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PUGET SOUND CLEAN AIR AGENCY **www.pscleanair.org**

1999-2001
Air Quality Data Summary

May 2003

Working Together for Clean Air

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The 1999-2001 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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Introduction

This report is issued by the Puget Sound Clean Air Agency (the Agency) to inform the public of air quality throughout the Puget Sound region. It describes the sources and effects of the following pollutants, for which the U.S. Environmental Protection Agency (EPA) and the State of Washington have established ambient air quality standards:

- Particulate Matter (10 micrometers and 2.5 micrometers)
- Carbon Monoxide
- Sulfur Dioxide
- Nitrogen Dioxide
- Ozone
- Lead

This report also summarizes the region's Air Quality Index (AQI) and visibility estimates as measured by our nephelometer network.

A brief discussion is provided of the ambient air-monitoring program, including a description of the monitoring network, AQI, visibility, and pollutant descriptions and levels. The data are presented graphically and as statistical summaries, including comparisons to the ambient air quality standards. The report discusses the recorded data, and the seasonal variability of some pollutants. Data and areas exceeding the ambient air quality standards are identified. Also included are the results of an emissions inventory of major sources in the region conducted by the Agency for calendar year 1999.

The Puget Sound Clean Air Agency and Washington State Department of Ecology work together to monitor air quality within the Puget Sound region. Real-time air monitoring data are available on the Internet at www.pscleanair.org and http://airr.ecy.wa.gov/Public/aqn.shtml. We encourage you to visit our website at www.pscleanair.org to find more extensive air quality data, educational materials, monthly air quality summaries, and discussions of current topics.

We are expanding and refining our Internet site to better serve the residents of the Puget Sound region. We want your feedback on our air quality data and program. Please submit your comments via email to Mary Hoffman at maryh@pscleanair.org or call at 206-689-4006.

Executive Summary for 1999 through 2001

The Puget Sound region's population growth continued from 1999 to 2001 at a rate of 1-2% annually. The amount of vehicle miles traveled also increased 1-2% from 1999 to 2001. Such growth rates in a region typically place a burden on air quality, degrading visibility and increasing pollutant concentrations. Fortunately, the Puget Sound region did not show most of these signs. The region's overall air quality maintained a level consistent with previous years, despite the increase in the number of vehicles, traffic congestion, and the average vehicle miles traveled. In part, the region continues to benefit from improved technologies that reduce vehicle emissions, the reduction of industrial emissions, decreases of wood burning in fireplaces and woodstoves, and the elimination of leaded gasoline.

In response to new pollutant standards for fine particulate matter, we implemented an upgrade to our monitoring network. Several monitoring stations were installed to monitor particulate matter of 2.5 micrometers or less ($PM_{2.5}$) to meet federal reference method requirements. These are in addition to the existing stations that already monitor $PM_{2.5}$ using a different analytical method. Other changes to our monitoring network occurred in 1999. Based on our review of sulfur dioxide (SO_2) and lead (Pb) levels in the region, monitoring for these pollutants was discontinued in 1999. These changes were in response to the shutdown of a lead smelting facility in May 1998, and the decrease of large SO_x sources in the region such as pulp and paper mills.

In 1999, EPA's pollutant standard index (PSI) was updated, reflecting revised fine particulate standards as well as improved knowledge of pollutants and their effects on human health and environment. The new index is referred to as the Air Quality Index (AQI). Because of the change from the PSI to the AQI, reported air quality worsened in 1999 but showed gradual improvements in 2001. This is a direct result of the incorporation of $PM_{2.5}$, the region's largest pollution problem, into the AQI.

The charts at the end of this summary show the region's air quality ratings for three areas: Everett/ Marysville, Seattle/Bellevue, and Tacoma/Puyallup. The tables below show the AQI breakdown by category for each year. The year 2000 AQI high of 153, which falls within the category of "unhealthy," was measured on December 6 at the South L Street monitoring station in Tacoma. This was the only day in the three years covered that an "unhealthy" AQI was measured in the Puget Sound area.

AQI Ratings for Everett/Marysville Area

Year	AQI Rating (% of year)				Highest AQI
	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy	
1999	82%	17%	1%	—	129
2000	75%	23%	2%	—	113
2001	79%	20%	1%	—	111

AQI Ratings for Seattle/Bellevue Area

Year	AQI Rating (% of year)				Highest AQI
	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy	
1999	74%	24%	2%	—	134
2000	67%	32%	1.4%	—	113
2001	75.5%	23%	1.5%	—	118

AQI Ratings for Tacoma/Puyallup Area

Year	AQI Rating (% of year)				Highest AQI
	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy	
1999	73%	26%	1%	—	139
2000	66%	30%	4%	1 day	153
2001	74%	22.5%	3.5%	—	139

Even though air quality in the Puget Sound region occasionally reached levels considered “unhealthy for sensitive groups”, and once reached a level considered “unhealthy”, there were no violations of the national ambient air quality standards in 1999-2001. Levels of all monitored pollutants were below regional standards as defined in Regulation I Article 11 of the Agency’s regulations.

The tables below present the maximum pollutant concentrations measured in 1999 to 2001, compared with the region’s ambient air quality standards. The minimum measured visibility is also shown.

The Highest Concentrations and Lowest Visibility Measured During 1999

Parameter	Max/ Min	Value	Units	Averaging Time	Standard	Monitoring Station	Date	Time
$PM_{2.5}$	Max	60	µg/m3	24 Hour	65	2301 Alexander Ave, Tacoma	Monday, January 4	full day
PM_{10}	Max	73	µg/m3	24 Hour	150	2301 Alexander Ave, Tacoma	Tuesday, September 21	full day
Ozone	Max	110	ppb	1 Hour	120	30525 SE Mud Mountain Rd, Enumclaw	Saturday, July 10	3-4 pm
Ozone	Max	90	ppb	8 Hour	84	30525 SE Mud Mountain Rd, Enumclaw	Saturday, July 10	11 am-7 pm
Visibility	Min	3	miles	1 Hour	None	James St & Central Ave, Kent	Monday, July 5	Midnight-1 am
Visibility	Min	10	miles	24 Hour	None	James St & Central Ave, Kent	Monday, January 4	all day
CO	Max	16.1	ppm	1 Hour	35	1424 4th Ave, Seattle	Tuesday, September 7	10 pm-11 pm
CO	Max	7.5	ppm	8 Hour	9	1101 Pacific Ave, Tacoma	Friday, October 22	3 pm-11 pm
SO_2	Max	24	ppb	24 Hour	100	27th St NE & 54th Ave NE, Northeast Tacoma	Tuesday, January 5	full day
Lead	Max	0.06	µg/m3	Calendar Quarter	1.5	Harbor Island, 2555 13th Ave SW, Seattle	April-June	2nd quarter

The Highest Concentrations and Lowest Visibility Measured During 2000

Parameter	Max/ Min	Value	Units	Averaging Time	Standard	Monitoring Station	Date	Time
$PM_{2.5}$	Max	70	ug/m3	24 Hour	65	7802 South L Street, Tacoma	December 6	Full day
PM_{10}	Max	81	ug/m3	24 Hour	150	4752 E Marginal Way S, Duwamish Site, Seattle	February 18	Full day
Ozone	Max	110	ppb	1 Hour	120	30525 SE Mud Mountain Road, Enumclaw	June 28	2 pm-3 pm
Ozone	Max	87	ppb	8 Hour	84	Highway 410, 2 miles east of Enumclaw	June 28	9 am-4 pm
Visibility	Min	2	miles	1 Hour	None	17171 Bothell Way NE, Lake Forest Park, Seattle	July 5	Midnight-1am
Visibility	Min	12	miles	24 Hour	None	Marysville JHS, 1605 7th St., Marysville	December 6	Full day
CO	Max	10.5	ppm	1 Hour	35	Broadway & Hewitt Ave, Everett	February 5	11 pm-Midnight
CO	Max	7.0	ppm	8 Hour	9	44th Ave W & 196th St SW, Lynwood	November 22	5 pm-1 am
SO_2	Not Monitored in 2000							
Lead	Not Monitored in 2000							

The Highest Concentrations and Lowest Visibility Measured During 2001

Parameter	Max/ Min	Value	Units	Averaging Time	Standard	Monitoring Station	Date	Time
$PM_{2.5}$	Max	60	ug/m3	24 Hour	65	7802 South L Street, Tacoma	November 29	Full day
PM_{10}	Max	77	ug/m3	24 Hour	150	4752 E Marginal Way S, Duwamish Site, Seattle	December 9	Full day
Ozone	Max	98	ppb	1 Hour	120	Charles L Pack Forest, La Grande	August 12	4 pm-5 pm
Ozone	Max	81	ppb	8 Hour	84	Charles L Pack Forest, La Grande	August 12	11 am-7 pm
Visibility	Min	2	miles	1 Hour	None	9616 128th St E, South Hill, Puyallup	July 19	9 pm-10 pm
CO	Max	9.5	ppm	1 Hour	35	1307 NE 45th St, University District, Seattle & 1101 Pacific Ave, Tacoma	November 9	10 pm-11 pm and 5 pm-6 pm
CO	Max	7.0	ppm	8 Hour	9	1101 Pacific Ave, Tacoma	November 10	5 pm-1 am
SO_2	Not monitored in 2001							
Lead	Not monitored in 2001							

Particulate Matter (PM): The Agency monitors two sizes of particulate matter, 10-micrometers and 2.5-micrometers. Particles smaller than 2.5 micrometers in diameter are called “fine” particles, or $PM_{2.5}$ and comes from all types of combustion, including cars, diesel trucks and buses, industrial facilities, and wood burning. It can also be formed in the atmosphere by chemical reactions of pollutant gases. Particles between 2.5 and 10 micrometers in diameter are called “coarse” particles. Pm_{10} includes both “fine” and “coarse” particles. Coarse particles typically come from crushing or grinding operations and dust from roads. In 1999, maximum concentrations for both pollutants were measured in Tacoma’s industrial area, near the Port of Tacoma. Maximum PM_{10} concentrations are nearly always measured in the Seattle or Tacoma industrial areas because of their heavy industry. In 2000 and 2001 the maximum concentration for $PM_{2.5}$ was measured at the South L Street site in South Tacoma, a neighborhood where wood burning stoves and fireplaces are the major source of particulates during the heating season. Ambient air quality standards were not violated for either $PM_{2.5}$ or PM_{10}.

Ozone (O_3): Ozone forms in the lower atmosphere when hydrocarbons (volatile organic compounds, or VOCs) and nitrogen oxides chemically react in sunlight and high temperatures. The highest measured concentrations for ozone were in the southern portion of the Puget Sound air shed, near Enumclaw. The highest ozone levels in the Puget Sound region occur from mid-May to mid-September on the few hot days favorable for photochemical activity. In this region the hot, sunny days favorable for ozone formation typically have light north-to-northwest afternoon winds. The photochemical reactions that produce ozone continue for several hours, and the trapped pollutants are transported downwind. This creates the greatest ozone concentrations between noon and early evening, at locations 10 to 30 miles from the major sources of the NO_x and VOCs. The highest concentrations in the Puget Sound region are measured in areas such as North Bend, Enumclaw, and Eatonville.

Although the measured maximum 8-hour average ozone concentration in 1999 (90 ppb) and in 2000 (87 ppb) exceeded the AQI standard's concentration of 84 ppb, they did not violate the standard. The standard accounts for minor exceedances due to variable meteorological conditions by comparing the 3-year average of the 4th highest daily maximum to 84 ppb. The 3-year average of the 4th highest daily maximum concentration was 73 ppb in 1999, 77 ppb in 2000, and 70 ppb in 2001, below the standard in all 3 years.

Carbon monoxide (CO): Carbon monoxide largely results from fuel combustion. The most likely areas to have excessive CO concentrations are larger cities where there are more cars, trucks, and congested streets. The highest concentrations of CO were measured in the downtown urban areas of Tacoma and Seattle. Neither the 1-hour nor 8-hour standard for CO was violated in 1999 through 2001.

Sulfur dioxide (SO_2): Sulfur dioxide is mainly produced by combustion of fossil fuels containing sulfur compounds. Because the Puget Sound's primary sources of SO_2 no longer exist, monitoring for this pollutant was stopped at the end of 1999. The maximum measured SO_2 concentration in 1999 was one quarter of the standard of 100 ppb.

Lead (Pb): The primary sources of lead in the region were the combustion of leaded gasoline and a large commercial lead smelter. Monitoring for lead was stopped at the end of 1999 because of the closure of the Harbor Island lead smelter and the elimination of leaded gasoline.

Visibility: Visibility is often explained in terms of visual range and light extinction. *Visual range* is the maximum distance at which 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 you have, the shorter your visual range. Reduced visibility is caused by weather (clouds, fog, and rain) and air pollution (fine particles and gases). The major pollution contributor is fine particulate matter ($PM_{2.5}$), which is transported aloft and may remain suspended for a week or longer. Visibility is generally seasonal, with lower visibilities during fall and winter. Summertime visibilities can be up to 20 miles higher than during winter months.

Based upon measurements by the Agency's nephelometer network, the average visibility for the Puget Sound basin has steadily increased over the last decade with year-to-year variability caused by meteorology. For the 11-year period from January 1991 through December 2001, the 12-month moving average of visual range increased from 48 miles to 64 miles, an average increase of 3% per year. The minimum visual range in 2000 was measured in November, a very stagnant period which included an 8-day burn ban. For the last three years, visibility was significantly reduced following July 4th celebrations, when fine particulate matter from fireworks created excessive smoke.

Smog Watch and Burn Bans

Indoor wood burning bans are most likely during the winter months, due to increased wood burning activities and longer lasting temperature inversions. A Smog Watch is a voluntary outreach awareness air quality program that addresses the causes of ozone pollution during the summer months.

1999: There were 3 days of burn bans in 1999, 1 in January and 2 in December. The ban in January was declared because of elevated PM levels and a stable weather pattern that created an inversion layer over the region. The next day a weather disturbance with overcast clouds, rain, and gusty winds removed the temperature inversion. In December, a high-pressure weather pattern settled over the Northwest, creating a persistent temperature inversion and poor air circulation. This combination led to elevated PM levels and the declaration of a burn ban.

One Smog Watch was issued for the Puget Sound region in 1999, beginning Monday, September 13 and ending Wednesday, September 15. High pressure aloft with a surface thermal trough and temperatures in the upper 80s were expected to restrict ventilation and allow pollutant buildup. However, pressure over the area shifted to the east earlier than expected midmorning on Tuesday, and an onshore push of cool Pacific marine air began replacing the warm stagnant air. The high temperature measured at Sea-Tac airport on Tuesday was only 80 degrees F. High ozone levels never materialized; the maximum 8-hour average was only 0.064 ppm (at the top of the “Good” category) on Tuesday the 14th, as measured at the Pack Forest site near Eatonville. The high temperature of 87 degrees F on Monday the 13th at Sea-Tac airport was the highest temperature of 1999.

2000: There were 11 days of burn bans in 2000, 3 in February and 8 in November. In February the air quality varied, with several periods of poor air quality caused by temperature inversions and elevated PM levels. In November, precipitation was less than half of normal. The low precipitation, combined with temperature inversions and poor air circulation, raised the region’s PM levels.

One Smog Watch was issued for the Puget Sound region in 2000, beginning Tuesday, June 27 and ending Thursday, June 29. A ridge of high pressure with a surface thermal trough over western Washington brought hot, stagnant conditions, low wind speeds, and poor dispersion of pollutants. Record high temperatures near 90 degrees F were forecast. The highest ozone levels of the year occurred on Wednesday the 28th, as both Enumclaw monitors just broke into the “Unhealthy for Sensitive Groups” category with 8-hour average measurements of 0.085 ppm and 0.087 ppm. The highest temperature of the year for Sea-Tac airport (88 degrees F) occurred on Tuesday, June 27.

2001: In November 2001 a burn ban was declared which lasted 5 days. A combination of temperature inversions and poor air circulation raised the region’s particulate levels.

One Smog Watch was issued for the Puget Sound region in 2001, beginning Friday, August 10 and ending Saturday, August 11. A ridge of high pressure with a surface thermal trough brought stagnant conditions, with temperatures forecast in the upper 80s, and created the potential for pollutant buildup. The highest ozone concentration of the year was measured on Sunday the 12th at the Pack Forest site near Eatonville. The 8-hour average of .081 ppm was just below the “Unhealthy for Sensitive Groups” category. The highest temperature of the year for Sea-Tac airport (88 deg F) occurred on Friday, August 10.

Emissions Inventory: An emissions inventory was developed by the Agency for calendar year 1999, summarizing the quantities of criteria air pollutants reported by large industrial sources or estimated using EPA methods. Inventories are typically performed every three years for the Puget Sound region. The inventory covered King, Kitsap, Pierce, and Snohomish counties. The table below presents the results of the Emissions Inventory.

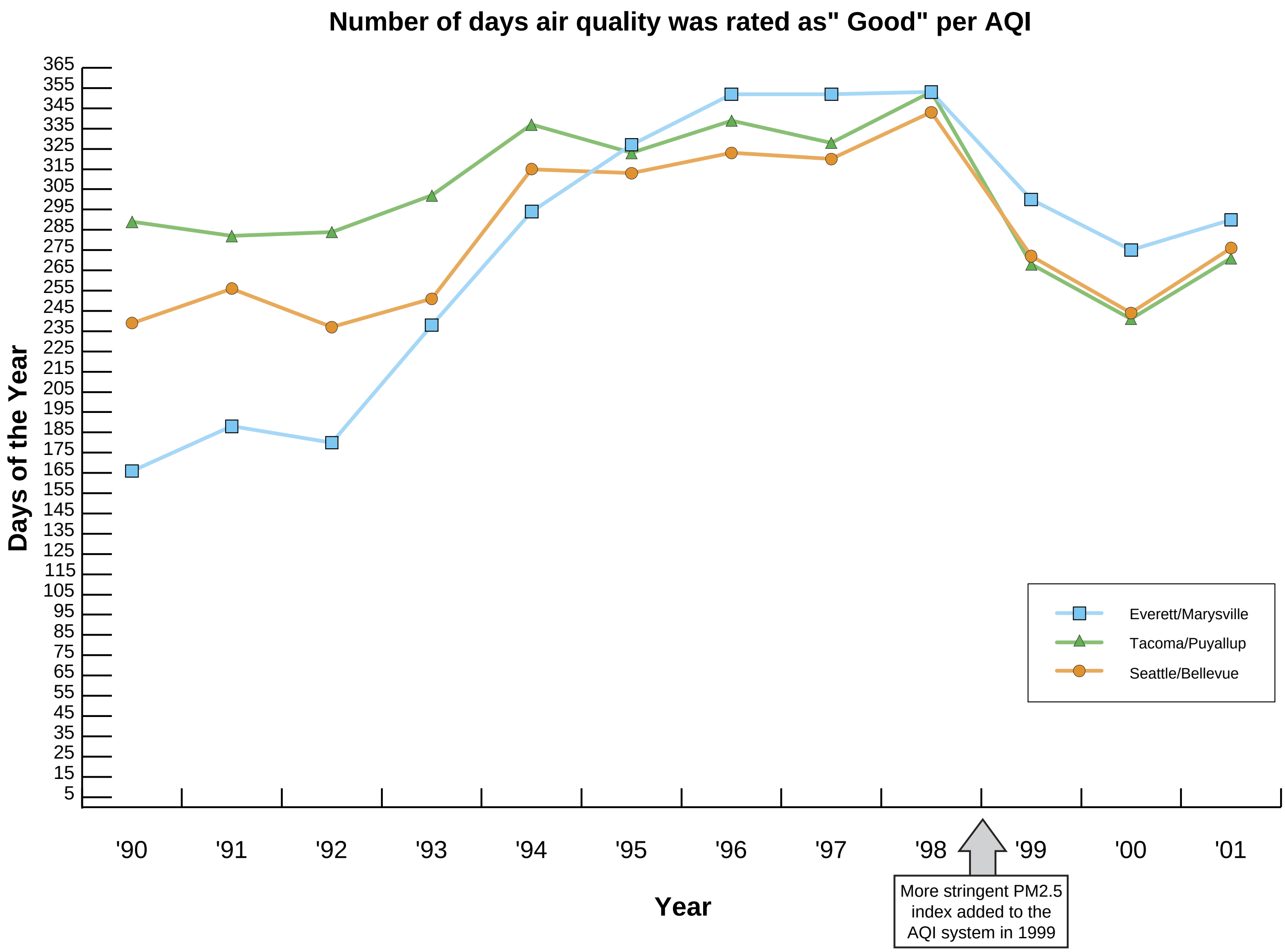
Estimated and Reported Air Contaminant Emission Inventory Summary for 1999 (thousands of tons)

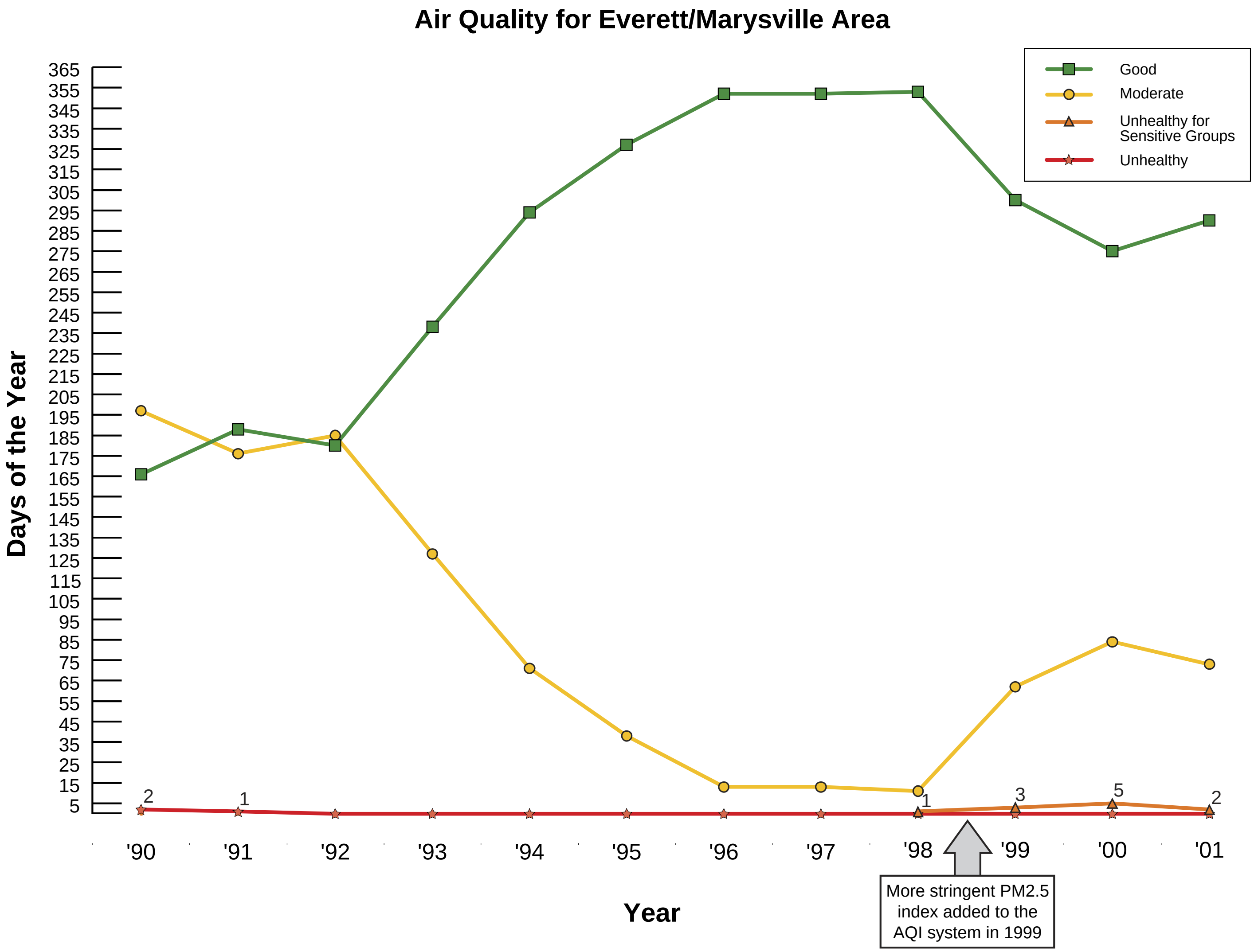
Source Category	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOCs
Point Sources	22	10	2	1	5	24
On-road Vehicles	733	83	2	2	3	56
Off-road Vehicles	269	40	3	3	5	21
Stationary Area Sources	115	10	65	29	2	53
TOTALS	1138	143	71	34	15	154

This inventory demonstrates that on-road and off-road vehicles are significant contributors to criteria pollutant emission in the Puget Sound air shed. Stationary area sources (home heating, small industrial sources, outdoor burning, etc.) are a major contributor of $PM_{2.5}$ emissions. Although biogenic sources (including trees, plants, and crops, all of which produce hydrocarbons) are not included in the above table, they are estimated to produce 70,000 tons of VOCs per year in Puget Sound and impact the production of ozone concentrations. Most of the changes from the previous inventory report are due to revised on-road mobile source estimates completed for our region by EPA using their newest MOBILE6 emission factor model. For additional information on emissions contact our Air Resource Department at 206-689-4051.

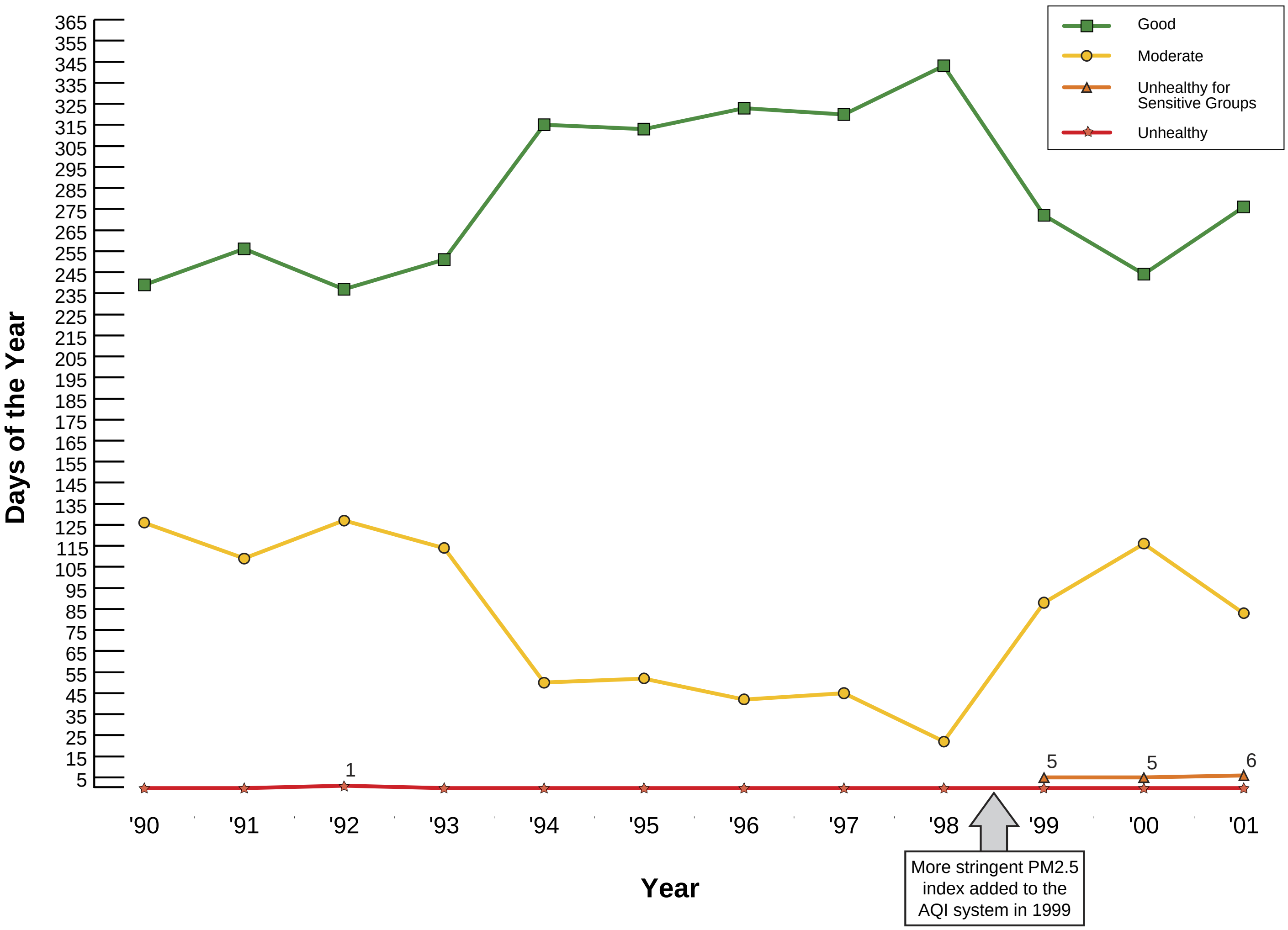
Percentage of Emissions Contributed

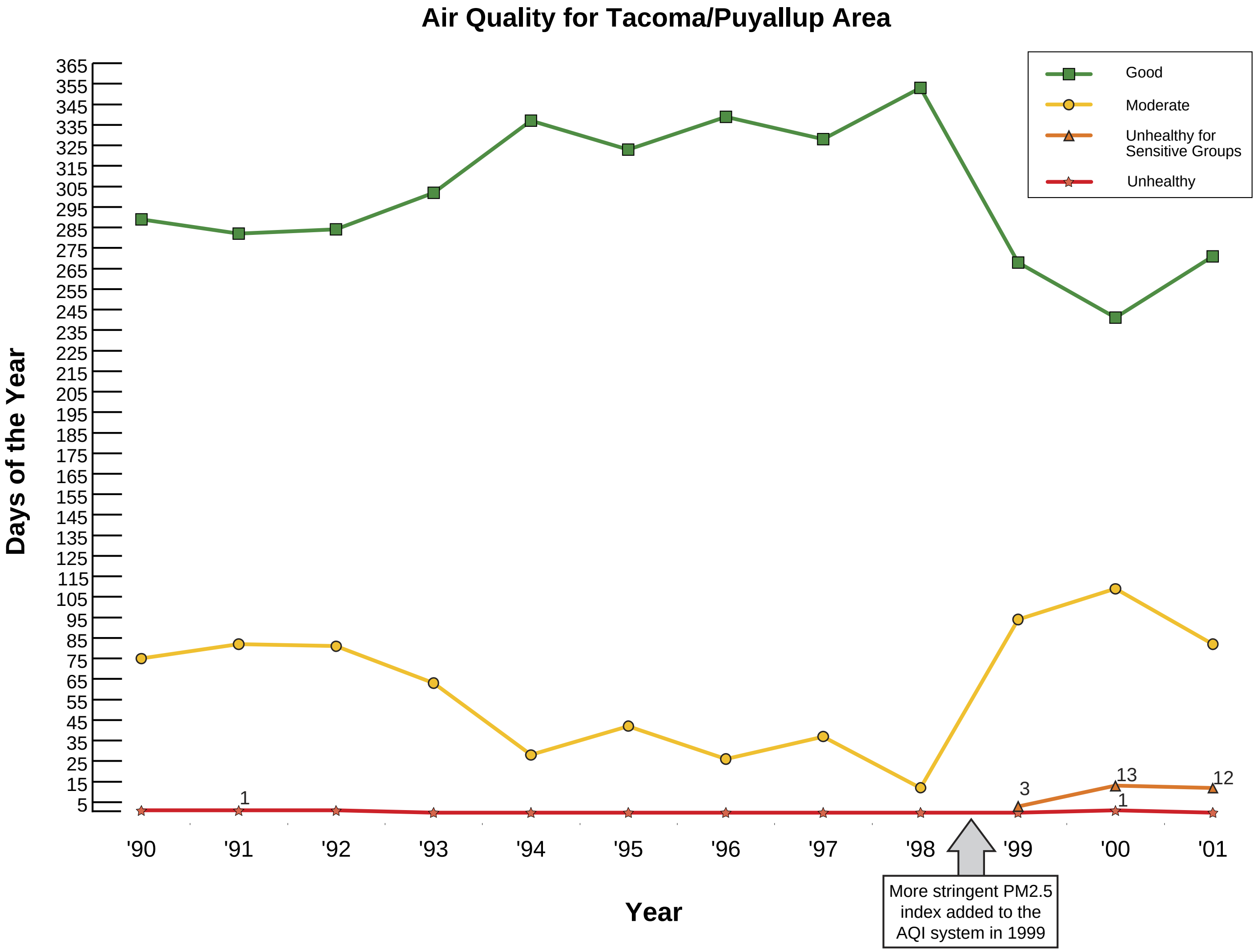
Source Category	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOCs
On-road/Off-road Vehicles	88%	86%	7%	12%	54%	51%
Stationary Area Sources	10%	7%	91%	84%	11%	34%
Point Sources	2%	7%	2%	4%	35%	15%


Number of days air quality was rated as" Good" per AQI
Days of the Year
365
355
345
335
325
315
305
295
285
275
265
255
245
235
225
215
205
195
185
175
165
155
145
135
125
115
105
95
85
75
65
55
45
35
25
15
5
'90
'91
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
Year
Everett/Marysville
Tacoma/Puyallup
Seattle/Bellevue
More stringent PM2.5 index added to the AQI system in 1999


Air Quality for Everett/Marysville Area
Days of the Year
365
355
345
335
325
315
305
295
285
275
265
255
245
235
225
215
205
195
185
175
165
155
145
135
125
115
105
95
85
75
65
55
45
35
25
15
5
Good
Moderate
Unhealthy for Sensitive Groups
Unhealthy
2
1
1
3
5
2
'90
'91
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
Year
More stringent PM2.5 index added to the AQI system in 1999

Air Quality for Seattle/Bellevue Area




Air Quality for Tacoma/Puyallup Area
Days of the Year
Year
Good
Moderate
Unhealthy for Sensitive Groups
Unhealthy
365
355
345
335
325
315
305
295
285
275
265
255
245
235
225
215
205
195
185
175
165
155
145
135
125
115
105
95
85
75
65
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45
35
25
15
5
'90
'91
'92
'93
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'95
'96
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'98
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'01
1
3
13
1
12
More stringent PM2.5 index added to the AQI system in 1999

Monitoring Network

The Puget Sound monitoring network is a composite of meteorological and pollutant-specific monitoring equipment. The Puget Sound Clean Air Agency and the Washington State Department of Ecology operate all of the monitoring stations. Data from the network are either collected manually by field staff or sent directly to engineers and scientists through a telemetry network. The table on the next page presents a summary of the monitoring stations used and parameters monitored from 1999 to 2001.

Numerous parameters affect the choice of site for a monitoring station. Using EPA siting criteria ensures a consistent and representative picture of air quality in the Puget Sound area. However, some sites are selected to focus on the emissions of a single pollutant or group of sources. Some sites are intended to represent an industrial area, while others represent a residential area.

For pollutants of particular interest in the Puget Sound, the Agency uses more than one method in order to better understand the effects of the pollutant on the environment. For example, as shown in the monitoring network table, particulates (both 10 micrometers and 2.5 micrometers) are monitored according to EPA methods as well as through continuous methods. The second table below lists the monitoring methods used.

The monitoring network map shows that monitoring stations are located throughout the Puget Sound region. As you might expect, there are more stations in highly populated areas and fewer stations in rural areas. The station IDs listed in the table correspond with map identifications. These identifications are used throughout this data summary.

Monitoring Network for 1999-2001

Station ID	Location	PM_{10}	PM_{10}co	$PM_{2.5}$	$PM_{2.5}$co	$PM_{2.5}$ls	O_3	SO_2	NO_x	CO	TSP/Pb	BSP	Wind	Temp	BAP	RH	VSBY	PHOTO
IG	Marysville JHS, 1605 7th St, Marysville	●	●	●	●	●						●	●				●	
ID	Hoyt Ave & 26th St, Everett (ended Feb 29, 2000)							●					●					
JS⦿	Broadway & Hewitt Ave, Everett (ended May 21, 2000)									●								
JP⦿	2939 Broadway Ave, Everett (began Apr 1, 2001)									●								
JQ⦿	44th Ave W & 196th St SW, Lynnwood									●								
IH	20935 59th Place West, Lynnwood (ended Jun 8, 1999)	●	●									●	●				●	
II	6120 212th St SW, Lynnwood (began Oct 1, 1999)			●	●	●						●	●				●	
CX	17711 Ballinger Way NE, Lake Forest Park (ended Jun 4, 1999)	●	●									●	●				●	
DB	17171 Bothell Way NE, Lake Forest Park (began Mar 10, 1999)	●	●	●	●	●						●	●				●	
AO⦿	Northgate, 310 NE Northgate Way, Seattle									●								
BV⦿	Sand Point, 7600 Sand Pt Way NE, Seattle												●	●				
BF⦿	University District, 1307 NE 45th St, Seattle									●								
AQ	Queen Anne Hill, 400 W Garfield St, Seattle (began Mar 1, 2001)					●						●					●	●
AR⦿	4th Ave & Pike St, 1424 4th Ave, Seattle									●								
AS⦿	5th Ave & James St, Seattle (ended Feb 28, 2001)									●								
BW⦿	Beacon Hill, 15th S & Charlestown, Seattle			●			●		●			●	●	●	●	●	●	
CU	Harbor Island, 2555 13th Ave SW, Seattle (ended Sep 30, 1999)										●							
CE	Duwamish, 4752 E Marginal Way S, Seattle	●	●	●	●	●						●	●				●	
DZ⦿	Georgetown, 6431 Corson Ave S, Seattle (began Feb 1, 2000)								●	●			●					
DA	South Park, 8025 10th Ave S, Seattle			●		●						●	●				●	
AU⦿	622 Bellevue Way NE, Bellevue (ended Jul 30, 1999)									●								
DP⦿	504 Bellevue Way NE, Bellevue (ended Sep 30, 1999)	●		●														
DC⦿	305 Bellevue Way NE, Bellevue (began Nov 2, 2000)			●														
DL⦿	NE 8th St & 108th Ave NE, Bellevue									●								
CZ	Aquatic Center, 601 143rd Ave NE, Bellevue (began Oct 1,2000)				●	●						●					●	

Monitoring Network for 1999-2001

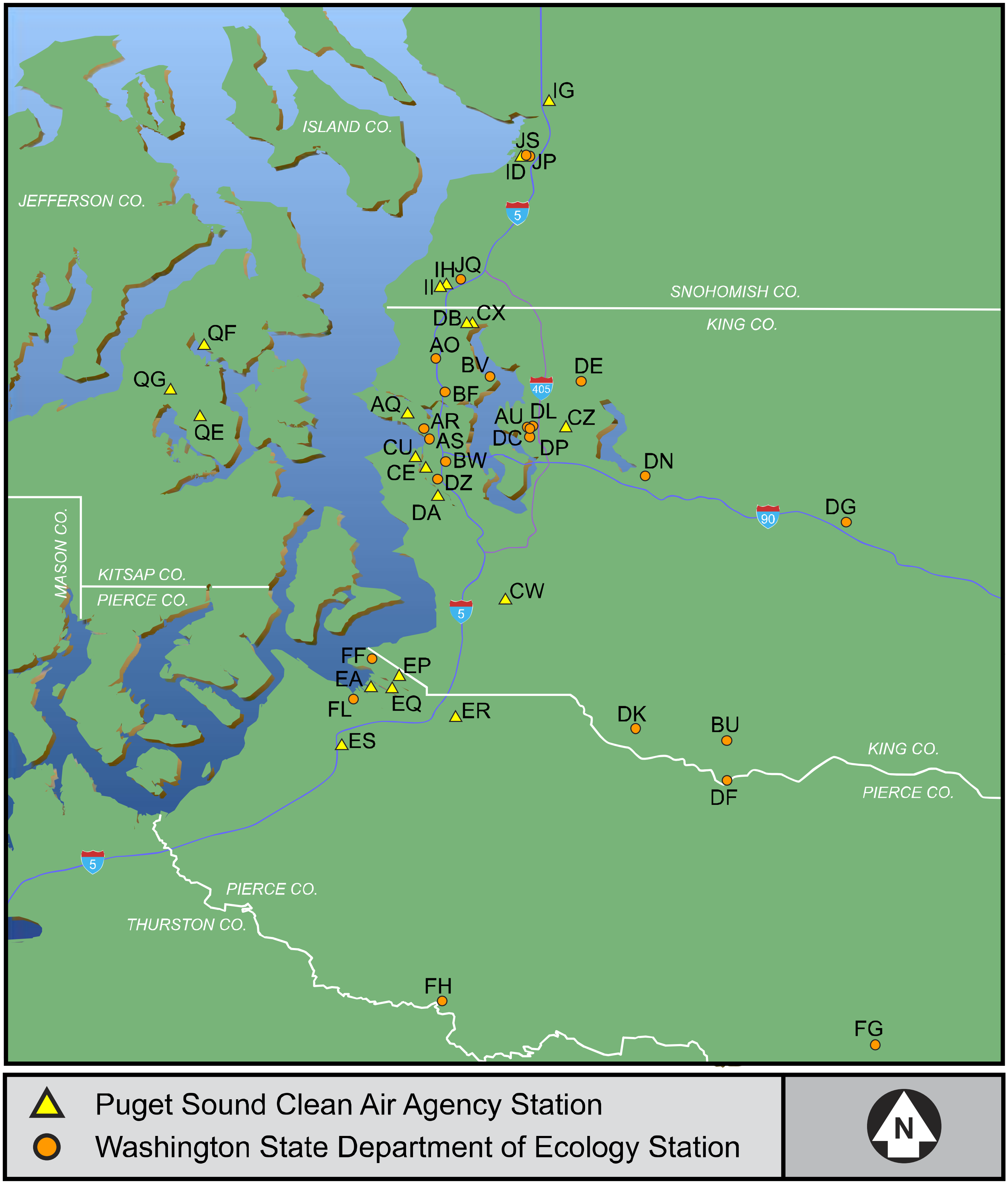
Station ID	Location	PM_{10}	PM_{10}co	$PM_{2.5}$	$PM_{2.5}$co	$PM_{2.5}$ls	O_3	SO_2	NO_x	CO	TSP/Pb	BSP	Wind	Temp	BAP	RH	VSBY	PHOTO
DE⦿	City Hall, 15670 NE 85th St, Redmond (began Aug 4, 1999)			●														
DN⦿	20050 SE 56th, Lake Sammamish State Park, Issaquah						●											
DG⦿	42404 SE North Bend Way, North Bend (began Jan 3, 1999)			●	●		●					●	●	●				
CW	James St & Central Ave, Kent	●	●	●	●	●						●	●				●	
DK⦿	43407 212th Ave SE, 2 mi W of Enumclaw												●	●				
BU⦿	Highway 410, 2 miles E of Enumclaw (ended Sep 30, 2000)						●											
DF⦿	30525 SE Mud Mountain Road, Enumclaw						●											
FH⦿	Charles L Pack Forest, La Grande						●											
ER	South Hill, 9616 128th St E, Puyallup	●	●	●	●	●						●	●				●	
FF⦿	5225 Tower Drive NE, Northeast Tacoma												●	●				
EP	27th St NE & 54th Ave NE, Tacoma (ended Feb 29, 2000)	●						●					●					
EQ	2301 Alexander Ave, Tacoma	●	●	●	●	●						●	●				●	
EA	Fire Station #12, 2316 E 11th St, Tacoma (ended Dec 31, 2000)	●	●										●					
FL⦿	1101 Pacific Ave, Tacoma									●								
ES	7802 South L St, Tacoma (began Oct 3, 1999)			●	●	●						●	●				●	
QE	Meadowdale, 7252 Blackbird Dr NE, Bremerton	●			●								●					
QG	Fire Sta #51, 10955 Silverdale Way, Silverdale (began Jun 2, 2000)				●								●					
QF	Lions Park, 6th Ave NE & Fjord Dr, Poulsbo (ended Feb 29, 2000)												●					
FG⦿	Mt Rainier National Park, Jackson Visitor Center (began May 1, 1999)						●											

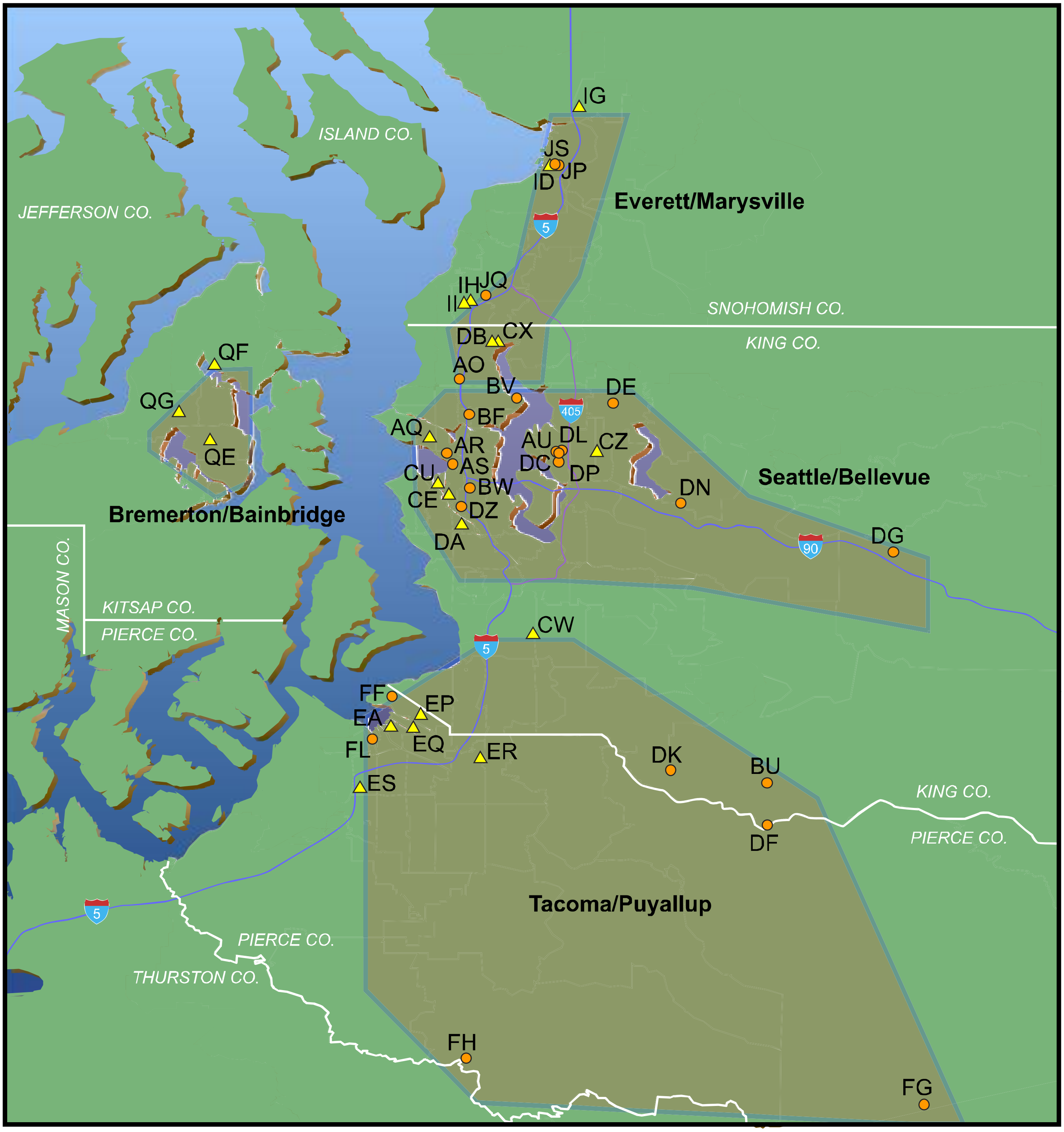
Notes:

⦿	Station operated by Washington State Department of Ecology
PM10	Particulate Matter 10 microns (US EPA)
PM10co	Particulate Matter 10 microns (Continuous)
PM2.5	Particulate Matter 2.5 microns (US EPA)
PM2.5co	Particulate Matter 2.5 microns (Continuous)
PM2.5ls	Particulate Matter 2.5 microns (light scattering)
O3	Ozone
SO2	Sulfur Dioxide
NOx	Nitrogen Oxide
CO	Carbon Monoxide
TSP/Pb	Total suspended particles and Lead
BSP	Light scattering by atmospheric particles (Nephelometer)
Wind	Wind direction & speed
Temp	Air temperature
BAP	Light absorption by atmospheric particles (absorption photometer)
RH	Relative Humidity
VSBY	Visual range (Light scattering)
PHOTO	Visibility (camera)

Monitoring Methods Used from 1999 to 2001 in 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
O_3	Ozone	UV Absorption	Parts per Million
Pb	Lead	Standard High Volume	Micrograms per Standard Cubic Meter
PM_{10}	PM_{10}	Reference - Hi Vol Andersen/ GMW 1200	Micrograms per Cubic Meter
PM_{10}co	PM_{10} Beta Attenuation	Andersen FH621-N	Micrograms per Cubic Meter
	PM_{10} Teom	R&P Mass Transducer	Micrograms per Cubic Meter
$PM_{2.5}$	$PM_{2.5}$ Partisol	Reference—R&P Partisol 2025	Micrograms per Cubic Meter
$PM_{2.5}$co	$PM_{2.5}$ Beta Attenuation	Andersen FH621-N	Micrograms per Cubic Meter
	$PM_{2.5}$ 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
RH	Relative Humidity	Continuous Instrument Output	Percent Relative Humidity
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	RM Young 05305 Wind Monitor AQ	Miles per Hour
	Wind Direction	RM Young 05305 Wind Monitor AQ	Degrees


ISLAND CO.
JEFFERSON CO.
SNOHOMISH CO.
KING CO.
MASON CO.
KITSAP CO.
PIERCE CO.
KING CO.
PIERCE CO.
PIERCE CO.
THURSTON CO.
IG
JS
JP
ID
5
IH
JQ
II
DB
CX
AO
BV
QF
QG
QE
DE
405
BF
AQ
AR
AS
AU
DL
DC
DP
CZ
CU
BW
CE
DZ
DA
DN
90
DG
CW
5
FF
EP
EA
FL
EQ
ER
ES
DK
BU
DF
5
FH
FG
Puget Sound Clean Air Agency Station
Washington State Department of Ecology Station
N



Puget Sound Clean Air Agency Station

Washington State Department of Ecology Station

N

Impaired Air Quality—Burn Bans and Smog Watch

Burn Bans

Washington State has a winter impaired air quality program targeting sources of particulate matter such as wood stoves and fireplaces. According to the Agency's *Regulation I, Article 13 Solid Fuel Burning Device Standards*, the first stage of impaired air quality is reached when at any monitoring station:

- PM_{10} concentrations (24-hour average) reach 60 ug/m^3, or
- Carbon monoxide concentrations (8-hour average) reach 8 ppm

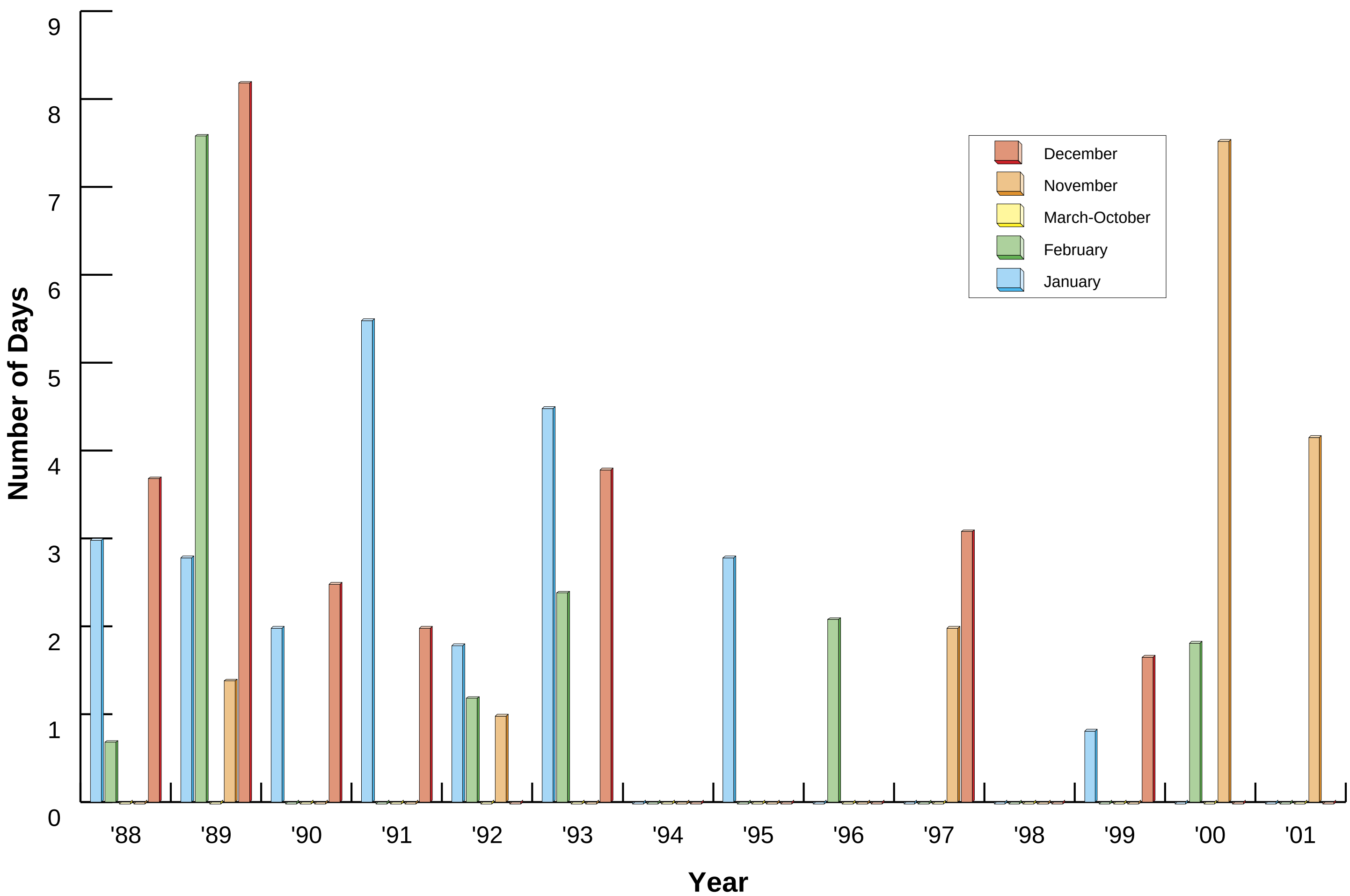
At these levels, a first-stage burn ban may be declared. For a first-stage burn ban, residential burning in fireplaces or uncertified wood stoves is prohibited (unless it is the only adequate source of heat). A second-stage burn ban may be declared when PM_{10} levels reach 105 ug/m^3 (24-hour average). For a second-stage burn ban, the use of any kind of wood-burning device is prohibited. The Agency has not issued a second-stage burn ban since 1991.

As the chart below shows, first-stage burn bans typically occur in November through February. In 1999 there were 3 days of first-stage bans, on 1 day in January and 2 days in December. The ban in January was declared because of elevated particulate levels and a stable weather pattern that created an inversion layer over the region. The next day a weather disturbance with overcast clouds, rain, and gusty winds removed the temperature inversion. In December, a high-pressure weather pattern settled over the Northwest, creating a persistent temperature inversion and poor air circulation. This combination led to elevated particulate levels and the declaration of a burn ban.

In 2000 there were 11 days of first-stage burn bans, 3 days in February and 8 days in November. In February the air quality varied, with several periods of temperature inversions and elevated particulate levels causing poor air quality. November, precipitation was less than half of normal. The low precipitation, combined with temperature inversions and poor air circulation, raised the region's particulate levels.

In 2001 there were 5 days of first-stage burn bans, all in November. A combination of temperature inversions and poor air circulation raised the region's particulate levels.

Number of Days with Indoor Burning Bans in Puget Sound Region



Smog Watch

The Agency maintains a voluntary air quality program called Smog Watch. It is an outreach awareness program that addresses causes of summer smog between June and September. The purpose of the program is to advise residents of potential smog problems and to recommend short-term actions they can take to help reduce maximum ozone levels. Smog Watch advisories are driven more by meteorology than by monitored air quality data. A Smog Watch is called when forecasts call for temperatures in the upper 80s or higher with little or no wind for at least a 72-hour period.

In 1999, one Smog Watch was issued for the Puget Sound region, beginning Monday, September 13 and ending Wednesday, September 15. High pressure aloft with a surface thermal trough and temperatures in the upper 80s were expected to restrict ventilation and allow pollutant buildup. However, pressure over the area shifted to the east earlier than expected midmorning on Tuesday, and an onshore push of cool Pacific marine air began replacing the warm stagnant air. The high temperature measured at Sea-Tac airport on Tuesday was only 80 degrees F. High ozone levels never materialized; the maximum 8-hour average was only 0.064 ppm (at the top of the "Good" category) on Tuesday the 14th, as measured at the Pack Forest site near Eatonville. The high temperature of 87 degrees F on Monday the 13th at Sea-Tac airport was the highest temperature of 1999.

In 2000, one Smog Watch was issued for the Puget Sound region, beginning Tuesday, June 27 and ending Thursday, June 29. A ridge of high pressure with a surface thermal trough over western Washington brought hot, stagnant conditions, low wind speeds, and poor dispersion of pollutants. Record high temperatures near 90 degrees F were forecast. The highest ozone levels of the year occurred on Wednesday the 28th, as both Enumclaw monitors just broke into the "Unhealthy for Sensitive Groups" category with 8-hour average measurements of 0.085 ppm and 0.087 ppm. The highest temperature of the year for Sea-Tac airport (88 degrees F) occurred on Tuesday, June 27.

In 2001, one Smog Watch was issued for the Puget Sound region, beginning Friday, August 10 and ending Saturday, August 11. A ridge of high pressure with a surface thermal trough over Washington brought stagnant conditions, with temperatures forecast in the upper 80s, and created the potential for pollutant buildup. The highest ozone concentration of the year occurred on Sunday the 12th at the Pack Forest site near Eatonville. The 8-hour average of .081 ppm was just below the "Unhealthy for Sensitive Groups" category. The highest temperature of the year for Sea-Tac airport (88 deg F) occurred on Friday, August 10.

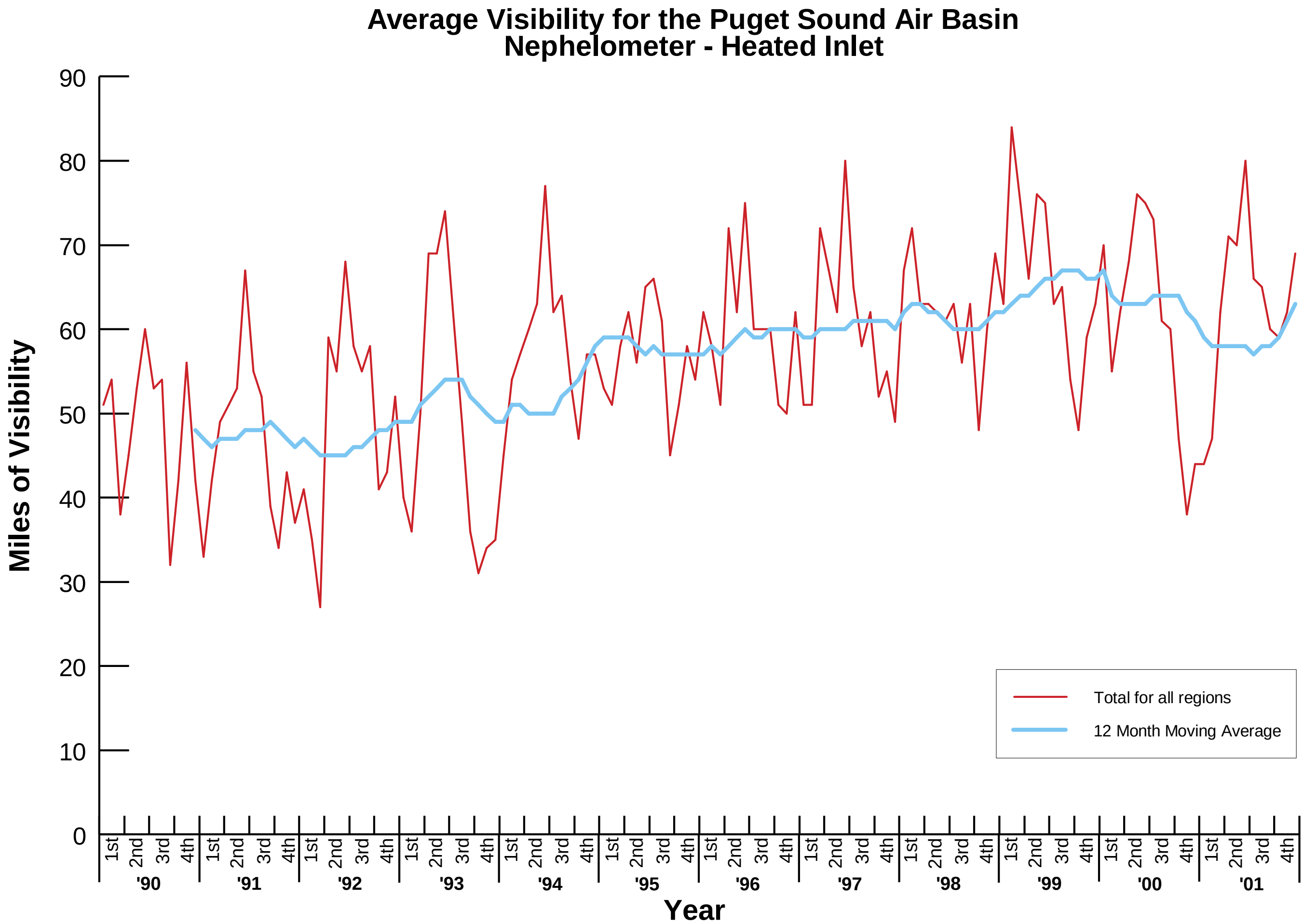
Visibility

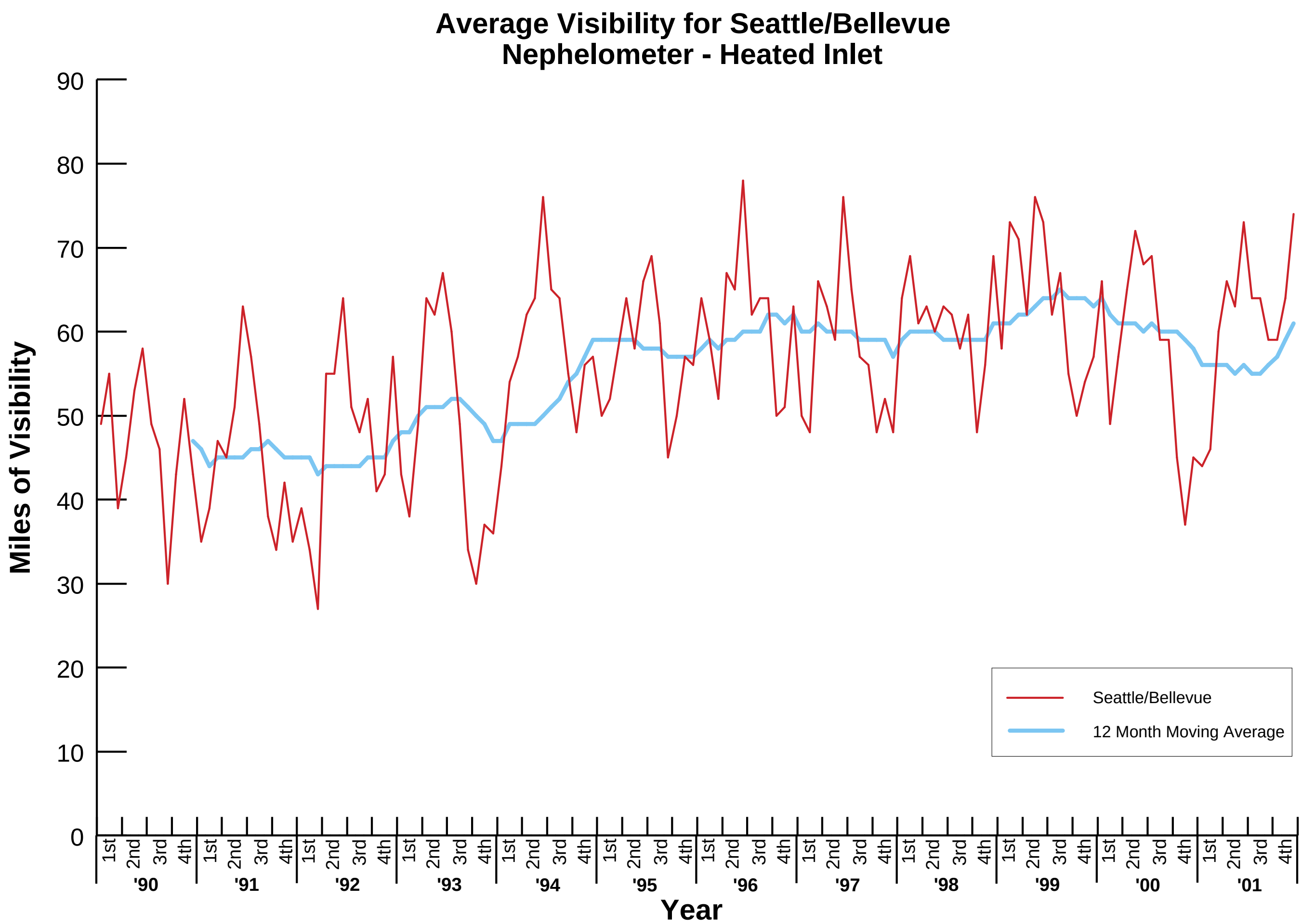
Visibility is often explained in terms of visual range and light extinction. *Visual range* is the maximum distance—usually miles or kilometers—that you can see a black object against the horizon. *Light extinction* is the sum of light scattering and light absorption by fine particles and gases in the atmosphere. The more light extinction you have, the shorter your visual range will be. Visual range as measured by nephelometer instruments utilizing light-scattering methodology provides an objective approach to measuring visibility at a specific location, but does not address individual perceptions regarding the "quality" of a view on a given day.

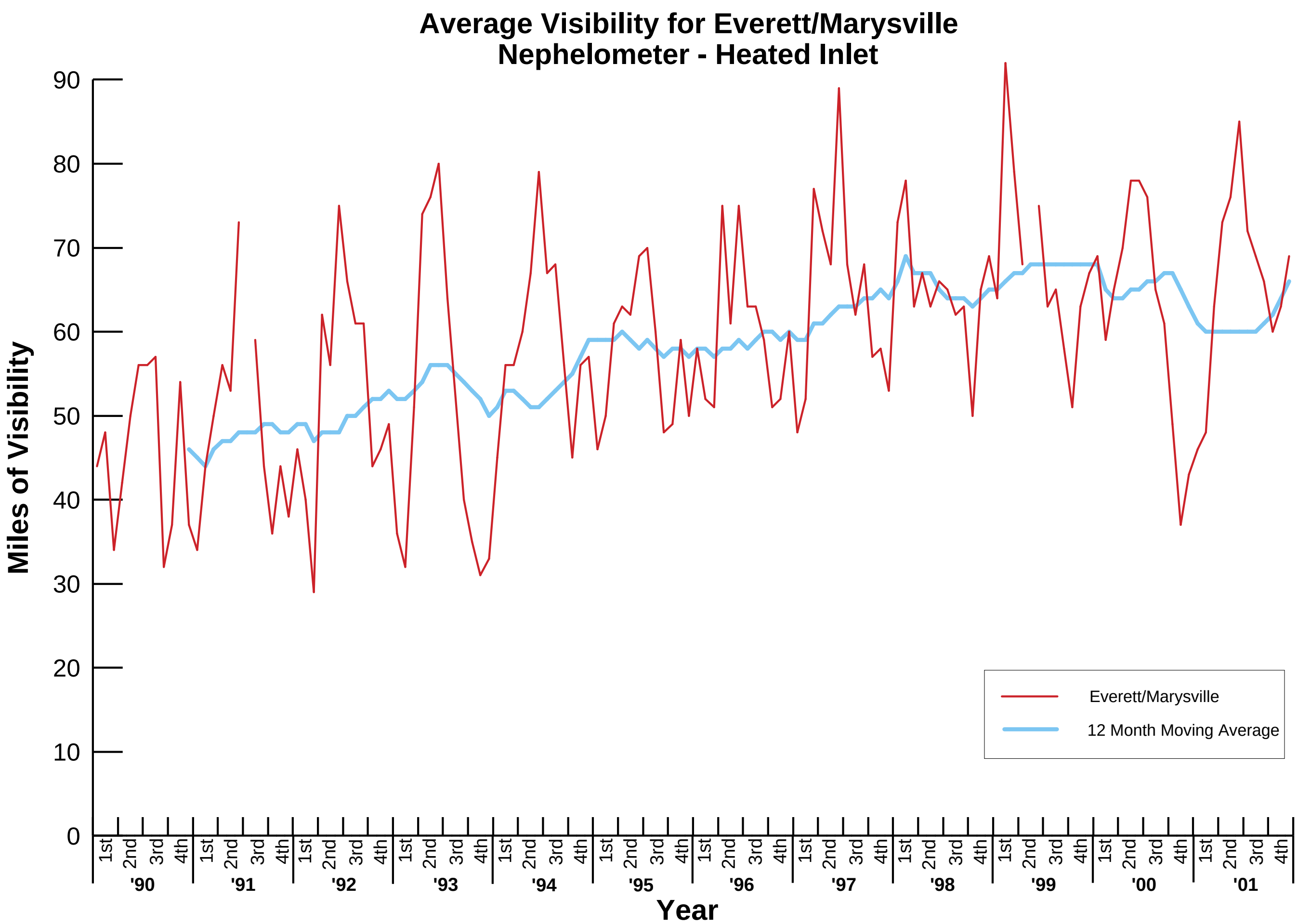
Reduced visibility (or visual range) is caused by weather (clouds, fog, and rain) and air pollution (fine particles and gases). The major pollution contributor is fine particulate matter ($PM_{2.5}$) emissions, which are transported aloft and may remain suspended for a week or longer. Fine particles have a greater impact than coarse particles at locations far from the emitting source because they remain suspended in the atmosphere longer and travel further. $PM_{2.5}$ also presents some of the most serious health hazards to the public, so you can roughly assume that the worse the visibility, the unhealthier the air is to breathe.

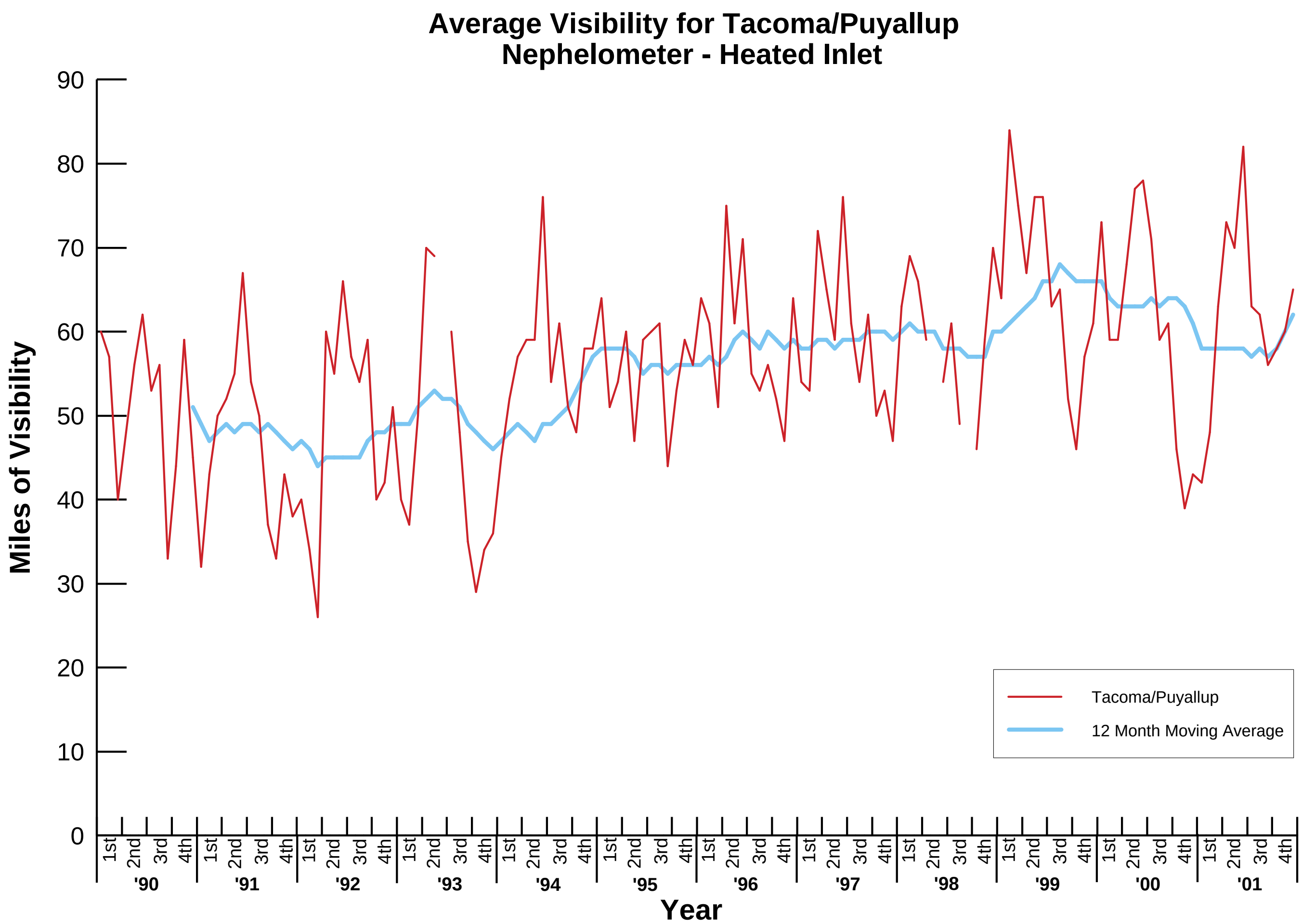
As shown in the following charts, visibility is seasonal, with the highest levels in the summer months and the lowest levels in the winter. Based upon measurements by the Agency's nephelometer network, the average visibility for the Puget Sound basin has steadily increased over the last decade with year-to-year variability caused by meteorology. For the 11-year period from January 1991 through December 2001, the 12-month moving average of visual range increased from 48 miles to 64 miles, an average increase of 3% per year.

Visibility in the Tacoma/Puyallup area remained flat in 1999-2001, with 1999's gains eliminated in 2000 and recovered in 2001. The Everett/Marysville area showed large swings in visibility, decreasing 11% in 2000 and increasing 12% in 2001. The Seattle/Bellevue area followed a similar trend.


Average Visibility for the Puget Sound Air Basin
Nephelometer - Heated Inlet
Miles of Visibility
90
80
70
60
50
40
30
20
10
0
Total for all regions
12 Month Moving Average
1st
2nd
3rd
4th
'90
'91
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
Year


Average Visibility for Seattle/Bellevue
Nephelometer - Heated Inlet
Miles of Visibility
90
80
70
60
50
40
30
20
10
0
Seattle/Bellevue
12 Month Moving Average
1st
2nd
3rd
4th
'90
'91
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
Year


Average Visibility for Everett/Marysville
Nephelometer - Heated Inlet
Miles of Visibility
90
80
70
60
50
40
30
20
10
0
1st 2nd 3rd 4th
'90 '91 '92 '93 '94 '95 '96 '97 '98 '99 '00 '01
Year
Everett/Marysville
12 Month Moving Average


Average Visibility for Tacoma/Puyallup
Nephelometer - Heated Inlet
Miles of Visibility
0
10
20
30
40
50
60
70
80
90
Year
'90
'91
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
1st
2nd
3rd
4th
Tacoma/Puyallup
12 Month Moving Average

Regional Emission Inventory

This section presents an emission inventory summary for the six criteria pollutants and hazardous air pollutants. This inventory for the Puget Sound region is performed every three years by the Agency.

Criteria Pollutants

An emissions inventory was performed by the Agency in 1999 that summarized the quantities of criteria air pollutants that were reported by large point sources or estimated using EPA methods. The inventory covered King, Kitsap, Pierce, and Snohomish counties and was based on the following sources of information:

- Annual operating permit emission reports
- Annual registered facility emission reports
- Emission factor derived estimates
- Transportation models

Emission inventory results are tabulated from:

- Point sources that are required to report emissions on a yearly basis
- Stationary area sources, comprising sources that have emissions below reporting thresholds such as indoor burning, painting, dry cleaning, and stationary diesel engines
- Emission factors for sources such as vegetation and agricultural activities
- Calculated emissions based on regional transportation models for sources such as automobiles

Hazardous air pollutants and toxic air contaminants are reported only for point sources. The following charts present the contributions from each source category for the six criteria pollutants.

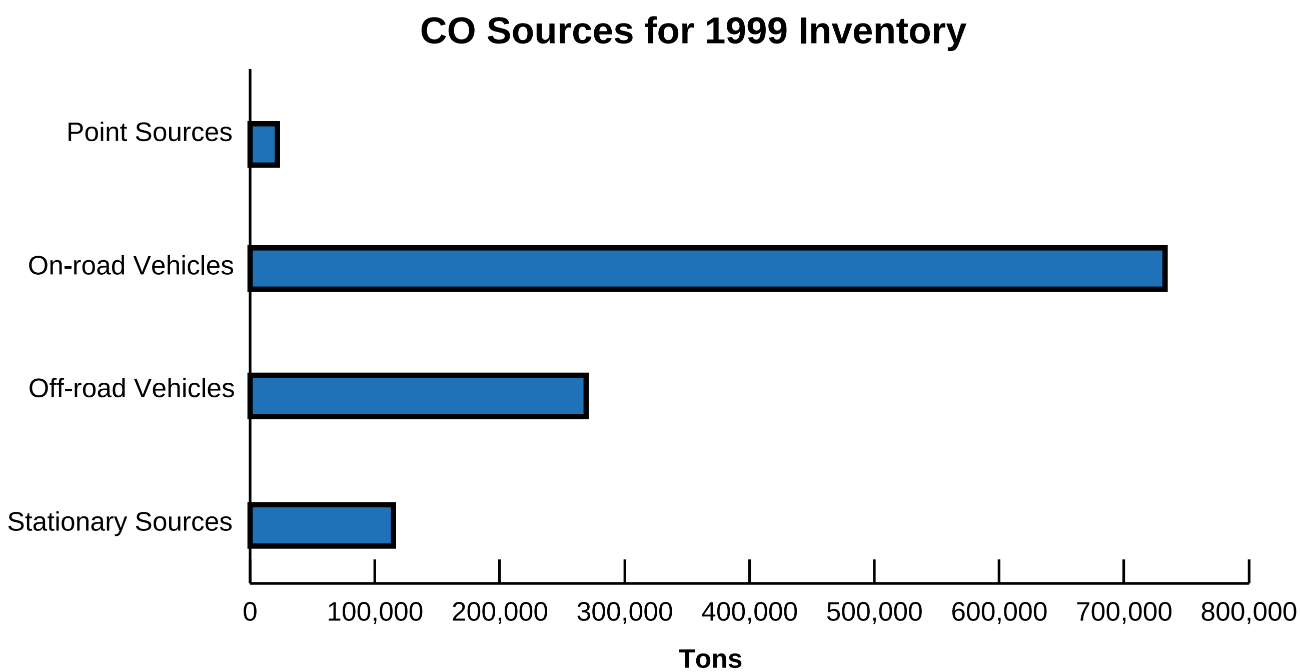
Estimated and Reported Air Contaminant Emission Inventory Summary for 1999 (thousand of tons)

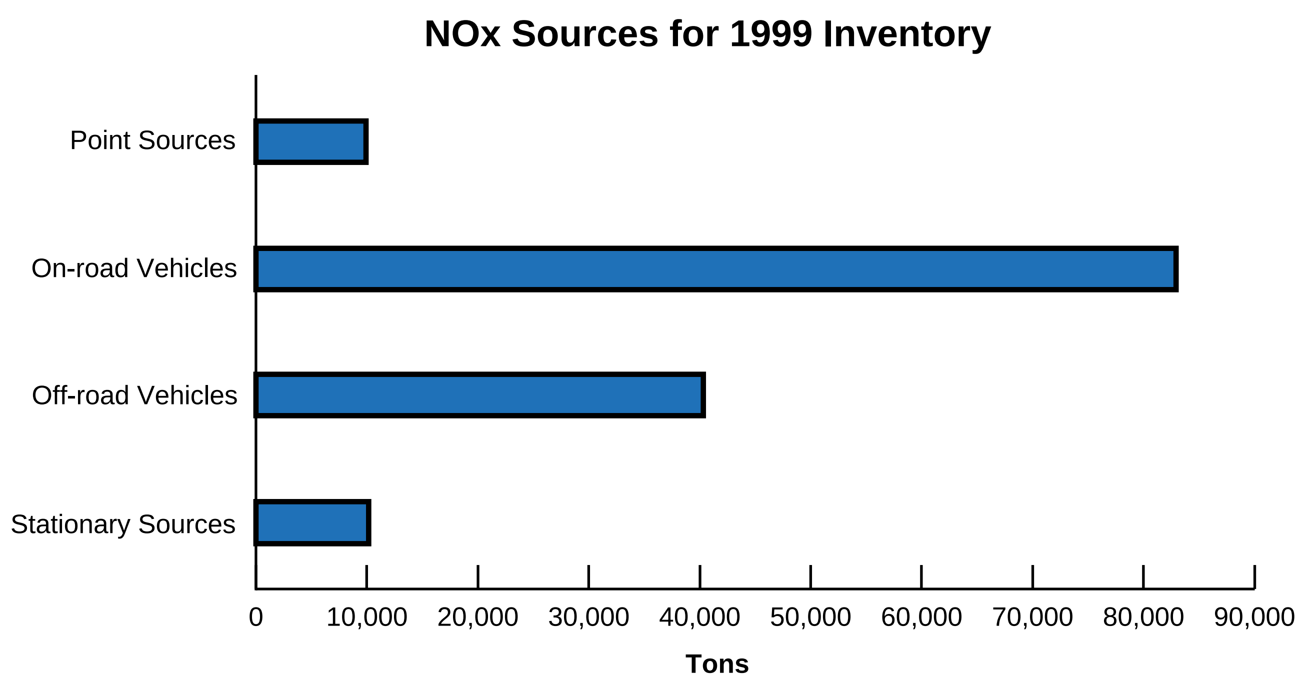
Source Category	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOCs
Point Sources	22	10	2	1	5	24
On-road Vehicles	733	83	2	2	3	56
Off-road Vehicles	269	40	3	3	5	21
Stationary Area Sources	115	10	65	29	2	53
TOTALS	1138	143	71	34	15	154

This inventory demonstrates that on-road and off-road vehicles are significant contributors to criteria pollutant emission in the Puget Sound air shed. Stationary area sources are a major contributor of $PM_{2.5}$ emissions. Although biogenic sources (including trees, plants, and crops, all of which produce hydrocarbons) are not included in the above table, they are estimated to produce 70,000 tons of VOCs per year in Puget Sound and impact the production of ozone concentrations. Most of the changes from the previous inventory report are due to revised on-road mobile source estimates completed for our region by EPA using their newest MOBILE6 emission factor model. For additional information on emissions contact our Air Resource Department at 206-689-4051.

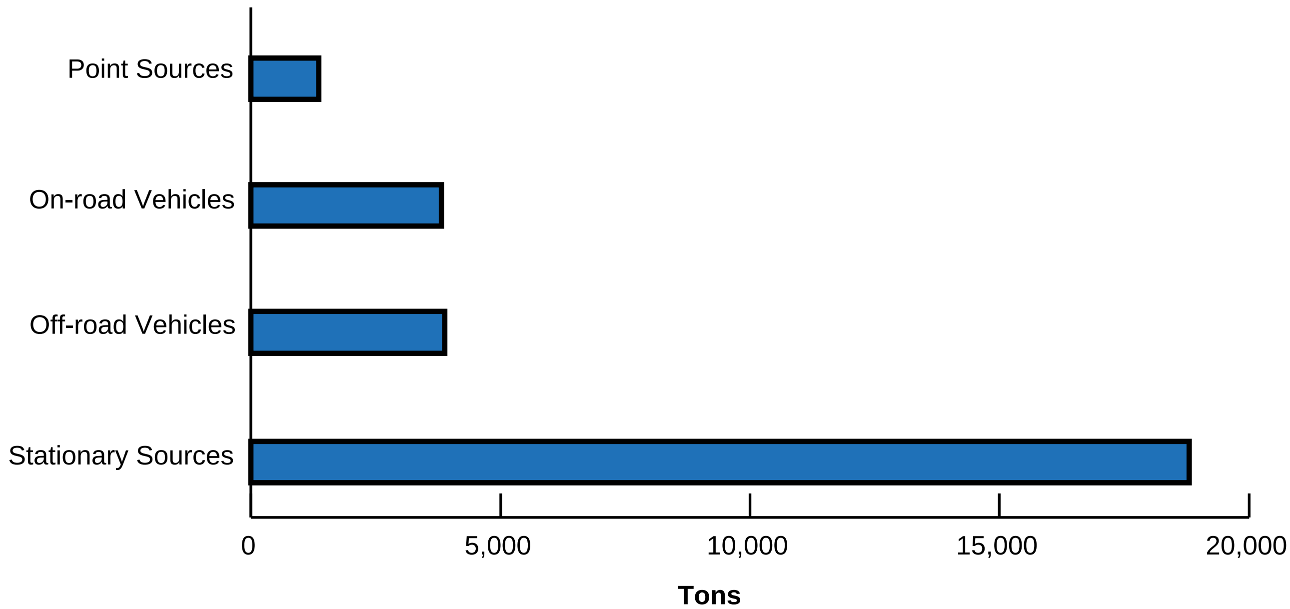
Percentage of Emissions Contributed

Source Category	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOCs
On-road/Off-road Vehicles	88%	86%	7%	12%	54%	51%
Stationary Area Sources	10%	7%	91%	84%	11%	34%
Point Sources	2%	7%	2%	4%	35%	15%

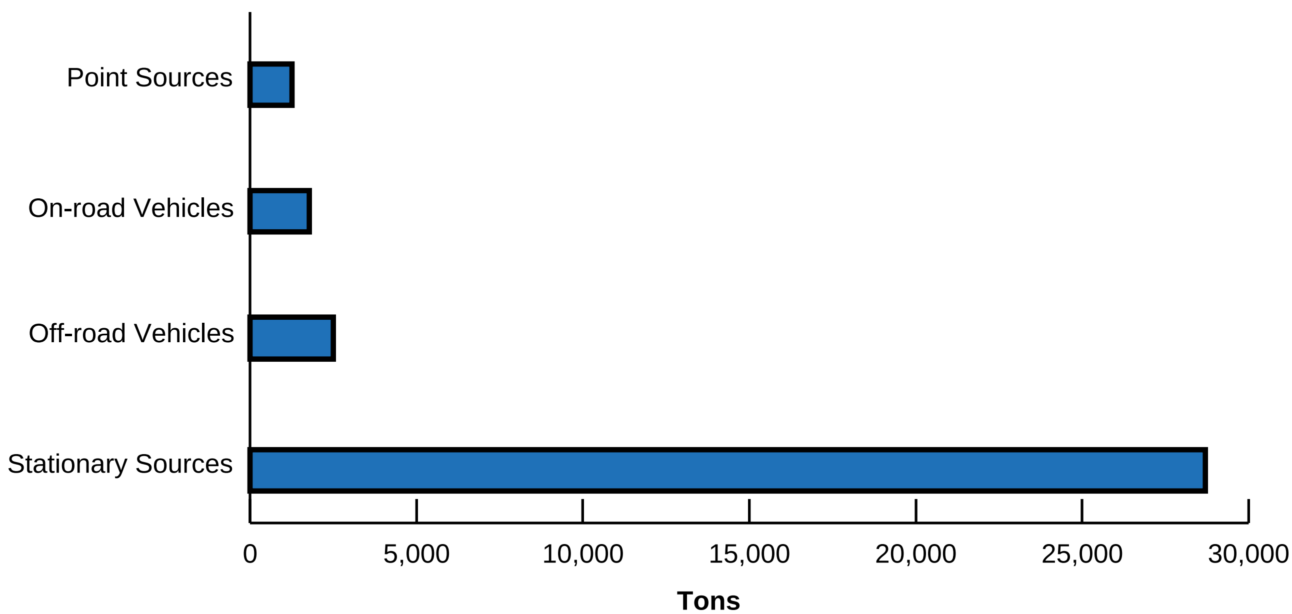

CO Sources for 1999 Inventory
Point Sources
On-road Vehicles
Off-road Vehicles
Stationary Sources
0
100,000
200,000
300,000
400,000
500,000
600,000
700,000
800,000
Tons

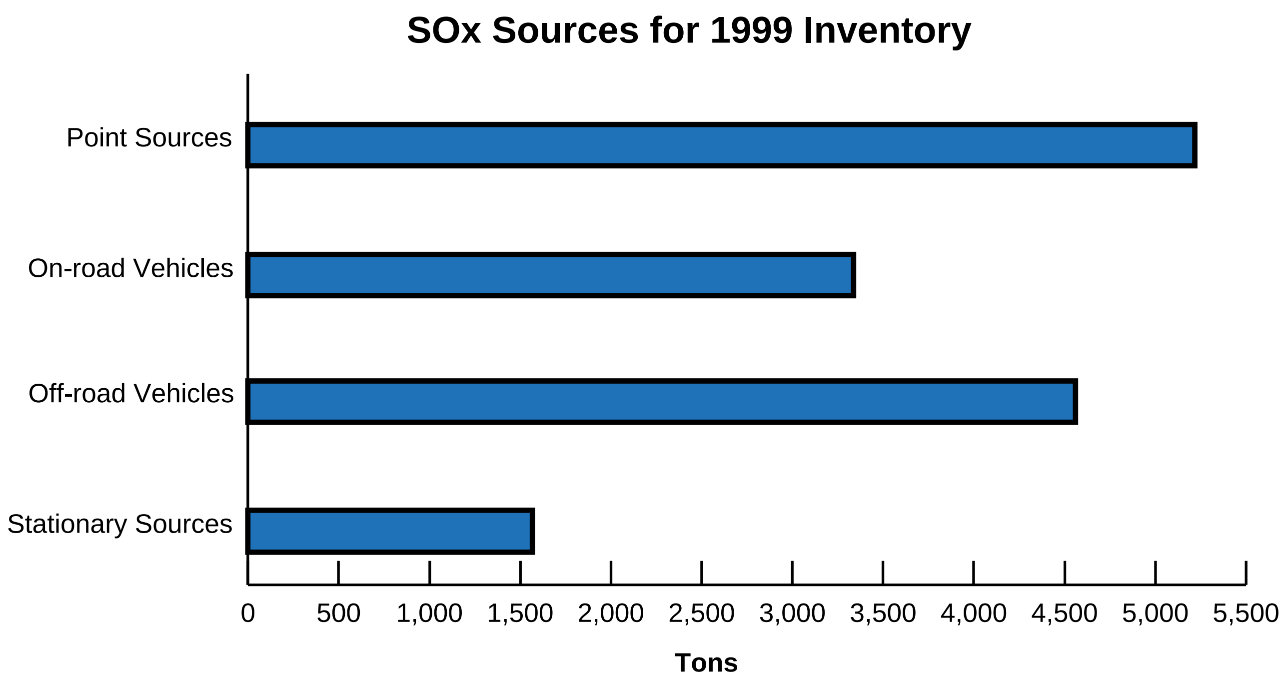

NOx Sources for 1999 Inventory
Point Sources
On-road Vehicles
Off-road Vehicles
Stationary Sources
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
Tons

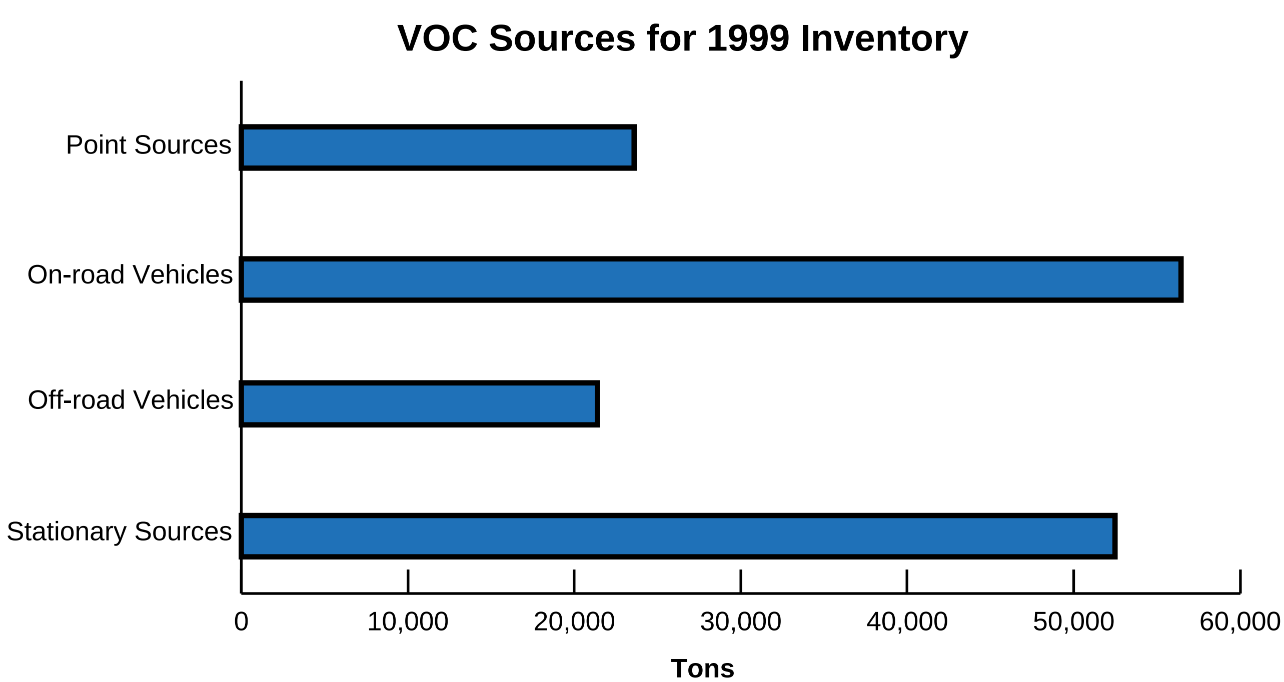
PM_{10} Sources for 1999 Inventory



$PM_{2.5}$ Sources for 1999 Inventory




SOx Sources for 1999 Inventory
Point Sources
On-road Vehicles
Off-road Vehicles
Stationary Sources
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
5,500
Tons


VOC Sources for 1999 Inventory
Point Sources
On-road Vehicles
Off-road Vehicles
Stationary Sources
0
10,000
20,000
30,000
40,000
50,000
60,000
Tons

Hazardous Air Pollutants (HAPs)

In 1999, 7,427 tons of HAPs were emitted into the Puget Sound air shed from point sources throughout the region. The highest levels were associated with solvents (MEK, toluene, methanol) as well as common household products. Additionally, the Agency estimates that 35,463 tons of HAPs were emitted from stationary area and mobile sources. For details on chemical toxicity, visit the EPA web site www.epa.gov/ttn/atw/index.htm.

20 Highest Totals of Hazardous Air Pollutants Emitted from Point Sources in 1999

CAS	Chemical Name	Tons
67-56-1	Methanol	3,698
78-93-3	Methyl Ethyl Ketone	435
108-88-3	Toluene	307
67-66-3	Chloroform	277
7647-01-0	Hydrochloric Acid	254
1319-77-3	Cresol	244
75-07-0	Acetaldehyde	217
1330-20-7	Xylene	205
98-82-8	Cumene	189
100-42-5	Styrene	135
100-41-4	Ethylbenzene	131
79-01-6	Trichloroethylene	108
463-58-1	Carbonyl Sulfide	106
108-95-2	Phenol	92
108-10-1	Methyl Isobutyl Ketone	89
120-82-1	1,2,4-Trichlorobenzene	84
56-23-5	Carbon Tetrachloride	80
7664-39-3	Hydrogen Fluoride	68
75-09-2	Methylene Chloride	66
540-84-1	2,2,4-Trimethylpentane	46

20 Highest Totals of Hazardous Air Pollutants from Non-point Area Sources and Mobile Sources for 1999

CAS	Chemical Name	Tons
108-88-3	Toluene	8651
1330-20-7	Xylene	5621
71-43-2	Benzene	4052
540-84-1	2,2,4-Trimethylpentane	2527
110-54-3	Hexane	2486
78-93-3	Methyl Ethyl Ketone	1582
100-41-4	Ethylbenzene	1361
67-56-1	Methanol	1078
75-07-0	Acetaldehyde	724
74-83-9	Methyl Bromide	624
100-42-5	Styrene	549
79-01-6	Trichloroethylene	545
75-09-2	Methylene Chloride	534
542-75-6	1,3-Dichloropropene	449
106-99-0	1,3-Butadiene	405
91-20-3	Napthalene	272
127-18-4	Perchloroethylene	228
108-10-1	Methyl Isobutyl Ketone	217
108-90-7	Chlorobenzene	202
106-46-7	1,4-Dichlorobenzene	176

Air Quality Standards

The Clean Air Act (CAA), which was last amended in 1990, requires the EPA to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. The standards are designed to protect the general public; sensitive populations such as asthmatics, children, and the elderly; and safeguard public welfare in such issues as decreased visibility and damage to animals, crops, vegetation and buildings. The EPA has established standards for six criteria pollutants. The State of Washington and the Puget Sound Region have adopted these standards, and in the case of sulfur dioxide also apply a stricter State standard. See Regulation I, Article 11 *Ambient Air Quality Standards* of the PSCAA regulations. The air quality standards for the Puget Sound air shed are:

Puget Sound Region Air Quality Standards

Pollutant	Standard	Level
Ozone	Over a 3-consecutive-year period, the daily maximum 1-hour average cannot exceed the level more than an average of once per year	0.12 ppm
	Over a 3-consecutive-year period, the 4th highest 8-hour average concentration cannot exceed	0.084 ppm
Particulate Matter (10 microns)	The 3-year annual average of the daily concentrations cannot exceed	50 $\mu g/m^3$
	The 3-year average of the 99th percentile (based on the number of samples taken) of the daily concentrations cannot exceed	150 $\mu g/m^3$
Particulate Matter (2.5 microns)	The 3-year annual average of the daily concentrations cannot exceed	15 $\mu g/m^3$
	The 3-year average of the 98th percentile (based on the number of samples taken) of the daily concentrations cannot exceed	65 $\mu g/m^3$
Carbon Monoxide	The 1-hour average cannot exceed the level more than once per year	35 ppm
	The 8-hour average cannot exceed the level more than once per year	9 ppm
Sulfur Dioxide	Annual arithmetic mean of 1-hour averages cannot exceed	0.02 ppm
	24-hour average cannot exceed	0.10 ppm
	1-hour average cannot exceed	0.40 ppm
	AND no more than twice in 7 consecutive days can the 1-hour average exceed	0.25 ppm
Lead	The quarterly average (by calendar) cannot exceed	1.5 $\mu g/m^3$
Nitrogen Dioxide	The annual average cannot exceed	0.053 ppm

Note: Daily concentration is the 24-hour average, measured from midnight to midnight.

The standards for ozone were implemented as a result of scientific research demonstrating a more serious health impact of long-term exposure (8-hour) to ozone pollution than to short term (1-hour) peak levels. In the case of particulate matter standards, EPA added standards for 2.5 micrometers and below because of the serious health effects associated with smaller particulate sizes.

The summaries that follow show how the Puget Sound air shed compared to these standards for the years 1999 through 2001.

Ozone

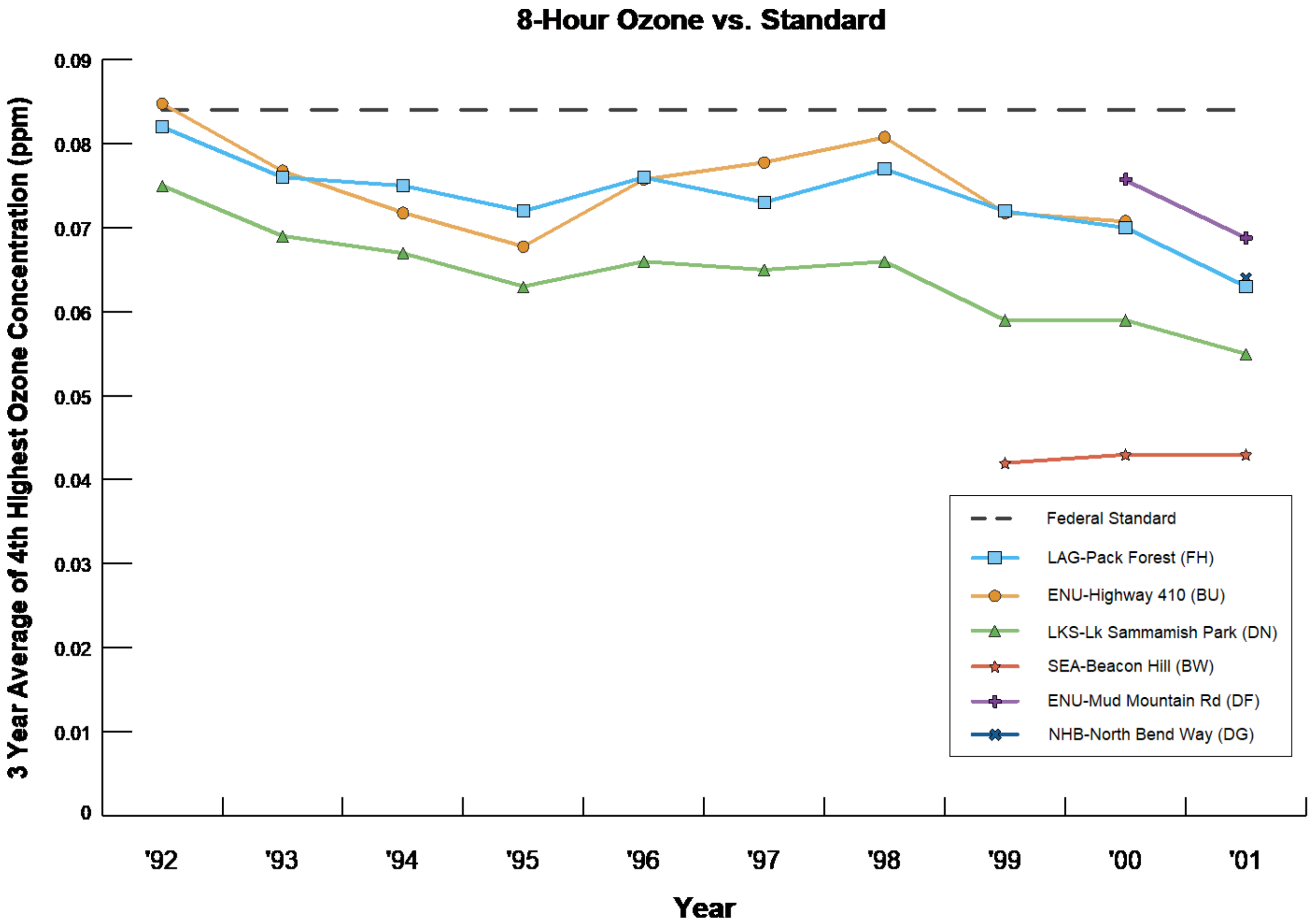
Ozone is a summertime air pollution problem, and is not directly emitted by pollutant sources. It forms when photo-chemical pollutants from cars and industrial sources react with sunlight. Ozone levels are usually highest in the afternoon. High concentrations of ozone can cause respiratory distress in humans and is responsible for decreased yields of agricultural crops and forests. The damage it causes to the lungs heals within a few days, but repeated or prolonged exposure may cause permanent damage. If ozone levels are high and you have a respiratory condition or are normally active outdoors, try to limit your outdoor exertion.

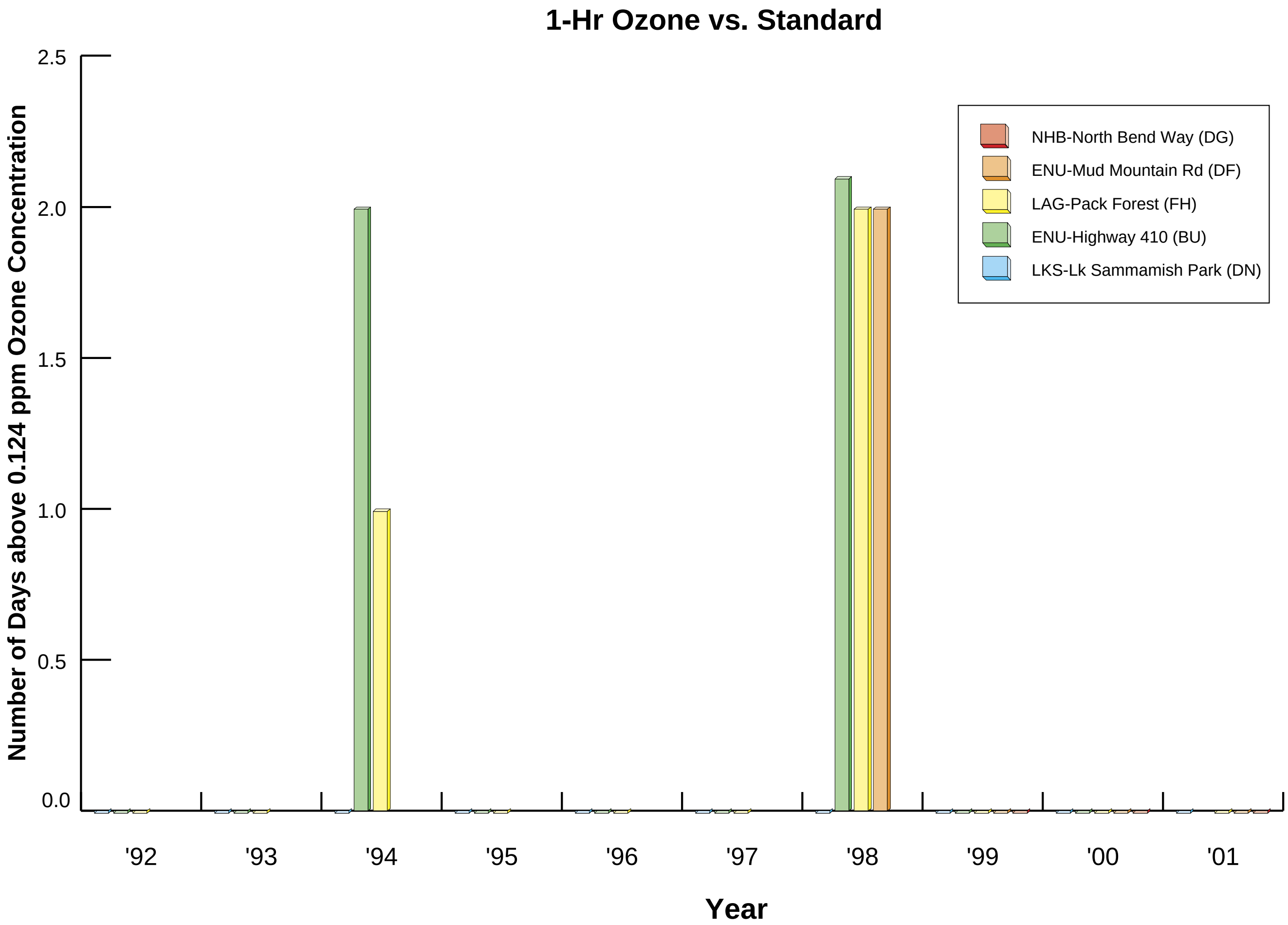
As shown in the charts below, the Puget Sound Air basin maintained attainment for ozone between 1999 and 2001. This means the 3-year average of the 4th-highest 8-hour concentration never exceeded the NAAQS standard. Because of the way the ozone standard is defined, the three highest concentrations can exceed the level of the standard while still maintaining attainment. In 1999, the highest 8-hour concentration at Enumclaw (0.090 ppm) exceeded the level of the standard, and in 2000 the highest and 2nd-highest concentrations exceeded this level.

The majority of monitoring stations measuring ozone are located in rural regions of the Puget Sound. The precursor chemicals that react with sunlight to produce ozone are generated primarily in large metropolitan areas. Because the photochemical process takes several hours, the communities downwind of the large urban areas are where the highest concentrations are measured. In the Puget Sound region, the hot sunny days favorable for ozone formation are typified by light north-to-northwest winds. By the time the highest concentration of ozone has formed in the afternoon and early evening, it has been transported 10 to 30 miles from the original source. In the Puget Sound region the highest concentrations are measured in areas such as North Bend, Enumclaw, and Eatonville.

Regional trends show a flat ozone level or a slight decrease over the 1999-2001 period. Because of our mild climate, ideal conditions for high ozone levels are infrequent in the Puget Sound area. Compared to other parts of the country, such as the southern states, ozone is not a critical health problem in our area.

For additional information on ozone, visit www.epa.gov/air/urbanair/ozone/index.html.


8-Hour Ozone vs. Standard
3 Year Average of 4th Highest Ozone Concentration (ppm)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
Year
Federal Standard
LAG-Pack Forest (FH)
ENU-Highway 410 (BU)
LKS-Lk Sammamish Park (DN)
SEA-Beacon Hill (BW)
ENU-Mud Mountain Rd (DF)
NHB-North Bend Way (DG)

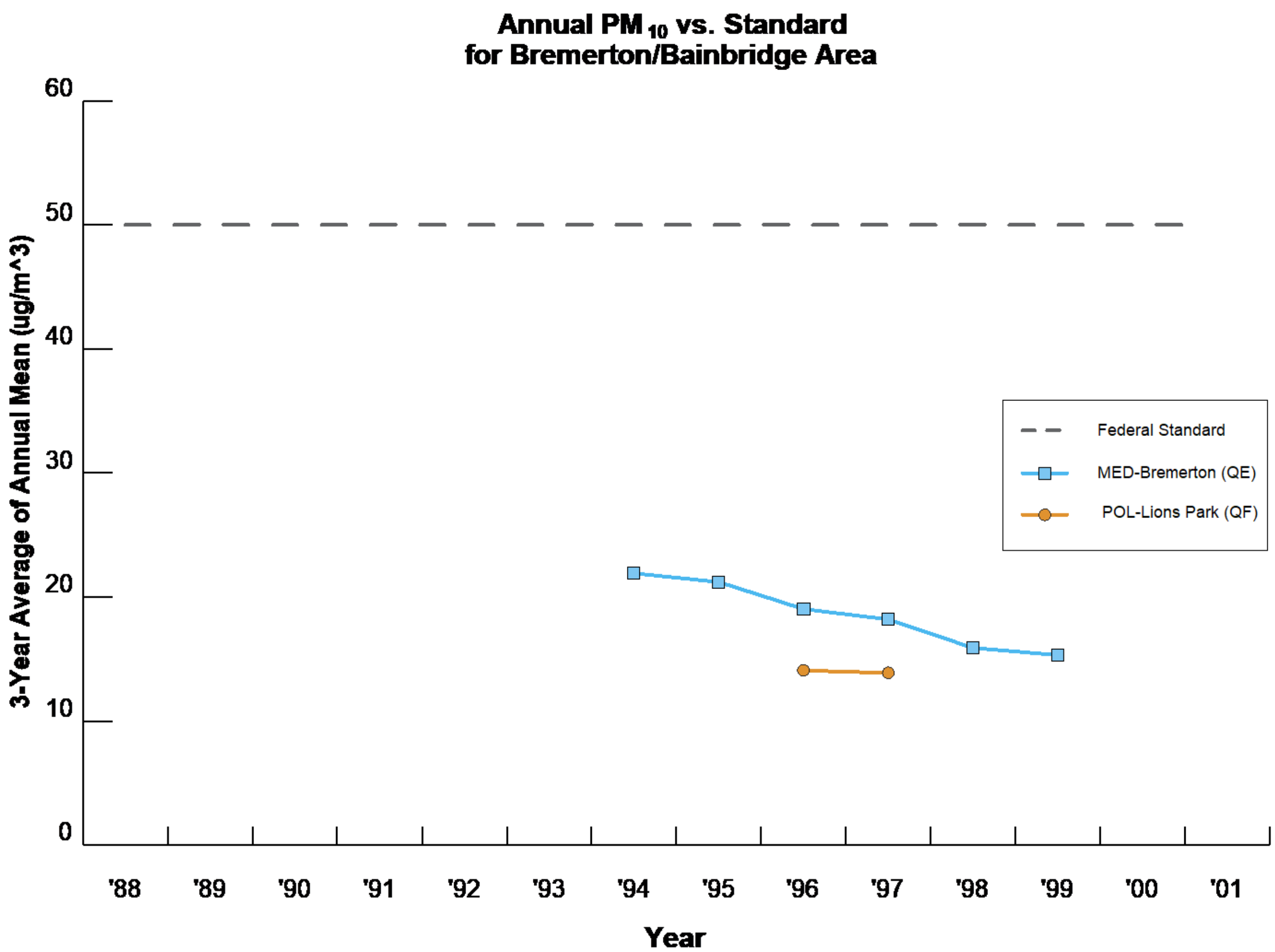

1-Hr Ozone vs. Standard
Number of Days above 0.124 ppm Ozone Concentration
2.5
2.0
1.5
1.0
0.5
0.0
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
Year
NHB-North Bend Way (DG)
ENU-Mud Mountain Rd (DF)
LAG-Pack Forest (FH)
ENU-Highway 410 (BU)
LKS-Lk Sammamish Park (DN)

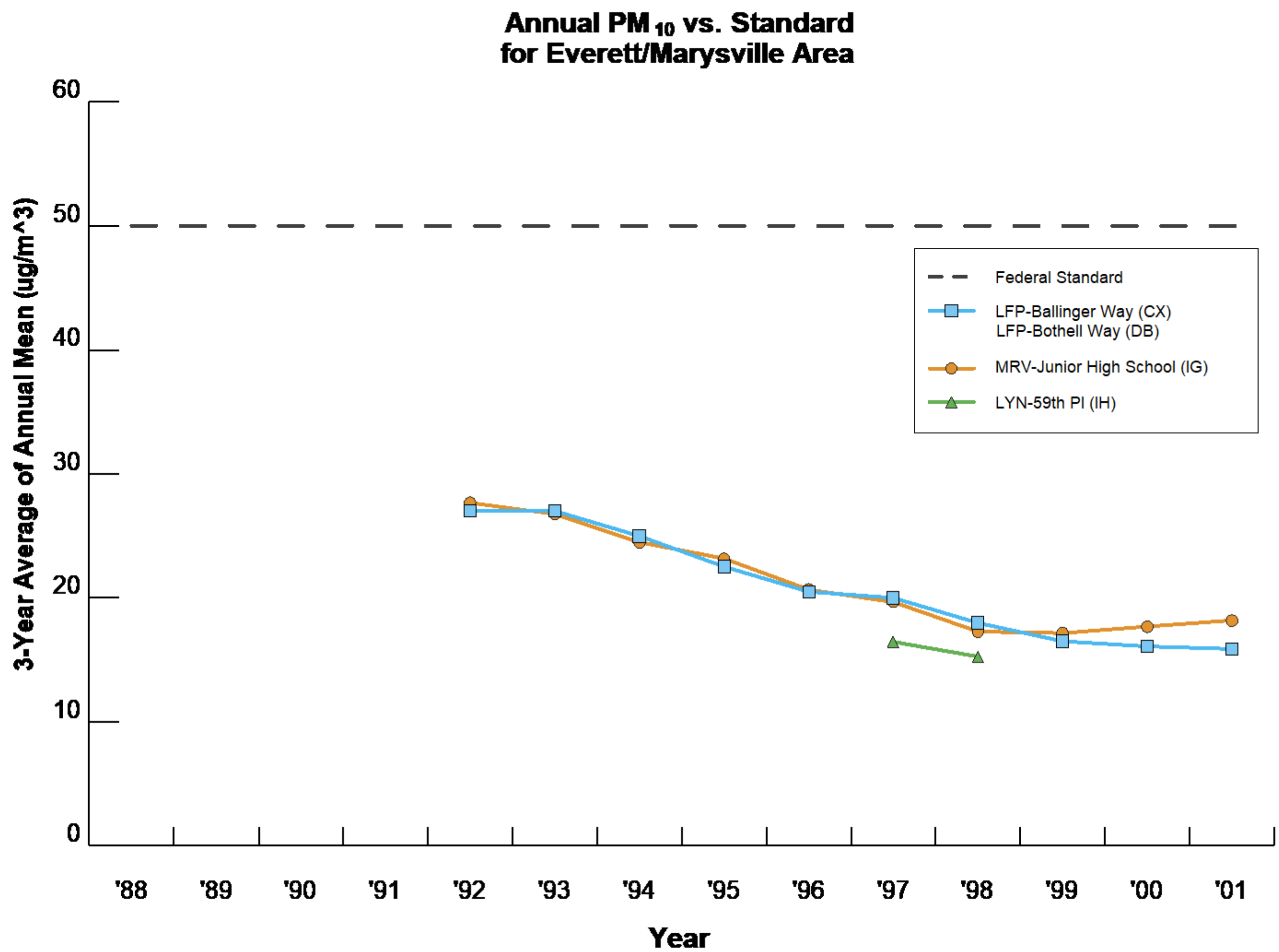
Particulate Matter (10 micrometers)

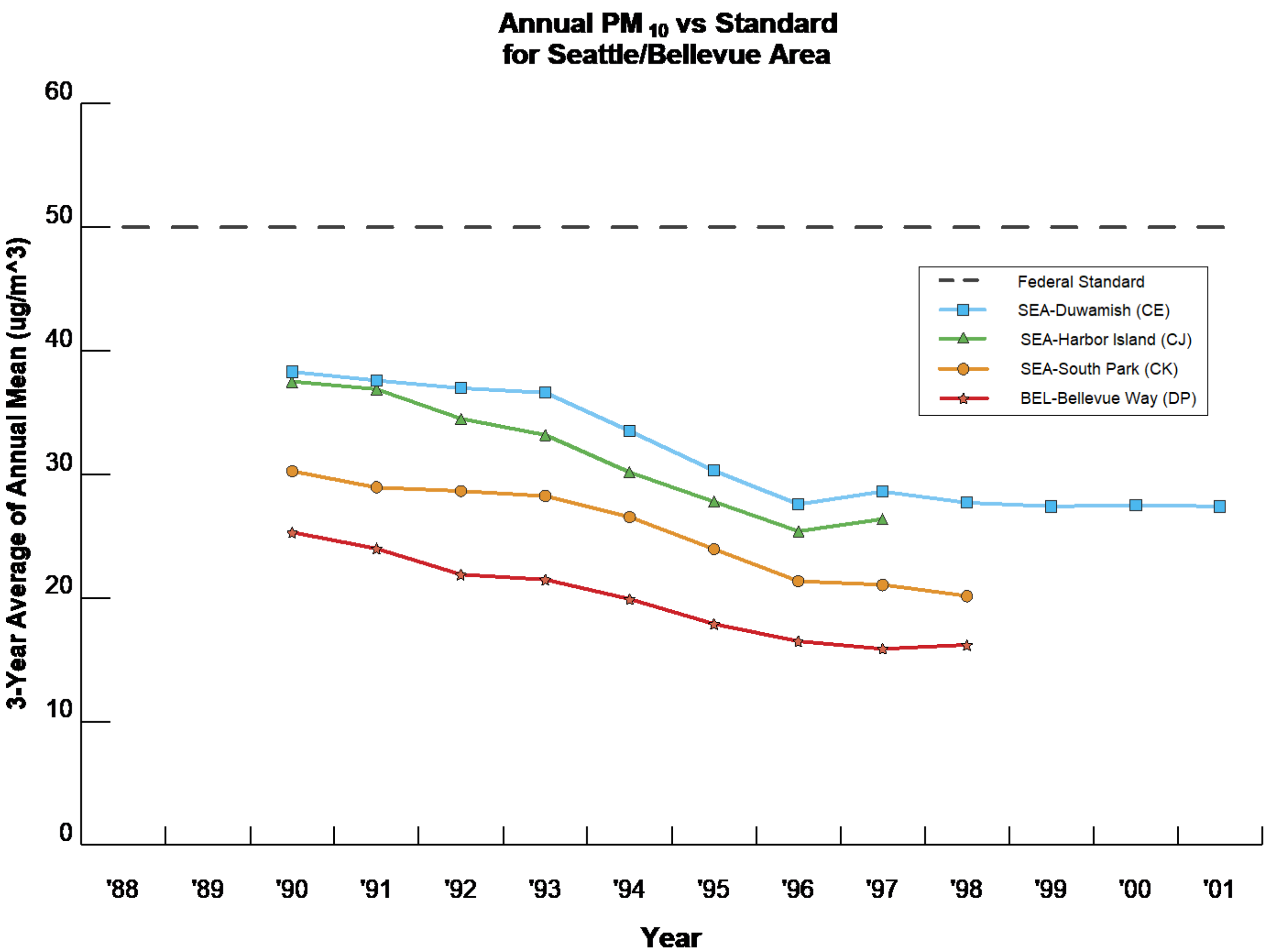
"Particulate matter" (PM) includes both solid matter and liquid droplets suspended in the air. Particles smaller than 2.5 micrometers in diameter are called "fine" particles, or $PM_{2.5}$. Particles between 2.5 and 10 micrometers in diameter are called "coarse" particles. PM_{10} includes both "fine" and "coarse" particles. "Coarse" particles typically come from crushing or grinding operations and dust from roads. PM_{10} can aggravate respiratory conditions such as asthma. If PM_{10} levels are high, people with respiratory conditions should avoid outdoor exertion.

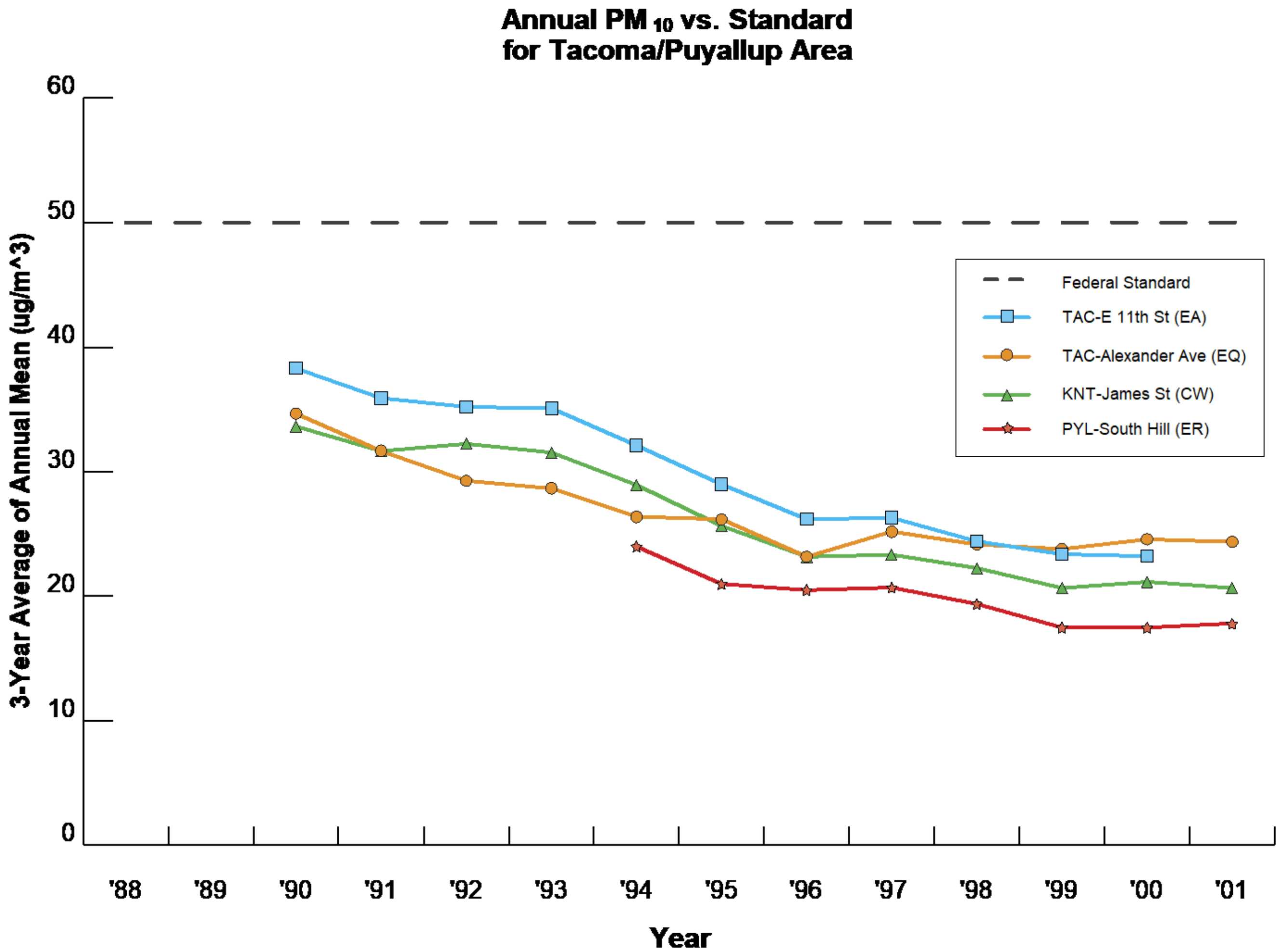
As shown in the charts below, the Puget Sound air shed was in compliance with both standards for PM_{10}. No monitored values exceeded the 50 $\mu g/m^3$ or 150 $\mu g/m^3$ standards. In 2001, the US EPA designated the Puget Sound in attainment for PM_{10}. Annual PM_{10} trends have flattened since 1998, and are well below the 50 $\mu g/m^3$ standard. Consistently, the highest values for annual PM_{10} were measured in the industrial areas of the Duwamish in Seattle (Station CE) and the Tidalflats in Tacoma (Station EQ). The maximum 24-hour PM_{10} value has shown a consistent decrease since 1990 in the majority of the Puget Sound air shed. The exception to this is in the industrial Duwamish section of the Seattle/Bellevue area, where the PM_{10} maximum concentration has remained relatively flat since 1998 at a level of 80 $\mu g/m^3$.

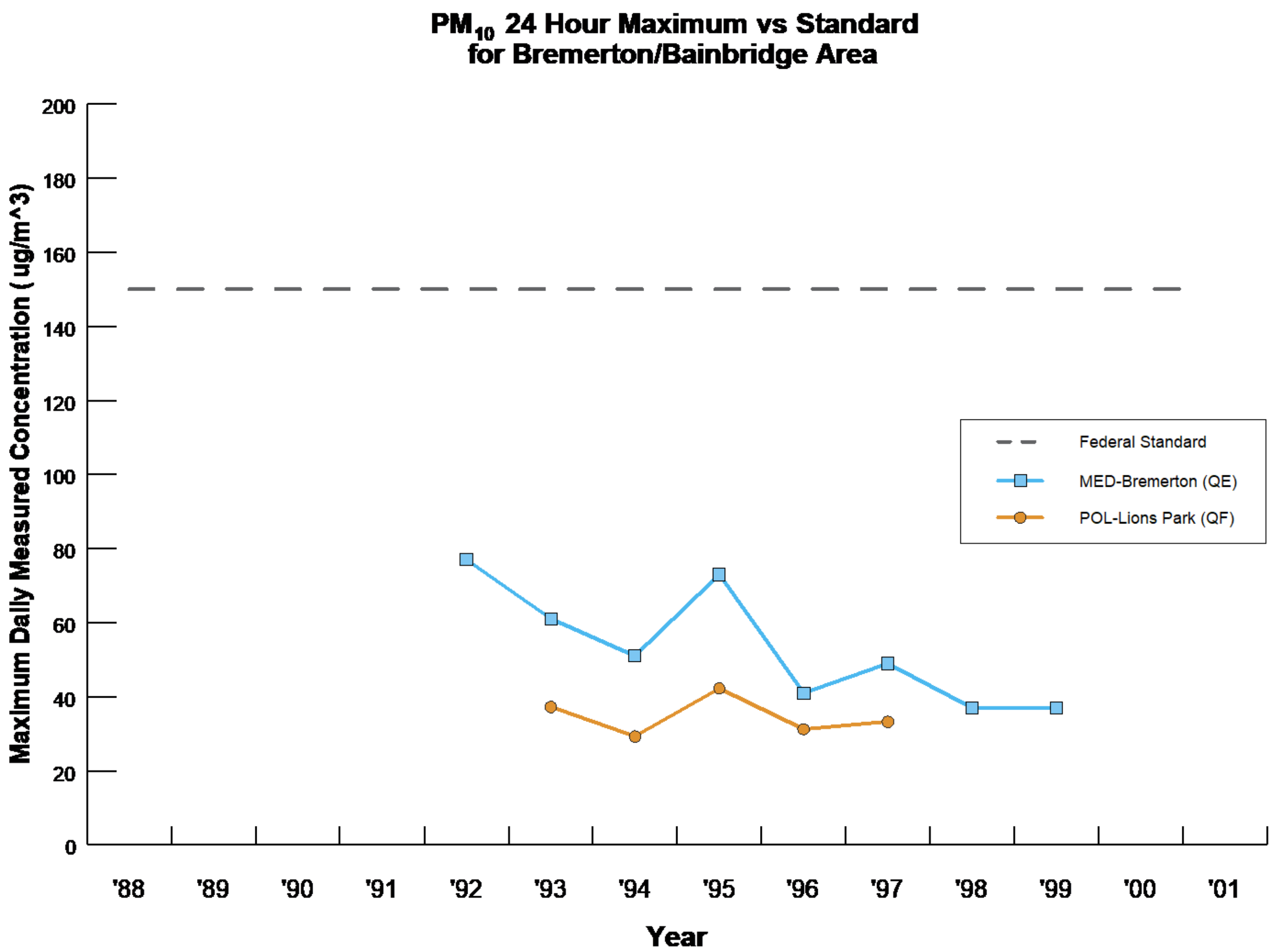
For additional information on PM, visit www.epa.gov/air/urbanair/pm/index.html.


Annual PM10 vs. Standard
for Bremerton/Bainbridge Area
3-Year Average of Annual Mean (ug/m^3)
60
50
40
30
20
10
0
'88
'89
'90
'91
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
Year
Federal Standard
MED-Bremerton (QE)
POL-Lions Park (QF)

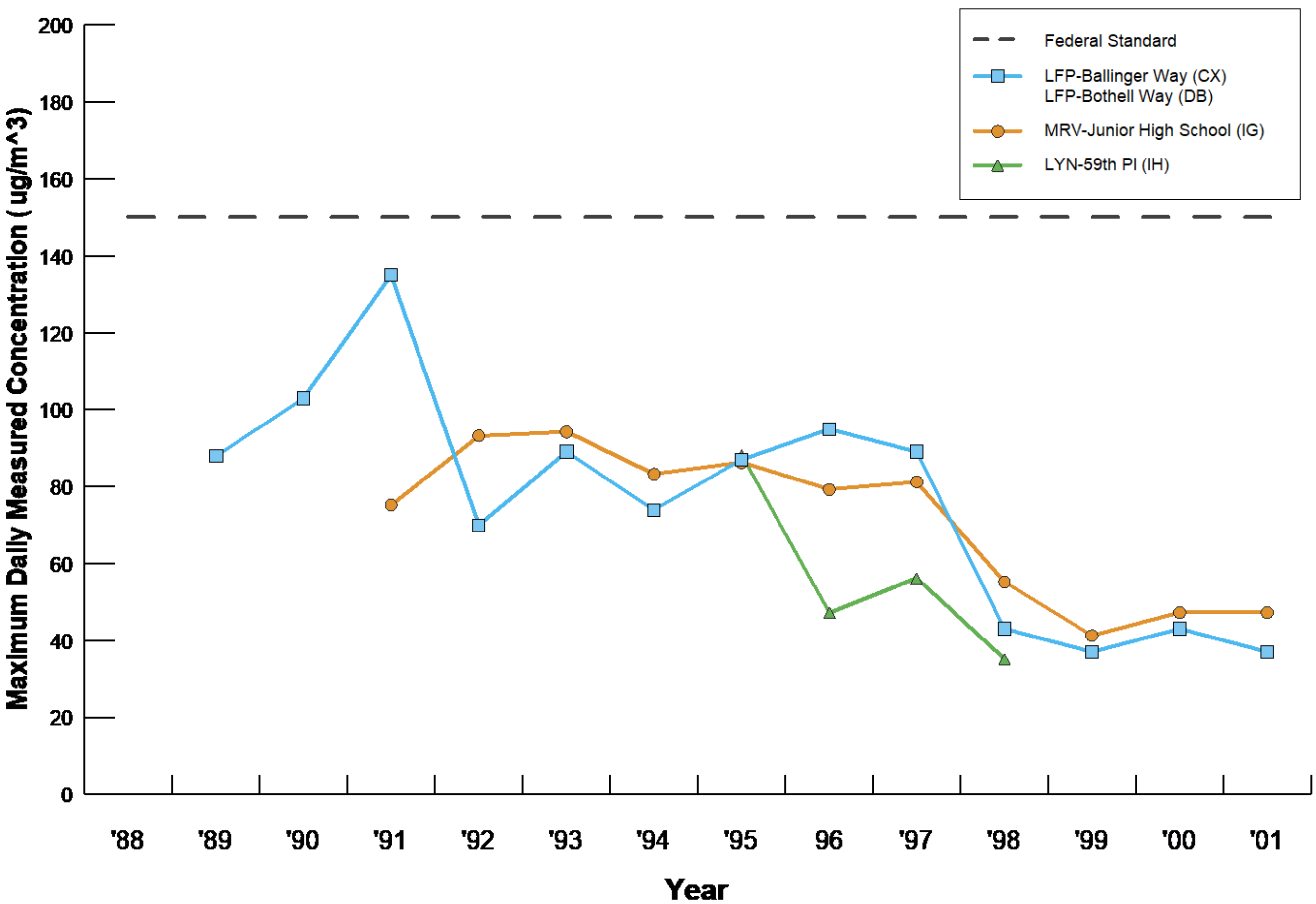

Annual PM10 vs. Standard
for Everett/Marysville Area
3-Year Average of Annual Mean (ug/m^3)
60
50
40
30
20
10
0
Federal Standard
LFP-Ballinger Way (CX)
LFP-Bothell Way (DB)
MRV-Junior High School (IG)
LYN-59th Pl (IH)
'88
'89
'90
'91
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
Year

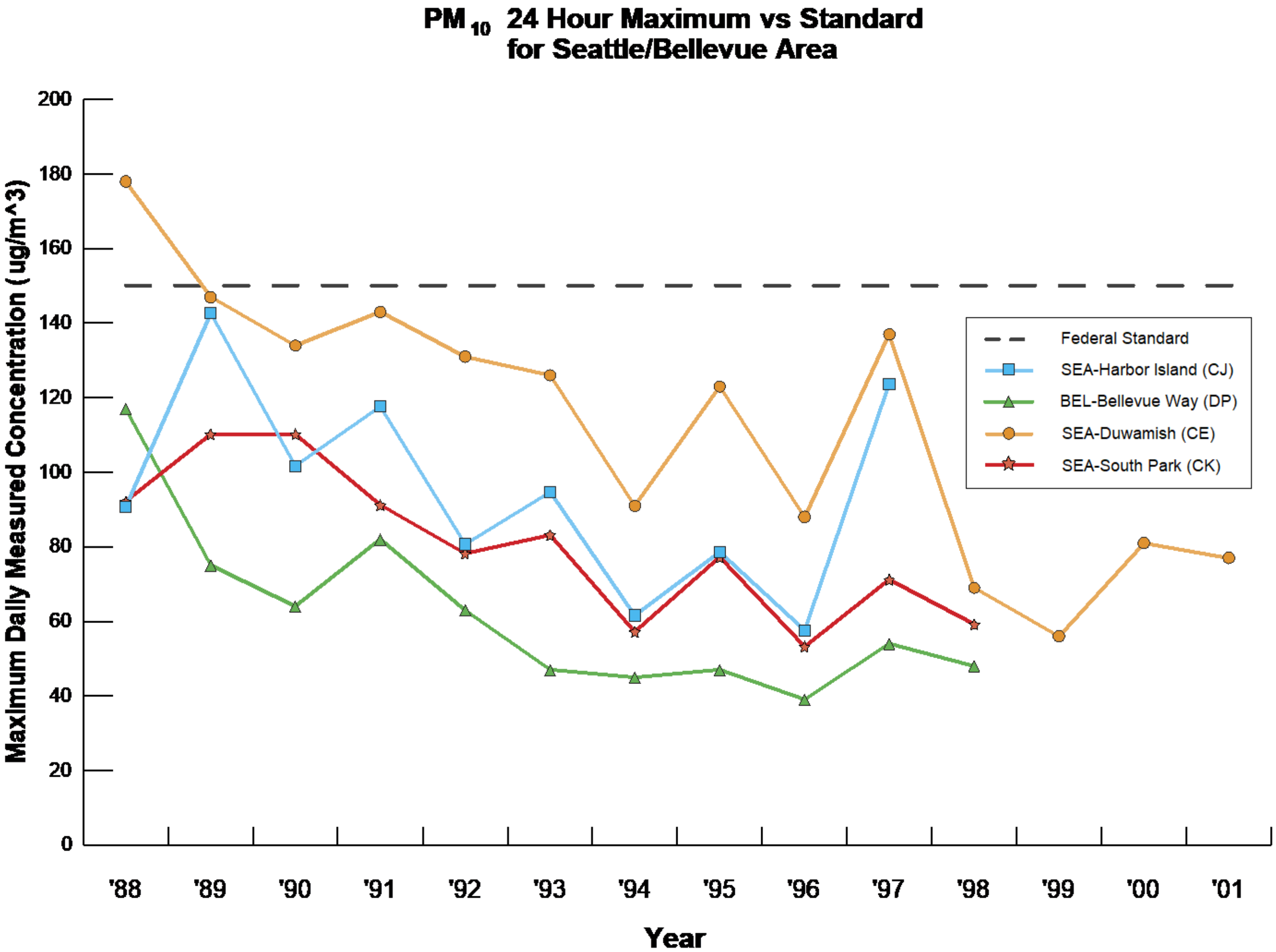

Annual PM 10 vs Standard
for Seattle/Bellevue Area
60
50
40
30
20
10
0
3-Year Average of Annual Mean (ug/m^3)
Federal Standard
SEA-Duwamish (CE)
SEA-Harbor Island (CJ)
SEA-South Park (CK)
BEL-Bellevue Way (DP)
'88
'89
'90
'91
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
Year

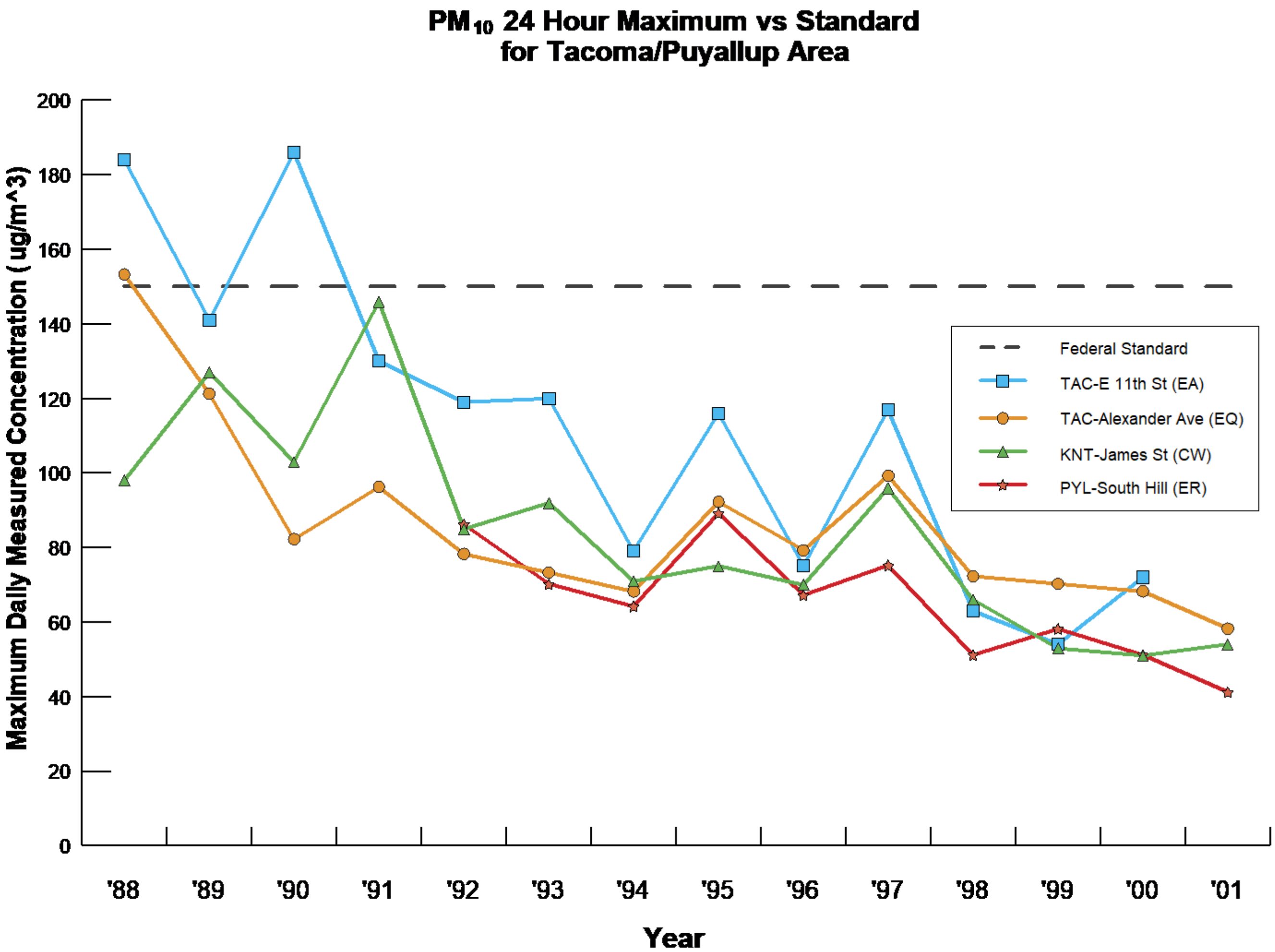

Annual PM 10 vs. Standard
for Tacoma/Puyallup Area
3-Year Average of Annual Mean (ug/m^3)
0
10
20
30
40
50
60
'88
'89
'90
'91
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
Year
Federal Standard
TAC-E 11th St (EA)
TAC-Alexander Ave (EQ)
KNT-James St (CW)
PYL-South Hill (ER)


PM10 24 Hour Maximum vs Standard
for Bremerton/Bainbridge Area
Maximum Daily Measured Concentration (ug/m^3)
200
180
160
140
120
100
80
60
40
20
0
'88
'89
'90
'91
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
Year
Federal Standard
MED-Bremerton (QE)
POL-Lions Park (QF)

PM_{10} 24 Hour Maximum vs Standard for Everett/Marysville Area




PM 10 24 Hour Maximum vs Standard
for Seattle/Bellevue Area
Maximum Daily Measured Concentration (ug/m^3)
200
180
160
140
120
100
80
60
40
20
0
'88
'89
'90
'91
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
Year
Federal Standard
SEA-Harbor Island (CJ)
BEL-Bellevue Way (DP)
SEA-Duwamish (CE)
SEA-South Park (CK)


PM10 24 Hour Maximum vs Standard
for Tacoma/Puyallup Area
Maximum Daily Measured Concentration (ug/m^3)
0
20
40
60
80
100
120
140
160
180
200
'88
'89
'90
'91
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
Year
Federal Standard
TAC-E 11th St (EA)
TAC-Alexander Ave (EQ)
KNT-James St (CW)
PYL-South Hill (ER)

Particulate Matter (2.5 micrometers)

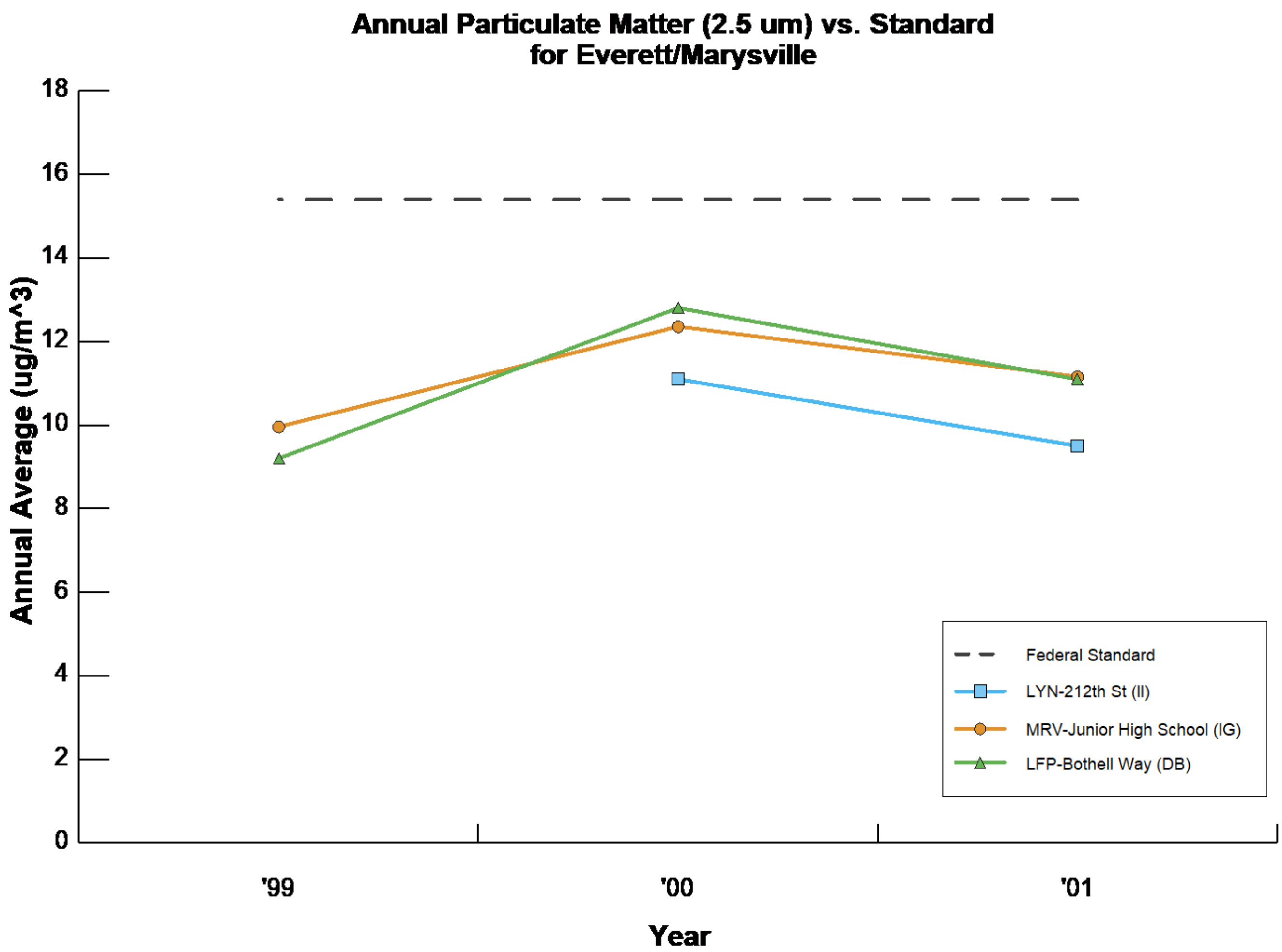
Particles smaller than 2.5 micrometers in diameter are called "fine" particles, or *$PM_{2.5}$*. The Agency considers $PM_{2.5}$ one of the major air pollution concerns affecting our community.

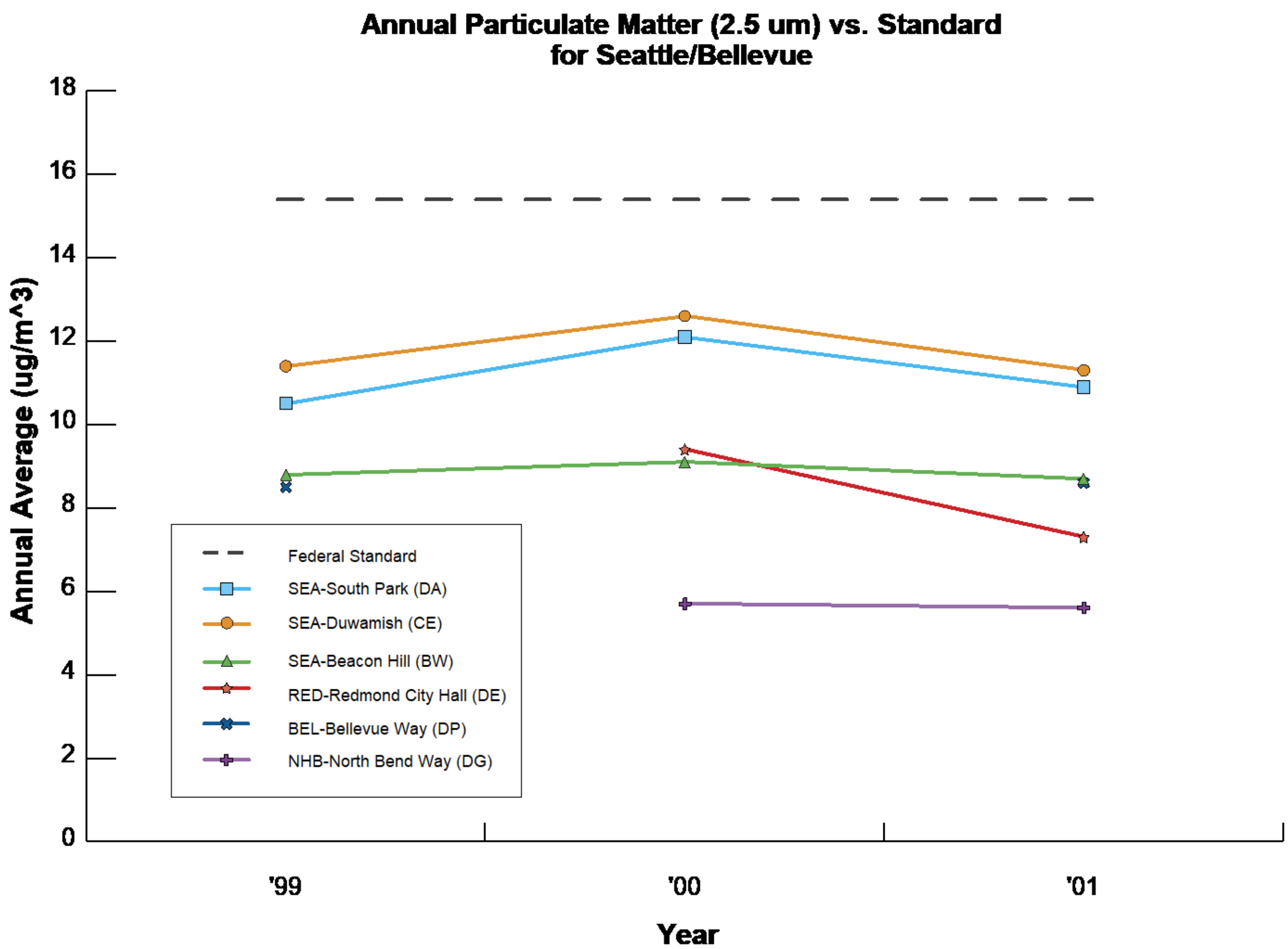
$PM_{2.5}$ generally comes from industrial fuel combustion, vehicle exhaust including cars, diesel trucks and buses, and from wood burning. It can also be formed in the atmosphere by chemical reactions of pollutant gases. $PM_{2.5}$ exposure can have serious health effects. Fine particles are most closely associated with increased respiratory disease, decreased lung function, and even premature death. Children and older adults are more likely to develop heart or lung problems. $PM_{2.5}$ also significantly affects visibility. If $PM_{2.5}$ levels are high, people with respiratory or heart disease, older adults, and children should avoid outdoor exertion.

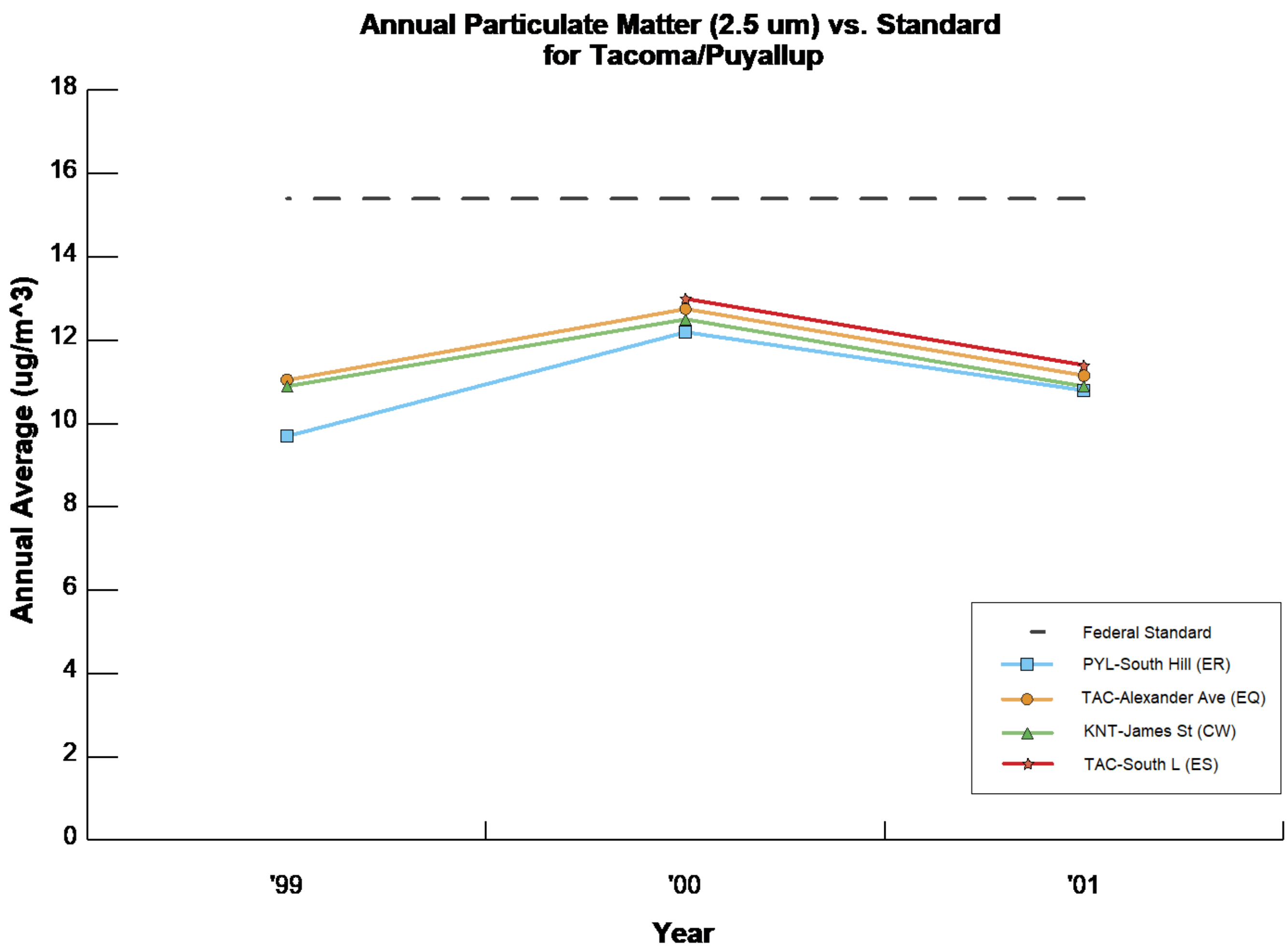
As shown in the charts below, the Puget Sound air shed was in compliance with both standards for $PM_{2.5}$ for the years 1999-2001. The annual standard of 15 $\mu g/m^3$ was not exceeded at any of the monitoring stations. Although the highest $PM_{2.5}$ concentration measured in 2000 (70 $\mu g/m^3$) exceeded the standard, it did not violate the standard. Because of the way the daily $PM_{2.5}$ standard is defined, the 3-year average of the 98^{th} percentile of daily concentrations must not exceed 65 $\mu g/m^3$. In 2000, the 98^{th} percentile was 49 $\mu g/m^3$ (2^{nd} highest concentration), and is the highest 98^{th} percentile of $PM_{2.5}$ measured in the Puget Sound region in 1999-2001. For the 1999 to 2001 period, concentration trends for $PM_{2.5}$ were flat at the 98^{th} percentile of daily levels of 30-50 $\mu g/m^3$ and annual daily levels of 10-12 $\mu g/m^3$.

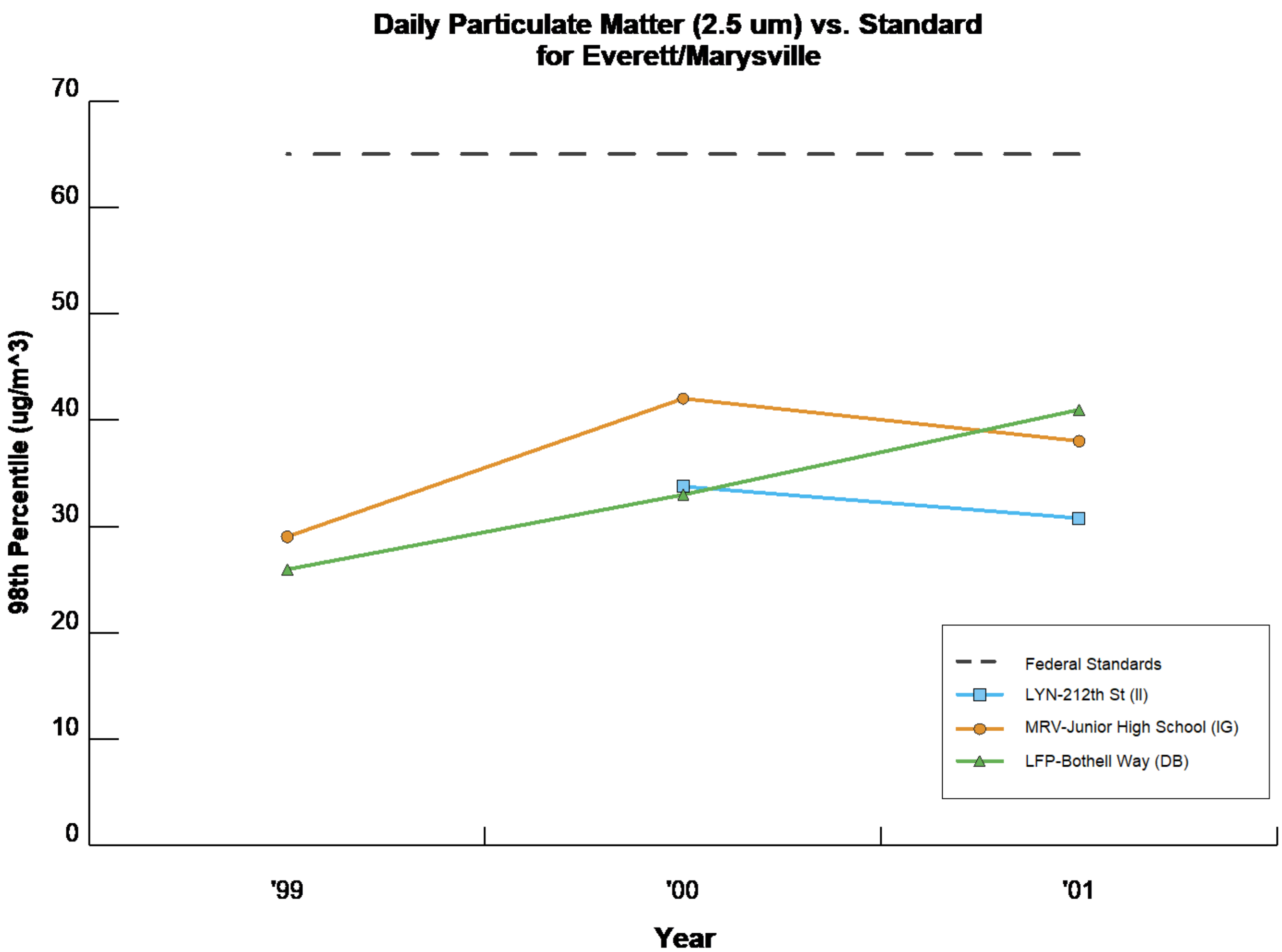
Prior to adoption of the $PM_{2.5}$ reference method standard, the Agency collected $PM_{2.5}$ data using the dichotomous sampler method from the late 1980s through the spring of 2000. The long term trend indicates a gradual downward tendency in $PM_{2.5}$ concentrations. This additional $PM_{2.5}$ data is available by contacting the Agency at 206-689-4006.

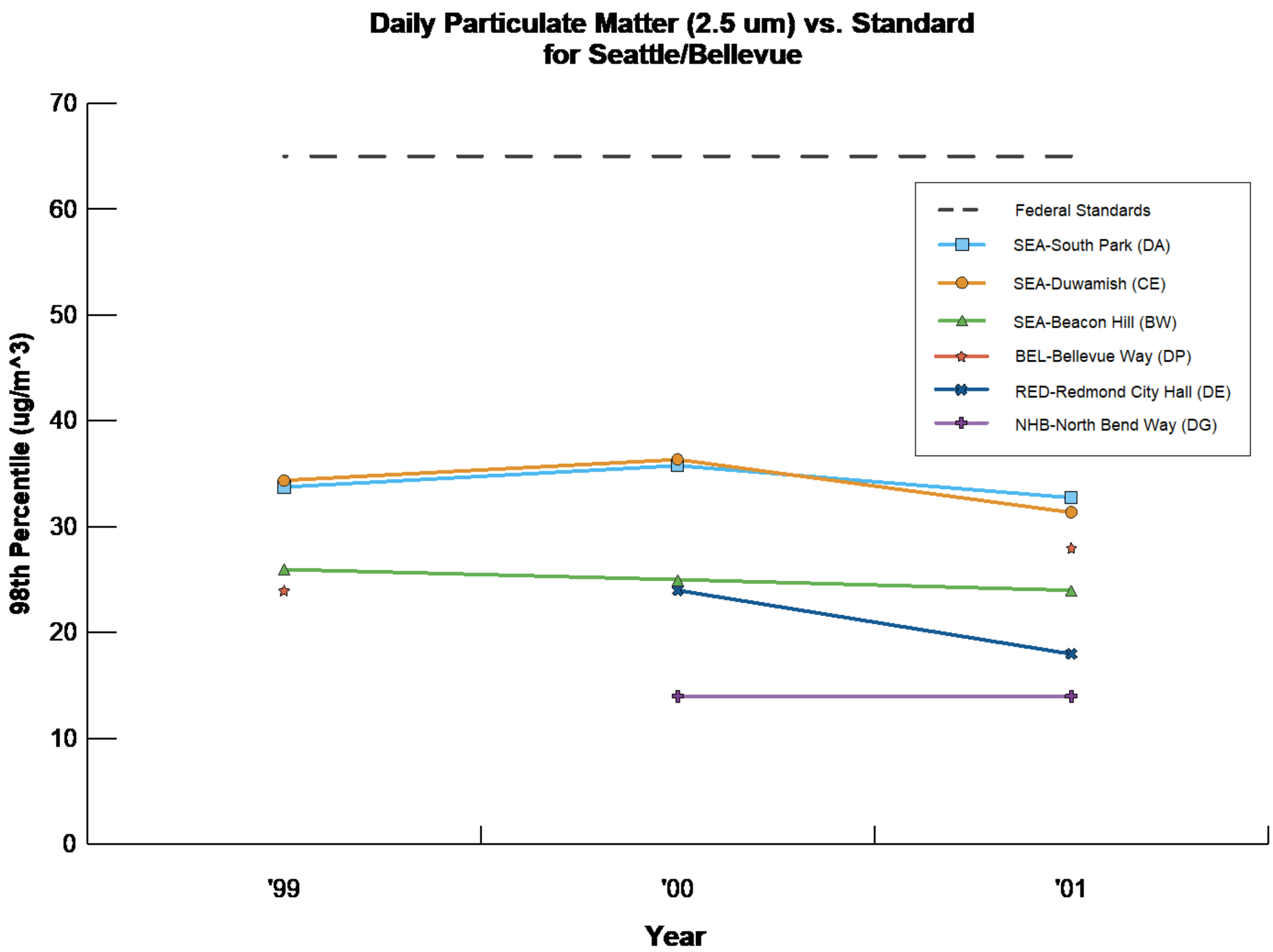
For additional information on PM, visit www.epa.gov/air/urbanair/pm/index.html.

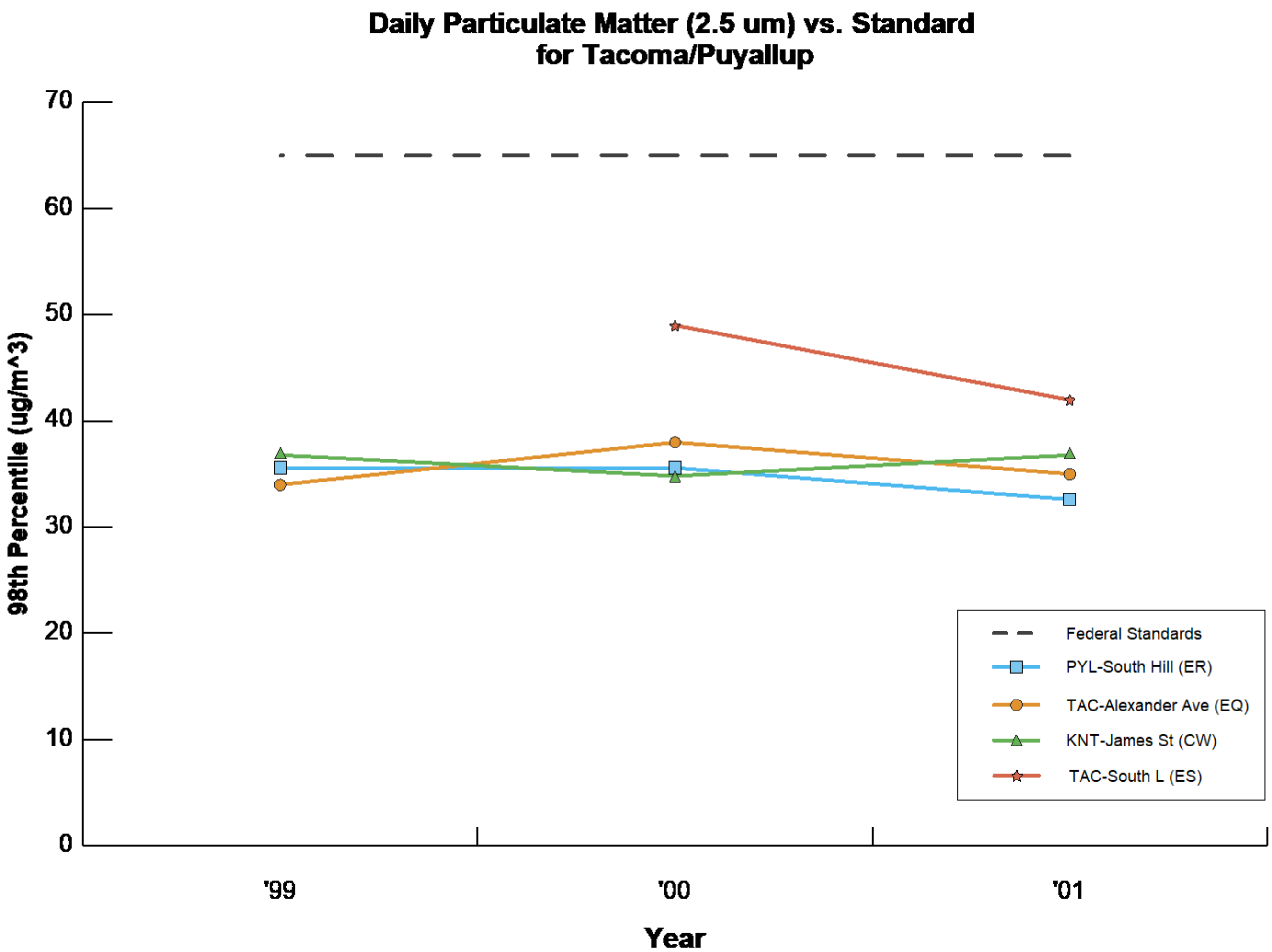

Annual Particulate Matter (2.5 um) vs. Standard
for Everett/Marysville
Annual Average (ug/m^3)
18
16
14
12
10
8
6
4
2
0
'99
'00
'01
Year
Federal Standard
LYN-212th St (II)
MRV-Junior High School (IG)
LFP-Bothell Way (DB)


Annual Particulate Matter (2.5 um) vs. Standard
for Seattle/Bellevue
Annual Average (ug/m^3)
0
2
4
6
8
10
12
14
16
18
'99
'00
'01
Year
Federal Standard
SEA-South Park (DA)
SEA-Duwamish (CE)
SEA-Beacon Hill (BW)
RED-Redmond City Hall (DE)
BEL-Bellevue Way (DP)
NHB-North Bend Way (DG)


Annual Particulate Matter (2.5 um) vs. Standard
for Tacoma/Puyallup
Annual Average (ug/m^3)
18
16
14
12
10
8
6
4
2
0
'99
'00
'01
Year
Federal Standard
PYL-South Hill (ER)
TAC-Alexander Ave (EQ)
KNT-James St (CW)
TAC-South L (ES)


Daily Particulate Matter (2.5 um) vs. Standard
for Everett/Marysville
98th Percentile (ug/m^3)
70
60
50
40
30
20
10
0
'99
'00
'01
Year
Federal Standards
LYN-212th St (II)
MRV-Junior High School (IG)
LFP-Bothell Way (DB)


Daily Particulate Matter (2.5 um) vs. Standard
for Seattle/Bellevue
98th Percentile (ug/m^3)
0
10
20
30
40
50
60
70
'99
'00
'01
Year
Federal Standards
SEA-South Park (DA)
SEA-Duwamish (CE)
SEA-Beacon Hill (BW)
BEL-Bellevue Way (DP)
RED-Redmond City Hall (DE)
NHB-North Bend Way (DG)


Daily Particulate Matter (2.5 um) vs. Standard
for Tacoma/Puyallup
98th Percentile (ug/m^3)
70
60
50
40
30
20
10
0
'99
'00
'01
Year
Federal Standards
PYL-South Hill (ER)
TAC-Alexander Ave (EQ)
KNT-James St (CW)
TAC-South L (ES)

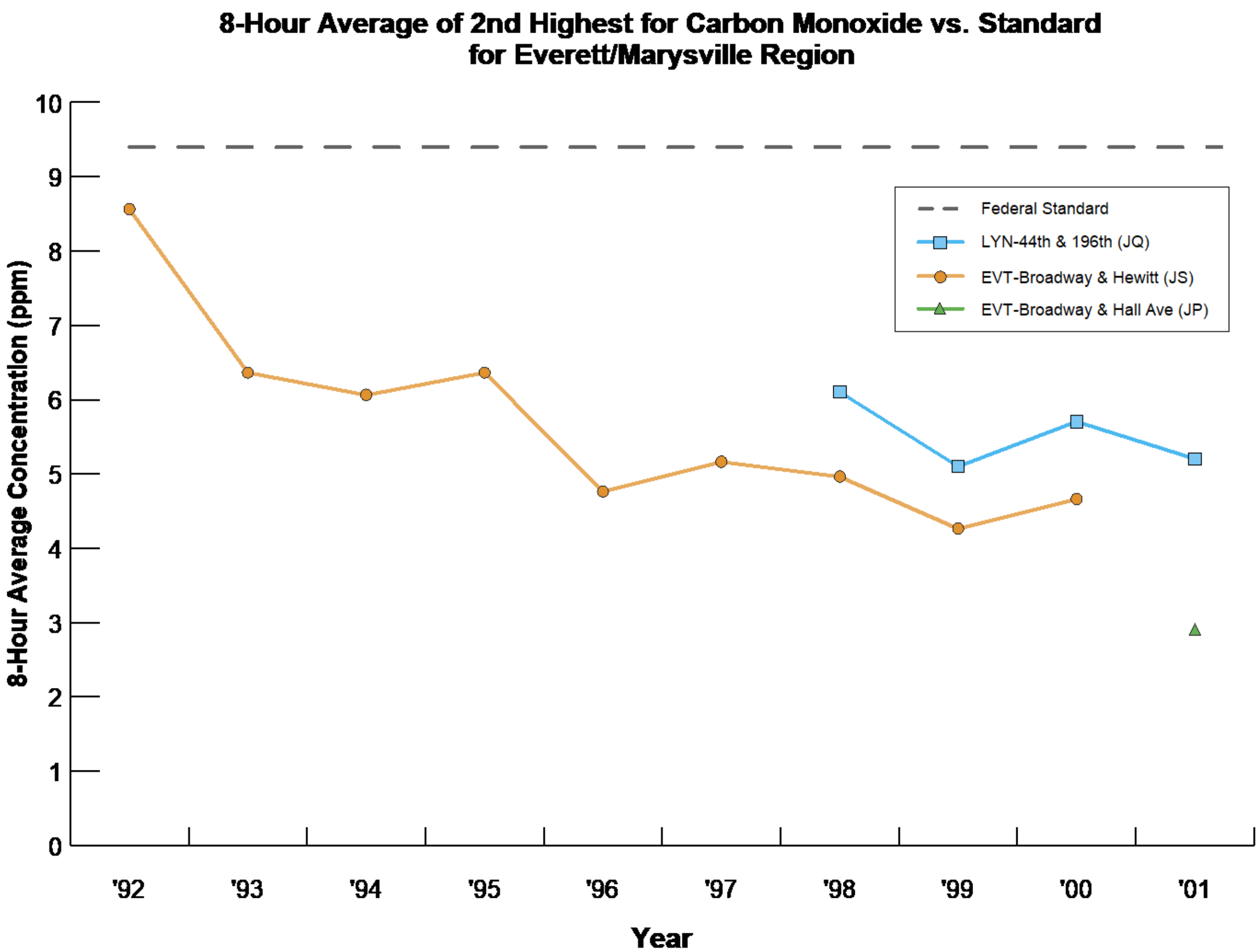
Carbon Monoxide

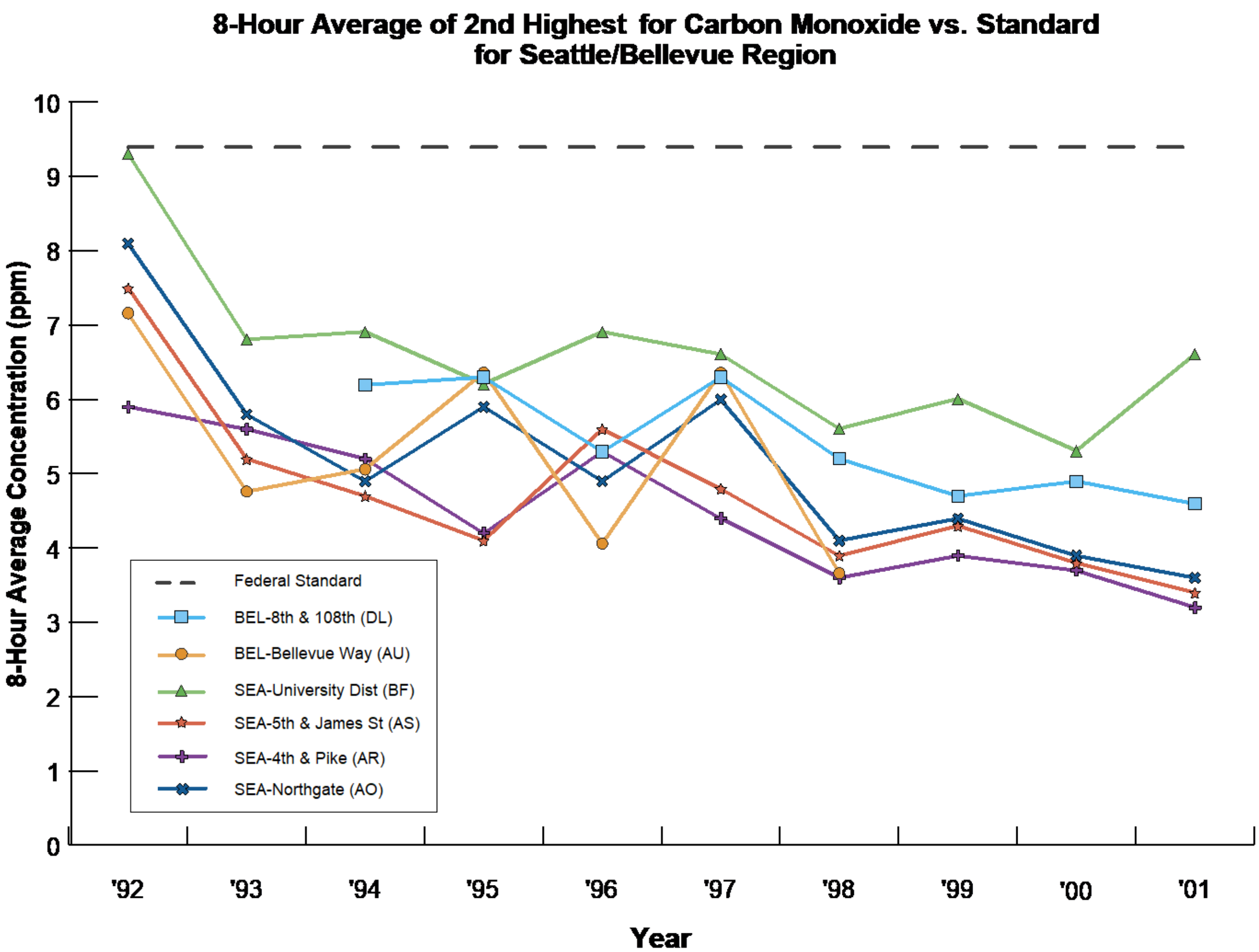
CO is an odorless, colorless gas that can enter the bloodstream through the lungs and reduce the amount of oxygen that reaches organs and tissues. Carbon monoxide forms when the carbon in fuels doesn't burn completely. About 60% of all CO comes from vehicle exhaust. Higher levels of CO generally occur in areas with heavy traffic congestion. In cities, 85 to 95 percent of all CO emissions may come from motor vehicle exhaust. The highest levels of CO in the outside air typically occur during the colder months of the year when temperature inversions are more frequent. People with cardiovascular disease or respiratory problems might experience chest pain and increased cardiovascular symptoms, particularly while exercising. High levels of CO can affect alertness and vision even in healthy individuals. If CO levels are high, limit exertion and avoid sources of CO such as heavy traffic.

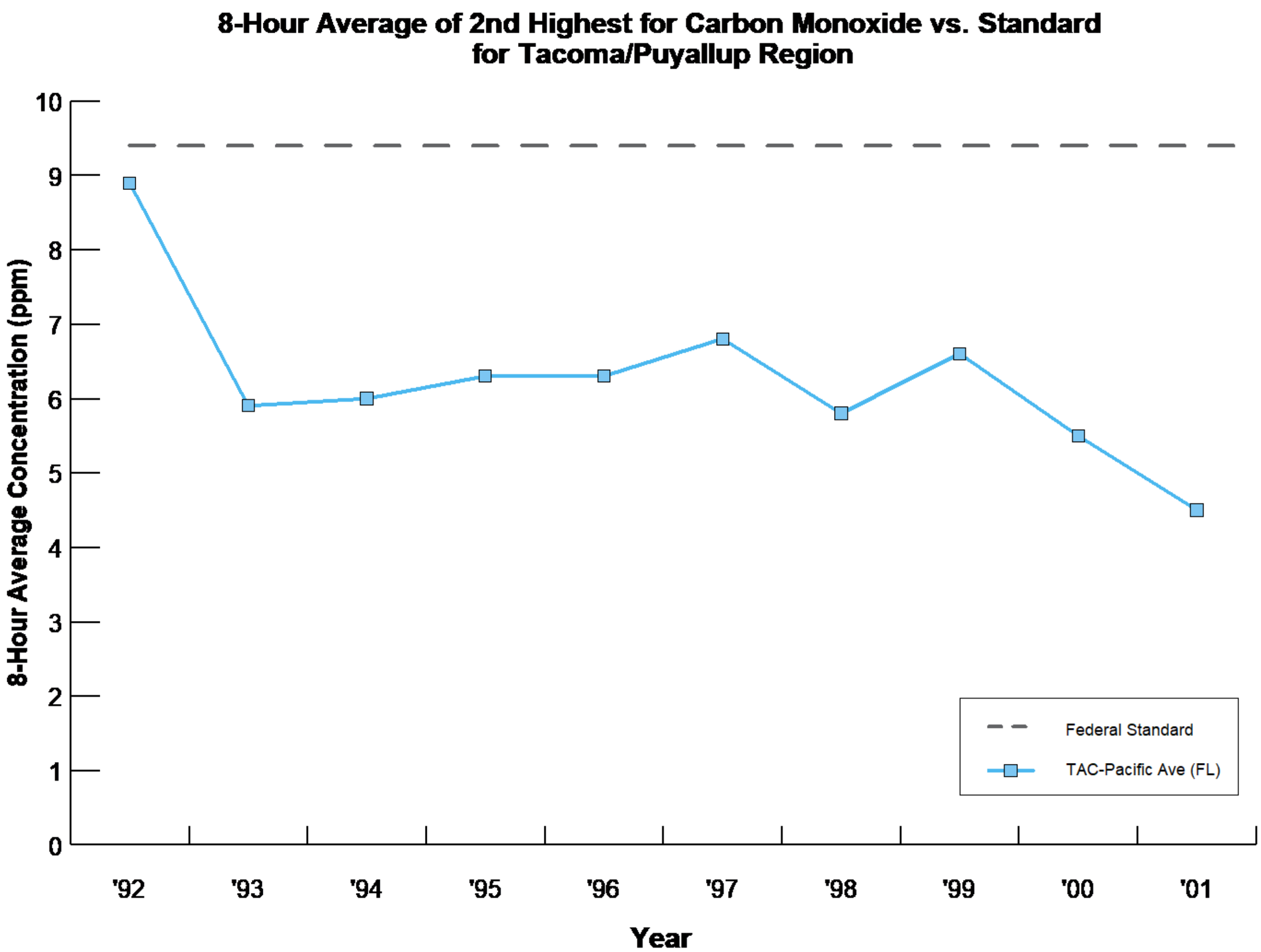
CO monitoring stations are located in areas with heavy traffic congestion. These include central business areas, roadsides, and shopping malls. The Washington Department of Ecology conducts all CO monitoring.

As shown in the charts below, the Puget Sound air shed was in compliance with the 8-hour CO standard for the years 1999 to 2001. Maximum concentrations for CO ranged from 2.8 to 7.5 ppm, well below the 8-hour standard. Because measured 1-hour concentrations are historically much lower than the 35 ppm standard, 1-hour CO trends were not charted. Maximum and second highest measured 1-hour CO are 16.1 and 15.6 ppm in 1999, 10.5 and 8.6 ppm in 2000, and 9.5 and 8.8 ppm in 2001.

For additional information on CO, visit www.epa.gov/air/urbanair/co/index.html.


8-Hour Average of 2nd Highest for Carbon Monoxide vs. Standard
for Everett/Marysville Region
8-Hour Average Concentration (ppm)
Year
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
0
1
2
3
4
5
6
7
8
9
10
Federal Standard
LYN-44th & 196th (JQ)
EVT-Broadway & Hewitt (JS)
EVT-Broadway & Hall Ave (JP)


8-Hour Average of 2nd Highest for Carbon Monoxide vs. Standard
for Seattle/Bellevue Region
8-Hour Average Concentration (ppm)
0
1
2
3
4
5
6
7
8
9
10
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
Year
Federal Standard
BEL-8th & 108th (DL)
BEL-Bellevue Way (AU)
SEA-University Dist (BF)
SEA-5th & James St (AS)
SEA-4th & Pike (AR)
SEA-Northgate (AO)


8-Hour Average of 2nd Highest for Carbon Monoxide vs. Standard
for Tacoma/Puyallup Region
8-Hour Average Concentration (ppm)
10
9
8
7
6
5
4
3
2
1
0
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
Year
Federal Standard
TAC-Pacific Ave (FL)

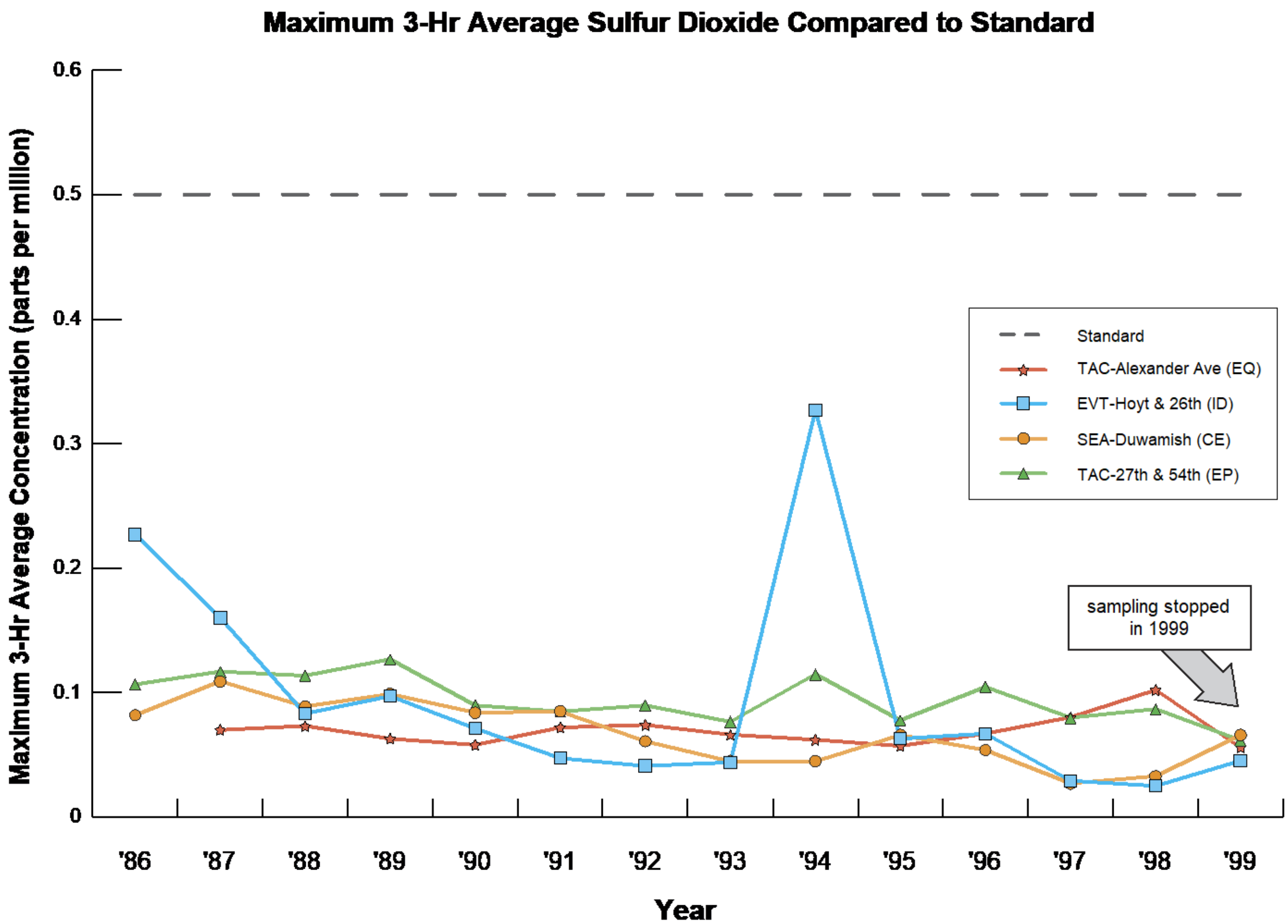
Sulfur Dioxide

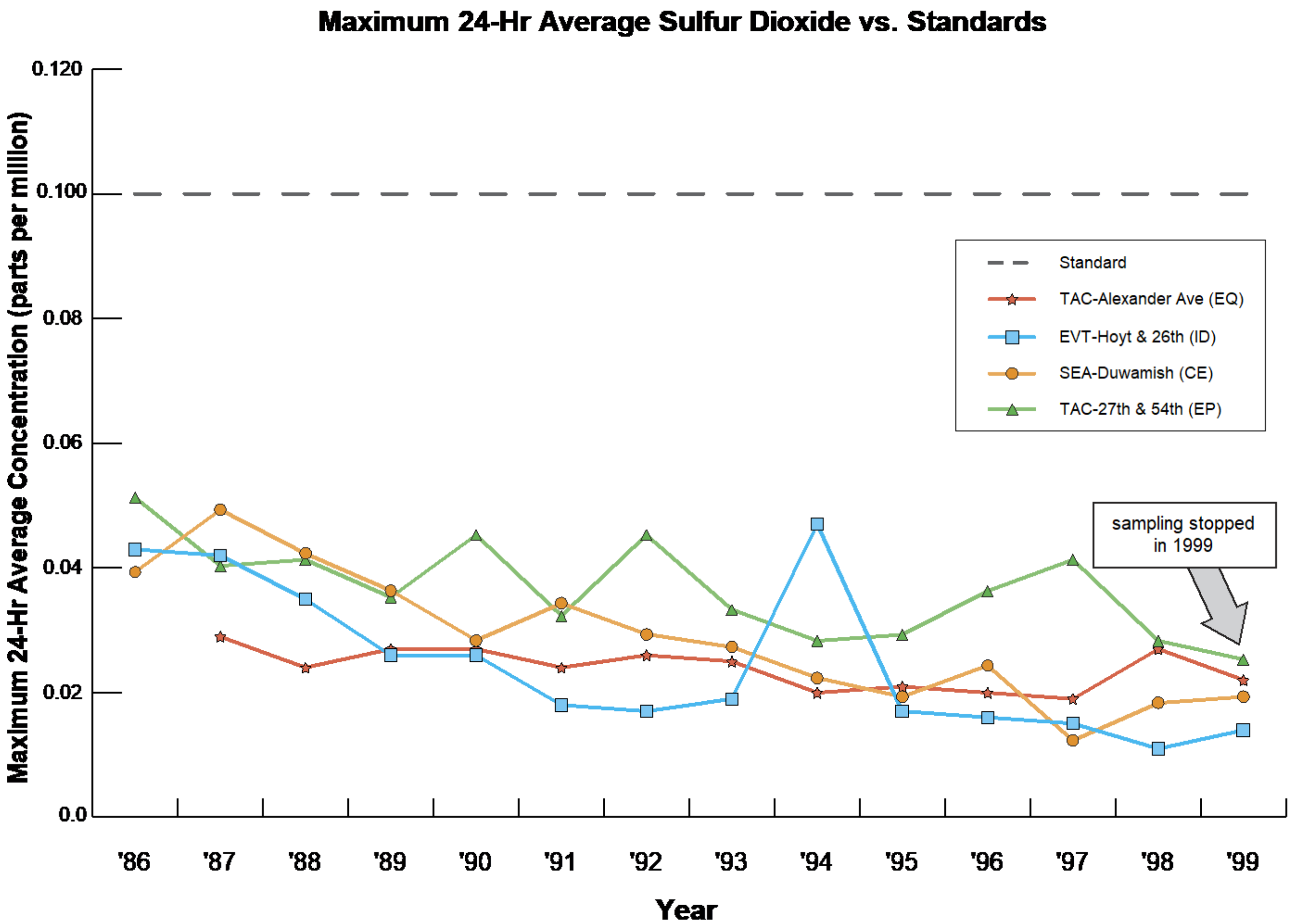
Sulfur dioxide (SO_2) is a colorless, reactive gas produced by burning sulfur-containing fuels such as coal and oil, and by industrial processes. The highest concentrations of SO_2 are usually near industrial facilities that derive their products from raw materials like metallic ore, coal, and crude oil, or that burn coal or oil to produce process heat. Examples are petroleum refineries, cement manufacturing, and metal processing facilities. Also locomotives, large ships, and some non-road diesel equipment currently burn high sulfur fuel and release SO_2 emissions to the air in large quantities.

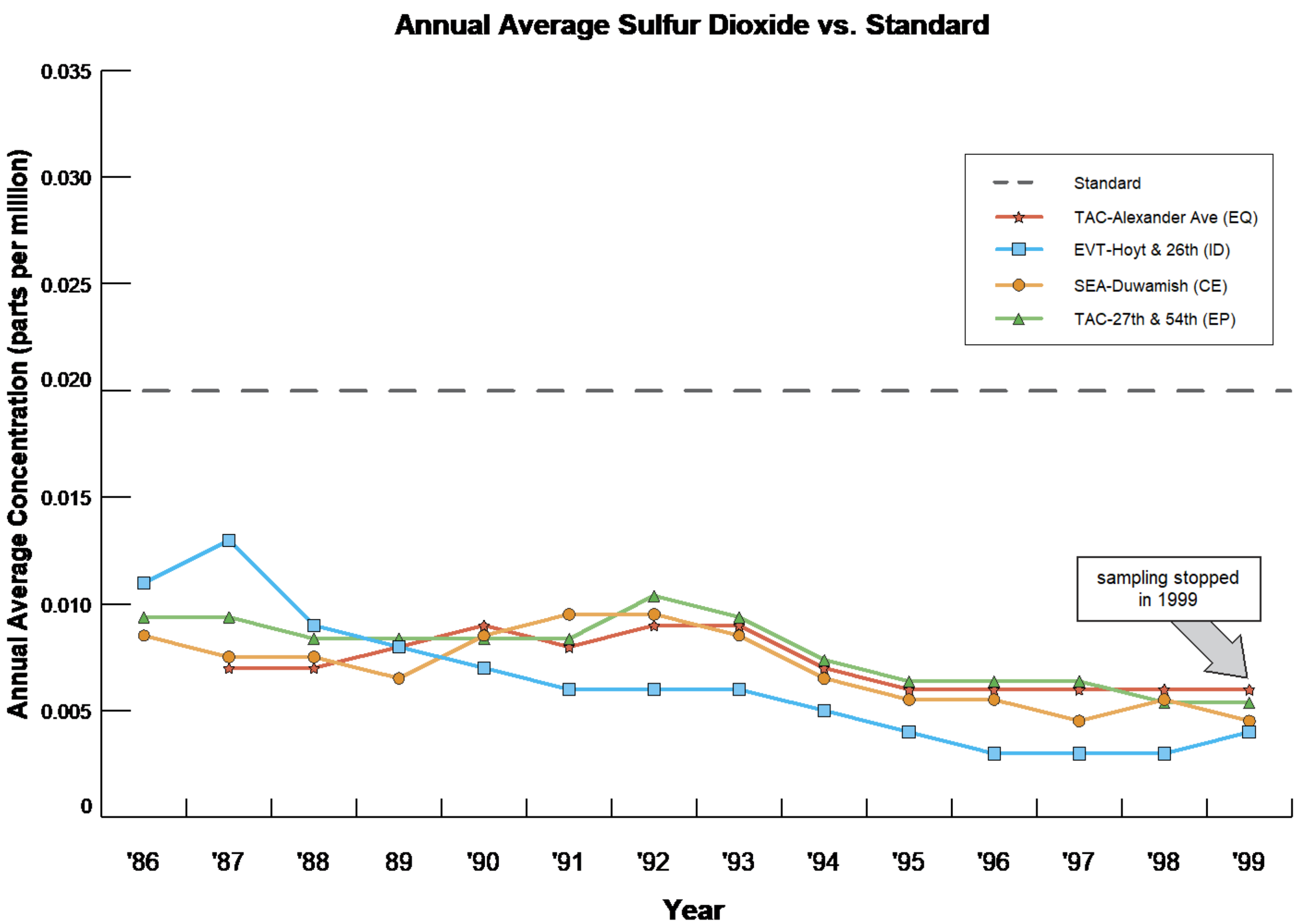
People with asthma who are active outdoors may experience bronchoconstriction, which can cause wheezing, shortness of breath, and tightening of the chest. If SO_2 levels are high, you should limit your outdoor exertion.

Because of the decreased activity of SO_2 sources such as pulp mills, cement plants, and smelters in the Puget Sound area, 1999 was the last year in which SO_2 was measured by the Puget Sound Clean Air Agency. Since May of 2000, the Department of Ecology monitors for SO_2 at their Beacon Hill site.

For additional information on SO_2, visit www.epa.gov/air/urbanair/so2/index.html.


Maximum 3-Hr Average Sulfur Dioxide Compared to Standard
Maximum 3-Hr Average Concentration (parts per million)
0.6
0.5
0.4
0.3
0.2
0.1
0
'86
'87
'88
'89
'90
'91
'92
'93
'94
'95
'96
'97
'98
'99
Year
Standard
TAC-Alexander Ave (EQ)
EVT-Hoyt & 26th (ID)
SEA-Duwamish (CE)
TAC-27th & 54th (EP)
sampling stopped in 1999


Maximum 24-Hr Average Sulfur Dioxide vs. Standards
Maximum 24-Hr Average Concentration (parts per million)
0.120
0.100
0.08
0.06
0.04
0.02
0.0
Standard
TAC-Alexander Ave (EQ)
EVT-Hoyt & 26th (ID)
SEA-Duwamish (CE)
TAC-27th & 54th (EP)
sampling stopped
in 1999
'86
'87
'88
'89
'90
'91
'92
'93
'94
'95
'96
'97
'98
'99
Year


Annual Average Sulfur Dioxide vs. Standard
Annual Average Concentration (parts per million)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0
'86
'87
'88
89
'90
'91
'92
'93
'94
'95
'96
'97
'98
'99
Year
Standard
TAC-Alexander Ave (EQ)
EVT-Hoyt & 26th (ID)
SEA-Duwamish (CE)
TAC-27th & 54th (EP)
sampling stopped in 1999

Lead

Lead is a highly toxic metal that was used for many years in household products, automobile fuel, and industrial chemicals. Locally, airborne lead was associated primarily with automobile exhaust and lead smelters. The large reductions in lead emissions from motor vehicles have changed the nature of the air quality lead problem in the United States. Industrial processes, particularly primary and secondary lead smelters and battery manufacturers, are now responsible for most of the lead emissions.

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

Lead has not been monitored in the Puget Sound area since 1998. Since the phase-out of lead in fuel and the closure of the Harbor Island lead smelter, airborne lead is no longer a public health concern in the region.

For additional information on lead, visit www.epa.gov/air/urbanair/lead/index.html.

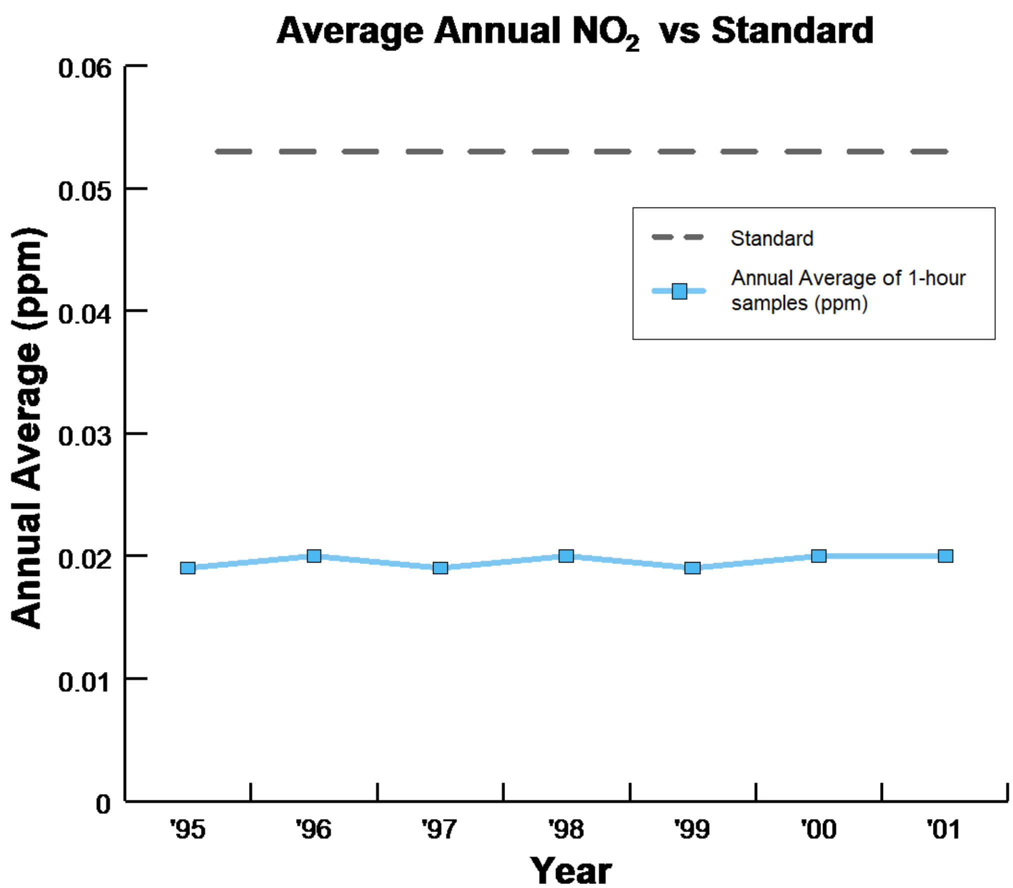
Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a reddish brown, highly reactive gas that forms from the reaction of nitrogen oxide (NO) and oxygen in the atmosphere. NO_2 will react with VOCs and can result in the formation of ozone. High temperature combustion sources such as industrial furnaces and boilers, trucks and automobiles are major producers of NO. Home heaters and gas stoves can also produce NO. NO_2 pollution is greatest in cold weather.

NO_2 can cause respiratory symptoms such as coughing, wheezing, and shortness of breath in people with respiratory diseases such as asthma. Long-term exposure can lead to respiratory infections.

Since the 1970s, motor vehicle manufacturers have been required to reduce NO_X emissions from cars and trucks. It is not a significant pollution problem in the Puget Sound area. The Department of Ecology maintains one monitoring site for nitrogen dioxide within the Puget Sound air shed, at Beacon Hill. The annual average for each year has consistently been less than half of the NAAQS standard.

For additional information on NO_2, visit www.epa.gov/air/urbanair/nox/index.html.



Definitions

Air Quality Index (AQI)

The AQI is a nationwide standard developed by the U.S. EPA to report daily air quality. Air quality is reported according to a 500-point scale for each of five major air pollutants. The scale breaks down into six categories:

- **0-50: Good.** Satisfactory air quality; little or no risk from pollution.
- **51 to 100: Moderate.** Acceptable air quality; potential moderate health concerns for a very small number of people.
- **101 to 150: Unhealthy for Sensitive Groups.** Air quality is acceptable for the general public, but people with health conditions that make them sensitive to a particular pollutant are at greater risk of health problems.
- **151 to 200: Unhealthy.** Everyone may experience some health effects, more serious for members of sensitive groups.
- **201 to 300: Very Unhealthy.** Everyone may experience more serious health effects.
- **301 to 500: Hazardous.** Health risk is at emergency levels. Everyone is likely to be affected.

A network of monitoring stations measures air quality in the Puget Sound, and an AQI value is assigned to each of the major pollutants. The highest value of the individual pollutant becomes the AQI value. For example, if an area has a carbon monoxide value of 132 on a given day and all other pollutants were below 50, the AQI for that day would be 132. The table on the next page shows a detailed breakdown of the AQI measurements for each measured pollutant.

In metropolitan areas with more than 350,000 people, state and local agencies report the AQI to the public daily. If the AQI is over 100, they also report which groups may be at risk. The AQI is a national index, so the values and colors used to show local air quality and the associated level of health concern will be the same everywhere you go in the U.S.A. Look for the reported AQI in your local newspaper, on television and radio, on the Internet, and on state and local telephone hotlines.

For more detailed information about the AQI and the pollutants it measures, go to www.epa.gov/airnow/aqibroch.

How the AQI Is Calculated

Breakpoints for Criteria Pollutants							AQI Categories	
0_3 (ppm) 8-hour	0_3 (ppm) 1-hour[a]	$PM_{2.5}$ (µg/m^3)	PM_{10} (µg/m^3)	CO (ppm)	SO_2 (ppm)	NO_2 (ppm)	AQI value	Category
0.000–0.064	—	0.0–15.4	0–54	0.0–4.4	0.000–0.034	(b)	0–50	Good
0.065–0.084	—	15.5–40.4	55–154	4.5–9.4	0.035–0.144	(b)	51–100	Moderate
0.085–0.104	0.125–0.164	40.5–65.4	155–254	9.5–12.4	0.145–0.224	(b)	101–150	Unhealthy for sensitive groups
0.105–0.124	0.165–0.204	65.5–150.4	255–354	12.5–15.4	0.225–0.304	(b)	151–200	Unhealthy
0.125–0.374	0.205–0.404	150.5–250.4	355–424	15.5–30.4	0.305–0.604	0.65–1.24	201–300	Very unhealthy
(c)	0.405–0.504	250.5–350.4	425–504	30.5–40.4	0.605–0.804	1.25–1.64	301–400	Hazardous
(c)	0.505–0.604	350.4–500.4	505–604	40.5–50.4	0.805–1.004	1.65–2.04	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 NO_2 has no short-term National Ambient Air Quality Standard (NAAQS) and can generate an AQI only above a value of 200.

c 8-hour O_3 values do not define higher AQI values (above 300). AQI values above 300 are calculated with 1-hour 0_3 concentrations.

Pollutants

Ozone (O_3)

- **What is it?**
Ozone, a bluish-colored gas molecule with a strong odor, is composed of three atoms of oxygen. In the upper atmosphere ozone occurs naturally and partially absorbs the sun's harmful ultraviolet rays. Ozone at ground level is a summertime air pollution problem.

- **How is it caused?**
Ozone forms when photo-chemical pollutants from cars, trucks and industrial sources react with sunlight. Even gasoline-powered yard equipment, paints, solvents, and boat motors contribute.

- **When does it happen?**
Ozone pollution is most common in the summer months, when sunlight and stable atmospheric conditions occur. Ozone levels are usually highest in the afternoon, as sunlight photochemically transforms NO_x and VOCs into ozone.

- **Who is affected?**
Adults and children who are active outdoors, people with respiratory disease such as asthma, and people with unusual sensitivity to ozone. During physical activity, ozone penetrates deeper into the lungs and can do more damage.

  Ozone is a very reactive gas. For this reason, high concentrations of ozone can cause respiratory distress and disease in humans, decreased yields of agricultural crops and forests, and damage to some rubber products, plastics, and paints used outdoors. National crop losses from ozone exposure are estimated at $3 billion to $5 billion annually. Forest losses are harder to estimate.

- **What are the health effects?**
Ozone can cause coughing and throat irritation, make deep vigorous breathing more difficult, and increase the chance of respiratory infections. It increases sensitivity to allergens and can trigger asthma attacks. The damage it causes to the lungs heals within a few days, but repeated or prolonged exposure may cause permanent damage.

- **What can I do about it?**
If ozone levels are high and you have a respiratory condition or are normally active outdoors, try to limit your outdoor exertion.

  In the United States, management of ozone and other photochemical oxidants has been a major goal of federal and state clean air legislation (Clean Air Act). Although many of the pollution control efforts required by the CAA have been implemented, efforts to decrease ozone pollution have been only partially successful.

  In the Puget Sound region the ozone trend is flat and is marginally within the Federal standards.

- **Where is it measured?**
  Unlike other pollutants monitored here in the Puget Sound, ozone is formed by precursors that react in the atmosphere. Winds transport ozone and chemical emissions from one area to another. For the Puget Sound, ozone precursors are emitted into the air in industrial areas of the Everett-Seattle-Tacoma urban corridor and subsequently travel southeasterly to more rural areas as they react to form ozone. The highest concentrations are measured downwind in areas such as North Bend, Enumclaw, and Eatonville. As a result, for the Puget Sound air shed the majority of sites that measure ozone are located in rural areas south to southeast of Seattle and Tacoma. See the map of the Puget Sound measuring locations. The Department of Ecology maintains all ozone-monitoring stations.

For additional information on ozone, visit www.epa.gov/air/urbanair/ozone/index.html.

Particulate Matter ($PM_{2.5}$ and PM_{10})

- **What is it?**
  "Particulate matter" (PM) includes both solid matter and liquid droplets suspended in the air. Particles smaller than 2.5 micrometers in diameter are called "fine" particles, or $PM_{2.5}$. Particles between 2.5 and 10 micrometers in diameter are called "coarse" particles. PM_{10} includes both "fine" and "coarse" particles. The Agency considers $PM_{2.5}$ one of the major air pollution concerns affecting our community.

- **How is it caused?**
  - $PM_{2.5}$ comes from all types of combustion, including cars, power plants, and wood burning, and from some industrial processes. It can also be formed in the atmosphere by chemical reactions of pollutant gases.
  - The "coarse" particles in PM_{10} typically come from crushing or grinding operations and dust from roads.

- **When does it happen?**
  Any time.

- **Who is affected?**
  People with asthma and heart or lung diseases, the elderly, and children. $PM_{2.5}$ also significantly affects visibility.

- **What are the health effects?**
  Fine particulates ($PM_{2.5}$) pose a greater risk to human health than coarse particulates, because they penetrate deeper into the respiratory system.
  - $PM_{2.5}$ exposure can have serious health effects. People with heart or lung diseases are at increased risk of attacks or premature death. Children and the elderly are more likely to develop heart or lung problems.
  - PM_{10} can aggravate respiratory conditions such as asthma.

- **What can I do about it?**
  - If $PM_{2.5}$ levels are high, people with respiratory or heart disease, the elderly, and children should avoid outdoor exertion.

- If PM_{10} levels are high, people with respiratory conditions should avoid outdoor exertion.

- **Where is it measured?**
Due to the health risks associated with PM, both $PM_{2.5}$ and PM_{10} are monitored throughout the Puget Sound. The majority of PM monitoring stations is maintained by the Agency.

For additional information on PM, visit www.epa.gov/air/urbanair/pm/index.html.

Carbon Monoxide (CO)

- **What is it?**
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.

- **How is it caused?**
Carbon monoxide forms when the carbon in fuels doesn't burn completely. 60% of all CO comes from vehicle exhaust, and up to 95% in cities.

- **When does it happen?**
CO pollution is worst in cold weather because fuels burn less efficiently in low temperatures. It is usually at its peak during morning and evening rush hours.

- **Who is affected?**
People with cardiovascular disease, such as angina, or cardiovascular or respiratory problems; also possibly fetuses and young infants.

- **What are the health effects?**
Chest pain and increased cardiovascular symptoms, particularly while exercising. High levels of CO can affect alertness and vision even in healthy individuals.

- **What can I do about it?**
If CO levels are high, limit exertion and avoid sources of CO such as heavy traffic.

- **Where is it measured?**
CO monitoring stations are located in areas with heavy traffic congestion. These include central business areas, roadsides, and shopping malls. Department of Ecology conducts all CO monitoring.

For additional information on CO, visit www.epa.gov/air/urbanair/co/index.html.

Sulfur Dioxide (SO_2)

- **What is it?**
Sulfur dioxide is a colorless, reactive gas.

- **How is it caused?**
SO_2 is produced by burning sulfur-containing fuels such as coal and oil, and by industrial processes.

- **Where does it happen?**
The highest concentrations of SO_2 are usually near large industrial sources.

- **Who is affected?**
  People with asthma who are active outdoors.
- **What are the health effects?**
  Bronchoconstriction, which can cause wheezing, shortness of breath, and tightening of the chest. When exposure to SO_2 ends, the symptoms should clear up within an hour.
- **What can I do about it?**
  If SO_2 levels are high, limit your outdoor exertion.
- **Where is it measured?**
  Because the large primary sources of SO_2 in the Puget Sound no longer exist, the Agency has not monitored for SO_2 since the end of 1999.

For additional information on SO_2, visit www.epa.gov/air/urbanair/so2/index.html.

Lead (Pb)

- **What is it?**
  Lead is a highly toxic metal that was used for many years in household products, automobile fuel, and industrial chemicals.
- **How is it caused?**
  Locally, airborne lead is associated primarily with automobile exhaust and lead smelters. Since the phase-out of lead in fuels, however, cars and trucks are no longer a significant source of lead. Also, Seattle's Harbor Island lead smelter ceased operation at the end of 1998.
- **When does it happen?**
  Lead concentrations are likely to be highest near sources where current or former lead smelting/ processing operations caused particle fallout, especially in nearby soils such as unpaved parking lots.
- **Who is affected?**
  Everyone. Children 6 years and younger are most at risk.
- **What are the health effects?**
  Lead can have health effects ranging from behavioral problems and learning disabilities to seizures and death.
- **What can I do about it?**
  According to the U.S. Environmental Protection Agency (USEPA), the primary sources of lead exposure are lead-based paint, lead-contaminated dust, and lead-contaminated residual soils. Refer to the EPA website (linked above) for ways to limit your exposure to these lead sources.
- **Where is it measured?**
  Due to the phase-out of leaded fuels and the closure of Seattle's lead smelter in 1998, the Agency no longer monitors for airborne lead.

For additional information on lead, visit www.epa.gov/air/urbanair/lead/index.html.

Nitrogen Dioxide (NO_2)

- **What is it?**
  Nitrogen dioxide (NO_2) is a reddish brown, highly reactive gas that forms from the reaction of nitrogen oxide (NO) and oxygen in the atmosphere. NO_2 will react with VOCs and can result in the formation of ozone.
- **How is it caused?**
  High temperature combustion sources such as power plants and automobiles are major producers of NO. Home heaters and gas stoves can also produce NO.
- **When does it happen?**
  NO_2 pollution is greatest in cold weather. It follows a similar trend to CO.
- **Who is affected?**
  People with respiratory diseases such as asthma; also children.
- **What are the health effects?**
  NO_2 can cause respiratory symptoms such as coughing, wheezing, and shortness of breath. Long-term exposure can lead to respiratory infections.
- **What can I do about it?**
  Since the 1970s, motor vehicle manufacturers have been required to reduce NO emissions from cars and trucks. It is not a significant pollution problem in the Puget Sound area.
- **Where is it measured?**
  Because NO_2 is not a major concern of the Puget Sound region, it is measured at only one location, Beacon Hill. The Department of Ecology conducts all NO_2 monitoring.

For additional information on NO_2, visit www.epa.gov/air/urbanair/nox/index.html.

Pollution Sources

Area Sources

Countywide categories of pollution sources, in which each individual source emits pollutants below the thresholds for a point source facility.

Biogenics

Natural sources such as trees, plants, grass, crops, and soils. The world-wide emission rate of these natural hydrocarbons has been estimated to exceed that of non-methane hydrocarbons originating from human sources. Isoprene, one of the major constituents of biogenic emissions, is very photoreactive, and would seem to make biogenic VOC a contributor in the formation of ozone. The study of hydrocarbon emissions from plants is therefore of key importance to our understanding of the global effects of naturally produced hydrocarbons.

Emission Factor

A value derived from source tests, material balance calculations, or engineering comparisons with similar processes. Used to estimate emissions from process quantities.

Hazardous Air Pollutant (HAP)

An air contaminant identified as toxic in the Federal Clean Air Act, Section 112(b).

Off-road Mobile Sources

Farm vehicles, on-site construction/industrial vehicles, logging equipment, small marine craft, aircraft, trains, ocean-going ships, tugs and ferries, lawn and garden equipment.

On-road Mobile Sources

Cars, trucks and buses.

Point Sources

Facilities that have annual air contaminant emissions equal to or exceeding one hundred tons per year of CO; twenty-five tons per year of nitrogen oxides (NO_x), PM_{10}, $PM_{2.5}$, sulfur oxides (SO_x) such as SO_2 and sulfur trioxide (SO_3), or volatile organic compounds (VOC); or two tons per year of a any single HAP or six tons per year of facility total HAP.

Registered Facility

The total of all pollutant-emitting activities located on adjacent or contiguous properties owned or operated by one person or corporate entity. It includes all of the pollutant-emitting buildings, processes, structures, equipment, control apparatuses, and storage areas at a facility. The annual fees for large and small registered emission sources are based on Regulation I, 5.07(c)(1) and 5.07(c)(2), respectively.

Stationary Area Sources

Sources include wood stoves/fireplaces, outdoor burning, architectural surface coating, automobile painting, commercial/consumer solvents, dry cleaning, printing, stationary diesel engines, and small utility engines, and construction activities.

Temperature Inversions

The earth gains and loses most of its energy at its surface. It is warmed by solar heating during the day and cooled by radiation emissions at night. During the late morning and afternoon hours, the air near the surface is warmer than the air aloft and allows for good pollutant dispersion (vertical mixing may be 1,500 meters or more). At night with clear skies, the surface radiates heat into outer space, creating cooler air at the surface and warmer air aloft. Warmer air above cooler air (temperature inversion) is a stable condition and limits the upward movement of pollution because the warmer air acts as a barrier.

With little or no wind, pollutants are trapped near the surface (vertical mixing may be 200 meters or less) and can reach high levels of concentration.

Toxic Air Contaminant (TAC)

An air contaminant listed in Regulation III, Appendix A.

Volatile Organic Compound (VOC)

An organic compound that participates in atmospheric photochemical reactions. This excludes all compounds determined to have negligible photochemical reactivity by the EPA and listed in 40 CFR 51.100(s) in effect July 1, 1998.

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—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 you have, the shorter your visual range will be. Reduced visibility (or visual range) is caused by weather (clouds, fog, and rain) and air pollution (fine particles and gases). The major pollution contributor is fine particulate matter ($PM_{2.5}$) emissions, which are transported aloft and may remain suspended for a week or longer. Fine particles have a greater impact than coarse particles at locations far from the emitting source because they remain suspended in the atmosphere longer and travel further. $PM_{2.5}$ also presents some of the most serious health hazards to the public, so you can roughly assume that the worse the visibility, the unhealthier the air is to breathe.

For additional information on Visibility/Regional Haze, visit www.epa.gov/air/visibility/index.html.