) is a main source of nickel in the Puget Sound area. Nickel's 2013 average potential cancer risk estimate at Beacon Hill was one in a million. We did not find a statistically significant trend in nickel levels over this time frame. Agency efforts that target reducing vehicle exhaust also reduce nickel emissions.

Figure 34: Nickel Annual Average Potential Cancer Risk at Beacon Hill, 2003-2013

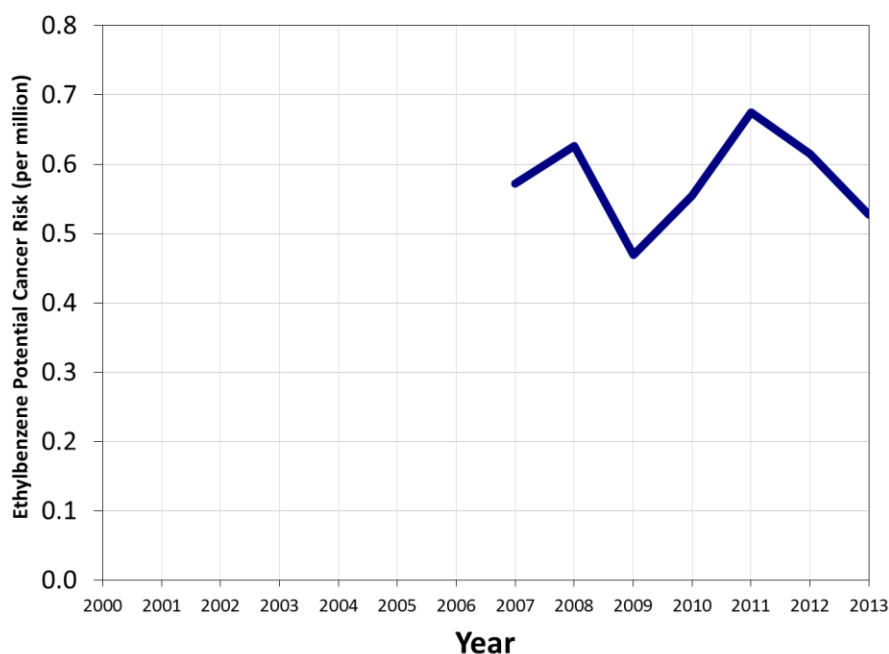


³²EPA Hazard Summary; epa.gov/iris/subst/0273.htm.

Ethylbenzene

EPA lists ethylbenzene as a Group D pollutant, which is not classifiable as to human carcinogenicity due to limited information available.³³ Chronic exposure to ethylbenzene may affect the blood, liver, and kidneys. Local sources of ethylbenzene are from fuels, asphalt and naphtha. It is also used in styrene production. Ethylbenzene's 2013 average potential cancer risk estimate at Beacon Hill was below one in a million, however is above one in the 95th percentile table in the appendix. We did not find a statistically significant trend in ethylbenzene levels over this time frame. The Agency works with and regulates solvent-using businesses to reduce ethylbenzene emissions.

Figure 35: Ethylbenzene Annual Average Potential Cancer Risk at Beacon Hill, 2007-2013



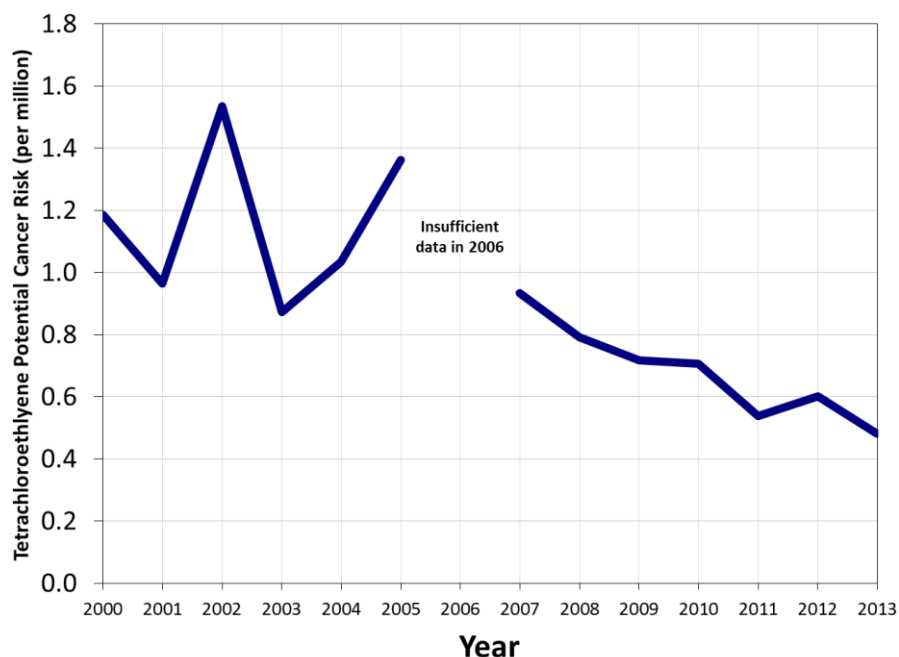
³³EPA Hazard Summary: epa.gov/ttn/atw/hlthef/ethylben.html.

Tetrachloroethylene

EPA lists tetrachloroethylene, also known as perchloroethylene or “perc”, as a probable human carcinogen. Tetrachloroethylene inhalation is also associated with central nervous system effects, liver and kidney damage, and cardiac arrhythmia.³⁴ Dry cleaners are the main source of tetrachloroethylene. Tetrachloroethylene’s 2013 average potential cancer risk estimate at Beacon Hill was below one in a million, however is above one in the 95th percentile table in the appendix.

Recently, we’ve been working with dry cleaners to monitor for and repair leaks in their equipment to reduce the release of tetrachloroethylene. Since 2000, we found a statistically significant drop in risk from tetrachloroethylene at a rate of about 0.1 per million per year.

Figure 36: Tetrachloroethylene Annual Average Potential Cancer Risk at Beacon Hill, 2000-2013



³⁴EPA Hazard Summary; epa.gov/ttn/atw/hlthef/tet-ethy.html.

Definitions

General Definitions

Air Quality Index

Table 4: 2013 Calculation and Breakpoints for the Air Quality Index (AQI)

| Breakpoints for Criteria Pollutants | | | | | | | AQI Categories | |
|-------------------------------------|---|---|--|--------------------|--|---------------------------------|----------------|-----------------------------------|
| O ₃ (ppm) 8-hour | O ₃ (ppm) 1-hour ^(a) | PM _{2.5} (µg/m ³) 24 hour | PM ₁₀ (µg/m ³) 24 hour | CO (ppm) 8 hour | SO ₂ ^(c) (ppb) 1 hour | NO ₂ (ppb) 1 hour | AQI value | Category |
| 0.000–0.059 | — | 0.0–12.0 | 0–54 | 0.0–4.4 | 0–35 | 0–53 | 0–50 | Good |
| 0.060–0.075 | — | 12.1–35.4 | 55–154 | 4.5–9.4 | 36–75 | 54–100 | 51–100 | Moderate |
| 0.076–0.095 | 0.125– 0.164 | 35.5–55.4 | 155–254 | 9.5–12.4 | 76–185 | 101–360 | 101–150 | Unhealthy for sensitive groups |
| 0.096–0.115 | 0.165– 0.204 | 55.5–150.4 | 255–354 | 12.5–15.4 | 186–304 | 361–649 | 151–200 | Unhealthy |
| 0.116–0.374 | 0.205– 0.404 | 150.5–250.4 | 355–424 | 15.5–30.4 | 305–604 | 650–1249 | 201–300 | Very unhealthy |
| (b) | 0.405– 0.504 | 250.5–350.4 | 425–504 | 30.5–40.4 | 604–804 | 1250– 1649 | 301–400 | Hazardous |
| (b) | 0.505– 0.604 | 350.4–500.4 | 505–604 | 40.5–50.4 | 805–1004 | 1650– 2049 | 401–500 | |

^(a) Areas are generally required to report the AQI based on 8-hour ozone values. However, there are a small number of areas where an AQI based on 1-hour ozone values would be safer. In these cases, in addition to calculating the 8-hour ozone value, the 1-hour ozone value may be calculated, and the greater of the two values reported.

^(b) 8-hour O₃ values do not define higher AQI values (above 300). AQI values above 300 are calculated with 1-hour O₃ concentrations.

^(c) EPA changed the SO₂ standard on June 22, 2010 to be based on an hourly maximum instead of a 24-hour and annual average.

For more information on the AQI, see airnow.gov/index.cfm?action=aqibasics.aqi.

Air shed

A geographic area that shares the same air, due to topography, meteorology and climate.

Air Toxics

Air toxics are broadly defined as over 400 pollutants that the Agency considers potentially harmful to human health and the environment. These pollutants are listed in the Washington Administrative Code at apps.leg.wa.gov/WAC/default.aspx?cite=173-460-150. Hazardous air pollutants (see below) are checked on this list to identify them as a subset of air toxics. Air toxics are also called Toxic Air Contaminants (TAC) under Agency Regulation III.

Criteria Air Pollutant (CAP)

The Clean Air Act of 1970 defined *criteria pollutants* and provided EPA the authority to establish ambient concentration standards for these criteria pollutants to protect public health. EPA periodically revises the original concentration limits and methods of measurement, most recently in 2011. The six criteria air pollutants are: particulate matter (10 micrometers and 2.5

micrometers), ozone, nitrogen dioxide, carbon monoxide, sulfur dioxide and lead. See appendix page A-29 for more information.

ppm, ppb (parts per million, or parts per billion))

A unit of concentration used for a many air pollutants. A ppm (ppb) means one molecule of the pollutant per million (or billion) molecules of air.

Hazardous Air Pollutant (HAP)

A *hazardous air pollutant* is an air contaminant listed in the Federal Clean Air Act, Section 112(b). EPA currently lists 188 pollutants as HAPs at epa.gov/ttn/atw/188polls.html.

Temperature Inversions

Air temperature usually decreases with altitude. On a sunny day, air near the surface is warmed and is free to rise. The warm surface air can rise to altitudes of 4000 feet or more and is dispersed (or mixed) into higher altitudes. In contrast, on clear nights with little wind, the surface can cool rapidly (by 10 degrees or more), which also cools the air just above the surface. The air aloft does not cool, which creates a very stable situation where the warm air aloft effectively caps the cooler air below. This limits mixing to just a few hundred feet or less. This situation is called a temperature inversion and allows for pollutants to accumulate to high concentrations.

Unit Risk Factor (URF)

A unit risk factor is a measure of a pollutant's cancer risk based on a 70-year inhalation exposure period. The units are risk/concentration. Unit risk factors are multiplied by concentrations to estimate potential cancer risk.

Visibility/Regional Haze

Visibility is often explained in terms of visual range and light extinction. *Visual range* is the maximum distance (usually miles or kilometers) a black object can be seen against the horizon. *Light extinction* is the sum of light scattering and light absorption by fine particles and gases in the atmosphere. The more light extinction, the shorter the visual range. Reduced visibility (or visual range) is caused by weather (clouds, fog, and rain) and air pollution (fine particles and gases).

Volatile Organic Compound (VOC)

An organic compound that participates in atmospheric photochemical reactions. This excludes compounds determined by EPA to have negligible photochemical reactivity.

2013

Air Quality Data Summary Appendix

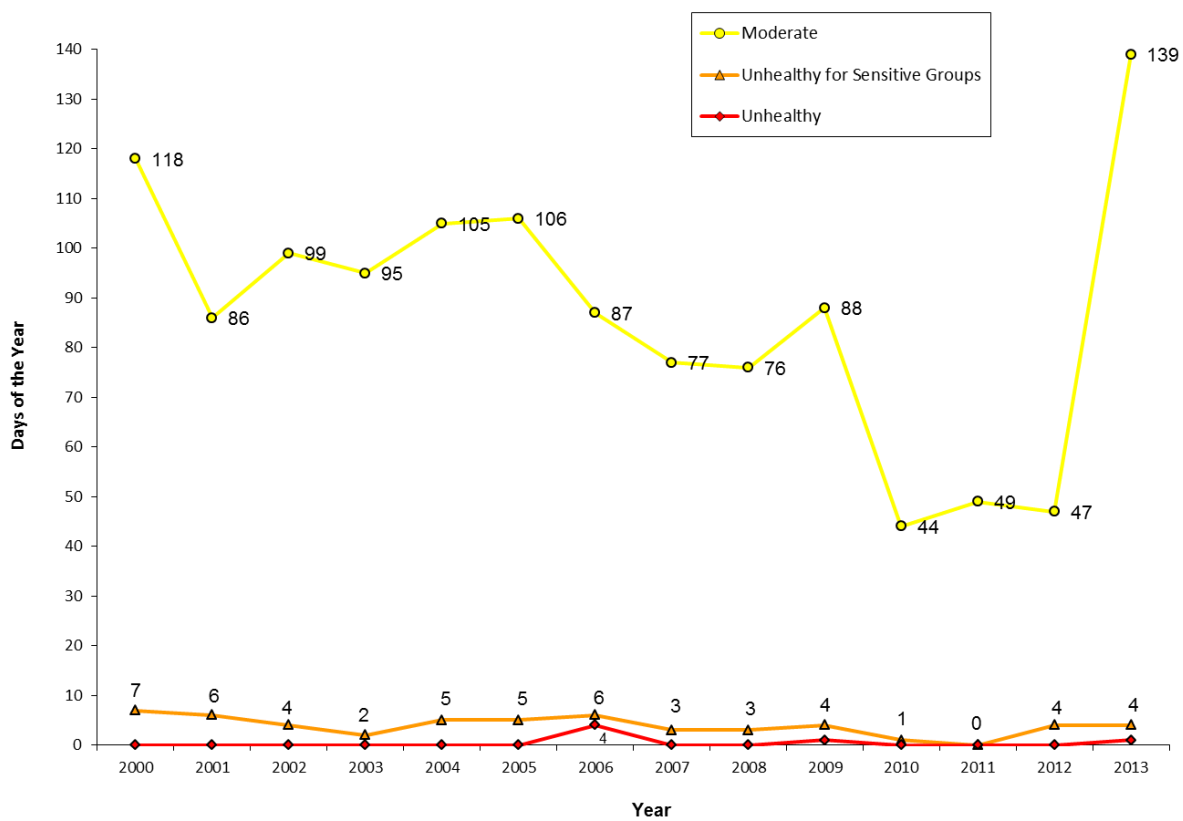
August 2014

Air Quality Index 1980 – 2013

| King County | | | | | | | | | | | | | | | | | |
|-----------------------------------|------|----------|----------------------------|-----------|-------------------|----------------------------------|------|-----------------|------------------------|-----------------|----------------|--------------------|----------------|------------------------------------|---------------|----------|----------------|
| Days in Each Air Quality Category | | | | | | Pollutant Determining the AQI | | | | | | | | | Highest Value | | |
| Year | Good | Moderate | Unhealthy for Sensitive | | Very Unhealthy | All Days | | | | | Unhealthy Days | | | | AQI | Date | Pollutant |
| | | | Groups | Unhealthy | | PM | CO | SO ₂ | O ₃ | NO ₂ | PM | CO | O ₃ | NO ₂ | | | |
| 1980 | 73 | 275 | | 18 | 0 | 95 | 270 | 1 | | | 1 | 17 | | | 194 | Jan 23 | PM |
| 1981 | 69 | 267 | | 28 | 1 | 109 | 254 | 2 | | | 5 | 24 | | | 213 | Jan 15 | CO |
| 1982 | 86 | 268 | | 10 | 1 | 96 | 264 | 5 | | | 1 | 10 | | | 214 | Feb 6 | PM |
| 1983 | 98 | 258 | | 9 | 0 | 101 | 261 | 3 | | | 0 | 9 | | | 183 | Jan 28 | CO |
| 1984 | 146 | 218 | | 2 | 0 | 111 | 242 | 13 | | | 2 | 0 | | | 103 | Dec 6 | PM |
| 1985 | 150 | 202 | | 10 | 3 | 156 | 206 | 3 | | | 6 | 7 | | | 204 | Dec 12 | PM |
| 1986 | 130 | 226 | | 8 | 1 | 113 | 246 | 6 | | | 1 | 8 | | | 206 | Jan 7 | PM |
| 1987 | 120 | 238 | | 7 | 0 | 119 | 246 | 0 | | | 3 | 4 | | | 184 | Feb 6 | PM |
| 1988 | 215 | 146 | | 5 | 0 | 67 | 298 | 1 | | | 2 | 3 | | | 150 | Dec 3 | CO |
| 1989 | 231 | 134 | | 0 | 0 | 129 | 233 | 3 | | | 0 | 0 | | | 100 | Jan 19 # | CO |
| 1990 | 216 | 145 | | 4 | 0 | 139 | 201 | 6 | 19 | | 0 | 0 | 4 | | 131 | Aug 11 | O ₃ |
| 1991 | 229 | 136 | | 0 | 0 | 140 | 190 | 8 | 27 | | 0 | 0 | 0 | | 100 | Dec 15 # | CO |
| 1992 | 206 | 159 | | 1 | 0 | 103 | 230 | 1 | 32 | | 0 | 1 | 0 | | 167 | Feb 3 | CO |
| 1993 | 240 | 125 | | 0 | 0 | 118 | 235 | 1 | 11 | | 0 | 0 | 0 | | 88 | Jan 11 | PM |
| 1994 | 293 | 70 | | 2 | 0 | 72 | 270 | 1 | 22 | | 0 | 0 | 2 | | 134 | Jul 21 | O ₃ |
| 1995 | 299 | 66 | | 0 | 0 | 95 | 249 | 5 | 16 | | 0 | 0 | 0 | | 89 | Jan 3 | CO |
| 1996 | 297 | 69 | | 0 | 0 | 85 | 252 | 2 | 27 | | 0 | 0 | 0 | | 100 | Oct 9 | CO |
| 1997 | 302 | 63 | | 0 | 0 | 117 | 230 | 0 | 18 | | 0 | 0 | 0 | | 94 | Jan 16 | PM |
| 1998 | 317 | 46 | | 2 | 0 | 111 | 228 | 0 | 26 | | 0 | 0 | 2 | | 114 | Jul 27 # | O ₃ |
| 1999 | 267 | 92 | 6 | 0 | 0 | 251 | 60 | 0 | 54 | | 5 | 0 | 1 | | 134 | Jan 4 | PM |
| 2000 | 241 | 118 | 7 | 0 | 0 | 288 | 25 | 0 | 53 | | 5 | 0 | 2 | | 114 | Nov 21 | PM |
| 2001 | 273 | 86 | 6 | 0 | 0 | 295 | 10 | 0 | 60 | | 6 | 0 | 0 | | 118 | Nov 10 | PM |
| 2002 | 262 | 99 | 4 | 0 | 0 | 275 | 11 | 0 | 79 | | 4 | 0 | 0 | | 113 | Nov 27 | PM |
| 2003 | 268 | 95 | 2 | 0 | 0 | 250 | 5 | 0 | 110 | | 0 | 0 | 2 | | 132 | Jun 6 | O ₃ |
| 2004 | 256 | 105 | 5 | 0 | 0 | 280 | 2 | 0 | 84 | | 4 | 0 | 1 | | 132 | Dec 18 | PM |
| 2005 | 254 | 106 | 5 | 0 | 0 | 302 | 3 | 0 | 60 | | 5 | 0 | 0 | | 117 | Dec 11 | PM |
| 2006 | 268 | 87 | 6 | 4 | 0 | 273 | 2 | 0 | 90 | | 6 | 0 | 4 | | 169 | Jul 22 | O ₃ |
| 2007 | 285 | 77 | 3 | 0 | 0 | 278 | 0 | | 87 | | 2 | 0 | 1 | | 115 | Jan 29 | PM |
| 2008 | 287 | 76 | 3 | 0 | 0 | 306 | 0 | | 60 | | 0 | 0 | 3 | | 140 | Jun 29 | O ₃ |
| 2009 | 272 | 88 | 4 | 1 | 0 | 254 | 0 | | 111 | | 1 | 0 | 4 | | 154 | Jul 5 | PM |
| 2010 | 320 | 44 | 1 | 0 | 0 | 261 | 0 | | 104 | | 0 | 0 | 1 | | 104 | Aug 17 | O ₃ |
| 2011 | 316 | 49 | 0 | 0 | 0 | 192 | 0 | | 173 | | 0 | 0 | 0 | | 98 | Dec 10 | PM |
| 2012 | 315 | 47 | 4 | 0 | 0 | 206 | 0 | | 160 | | 2 | 0 | 2 | | 116 | Aug 5 | O ₃ |
| 2013 | 221 | 139 | 4 | 1 | 0 | 308 | 0 | | 53 | 4 | 5 | 0 | 0 | 0 | 152 | Nov 28 | PM |
| Totals | 7822 | 4419 | 60 | 112 | 6 | 6095 | 4723 | 61 | 1536 | 4 | 66 | 83 | 29 | 0 | | | |
| PM = Particulate Matter | | | CO = Carbon Monoxide | | | SO ₂ = Sulfur Dioxide | | | O ₃ = Ozone | | | # = 1st Occurrence | | NO ₂ = Nitrogen Dioxide | | | |

Note: In 1987 the particulate matter (PM) standard, total suspended particulates (TSP), was replaced by only that fraction of particulate matter with particle diameters equal to or less than 10 micrometers (PM₁₀).
In 1999 the Pollutant Standard Index (PSI) was replaced by the Air Quality Index (AQI) and included new and more stringent fine particle (PM_{2.5}) and 8-hour ozone (O₃) standards. The O₃ standard was again revised in March 2008.
NO₂ data added beginning 2013

Air Quality for King County

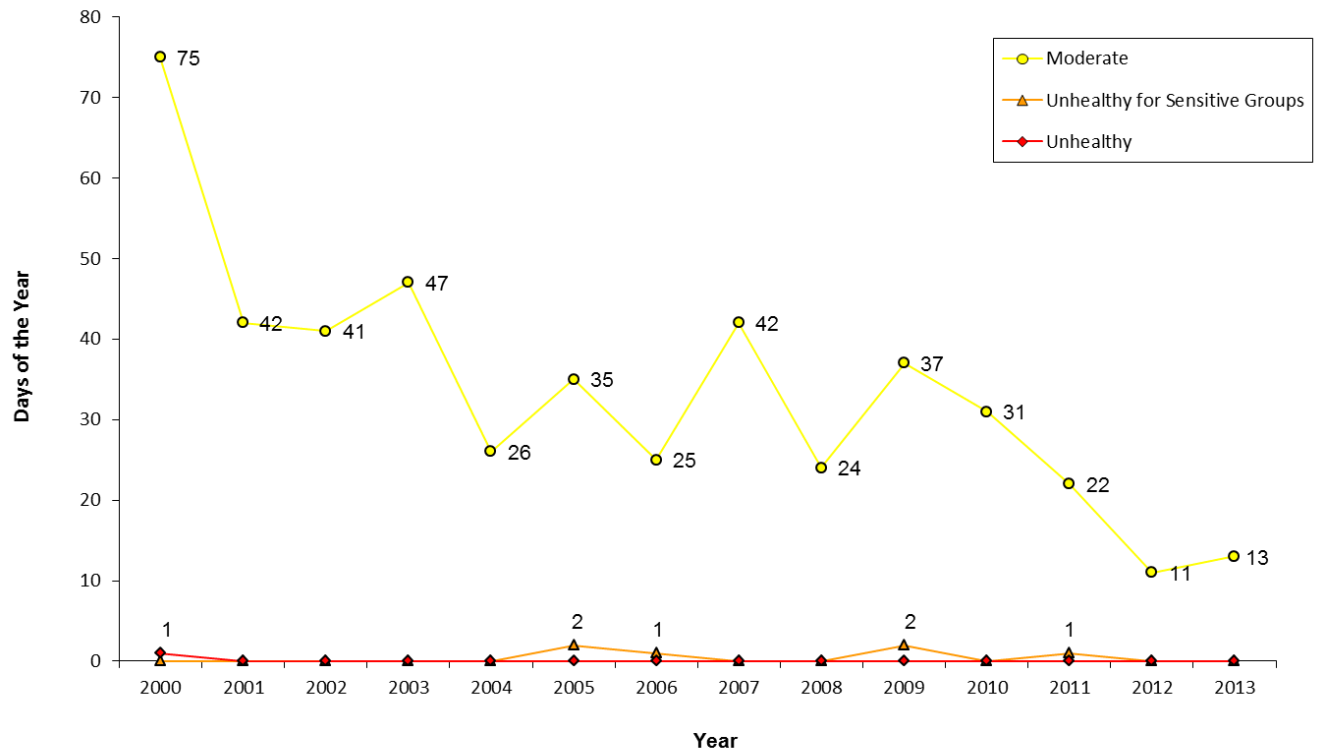


Air Quality Index 1990 – 2013

| Kitsap County | | | | | | | | | | | | | | | |
|---|------|----------|--------------------------------------|--|-------------------|-------------------------------|------|-----------------|----------------|----------------|----|----------------|-----|---------------|-----------|
| Days in Each Air Quality Category | | | | | | Pollutant Determining the AQI | | | | | | | | Highest Value | |
| Year | Good | Moderate | Unhealthy for Sensitive Groups | | Very Unhealthy | All Days | | | | Unhealthy Days | | | AQI | Date | Pollutant |
| | | | | | | PM | CO | SO ₂ | O ₃ | PM | CO | O ₃ | | | |
| 1990 | | | | | | | | | | | | | | | |
| 1991 | | | | | | | | | | | | | | | |
| 1992 | 353 | 8 | | | 0 | 0 | 361 | | | 0 | | | 68 | Nov 25 | PM |
| 1993 | 343 | 12 | | | 0 | 0 | 355 | | | 0 | | | 62 | Jan 11 | PM |
| 1994 | 364 | 1 | | | 0 | 0 | 248 | 117 | | 0 | 0 | | 54 | Dec 23 | CO |
| 1995 | 361 | 4 | | | 0 | 0 | 86 | 279 | | 0 | 0 | | 57 | Jan 5 | CO |
| 1996 | 361 | 1 | | | 0 | 0 | 206 | 156 | | 0 | 0 | | 51 | Mar 2 | PM |
| 1997 | 361 | 1 | | | 0 | 0 | 362 | | | 0 | | | 55 | Jan 15 | PM |
| 1998 | 347 | 9 | | | 0 | 0 | 356 | | | 0 | | | 87 | Nov 8 | PM |
| 1999 | 333 | 32 | 0 | | 0 | 0 | 365 | | | 0 | | | 81 | Jan 5 # | PM |
| 2000 | 290 | 75 | 0 | | 1 | 0 | 366 | | | 1 | | | 159 | Jul 4 | PM |
| 2001 | 320 | 42 | 0 | | 0 | 0 | 362 | | | 0 | | | 91 | Dec 25 | PM |
| 2002 | 324 | 41 | 0 | | 0 | 0 | 365 | | | 0 | | | 78 | Nov 2 | PM |
| 2003 | 318 | 47 | 0 | | 0 | 0 | 365 | | | 0 | | | 78 | Nov 3 | PM |
| 2004 | 340 | 26 | 0 | | 0 | 0 | 366 | | | 0 | | | 80 | Jul 4 | PM |
| 2005 | 328 | 35 | 2 | | 0 | 0 | 365 | | | 2 | | | 136 | Jul 4 | PM |
| 2006 | 339 | 25 | 1 | | 0 | 0 | 365 | | | 1 | | | 105 | Dec 17 | PM |
| 2007 | 322 | 42 | 0 | | 0 | 0 | 364 | | | 0 | | | 92 | Nov 24 | PM |
| 2008 | 342 | 24 | 0 | | 0 | 0 | 366 | | | 0 | | | 78 | Dec 23 | PM |
| 2009 | 300 | 37 | 2 | | 0 | 0 | 339 | | | 2 | | | 111 | Dec 3 | PM |
| 2010 | 321 | 31 | 0 | | 0 | 0 | 352 | | | 0 | | | 88 | Dec 31 | PM |
| 2011 | 340 | 22 | 1 | | 0 | 0 | 363 | | | 1 | | | 111 | Jan 1 | PM |
| 2012 | 345 | 11 | 0 | | 0 | 0 | 356 | | | 0 | | | 68 | Jan 1 | PM |
| 2013 | 352 | 13 | 0 | | 0 | 0 | 365 | | | 0 | | | 75 | Jul 4 | PM |
| Totals | 7404 | 539 | 6 | | 1 | 0 | 7398 | 552 | 0 | 0 | 7 | 0 | 0 | | |
| PM = Particulate Matter CO = Carbon Monoxide SO ₂ = Sulfur Dioxide O ₃ = Ozone # = 1st Occurrence | | | | | | | | | | | | | | | |

Note: In 1987 the particulate matter (PM) standard, total suspended particulates (TSP), was replaced by only that fraction of particulate matter with particle diameters equal to or less than 10 micrometers (PM₁₀). In 1999 the Pollutant Standard Index (PSI) was replaced by the Air Quality Index (AQI) and included new and more stringent fine particle (PM_{2.5}) and 8-hour ozone (O₃) standards. The O₃ standard was again revised in March 2008.

Air Quality for Kitsap County

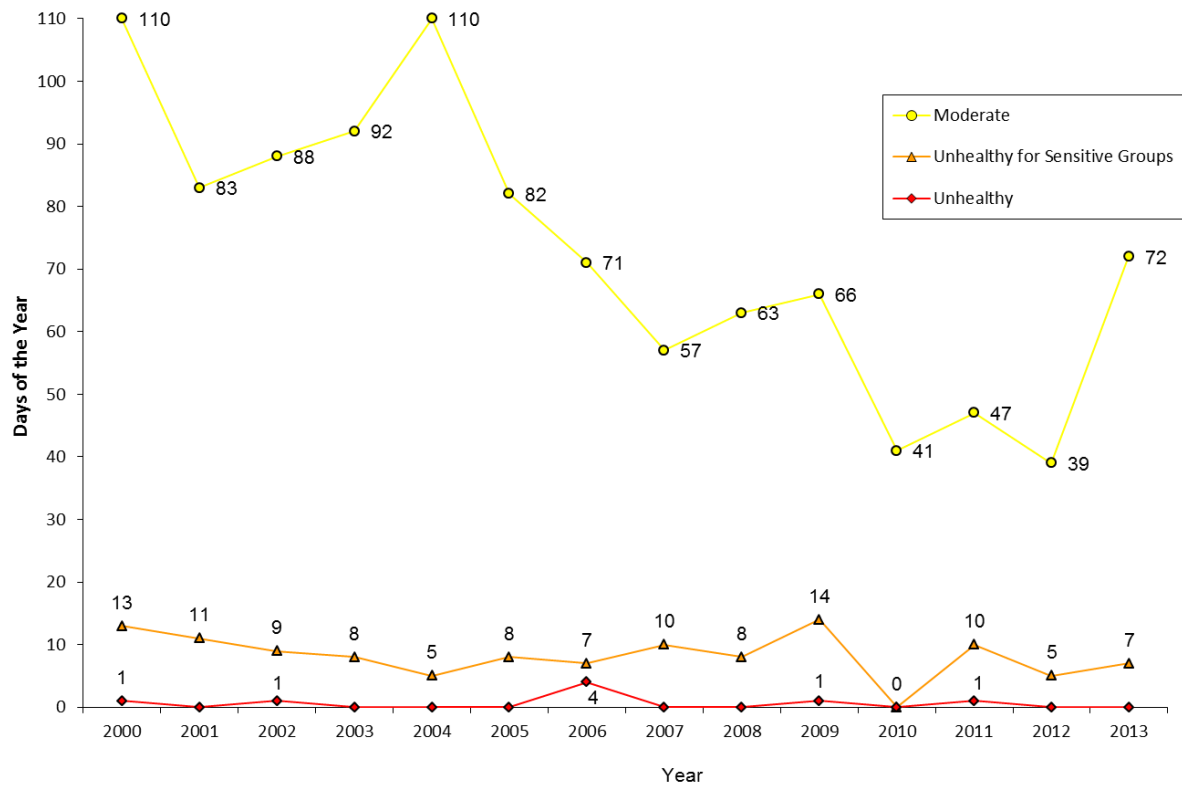


Air Quality Index 1980 – 2013

| Pierce County | | | | | | | | | | | | | | | | |
|-----------------------------------|------|----------|----------------------------|-----------|-------------------|----------------------------------|------|-----------------|------------------------|----------------|----|--------------------|---------------|----------|----------------|--|
| Days in Each Air Quality Category | | | | | | Pollutant Determining the AQI | | | | | | | Highest Value | | | |
| Year | Good | Moderate | Unhealthy for Sensitive | | Very Unhealthy | All Days | | | | Unhealthy Days | | | AQI | Date | Pollutant | |
| | | | Groups | Unhealthy | | PM | CO | SO ₂ | O ₃ | PM | CO | O ₃ | | | | |
| 1980 | 83 | 271 | | 12 | 0 | 256 | 107 | 3 | | 4 | 8 | | 160 | Apr 12 | PM | |
| 1981 | 74 | 278 | | 10 | 3 | 222 | 137 | 6 | | 1 | 12 | | 227 | Jan 12 | CO | |
| 1982 | 119 | 242 | | 4 | 0 | 255 | 101 | 9 | | 0 | 4 | | 167 | Dec 30 | CO | |
| 1983 | 140 | 222 | | 3 | 0 | 228 | 128 | 9 | | 1 | 2 | | 137 | Dec 23 | PM | |
| 1984 | 162 | 198 | | 6 | 0 | 207 | 149 | 10 | | 0 | 6 | | 117 | Jan 19 # | CO | |
| 1985 | 140 | 213 | | 12 | 0 | 252 | 109 | 4 | | 1 | 11 | | 165 | Dec 13 | PM | |
| 1986 | 161 | 197 | | 7 | 0 | 247 | 114 | 4 | | 2 | 5 | | 167 | Oct 23 | CO | |
| 1987 | 173 | 177 | | 13 | 2 | 227 | 136 | 2 | | 5 | 10 | | 220 | Feb 5 | CO | |
| 1988 | 226 | 132 | | 8 | 0 | 184 | 175 | 7 | | 3 | 5 | | 183 | Jan 27 | CO | |
| 1989 | 260 | 103 | | 2 | 0 | 217 | 121 | 27 | | 0 | 2 | | 117 | Nov 30 # | CO | |
| 1990 | 271 | 91 | | 3 | 0 | 219 | 87 | 41 | 18 | 1 | 0 | 2 | 118 | May 5 | PM | |
| 1991 | 261 | 103 | | 1 | 0 | 247 | 85 | 12 | 21 | 0 | 1 | 0 | 117 | Jan 31 | CO | |
| 1992 | 260 | 106 | | 0 | 0 | 231 | 83 | 27 | 25 | 0 | 0 | 0 | 100 | Feb 3 # | CO | |
| 1993 | 289 | 76 | | 0 | 0 | 247 | 82 | 23 | 13 | 0 | 0 | 0 | 89 | Feb 1 | CO | |
| 1994 | 313 | 51 | | 1 | 0 | 235 | 75 | 31 | 24 | 0 | 0 | 1 | 105 | Jul 21 | O ₃ | |
| 1995 | 307 | 58 | | 0 | 0 | 239 | 97 | 13 | 16 | 0 | 0 | 0 | 83 | Jan 3 | PM | |
| 1996 | 322 | 44 | | 0 | 0 | 206 | 119 | 23 | 18 | 0 | 0 | 0 | 78 | Oct 9 | CO | |
| 1997 | 316 | 49 | | 0 | 0 | 262 | 75 | 16 | 12 | 0 | 0 | 0 | 84 | Jan 16 | PM | |
| 1998 | 338 | 25 | | 2 | 0 | 213 | 112 | 25 | 15 | 0 | 0 | 2 | 120 | Jul 27 | O ₃ | |
| 1999 | 265 | 97 | 3 | 0 | 0 | 318 | 1 | 1 | 45 | 3 | 0 | 0 | 139 | Jan 4 | PM | |
| 2000 | 242 | 110 | 13 | 1 | 0 | 318 | 2 | | 46 | 14 | 0 | 0 | 153 | Dec 6 | PM | |
| 2001 | 271 | 83 | 11 | 0 | 0 | 306 | 2 | | 57 | 11 | 0 | 0 | 139 | Nov 10 | PM | |
| 2002 | 267 | 88 | 9 | 1 | 0 | 291 | 1 | | 73 | 10 | 0 | 0 | 158 | Nov 27 | PM | |
| 2003 | 265 | 92 | 8 | 0 | 0 | 264 | 1 | | 100 | 8 | 0 | 0 | 122 | Jan 7 | PM | |
| 2004 | 251 | 110 | 5 | 0 | 0 | 272 | 0 | | 94 | 5 | 0 | 0 | 133 | Nov 5 | PM | |
| 2005 | 275 | 82 | 8 | 0 | 0 | 276 | 2 | | 87 | 8 | 0 | 0 | 120 | Dec 10 | PM | |
| 2006 | 283 | 71 | 7 | 4 | 0 | 270 | 0 | | 95 | 8 | 0 | 3 | 170 | Dec 17 | PM | |
| 2007 | 298 | 57 | 10 | 0 | 0 | 261 | | | 104 | 9 | 0 | 1 | 137 | Jan 29 | PM | |
| 2008 | 295 | 63 | 8 | 0 | 0 | 259 | | | 107 | 5 | 0 | 3 | 129 | Aug 16 | O ₃ | |
| 2009 | 284 | 66 | 14 | 1 | 0 | 250 | | | 115 | 15 | 0 | 0 | 158 | Jul 5 | PM | |
| 2010 | 324 | 41 | 0 | 0 | 0 | 259 | | | 106 | 0 | 0 | 0 | 83 | Dec 5 | PM | |
| 2011 | 307 | 47 | 10 | 1 | 0 | 365 | | | 0 | 11 | 0 | 0 | 152 | Jan 1 | PM | |
| 2012 | 322 | 39 | 5 | 0 | 0 | 366 | | | 0 | 5 | 0 | 0 | 144 | Jan 20 | PM | |
| 2013 | 286 | 72 | 7 | 0 | 0 | 365 | | | 0 | 7 | 0 | 0 | 116 | Jan 13 | PM | |
| Totals | 8450 | 3754 | 118 | 92 | 5 | 8834 | 2101 | 293 | 1191 | 137 | 66 | 12 | | | | |
| PM = Particulate Matter | | | CO = Carbon Monoxide | | | SO ₂ = Sulfur Dioxide | | | O ₃ = Ozone | | | # = 1st Occurrence | | | | |

Note: In 1987 the particulate matter (PM) standard, total suspended particulates (TSP), was replaced by only that fraction of particulate matter with particle diameters equal to or less than 10 micrometers (PM₁₀).
 In 1999 the Pollutant Standard Index (PSI) was replaced by the Air Quality Index (AQI) and included new and more stringent fine particle (PM_{2.5}) and 8-hour ozone (O₃) standards. The O₃ standard was again revised in March 2008.

Air Quality for Pierce County



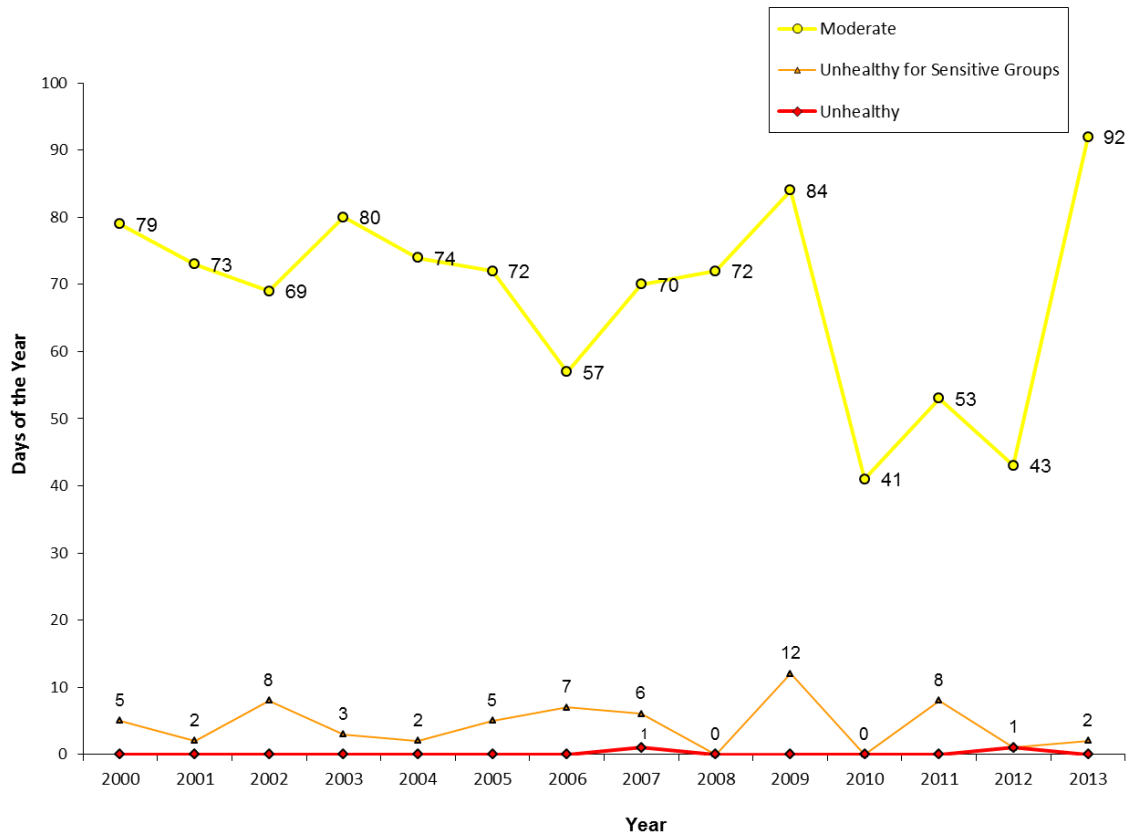
Air Quality Index 1980 – 2013

| Snohomish County | | | | | | | | | | | | | | | |
|---|------|----------|----------------------------|-----------|-------------------|-------------------------------|------|-----------------|----------------|----------------|----|-----------------|---------------|----------|----------------|
| Days in Each Air Quality Category | | | | | | Pollutant Determining the AQI | | | | | | | Highest Value | | |
| Year | Good | Moderate | Unhealthy for Sensitive | | Very Unhealthy | All Days | | | | Unhealthy Days | | | AQI | Date | Pollutant |
| | | | Groups | Unhealthy | | PM | CO | SO ₂ | O ₃ | PM | CO | SO ₂ | | | |
| 1980 | 340 | 19 | | 0 | 0 | 356 | | 3 | | 0 | | 0 | 60 | Jan 23 | PM |
| 1981 | 350 | 11 | | 0 | 0 | 340 | | 21 | | 0 | | 0 | 62 | Jan 16 | PM |
| 1982 | 334 | 30 | | 1 | 0 | 277 | 70 | 18 | | 0 | 1 | 0 | 117 | Dec 30 | CO |
| 1983 | 308 | 56 | | 1 | 0 | 191 | 150 | 24 | | 0 | 1 | 0 | 117 | Nov 30 | CO |
| 1984 | 309 | 57 | | 0 | 0 | 105 | 217 | 44 | | 0 | 0 | 0 | 92 | Sep 28 | PM |
| 1985 | 300 | 64 | | 1 | 0 | 152 | 166 | 47 | | 0 | 1 | 0 | 117 | Dec 11 | CO |
| 1986 | 324 | 41 | | 0 | 0 | 169 | 148 | 48 | | 0 | 0 | 0 | 89 | Jan 25 | CO |
| 1987 | 203 | 158 | | 3 | 0 | 96 | 250 | 18 | | 0 | 3 | 0 | 117 | Jun 26 # | CO |
| 1988 | 174 | 184 | | 8 | 0 | 15 | 345 | 6 | | 0 | 8 | 0 | 133 | Sep 13 # | CO |
| 1989 | 150 | 213 | | 2 | 0 | 26 | 338 | 1 | | 0 | 2 | 0 | 133 | Feb 10 | CO |
| 1990 | 166 | 197 | | 2 | 0 | 29 | 335 | 1 | | 0 | 2 | 0 | 117 | Mar 2 # | CO |
| 1991 | 188 | 176 | | 1 | 0 | 32 | 333 | 0 | | 0 | 1 | 0 | 117 | Dec 16 | CO |
| 1992 | 180 | 186 | | 0 | 0 | 34 | 332 | 0 | | 0 | 0 | 0 | 100 | Feb 4 # | CO |
| 1993 | 237 | 128 | | 0 | 0 | 56 | 306 | 0 | 3 | 0 | 0 | 0 | 79 | Jan 11 | PM |
| 1994 | 294 | 71 | | 0 | 0 | 28 | 334 | 1 | 2 | 0 | 0 | 0 | 78 | Dec 30 | CO |
| 1995 | 316 | 49 | | 0 | 0 | 59 | 294 | 1 | 11 | 0 | 0 | 0 | 78 | Jul 7 | CO |
| 1996 | 340 | 26 | | 0 | 0 | 54 | 299 | 0 | 13 | 0 | 0 | 0 | 67 | Jul 26 | O ₃ |
| 1997 | 348 | 17 | | 0 | 0 | 210 | 151 | 0 | 4 | 0 | 0 | 0 | 67 | Jan 14 | PM |
| 1998 | 353 | 11 | | 1 | 0 | 143 | 219 | 3 | | 1 | 0 | 0 | 153 | Dec 22 | PM |
| 1999 | 300 | 62 | 3 | 0 | 0 | 260 | 105 | 0 | | 3 | 0 | 0 | 129 | Jan 3 | PM |
| 2000 | 253 | 79 | 5 | 0 | 0 | 301 | 36 | | | 5 | 0 | 0 | 113 | Jul 4 | PM |
| 2001 | 290 | 73 | 2 | 0 | 0 | 356 | 9 | | | 2 | 0 | 0 | 111 | Nov 10 | PM |
| 2002 | 288 | 69 | 8 | 0 | 0 | 343 | 22 | | | 8 | 0 | 0 | 116 | Nov 4 | PM |
| 2003 | 282 | 80 | 3 | 0 | 0 | 364 | 1 | | | 3 | 0 | 0 | 108 | Nov 4 | PM |
| 2004 | 290 | 74 | 2 | 0 | 0 | 364 | 2 | | | 2 | 0 | 0 | 107 | Nov 5 | PM |
| 2005 | 288 | 72 | 5 | 0 | 0 | 360 | 5 | | | 5 | 0 | 0 | 139 | Dec 11 | PM |
| 2006 | 301 | 57 | 7 | 0 | 0 | 364 | 1 | | | 7 | 0 | 0 | 143 | Dec 17 | PM |
| 2007 | 288 | 70 | 6 | 1 | 0 | 365 | | | | 7 | 0 | 0 | 155 | Jan 15 | PM |
| 2008 | 294 | 72 | 0 | 0 | 0 | 366 | | | | 0 | 0 | 0 | 96 | Dec 19 | PM |
| 2009 | 269 | 84 | 12 | 0 | 0 | 365 | | | | 12 | 0 | 0 | 117 | Jul 5 | PM |
| 2010 | 324 | 41 | 0 | 0 | 0 | 365 | | | | 0 | 0 | 0 | 98 | Nov 24 | PM |
| 2011 | 304 | 53 | 8 | 0 | 0 | 365 | | | | 8 | 0 | 0 | 147 | Jan 1 | PM |
| 2012 | 321 | 43 | 1 | 1 | 0 | 366 | | | | 2 | 0 | 0 | 156 | Jul 4 | PM |
| 2013 | 271 | 92 | 2 | 0 | 0 | 365 | | | | 2 | 0 | 0 | 115 | Nov 24 | PM |
| Totals | 9577 | 2715 | 64 | 22 | 0 | 7641 | 4468 | 236 | 33 | 67 | 19 | 0 | | | |
| PM = Particulate Matter CO = Carbon Monoxide SO ₂ = Sulfur Dioxide O ₃ = Ozone # = 1st Occurrence | | | | | | | | | | | | | | | |

Note: In 1987 the particulate matter (PM) standard, total suspended particulates (TSP), was replaced by only that fraction of particulate matter with particle diameters equal to or less than 10 micrometers (PM₁₀).

In 1999 the Pollutant Standard Index (PSI) was replaced by the Air Quality Index (AQI) and included new and more stringent fine particle (PM_{2.5}) and 8-hour ozone (O₃) standards. The O₃ standard was again revised in March 2008.

Air Quality for Snohomish County



Monitoring Methods Used from 1999 to 2013 in the Puget Sound Air shed

| Pollutant Code | Measurement | Method | Units |
|------------------------|--|---|-------------------------------------|
| Bap | Light Absorption by Particles | Light Absorption by Aethalometer | bap (x 10 exp-4)/m |
| Bsp | Light Scattering by Particles | Nephelometer - Heated Inlet | bsp (x 10 exp-4)/m |
| CO | Carbon Monoxide | Gas Nondispersive Infrared Radiation | parts per million |
| NO _x | Nitrogen Oxides (NO _x) | Chemiluminescence | parts per million |
| | Nitric Oxide (NO) | Chemiluminescence | parts per million |
| | Nitrogen Dioxide (NO ₂) | Chemiluminescence | parts per million |
| NO _y | Reactive Nitrogen Compounds (NO _x + other reactive compounds) | Chemiluminescence | parts per billion |
| O ₃ | Ozone | UV Absorption | parts per million |
| Pb | Lead | Standard High Volume | micrograms per standard cubic meter |
| PM ₁₀ ref | PM ₁₀ Reference | Reference - Hi Vol Andersen/GMW 1200 | micrograms per cubic meter |
| PM ₁₀ bam | PM ₁₀ Beta Attenuation | Andersen FH621-N | micrograms per cubic meter |
| PM ₁₀ teom | PM ₁₀ Teom | R&P Mass Transducer | micrograms per cubic meter |
| PM _{2.5} ref | PM _{2.5} Reference | Reference—R&P Partisol 2025 | micrograms per cubic meter |
| PM _{2.5} bam | PM _{2.5} Beta Attenuation | Andersen FH621-N | micrograms per cubic meter |
| PM _{2.5} teom | PM _{2.5} Teom | R&P Mass Transducer | micrograms per cubic meter |
| PM _{2.5} ls | PM _{2.5} Nephelometer | Radiance Research M903 Nephelometer | micrograms per cubic meter |
| PM _{2.5} bc | PM _{2.5} Black Carbon | Light Absorption by Aethalometer | micrograms per cubic meter |
| RH | Relative Humidity | Continuous Instrument Output | percent |
| SO ₂ | Sulfur Dioxide | UV Fluorescence | parts per million |
| Temp | Temperature | Continuous Instrument Output | degrees F |
| TSP | PM Total Hi-Vol | Standard High Volume | micrograms per standard cubic meter |
| Vsby | Visual Range | Light Scattering by Nephelometer | miles |
| Wind | Wind Speed/ Wind Direction | RM Young 05305 Wind Monitor AQ (old method) | miles per hour/degrees |
| | Wind Speed/ Wind Direction | Ultrasonic (new method) | miles per hour/degrees |

Historical Air Quality Monitoring Network

| Station ID | Location | PM ₁₀ Ref | PM ₁₀ bam | PM ₁₀ Teom | PM _{2.5} ref | PM _{2.5} bam | PM _{2.5} teom | PM _{2.5} ls | PM _{2.5} bc | O ₃ | SO ₂ | NO _y | CO | b _{sp} | Wind | Temp | AT | Vsby | Location |
|-------------|---|-------------------------|-------------------------|--------------------------|--------------------------|--------------------------|---------------------------|-------------------------|-------------------------|----------------|-----------------|-----------------|----|-----------------|------|------|----|------|----------|
| AO☉ | Northgate, 310 NE Northgate Way, Seattle (ended Mar 31, 2003) | | | | | | | | | | | | X | | | | | | b, d, f |
| AQ | Queen Anne Hill, 400 W Garfield St, Seattle (photo/visibility included) | | | | | | | ● | | | | | | ● | ● | ● | | ● | a, d, f |
| AR☉ | 4th Ave & Pike St, 1424 4 th Ave, Seattle (ended Jun 30, 2006) | | | | | | | | | | | | X | | | | | | a, d |
| AS☉ | 5th Ave & James St, Seattle (ended Feb 28, 2001) | | | | | | | | | | | | X | | | | | | a, d |
| AU☉ | 622 Bellevue Way NE, Bellevue (ended Jul 30, 1999) | | | | | | | | | | | | X | | | | | | a, d |
| AZ | Olive Way & Boren Ave, 1624 Boren Ave, Seattle | | | | | | | ● | X | | | | | ● | ● | ● | | ● | a, d |
| BF☉ | University District, 1307 NE 45th St, Seattle (ended Jun 30, 2006) | | | | | | | | | | | | X | | | | | | b, d |
| BU☉ | Highway 410, 2 miles E of Enumclaw (ended Sep 30, 2000) | | | | | | | | | X | | | | | | | | | c, e |
| BV | Sand Point, 7600 Sand Pt Way NE, Seattle (ended Aug 31, 2006) | | | | | | | X | | | | | | X | X | X | | | b, d |
| BW☉/ BZ☉ | Beacon Hill, 15th S & Charlestown, Seattle SPECIATION SITE | | | | ● | | ● | X | X | ● | ● | ● | ● | X | ● | ● | ● | ● | b, d, f |
| CE | Duwamish, 4752 E Marginal Way S, Seattle SPECIATION SITE | X | | X | X | | ● | ● | ● | | X | | | X | ● | ● | | ● | a, e |
| CG☉ | Woodinville, 17401 133 rd Av NE, Woodinville | | | | | | | ● | | | | | | ● | | | | | b, d, f |
| CW | James St & Central Ave, Kent | X | | X | X | | ● | ● | | | | | | ● | ● | ● | | ● | b, d |
| CX | 17711 Ballinger Way NE, Lake Forest Park (ended Jun 4, 1999) | X | X | | | | | | | | | | | X | X | | | X | b, d, f |
| CZ | Aquatic Center, 601 143 rd Ave NE, Bellevue (ended May 31, 2006) | | | | | | X | X | | | | | | X | | | | X | b, f |
| DA | South Park, 8025 10 th Ave S, Seattle (ended Dec 31, 2002) | X | | | X | | | X | | | | | | X | X | | | X | b, e, f |

| Station ID | Location | PM ₁₀ Ref | PM ₁₀ bam | PM ₁₀ Teom | PM _{2.5} ref | PM _{2.5} bam | PM _{2.5} teom | PM _{2.5} ls | PM _{2.5} bc | O ₃ | SO ₂ | NO _y | CO | b _{sp} | Wind | Temp | AT | Vsby | Location |
|------------|---|-------------------------|-------------------------|--------------------------|--------------------------|--------------------------|---------------------------|-------------------------|-------------------------|----------------|-----------------|-----------------|----|-----------------|------|------|----|------|------------|
| DB | 17171 Bothell Way NE, Lake Forest Park | X | X | | X | | X | ● | X | | | | | ● | ● | ● | | ● | b, d, f |
| DC☉ | 305 Bellevue Way NE, Bellevue | | | | X | | | ● | | | | | | ● | | | | ● | a, d |
| DD | South Park, 8201 10 th Ave S, Seattle | | | | | | | ● | | | | | | ● | | | | ● | b, e, f |
| DE☉ | City Hall, 15670 NE 85 th St, Redmond (ended Dec 14, 2005) | | | | X | | | X | | | | | | X | | | | X | a, d |
| DF☉ | 30525 SE Mud Mountain Road, Enumclaw | | | | X | | | X | | ● | | | | X | ● | ● | | X | c |
| DG☉ | 42404 SE North Bend Way, North Bend | | | | X | | X | ● | | ● | | | | ● | ● | ● | | ● | c, d, f |
| DH☉ | 2421 148 th Ave NE, Bellevue | | | | | | | | | | | | ● | | | | | | b, d |
| DK☉ | 43407 212 th Ave SE, 2 mi west of Enumclaw (ended Sep 6, 2006) | | | | | | | | | | | | | | X | X | | | c |
| DL☉ | NE 8th St & 108th Ave NE, Bellevue (ended March 4, 2003) | | | | | | | | | | | | X | | | | | | a, d |
| DN☉ | 20050 SE 56 th , Lake Sammamish State Park, Issaquah | | | | | | | | | ● | | | | | X | X | | | b, d |
| DP☉ | 504 Bellevue Way NE, Bellevue (ended Sep 30, 1999) | X | | | X | | | | | | | | | | | | | | a, d |
| DZ☉ | Georgetown, 6431 Corson Ave S, Seattle (ended August 31, 2002) | | | | | | | | | | | X | X | | X | | | | a, d, e, f |
| EA | Fire Station #12, 2316 E 11 th St, Tacoma (ended Dec 31, 2000) | X | X | | | | | | | | | | | | X | | | | a, e |
| EP | 27th St NE & 54th Ave NE, Tacoma (ended Feb 29, 2000) | X | | | | | | | | | X | | | | X | | | | b, e, f |
| EQ | Tacoma Tideflats, 2301 Alexander Ave, Tacoma SPECIATION SITE | X | X | X | X | | X | ● | ● | | X | | | ● | ● | ● | | ● | a, e |
| ER | South Hill, 9616 128 th St E, Puyallup | X | X | | X | X | | ● | ● | | | | | ● | ● | ● | | ● | b, f |
| ES | 7802 South L St, Tacoma SPECIATION SITE | | | | ● | | ● | ● | ● | | | | | ● | ● | ● | | ● | b, f |
| FF☉ | Tacoma Indian Hill, 5225 Tower Drive NE, northeast Tacoma | | | | | | | | | | | | | | ● | ● | | | b, f |

| Station ID | Location | PM ₁₀ Ref | PM ₁₀ bam | PM ₁₀ Teom | PM _{2.5} ref | PM _{2.5} bam | PM _{2.5} teom | PM _{2.5} ls | PM _{2.5} bc | O ₃ | SO ₂ | NO _y | CO | b _{sp} | Wind | Temp | AT | Vsby | Location |
|------------|--|-------------------------|-------------------------|--------------------------|--------------------------|--------------------------|---------------------------|-------------------------|-------------------------|----------------|-----------------|-----------------|----|-----------------|------|------|----|------|----------|
| FG☉ | Mt Rainier National Park, Jackson Visitor Center | | | | | | | | | ● | | | | | | | | | c |
| FH☉ | Charles L Pack Forest, La Grande | | | | | | | | | ● | | | | | | | | | c, f |
| FL☉ | 1101 Pacific Ave, Tacoma (ended Jun 30, 2006) | | | | | | | | | | | | X | | | | | | a, d |
| ID | Hoyt Ave & 26th St, Everett (ended Feb 29, 2000) | | | | | | | | | | x | | | | X | | | | a, e, d |
| IG | Marysville JHS, 1605 7 th St, Marysville SPECIATION SITE | X | X | | ● | | ● | ● | ● | | | | | ● | ● | ● | | ● | b, d |
| IH | 20935 59 th Place West, Lynnwood (ended Jun 8, 1999) | X | | X | | | | | | | | | | X | X | | | X | a, d |
| II | 6120 212 th St SW, Lynnwood | | | | X | X | ● | ● | | | | | | ● | ● | ● | | ● | b, d |
| JN☉ | 5810 196 th Street, Lynwood (ended Jun 30, 2006) | | | | | | | | | | | | X | | | | | | a,d |
| JO | Darrington High School, Darrington 1085 Fir St | | | | ● | | ● | ● | ● | | | | | ● | ● | ● | | ● | d, f |
| JP☉ | 2939 Broadway Ave, Everett (ended March 31, 2003) | | | | | | | | | | | | X | | | | | | a, d |
| JQ☉ | 44th Ave W & 196 th St SW, Lynnwood (ended May 3, 2004) | | | | | | | | | | | | X | | | | | | a, d |
| JS☉ | Broadway & Hewitt Ave, Everett (ended May 21, 2000) | | | | | | | | | | | | X | | | | | | a, d |
| QE | Meadowdale, 7252 Blackbird Dr NE, Bremerton | X | | | | X | ● | ● | | | | | | ● | ● | ● | | ● | b, f |
| QF | Lions Park, 6th Ave NE & Fjord Dr, Poulsbo (ended Feb 29, 2000) | | | | | | | | | | | | | | X | | | | b, f |
| QG | Fire Station #51, 10955 Silverdale Way, Silverdale (ended September 4, 2008) | | | | | X | | X | | | | | | X | X | X | | X | a, d |
| RV☉ | Yelm N Pacific Road, 931 Northern Pacific Rd SE, Yelm | | | | | | | | | ● | | | | | | | | | c,f |
| UB☉ | 71 E Campus Dr, Belfair (ended Sep 30, 2004) | | | | | | | | | X | | | | | | | | | c |
| VK☉ | Fire Station, 709 Mill Road SE, Yelm (ended Oct 2005) | | | | | | | | | X | | | | | | | | | c,f |

| | | | |
|------------------------|--|-----------------|---|
| ☉ | Station operated by Ecology | SO ₂ | Sulfur Dioxide |
| RV☉ | Shading indicates station functioning | NO _y | Nitrogen Oxides |
| ● | Indicates parameter currently monitored | CO | Carbon Monoxide |
| X | Indicates parameter previously monitored | b _{sp} | Light scattering by atmospheric particles (nephelometer) |
| PM ₁₀ ref | Particulate matter <10 micrometers (reference) | Wind | Wind direction and speed |
| PM ₁₀ bam | Particulate matter <10 micrometers (beta attenuation continuous) | Temp | Air temperature (relative humidity also measured at BW, IG, ES) |
| PM ₁₀ teom | Particulate matter <10 micrometers (teom continuous) | AT | Air Toxics |
| PM _{2.5} ref | Particulate matter <2.5 micrometers (reference) | VSBY | Visual range (light scattering by atmospheric particles) |
| PM _{2.5} bam | Particulate matter <2.5 micrometers (beta attenuation continuous) | PHOTO | Visibility (camera) |
| PM _{2.5} teom | Particulate matter <2.5 micrometers (teom-fdms continuous) | O ₃ | Ozone (May through September) |
| PM _{2.5} ls | Particulate matter <2.5 micrometers (light scattering nephelometer continuous) | | |
| PM _{2.5} bc | Particulate matter <2.5 micrometers black carbon (light absorption aethalometer) | | |
| Location | | | |
| a | Urban Center | | |
| b | Suburban | | |
| c | Rural | | |
| d | Commercial | | |
| e | Industrial | | |
| f | Residential | | |

Burn Bans 1988 – 2013

| | | | |
|------|--|------|---|
| 1988 | Jan 25 (0830) - Jan 28 (0830) Feb 5 (1630) - Feb 6 (0930) Dec 1 (1430) - Dec 2 (0800) Dec 4 (1430) - Dec 5 (1400) Dec 16 (1430) - Dec 18 (1430) | 2001 | Nov 8 (1400) - Nov 12 (1800) |
| | | 2002 | Nov 1 (1500) - Nov 6 (0900) Nov 27 (1000) - Dec 4 (1000) |
| | | 2003 | Jan 7 (1500) - Jan 9 (1300) |
| 1989 | Jan 19 (1430) - Jan 20 (1430) Jan 24 (1430) - Jan 26 (0930) Feb 6 (1430) - Feb 8 (0930) Feb 10 (1430) - Feb 16 (0930) Nov 29 (1430) - Dec 2 (0930) Dec 22 (1430) - Dec 23 (1430) | 2004 | None |
| | | 2005 | Feb 21 (1600) - Feb 28 (0800) Dec 9 (1700) - Dec 18 (1200) |
| | | 2006 | None |
| 1990 | Jan 19 (1430) - Jan 21 (1430) Dec 7 (1430) - Dec 8 (0930) Dec 25 (1430) - Dec 27 (0815)* *(Dec 26 1430 – Dec 27 0815) 2 nd Stage | 2007 | Jan 13 (1400) - Jan 16 (1500) Jan 28 (1400) - Jan 31 (1400) Dec 9 (1400) - Dec 11 (0930) |
| 1991 | Jan 5 (1430) - Jan 6 (0930) Jan 21 (1430) - Jan 24 (1500)* *(Jan 22 0930 – Jan 24 1500) 2 nd Stage Jan 29 (1430) - Jan 31 (0830) Dec 15 (1430) - Dec 17 (1430)* *(Dec 16 1430 – Dec 17 0930) 2 nd Stage | 2008 | Jan 23 (1400) - Jan 26 (1200) |
| | | 2009 | Jan 16 (1200) - Jan 24 (1200) Feb 3 (1400) - Feb 6 (0900) Dec 8 (1000) - Dec 13 (1000) Dec 23 (1600) - Dec 30 (1200) |
| 1992 | Jan 8 (1430) - Jan 9 (0930) Jan 19 (1430) - Jan 20 (1430) Feb 5 (1000) - Feb 6 (1430) Nov 25 (1430) - Nov 26 (1430) | 2010 | Jan 28 (1200) – Jan 31 (1000) Dec 30 (1700) – 31 Dec (2400)* * continued to Jan 4 (1700) |
| | | 2011 | Jan 1 (0000) – Jan 4 (1700) Nov 30 (1700) – Dec 7 (1300) Dec 11 (1700) – Dec 14 (1600) |
| 1993 | Jan 11 (1430) - Jan 13 (0830) Jan 15 (1430) - Jan 16 (0700) Jan 17 (1430) - Jan 19 (0600) Jan 31 (1430) - Feb 3 (0830) Dec 20 (1430) - Dec 21 (1430) Dec 26 (1430) - Dec 29 (0830) | 2012 | Jan 11 (1600) – Jan 14 (1000) Jan 27 (1200) – Jan 28 (1700) Feb 3 (1600) – Feb 6 (1600) Nov 25 (1300) – Nov 28 (0900) Dec 29 (1700) – Dec 31 (2400)* * continued to Jan 3 (1200) |
| 1994 | None | | |
| 1995 | Jan 4 - Jan 7 | | |
| 1996 | Feb 14 (1430) - Feb 16 (1630) | 2013 | Jan 1 (0000) – Jan 3 (1200) Jan 12 (1300) – Jan 22 (1000) Nov 22 (1600) – Nov 29 (1000) Dec 7 (1400) – Dec 9 (1000) Dec 25 (1700) – Dec 26 (1100) |
| 1997 | Nov 13 (1500) - Nov 15 (1500) Dec 4 (1500) - Dec 7 (1800) | | |
| 1998 | None | | |
| 1999 | Jan 5 (1400) - Jan 6 (1000) Dec 29 (1400) - Dec 31 (0600) | | |
| 2000 | Feb 18 (1400) - Feb 20 (1000) Nov 15 (1700) - Nov 23 (0600) | | |

PARTICULATE MATTER (PM_{2.5}) - Federal Reference Method

Micrograms per Cubic Meter

Reference Sampling Method: R&P Partisol 2025 Sampler – Teflon Filter

2013

| Location | Number of Values | Quarterly Arithmetic Averages | | | | Year Arith Mean | 98th Percentile | Max Value |
|--|------------------|-------------------------------|-----|-----|------|-----------------|-----------------|-----------|
| | | 1st | 2nd | 3rd | 4th | | | |
| 7802 South L St, Tacoma | 349 | 10.3 | 3.9 | 5.1 | 13.2 | 8.1 | 34.0 | 41.5 |
| 15 th S & Charlestown, Beacon Hill, Seattle | 118 | 6.7 | 4.4 | 5.3 | 8.4 | 6.2 | 17.7 | 20.7 |

Notes:

(1) Sampling occurs for a 24 hour period from midnight to midnight.

Quarterly averages are shown only if 75 percent or more of the data is available.

(2) Annual averages are shown only if there is at least 75 percent of each 4 quarterly averages.

(3) Data from primary sampler at site

Summary of Maximum Observed Concentrations

| Location | Jan 13 Sun | Jan 22 Tue |
|-------------------------|------------|------------|
| 7802 South L St, Tacoma | 41.5 | |
| Beacon Hill | | 20.7 |

- - Indicates no sample on specified day

Air Quality Index Summary

| Location | Good | Moderate | Unhealthy for Sensitive Groups | Unhealthy |
|--|------|----------|--------------------------------|-----------|
| 7802 South L St, Tacoma | 291 | 54 | 4 | 0 |
| 15 th S & Charlestown, Beacon Hill, Seattle | 110 | 8 | 0 | 0 |

PARTICULATE MATTER (PM2.5) – Continuous -TEOM

Micrograms per Cubic Meter

Equivalent Sampling Methods: Mass Transducer R&P TEOM 1400ab-8500 FDMS – Teflon-coated Glass Fiber

2013

| Location | Number of Values | Quarterly Arithmetic Averages | | | | Year Arith Mean | 98th Percentile | Max Value |
|--|------------------|-------------------------------|-----|------|------|-----------------|-----------------|-----------|
| | | 1st | 2nd | 3rd | 4th | | | |
| Darrington HS, 1085 Fir St, Darrington | 362 | 8.3 | 2.5 | 4.0 | 11.5 | 6.6 | 26.9 | 34.6 |
| Marysville JHS, 1605 7th St, Marysville | 309 | 8.6 | | 6.1 | 13.2 | | 29.3 | 39.4 |
| 6120 212th St SW, Lynnwood | 345 | 8.0 | 3.5 | 4.8 | 10.6 | 6.7 | 24.0 | 31.3 |
| Duwamish, 4752 E Marginal Way S, Seattle | 344 | 12.2 | 8.9 | 11.4 | 16.7 | 12.3 | 30.7 | 55.0 |
| James St & Central Ave, Kent | 364 | 7.4 | 4.0 | 6.0 | 11.7 | 7.3 | 24.7 | 39.4 |
| 7802 South L St, Tacoma | 353 | 9.7 | 4.2 | 5.5 | 13.1 | 8.1 | 32.8 | 40.4 |
| Spruce, 3250 Spruce Ave, Bremerton | 349 | 5.2 | 3.1 | 3.9 | 6.9 | 4.8 | 13.2 | 23.4 |

Notes

(1) Sampling occurs continuously for 24 hours each day.

Quarterly averages are shown only if 75 percent or more of the data is available.

(2) Annual averages are shown only if there is at least 75 percent of each 4 quarterly averages.

(3) Data from primary sampler at site

Summary of Maximum Observed Concentrations

| Location | Jan 13 Sun | Jul 4 Thu | Nov 24 Sun | Nov 25 Mon | Nov 28 Thu | Dec 21 Sat |
|--|------------|-----------|------------|------------|------------|------------|
| Darrington HS, 1085 Fir St, Darrington | | | | | | 34.6 |
| Marysville JHS, 1605 7th St, Marysville | | | | 39.4 | -- | |
| 6120 212th St SW, Lynnwood | | | | 31.3 | | |
| Duwamish, 4401 E Marginal Way S, Seattle | | | | | 55.0 | -- |
| James St & Central Ave, Kent | | | 39.4 | | | |
| 7802 South L St, Tacoma | 40.4 | | | | | |
| Spruce, 3250 Spruce Ave, Bremerton | | 23.4 | | | | |

- - Indicates no sample on specified day

PARTICULATE MATTER (PM2.5) – Continuous - Nephelometer

Micrograms per Cubic Meter

Sampling Method: Equivalent – (R) Radiance Research M903 Nephelometer - (E) Ecotech Nephelometer

2013

| Location | Number of Values | Quarterly Arithmetic Averages | | | | Year Arith Mean | 98th Percentile | Max Value |
|--|------------------|-------------------------------|-----|-----|------|-----------------|-----------------|-----------|
| | | 1st | 2nd | 3rd | 4th | | | |
| Darrington HS, 1085 Fir St, Darrington (R,E) | 350 | 8.8 | 3.0 | 5.0 | 12.7 | 7.4 | 27.0 | 35.4 |
| Marysville JHS, 1605 7th St, Marysville (R,E) | 365 | 8.7 | 4.8 | 5.9 | 14.1 | 8.4 | 30.5 | 41.0 |
| 6120 212th St SW, Lynnwood (E) | 350 | 7.4 | 3.9 | 5.4 | 11.5 | 7.1 | 22.9 | 28.8 |
| 17171 Bothell Way NE, Lake Forest Park (R) | 359 | 9.6 | 4.5 | 6.0 | 13.6 | 8.4 | 27.0 | 35.9 |
| Queen Anne Hill, 400 W Garfield St, Seattle (E) | 364 | 7.1 | 4.5 | 6.4 | 10.0 | 7.0 | 20.7 | 26.4 |
| Olive & Boren, Seattle (R) | 339 | 7.2 | 5.3 | 7.0 | 10.5 | 7.5 | 20.4 | 27.1 |
| Duwamish, 4752 E Marginal Way S, Seattle (E) | 346 | 9.8 | 6.4 | 8.4 | 14.1 | 9.7 | 24.8 | 58.2 |
| South Park, 8025 10 th Ave S, Seattle (R,E) | 365 | 10.6 | 6.9 | 8.8 | 13.9 | 10.0 | 24.7 | 41.7 |
| 305 Bellevue Way NE, Bellevue (R) | 305 | 5.3 | 3.2 | | | | | 17.4 |
| 42404 SE North Bend Way, North Bend (R) | 365 | 5.8 | 4.2 | 7.0 | 7.1 | 6.0 | 14.1 | 22.3 |
| James St & Central Ave, Kent (E) | 364 | 8.3 | 5.2 | 7.4 | 12.2 | 8.3 | 22.5 | 32.8 |
| Tacoma Tideflats, 2301 Alexander Ave, Tacoma (R,E) | 343 | 9.4 | 5.3 | 7.7 | 12.3 | 8.7 | 27.4 | 37.5 |
| 7802 South L St, Tacoma (E) | 359 | 10.0 | 3.9 | 5.8 | 13.5 | 8.3 | 30.5 | 37.7 |
| South Hill, 9616 128 th St E, Puyallup (E) | 352 | 8.4 | 3.5 | 5.7 | 10.9 | 7.1 | 23.9 | 31.1 |
| Spruce, 3250 Spruce Ave, Bremerton (E) | 365 | 5.7 | 3.7 | 5.0 | 7.8 | 5.6 | 13.9 | 16.8 |

Notes

(1) Sampling occurs continuously for 24 hours each day.

Quarterly averages are shown only if 75 percent or more of the data is available.

(2) Annual averages are shown only if there is at least 75 percent of each 4 quarterly averages.

(3) All data values are correlated using site-specific relationships with Federal Reference Method samplers where available.

(4) Data from primary sampler at site

Summary of Maximum Observed Concentrations

| Location | Jan 13 Sun | Jan 16 Wed | Jul 4 Thu | Nov 24 Sun | Nov 25 Mon | Nov 28 Thu | Dec 11 Wed | Dec 12 Thu | Dec 21 Sat |
|---|------------|------------|-----------|------------|------------|------------|------------|------------|------------|
| Darrington HS, 1085 Fir St, Darrington | | | | | | | | | 35.4 |
| Marysville JHS, 1605 7th St, Marysville | | | | 41.0 | | | | | |
| 6120 212th St SW, Lynnwood | -- | | | | 28.8 | | | | |
| 17171 Bothell Way NE, Lake Forest Park | 35.9 | | | | | | | | |
| Queen Anne Hill, 400 W Garfield St, Seattle | | | | | 26.4 | | | | |
| Olive & Boren, Seattle | | -- | | | 27.1 | | | | |
| Duwamish, 4752 E Marginal Way S, Seattle | | | | | | 58.2 | | | -- |
| South Park, 8025 10 th Ave S, Seattle | | | | | | 41.7 | | | |
| 305 Bellevue Way NE, Bellevue | | | | | 17.4 | | -- | -- | -- |
| 42404 SE North Bend Way, North Bend | | 22.3 | | | | | | | |
| James St & Central Ave, Kent | | | | 32.8 | | | | | |
| Tacoma Tideflats, 2301 Alexander Ave, Tacoma | | | 37.5 | | | | | | |
| 7802 South L St, Tacoma | 37.7 | | | | | | | | |
| South Hill, 9616 128 th St E, Puyallup | | | | -- | -- | | | 31.1 | |
| Spruce, 3250 Spruce Ave, Bremerton | | | | | | | 16.8 | | |

-- Indicates no sample on specified day

PM_{2.5} Speciation Analytes Monitored in 2013
Average Annual Concentrations in Micrograms per Cubic Meter

| Parameter |
|--|
| Acceptable Pm2.5 Aqi & Speciation Mass |
| Aluminum Pm2.5 Lc |
| Ammonium Ion Pm2.5 Lc |
| Antimony Pm2.5 Lc |
| Arsenic Pm2.5 Lc |
| Barium Pm2.5 Lc |
| Bromine Pm2.5 Lc |
| Cadmium Pm2.5 Lc |
| Calcium Pm2.5 Lc |
| Cerium Pm2.5 Lc |
| Cesium Pm2.5 Lc |
| Chlorine Pm2.5 Lc |
| Chromium Pm2.5 Lc |
| Cobalt Pm2.5 Lc |
| Copper Pm2.5 Lc |
| Indium Pm2.5 Lc |
| Iron Pm2.5 Lc |
| Lead Pm2.5 Lc |
| Magnesium Pm2.5 Lc |
| Manganese Pm2.5 Lc |
| Nickel Pm2.5 Lc |
| Phosphorus Pm2.5 Lc |
| Potassium Ion Pm2.5 Lc |
| Potassium Pm2.5 Lc |
| Rubidium Pm2.5 Lc |
| Selenium Pm2.5 Lc |
| Silicon Pm2.5 Lc |
| Silver Pm2.5 Lc |
| Sodium Ion Pm2.5 Lc |
| Sodium Pm2.5 Lc |
| Strontium Pm2.5 Lc |
| Sulfate Pm2.5 Lc |
| Sulfur Pm2.5 Lc |
| Tin Pm2.5 Lc |
| Titanium Pm2.5 Lc |
| Total Nitrate Pm2.5 Lc |
| Vanadium Pm2.5 Lc |
| Zinc Pm2.5 Lc |
| Zirconium Pm2.5 Lc |
| Elemental Carbon TOR |
| Organic Carbon TOR |
| Total Carbonaceous Mass |
| Soil |
| Reconstructed Fine Mass - Urban PM2.5 |

Additional information can be obtained at: epa.gov/ttn/airs/aqsdatamart/

PM_{2.5} BLACK CARBON

Micrograms per Cubic Meter

Sampling Method: Light Absorption by Aethalometer

2013

| Location | Number of Values | Quarterly Arithmetic Averages | | | | Annual Mean | Max Value |
|---|------------------|-------------------------------|-----|-----|-----|-------------|-----------|
| | | 1st | 2nd | 3rd | 4th | | |
| Marysville JHS, 1605 7th St, Marysville | 357 | 1.0 | 0.5 | 0.6 | 1.8 | 1.0 | 5.2 |
| Duwamish, 4401 E Marginal Way S, Seattle | 342 | 1.3 | 0.7 | 1.0 | 1.7 | 1.2 | 6.4 |
| James St & Central Ave, Kent | 359 | 1.1 | 0.6 | 0.7 | 1.6 | 1.0 | 4.7 |
| 7802 South L St, Tacoma | 354 | 1.0 | 0.4 | 0.4 | 1.5 | 0.8 | 4.5 |
| Tacoma Tideflats, 2301 Alexander Ave, Tacoma | 357 | 1.1 | 0.7 | 0.9 | 1.9 | 1.1 | 6.1 |
| South Hill, 9616 128 th St E, Puyallup | 358 | 0.9 | 0.5 | 0.6 | 1.1 | 0.8 | 3.6 |

Notes

(1) Sampling occurs continuously for 24 hours each day.

Quarterly averages are shown only if 75 % or more of the data is available.

(2) Annual averages are shown only if there are at least three quarterly averages.

Summary of Maximum Observed Concentrations

| Location | Nov 25 Mon | Nov 26 Tue | Dec 12 Thu |
|---|------------------|------------------|------------------|
| Marysville JHS, 1605 7th St, Marysville | 5.2 | | |
| Duamish, 4752 E Marginal Way S, Seattle | | 6.4 | |
| James St & Central Ave, Kent | 4.7 | | |
| 7802 South L St, Tacoma | 4.5 | | |
| Tacoma Tideflats, 2301 Alexander Ave, Tacoma | 6.1 | | |
| South Hill, 9616 128 th St E, Puyallup | | | 3.6 |

OZONE
(parts per million)

2013

| Location / Continuous Sampling Period(s) | 2011 Four Highest Daily 8-Hour Concentrations | | 4 th Highest Daily 8-Hour Concentration | | | 3-Year Average of 4 th Highest 8-Hour Concentration |
|--|--|-------------------------------------|---|------|------|--|
| | Value | Date | 2011 | 2012 | 2013 | 2011 – 2013 |
| Beacon Hill, 15th S & Charlestown Seattle, WA 1 Jan – 31 Dec | .047 .047 .046 .045 | 4 May 5 May 14 May 6 Apr | .044 | .044 | .045 | .044 |
| 20050 SE 56 th Lake Sammamish State Park, WA 1 May – 30 Sep | .051 .051 .048 .048 | 5 May 6 May 1 May 14 May | .054 | .059 | .048 | .053 |
| 42404 SE North Bend Way, North Bend, WA 1 May – 30 Sep | .058 .057 .056 .056 | 1 Jul 6 May 10 May 6 Aug | .052 | .058 | .056 | .055 |
| 30525 SE Mud Mountain Road, Enumclaw, WA 1 May – 30 Sep | .073 .069 .057 .057 | 1 Jul 30 Jun 10 May 11 May | .059 | .071 | .057 | .062 |
| 931 Northern Pacific Rd SE, Yelm, WA 1 May – 30 Sep | .056 .055 .053 .050 | 6 May 5 May 30 Jun 4 May | .054 | .061 | .050 | .055 |

Notes

- (1) All ozone stations operated by the Washington State Department of Ecology.
- (2) Ending times are reported in Pacific Standard Time.
- (3) For equal concentration values the date and time refer to the earliest occurrences.
- (4) Continuous sampling periods are those with fewer than 10 consecutive days of missing data.
- (5) At all stations ozone was measured using the continuous ultraviolet photometric detection method.

REACTIVE NITROGEN

(Parts per Million)

2013

Monthly and Annual Arithmetic Averages

| Location | Monthly Arithmetic Averages | | | | | | | | | | | | No of 1-Hour Samples | Year Arith Mean |
|---|-----------------------------|------|------|------|------|------|------|------|------|------|------|------|----------------------------|-----------------------|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Beacon Hill, 15th S & Charlestown, Seattle | .017 | .013 | .013 | .009 | .010 | .009 | .010 | .011 | .012 | .013 | .015 | .016 | 8666 | .012 |

Maximum and Second Highest Concentrations

| Location / Continuous Sampling Periods(s) | 1-Hour Average | | |
|--|----------------|--------|----------|
| | Value | Date | End Time |
| | | | |
| Beacon Hill, 15th S & Charlestown, Seattle | .058 | 25 Apr | 1900 |
| 1 Jan - 31 Dec | .053 | 26 Nov | 1500 |
| | | | |

Notes

- (1) Ending times are reported in Pacific Standard Time.
- (2) For equal concentration values the date and time refer to the earliest occurrences.
- (3) Continuous sampling periods are those with fewer than 10 consecutive days of missing data.
- (4) At all stations nitrogen dioxide was measured using the continuous chemiluminescence method.

CARBON MONOXIDE

(parts per million)

2013

| Location / Continuous Sampling Period(s) | Six Highest Concentrations | | | | | Number of 8-Hour Averages Exceeding 9 ppm | Number of Days 8-Hour Averages Exceeded 9 ppm |
|--|----------------------------|--------|----------|----------------|--------|---|---|
| | 1 Hour Average | | | 8 Hour Average | | | |
| | Value | Date | End Time | Value | Date | | |
| Beacon Hill, 15th S & Charlestown, Seattle 1 Jan – 13 Oct, 1 Nov – 31 Dec | 1.8 | 28 Jan | 1300 | 1.0 | 22 Jan | 0 | 0 |
| | 1.6 | 22 Jan | 1800 | 1.0 | 25 Nov | | |
| | 1.5 | 22 Jan | 1900 | 1.0 | 26 Nov | | |
| | 1.5 | 26 Nov | 1500 | 1.0 | 27 Dec | | |
| | 1.4 | 27 Dec | 0200 | 0.9 | 26 Dec | | |
| | 1.4 | 22 Jan | 1700 | 0.9 | 23 Jan | | |

Notes

- (1) All carbon monoxide stations operated by the Washington State Department of Ecology.
- (2) Ending times are reported in Pacific Standard Time.
- (3) For equal concentration values the date and time refer to the earliest occurrences.
- (4) Continuous sampling periods are those with fewer than 10 consecutive days of missing data.
- (5) At all stations carbon monoxide was measured using the continuous nondispersive infrared method.

SULFUR DIOXIDE

(parts per million)

2013

Monthly and Annual Arithmetic Averages

| Location | Monthly Arithmetic Averages | | | | | | | | | | | | No of 1-Hour Samples | Year Arith Mean |
|---|-----------------------------|------|------|------|------|------|------|------|-----|-----|-----|-----|----------------------------|-----------------------|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Beacon Hill, 15th S & Charlestown, Seattle | .001 | .001 | .001 | .001 | .001 | .001 | .002 | .001 | --- | --- | --- | --- | 5753 | .001 |

--- indicates no data available. Sampling ended 9/8/14.

Maximum and Second Highest Concentrations for Various Averaging Periods

| Location / Continuous Sampling Period(s) | 1 Hour Average | | |
|--|----------------|--------|----------|
| | Value | Date | End Time |
| Beacon Hill, 15th S & Charlestown, Seattle 1 Jan – 8 Sept | .012 | 17 Aug | 2000 |
| | .009 | 11 May | 1900 |

Notes

- (1) Ending times are reported in Pacific Standard Time.
- (2) For equal concentration values the date and time refer to the earliest occurrences.
- (3) Continuous sampling periods are those with fewer than 10 consecutive days of missing data.
- (4) Sulfur dioxide was measured using the continuous ultraviolet fluorescence method.
- (5) --- indicates no data available. Sampling ended 9/8/14.

2013 Beacon Hill Air Toxics Statistical Summary for Air Toxics (*units in parts per billion*)

| | 1,3- Butadiene | Acetaldehyde | Acrolein | Acrylonitrile | Benzene | Carbon Tetrachloride | Chloroform | Dichloromethane | Ethylbenzene | Ethylene Dichloride | Formaldehyde | Tetrachloroethylene |
|------------------------|-------------------|--------------|----------|---------------|---------|-------------------------|------------|-----------------|--------------|---------------------|--------------|---------------------|
| 2013 Count | 57 | 57 | 56 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 57 |
| NDs (reported as 0) | 8 | 0 | 0 | 56 | 0 | 0 | 1 | 0 | 0 | 7 | 0 | 12 |
| Median (ppb) | 0.028 | 0.328 | 0.232 | 0.000 | 0.144 | 0.106 | 0.024 | 0.236 | 0.050 | 0.018 | 0.419 | 0.012 |
| Mean (ppb) | 0.034 | 0.397 | 0.285 | 0.002 | 0.175 | 0.109 | 0.025 | 0.372 | 0.055 | 0.017 | 0.460 | 0.012 |
| 95%tile (ppb) | 0.097 | 0.836 | 0.699 | 0.000 | 0.376 | 0.137 | 0.035 | 1.05 | 0.109 | 0.028 | 0.935 | 0.025 |
| Max (ppb) | 0.148 | 1.16 | 0.890 | 0.122 | 0.469 | 0.165 | 0.042 | 2.41 | 0.152 | 0.032 | 1.01 | 0.039 |
| MDL (ppb) | 0.007 | 0.008 | 0.050 | | 0.029 | 0.024 | 0.009 | 0.010 | 0.017 | | 0.012 | 0.018 |
| # Below MDL | 10 | 0 | 0 | 56 | 0 | 0 | 2 | 0 | 2 | 23 | 0 | 40 |
| % Below MDL | 18% | 0% | 0% | 98% | 0% | 0% | 4% | 0% | 4% | 40% | 0% | 70% |

2013 Beacon Hill Air Toxics Statistical Summary for Air Toxics (*units in nanograms per cubic meter*)

| | Arsenic | Cadmium | Cr+6 TSP | Naphthalene | Nickel |
|------------------------|---------|---------|-------------|-------------|--------|
| 2013 Count | 60 | 60 | 29 | 57 | 60 |
| NDs (reported as 0) | 0 | 0 | 13 | 0 | 0 |
| Median (ng/m3) | 0.625 | 0.090 | 0.013 | 59.1 | 1.25 |
| Mean (ng/m3) | 0.786 | 2.176 | 0.021 | 70.54 | 1.78 |
| 95%tile (ng/m3) | 1.843 | 0.744 | 0.061 | 190.00 | 5.09 |
| Max (ng/m3) | 2.42 | 120 | 0.078 | 206 | 9.75 |
| MDL (ng/m3) | 0.058 | 0.021 | 0.004 | 0.112 | 0.506 |
| # Below MDL | 2 | 0 | 13 | 0 | 1 |
| % Below MDL | 3% | 0% | 45% | 0% | 2% |

Toxics in gray are over 50% below the method detection limit.

Estimates of Air Toxics Risk 2013 Air Toxics Unit Risk Factors

Potential cancer risk is estimated by multiplying the concentration of a pollutant by its unit risk factor (URF), a constant that takes into account its cancer potency. This is shown in the equation below:

$$\text{Potential cancer risk} = \text{ambient concentration } (\mu\text{g}/\text{m}^3) * \text{unit risk factor } (\text{risk}/\mu\text{g}/\text{m}^3)$$

Unit risk factors are often based on epidemiological studies (studies of diseases occurring in human populations) and are also extrapolated from laboratory animal studies. Unit risk factors are typically based on an assumed 70-year (lifetime) exposure interval and are available from multiple sources. Cancer risk was estimated using unit risk factors from the Washington State Acceptable Source Impact Levels (ASIL).¹ The two sources for the ASIL include EPA's Integrated Risk Information System² (IRIS) as well as California EPA's Office of Environmental Health and Hazard Assessment³ (OEHHA).⁴ Both of these sources are based on peer-reviewed literature and extensive review. We present potential cancer risk estimates based on the Washington ASIL values (listed below). The cancer rating, based on IARC definitions, refers to its "weight of evidence" ranking: 1 = carcinogenic to humans, 2A = probably carcinogenic to humans, and 2B = possibly carcinogenic to humans.⁵

2013 Air Toxics Unit Risk Factors

| AIR TOXIC | WA ASIL 460 UNIT RISK FACTOR RISK/ $\mu\text{g}/\text{m}^3$ | CANCER RATING ⁶ |
|-----------------------|---|-------------------------------|
| 1,3-Butadiene | 1.7×10^{-4} | 1 |
| Acetaldehyde | 2.7×10^{-6} | 2B |
| Acrylonitrile | 3.5×10^{-3} | 2B |
| Arsenic | 3.3×10^{-3} | 1 |
| Benzene | 2.9×10^{-5} | 1 |
| Cadmium | 4.2×10^{-3} | 1 |
| Carbon Tetrachloride | 4.2×10^{-5} | 2B |
| Chloroform | 2.3×10^{-5} | 2B |
| Chromium (Hexavalent) | 1.5×10^{-1} | 1 |
| Dichloromethane | 1.0×10^{-6} | 2B |
| Ethylbenzene | 2.5×10^{-6} | 2B |
| Ethylene Dichloride | 2.1×10^{-5} | 2B |
| Formaldehyde | 6.0×10^{-6} | 1 |
| Naphthalene | 3.4×10^{-5} | 2B |
| Nickel (Subsulfide) | 2.4×10^{-4} | 1 |
| Tetrachloroethylene | 7.4×10^{-6} | 2A |

¹Washington State Administrative Code. apps.leg.wa.gov/wac/default.aspx?cite=173-460-150.

²Integrated Risk Information System, EPA; epa.gov/iris/.

³California EPA, Consolidated Table of OEHHA/ARB-Approved Risk Assessment Health Values, June 25, 2008; arb.ca.gov/toxics/healthval/healthval.htm.

⁴For details on the ASIL, see: ecy.wa.gov/laws-rules/wac173460_400/February/ASIL_20list_20pollutants2-8-08-5pm1.pdf.

⁵International Agency for Research on Cancer; <http://monographs.iarc.fr/>.

⁶Ratings per International Agency for Research on Cancer, updated October 2014; <http://monographs.iarc.fr/ENG/Classification/>

**2013 Beacon Hill Potential Cancer Risk Estimates per 1,000,000 – 95th Percentile
percentage of samples greater than cancer screen value**

| Air Toxic | Rank | RISK based on 95th Percentile Concentrations Washington ASIL | % of samples > ASIL screen |
|----------------------|-------------|---|--------------------------------------|
| 1,3-Butadiene | 1 | 36 | 86% |
| Carbon Tetrachloride | 2 | 36 | 100% |
| Benzene | 3 | 35 | 100% |
| Chromium VI (TSP) | 4 | 9 | 55% |
| Formaldehyde | 5 | 7 | 95% |
| Naphthalene | 6 | 6 | 84% |
| Arsenic (PM10) | 7 | 6 | 88% |
| Acetaldehyde | 8 | 4 | 82% |
| Chloroform | 9 | 4 | 98% |
| Dichloromethane | 10 | 4 | 44% |
| Cadmium (PM10) | 11 | 3 | 15% |
| Ethylene Dichloride | 12 | 3 | 88% |
| Nickel (PM10) | 13 | 3 | 25% |
| Ethylbenzene | 14 | 1 | 9% |
| Tetrachloroethylene | 15 | 1 | 7% |

Shaded air toxics have >50% of samples with estimated concentrations (values below the reported laboratory detection limit). Screening value used is concentration equivalent to an estimated one-in-a-million potential cancer risk.

Non-cancer Reference Concentrations (RfC) and Hazard Indices >1

| Air toxic | Non Cancer RfC (ug/m3) | Mean Hazard Index |
|----------------------|------------------------|-------------------|
| Acrolein | 0.35 | 1.865 |
| Cadmium Pm10 Stp | 0.02 | 0.109 |
| Manganese Pm10 Stp | 0.09 | 0.076 |
| Formaldehyde | 9 | 0.063 |
| Arsenic Pm10 Stp | 0.015 | 0.052 |
| Nickel Pm10 Stp | 0.05 | 0.036 |
| Carbon Tetrachloride | 40 | 0.017 |
| Benzene | 60 | 0.009 |
| Acetaldehyde | 140 | 0.005 |
| 1,3-Butadiene | 20 | 0.004 |
| Dichloromethane | 400 | 0.003 |
| Tetrachloroethylene | 35 | 0.002 |
| Chloroform | 300 | < 0.001 |
| Chromium VI Tsp | 0.2 | < 0.001 |

Reference concentrations are based on chronic values from California Air Resources Board (OEHHA).

Mean hazard index is based on HQ=1, HI = mean concentration/reference concentration.

Acrolein is the only air toxic that fails the screen with a hazard index greater than 1.

Air Toxics Trends Statistical Summary

The following table includes the statistical information for the potential cancer risk trends found in the data summary, including if the trend is statistically significant.

| Air Toxic | Significance (p-value) | Slope (change in risk per million per year) | y-intercept | Correlation (R^2) | Number of years (N) |
|----------------------|------------------------|---|-------------|-----------------------|---------------------|
| 1,3-Butadiene | True (0.008) | -0.848 | 0.060 | 0.483 | 13 |
| Acetaldehyde | True (0) | -0.207 | 0.965 | 0.785 | 13 |
| Arsenic PM10 | False (0.105) | -0.075 | 0.969 | 0.295 | 10 |
| Benzene | True (0) | -2.190 | 0.475 | 0.773 | 13 |
| Cadmium PM10 | False (0.168) | 0.405 | -0.517 | 0.252 | 9 |
| Carbon Tetrachloride | False (0.154) | 0.275 | 0.102 | 0.176 | 13 |
| Chloroform | True (0) | -0.290 | 0.057 | 0.852 | 13 |
| Chromium VI Tsp | True (0.003) | -0.430 | 0.066 | 0.799 | 8 |
| Dichloromethane | False (0.265) | 0.220 | -0.302 | 0.239 | 7 |
| Ethylbenzene | False (0.77) | 0.004 | 0.054 | 0.019 | 7 |
| Formaldehyde | True (0.007) | -0.889 | 1.987 | 0.505 | 13 |
| Naphthalene | False (0.557) | 0.038 | 56.122 | 0.093 | 6 |
| Nickel PM10 | False (0.458) | -0.019 | 2.707 | 0.081 | 9 |
| Tetrachloroethylene | True (0.001) | -0.058 | 0.033 | 0.645 | 13 |

AIR QUALITY STANDARDS AND HEALTH GOALS

National Ambient Air Quality Standards (NAAQS)

The [Clean Air Act](#), which was last amended in 1990, requires EPA to set [National Ambient Air Quality Standards](#) (40 CFR part 50) for pollutants considered harmful to public health and the environment. The Clean Air Act identifies two types of national ambient air quality standards. **Primary standards** provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. **Secondary standards** provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

EPA has set National Ambient Air Quality Standards for six principal pollutants, called "criteria" pollutants (listed below). Units of measure for the standards are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air ($\mu\text{g}/\text{m}^3$).

EPA is required to re-visit and update standards every five years, to incorporate the latest health and welfare information.

The state of Washington and the Puget Sound region have adopted these standards. For more information, EPA air quality standards and supporting rationale are available at epa.gov/air/criteria.html. Washington State air quality regulations are available at ecy.wa.gov/laws-rules/ecywac.html#air.⁷ The air quality standards that apply to the Puget Sound air shed are summarized below.

⁷Washington Administrative Code chapters 173-470, 173-474, and 173-475.

Puget Sound Region Air Quality Standards for Criteria Pollutants for 2013

| Pollutant [final rule cite] | | Primary/ Secondary | Averaging Time | Level | Form |
|---|-------------------|-----------------------|-------------------------|---------------------------------------|---|
| Carbon Monoxide [76 FR 54294, Aug 31, 2011] | | primary | 8-hour | 9 ppm | Not to be exceeded more than once per year |
| | | | 1-hour | 35 ppm | |
| Lead [73 FR 66964, Nov 12, 2008] | | primary and secondary | Rolling 3 month average | 0.15 µg/m ³ ⁽¹⁾ | Not to be exceeded |
| Nitrogen Dioxide [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996] | | primary | 1-hour | 100 ppb | 98th percentile, averaged over 3 years |
| | | primary and secondary | Annual | 53 ppb ⁽²⁾ | Annual Mean |
| Ozone [73 FR 16436, Mar 27, 2008] | | primary and secondary | 8-hour | 0.075 ppm ⁽³⁾ | Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years |
| Particulate Pollution Dec 14, 2012 | PM _{2.5} | primary | Annual | 12 µg/m ³ | annual mean, averaged over 3 years |
| | | secondary | Annual | 15 µg/m ³ | annual mean, averaged over 3 years |
| | | primary and secondary | 24-hour | 35 µg/m ³ | 98th percentile, averaged over 3 years |
| | PM ₁₀ | primary and secondary | 24-hour | 150 µg/m ³ | Not to be exceeded more than once per year on average over 3 years |
| Sulfur Dioxide [75 FR 35520, Jun 22, 2010] [38 FR 25678, Sept 14, 1973] | | primary | 1-hour | 75 ppb ⁽⁴⁾ | 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years |
| | | secondary | 3-hour | 0.5 ppm | Not to be exceeded more than once per year |

as of October 2011

(1) Final rule signed October 15, 2008. The 1978 lead standard (1.5 µg/m³ as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

(2) The official level of the annual NO₂ standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.

(3) Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.

(4) Final rule signed June 2, 2010. The 1971 annual and 24-hour SO₂ standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

Pollutants typically have multiple standards with different averaging times; for example, daily and annual standards. Multiple standards are created and enforced to address health impacts as a result of a shorter, high-level exposure versus longer, low-level exposures. These differences are addressed pollutant-by-pollutant in the following sections. Additional information is on EPA's website at epa.gov/air/criteria.html.

The Agency has developed an air quality health goal for daily PM_{2.5} concentrations. The Agency convened a Particulate Matter Health Committee, comprised of local health professionals, who examined the fine particulate health research.⁸ The Health Committee did not consider the federal standard at the time to be protective of human health. In 1999, the Agency adopted a health goal of 25 µg/m³ for a daily average, more protective than the current federal standard of 35 µg/m³. This level is consistent with the American Lung Association's goal and the EPA Clean Air Science Advisory Committee's recommended lower range for the EPA's 2006 ambient air quality standard revision.^{9,10} The Agency did not adopt a separate health goal for the annual average.

⁸ Puget Sound Clean Air Agency. Final Report of the Puget Sound Clean Air Agency PM_{2.5} Stakeholder Group; psccleanair.org/news/library/reports/pm2_5_report.pdf.

⁹ American Lung Association; lungusa.org/assets/documents/publications/state-of-the-air/state-of-the-air-report-2006.pdf.

¹⁰ EPA Clean Air Science Advisory Committee (CASAC) Particulate Matter (PM) Review Panel; epa.gov/sab/panels/casacpmpanel.html.