Knechtel

1992 Air Quality Data Summary

for the counties

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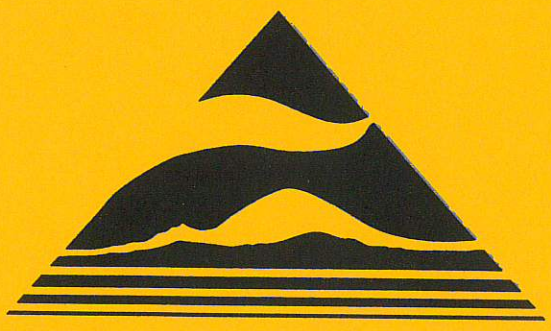

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PUGET SOUND AIR POLLUTION CONTROL AGENCY

Serving King, Kitsap, Pierce and Snohomish Counties

1992 AIR QUALITY DATA SUMMARY

Contents

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EXECUTIVE SUMMARY

Introduction

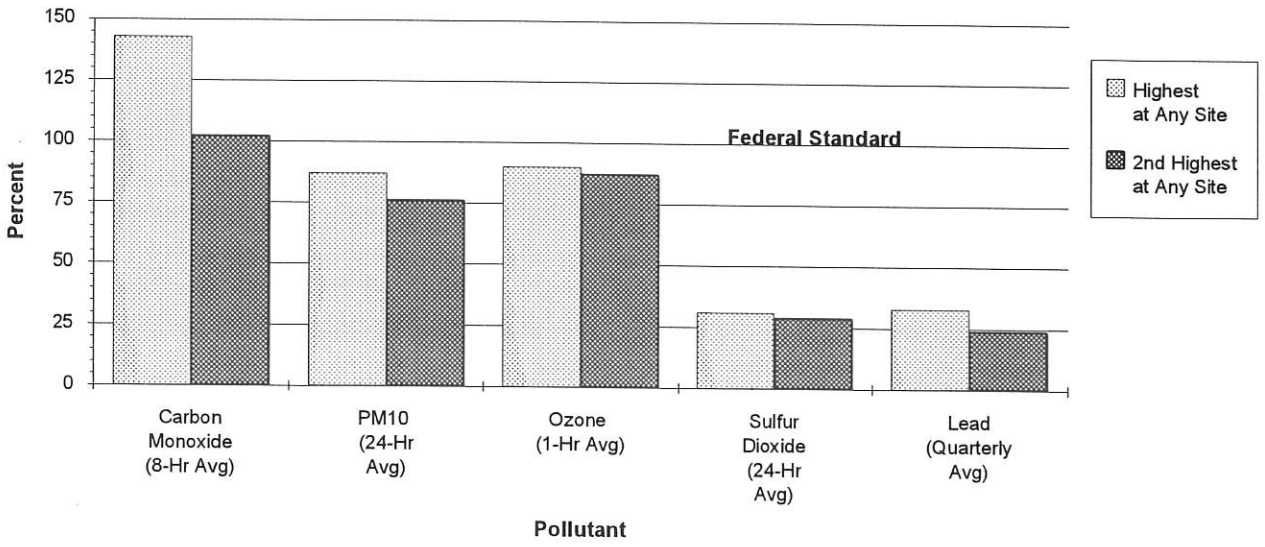
This twenty-first annual data summary reviews 1992 air quality and meteorological data for the Puget Sound Region. The report begins with sampling network tables providing the address and type of sampling at each location. Summaries of pollutant measurements and information to assist in interpretation appear within the report. Sections near the back summarize air pollution episodes and "impaired air quality" periods and provide meteorological analyses consisting of wind speed averages and graphs of wind patterns.

Air pollution consists of a complex mixture of compounds that each requires specialized equipment for identification and measurement. National ambient air quality standards have been established for the six common pollutants known as carbon monoxide, particulate matter, ozone, sulfur dioxide, lead and nitrogen dioxide. For these pollutants Federal law requires meeting the national primary standards that protect health and establishes deadlines for states to develop and implement plans to achieve and maintain the air quality standards.

The Washington State Department of Ecology and the Puget Sound Air Pollution Control Agency have established state and local ambient air quality standards for the same six pollutants that are at least as stringent as the national standards. A discussion of the characteristics and effects of each of these air pollutants and a table of all the ambient air quality standards appear on pages 47 and 48 of this report.

The Puget Sound Region continues in compliance with the standards for sulfur dioxide, lead and nitrogen dioxide. In specific areas, the Region has been out of compliance with the standards for the pollutants carbon monoxide, particulate matter and ozone. However, data through 1992 show the standards have been achieved for carbon monoxide and particulate matter; the ozone standard will be attained if data through 1993 shows three years in compliance. The chart below displays 1992 maximum pollutant concentrations compared to the Federal primary standard. As shown, the second highest concentration at any site is not greater than 100 percent of the standard and this means the Region complied with the air quality standards during 1992.

1992 Maximum Pollutant Concentrations Compared to the Federal Standard



Carbon Monoxide

The area that was designated out of compliance with the carbon monoxide standard includes Everett, Seattle, Bellevue and Tacoma. During 1992, only the Seattle University District station measured a carbon monoxide value that exceeded the level of the primary (health related) standard of 9 ppm averaged over eight hours. A single exceedance is not considered to be a violation, so the Puget Sound Region stayed within the established standard during 1992. The following table summarizes the highest and second highest 8 hour average carbon monoxide values during 1992 for each carbon monoxide monitoring station.

1992 Carbon Monoxide Summary

Location	Highest 8 hr Avg (ppm)	2nd Highest 8 hr Avg (ppm)
Everett, Broadway	9.0	8.7
Bellevue, Bellevue Way NE	8.1	7.3
Seattle, NE Northgate Way	8.4	8.1
Seattle, University District	12.9	9.2
Seattle, 1424 4th Ave	6.9	5.9
Seattle, 5th Ave & James	8.0	7.5
Tacoma, 1101 Pacific Ave	9.3	8.9

Particulate Matter

The particulate matter standards adopted by the U. S. EPA in July 1987 measure only PM_{10} (particles 10 micrometers or less in diameter). The levels for the national primary and secondary PM_{10} standards are 150 micrograms per cubic meter ($\mu g/m^3$) for a 24 hour average and 50 $\mu g/m^3$ for an annual arithmetic mean. Washington State and Puget Sound Region PM_{10} standards were established at the same level as the national PM_{10} standards.

For 1992, none of the daily or annual average PM_{10} values exceeded the level of the standard. The following table summarizes the maximum daily PM_{10} value and the annual PM_{10} arithmetic average by monitoring location for the year 1992.

1992 PM_{10} Summary

Location	Maximum Daily PM_{10} Value ($\mu g/m^3$)	Annual PM_{10} Arith Avg ($\mu g/m^3$)
Marysville, Jr Hi School	107	26.3
Everett, Hoyt & 26th	57	23.7
Bellevue, Bellevue Wy NE	63	21.9
Lake Forest Pk, City Hall	91	26.3
Seattle, Harbor Is	79	33.1
Seattle, Duwamish	131	37.9
Seattle, South Park	76	29.1
Kent, James & Central	85	32.5
Puyallup, South Hill	84	28.5
NE Tacoma, 27th & 54th	124	34.0
Tacoma, Taylor Way	81	30.9
Tacoma, Alexander	81	29.9
Tacoma, E 11th St	119	36.5
Kitsap County, Meadowdale	89	22.6

Under the Federal regulation, the last three years of data must be used to determine compliance with the PM_{10} standards. None of the annual PM_{10} values for the past three calendar years exceeded the annual PM_{10} standard of 50 $\mu g/m^3$, so the Puget Sound Region is in compliance with the annual standard.

For the 24 hour average PM_{10} standard, the Federal regulation requires statistically adjusting for days without data and then calculating the "expected" number of days per year exceeding the standard at a particular location as a three year average. If this "expected" number of days above the standard

exceeds one, then the PM_{10} standard has not been attained. Through 1992 there were no locations within the Puget Sound Region where the "expected" number of days above the standard exceeded one per year. Therefore the Region is in compliance with the 24 hour average PM_{10} standard.

Ozone

Ozone is a photochemical pollutant with highest levels measured on hot days from mid May to mid September. In 1987 the Puget Sound Region attained the ozone standard, but monitoring data during the summer of 1990 resulted again in a designation as out of compliance with this standard. If a particular location shows more than one (1.0) daily maximum hour per year, averaged over the last three years, with a concentration greater than 0.12 ppm, then the ozone standard has been violated. At the Enumclaw monitoring location, for the three year period ending with 1992, the "expected" number of days per year with an hourly average above 0.12 ppm calculated to be 1.3 days; all other ozone monitoring locations showed 1.0 or fewer days. The following table summarizes the maximum 1 hour average ozone value during 1992 for each ozone monitoring site.

1992 Ozone Summary

Location	Maximum 1 hr Avg (ppm)
Lake Sammamish State Park	0.094
Enumclaw, Highway 410	0.108
La Grande, Pack Forest	0.103

Weather and Air Quality

One of the variables that influences the air quality on a given day is the weather. Weather never causes high pollutant levels, but sometimes under stable conditions the pollutants emitted from human activities are not quickly dispersed. Poor dispersion exists on about one-third of the days during night to early morning hours, but weather effectively disperses pollutants by afternoon on most of these days. A few times during the months of January, February, October, November or December, poor dispersion persists for 24 or more hours and may result in the declaration of an "air pollution episode" or local "impaired air quality". During 1992, the Department of Ecology declared the "Forecast" stage of an air pollution episode that included the Puget Sound Region for only one period:

10:00 am, Wednesday, February 5 -
4:00 pm, Friday, February 7.

The Washington Clean Air Act established the criteria for determining "impaired air quality". During 1992, "impaired air quality" was in effect in the Puget Sound Region as follows:

Dates/Counties

2:30 pm, Wednesday, January 8 -
9:30 am, Thursday, January 9;
(King, Pierce, Snohomish & Kitsap)

2:30 pm, Sunday, January 19 -
2:30 pm, Monday, January 20;
(King, Pierce & Snohomish)

10:00 am, Wednesday, February 5 -
2:30 pm, Thursday, February 6;
(King, Pierce & Snohomish)

2:30 pm, Wednesday, November 25 -
2:30 pm, Thursday, November 26.
(Kitsap)

Daily Air Quality

The Agency uses the national Pollutant Standards Index to report daily air quality. The report includes the Index value as determined by pollutant levels and a descriptive term for the Index value. This term describes the air quality (in progressively more polluted stages) as "Good", "Moderate", "Unhealthful", or "Very Unhealthful". Any pollutant measurement exceeding the short term national primary standard causes the Index value to be in the Unhealthful or a worse category. Summarizing from the daily Pollutant Standards Index values, in 1992:

Everett had 180 Good, 186 Moderate, and 0 Unhealthful days;
Seattle had 238 Good, 127 Moderate, and 1 Unhealthful days;
Tacoma had 285 Good, 81 Moderate, and 0 Unhealthful days.

The current daily Pollutant Standards Index is available toll free from the Puget Sound Air Pollution Control Agency by dialing 1-800-433-2215.

1992 SAMPLING NETWORK

Location	*Type of Sampling*
Marysville JHS, 1605 7th St, Marysville, Wa	PM10 $(PM10)_{eq}$ Wind
Hoyt Ave & 26th St, Everett, Wa	PM10 bsp, SO_2, Wind
* Broadway & Hewitt Ave, Everett, Wa	CO
* 622 Bellevue Way NE, Bellevue, Wa	CO
* 504 Bellevue Way NE, Bellevue, Wa	PM10
* 20050 SE 56th, Lake Sammamish State Park, Wa (seasonal)	O_3
17711 Ballinger Way NE, Lake Forest Park, Wa	PM10 $(PM10)_{eq}$ bsp, Wind
* Northgate, 310 NE Northgate Way, Seattle, Wa	CO
* Sand Point, 7600 Sand Pt Way NE, Seattle, Wa	Wind, Temp, dT
* 5701 8th Ave NE, Seattle, Wa	TSP/Pb
* University Dist, 1307 NE 45th St, Seattle, Wa	CO
* 1424 4th Ave, Seattle, Wa	CO
* 5th Ave & James St, Seattle, Wa	CO
* Beacon Hill, 15th S & Charlestown, Seattle, Wa	Wind, Temp
Harbor Island, 2555 13th Ave SW, Seattle, Wa	TSP/Pb
Harbor Island, 3400 13th Ave SW, Seattle, Wa	PM10
Duwamish, 4752 E Marginal Way S, Seattle, Wa	PM10 PM2.5, bsp, SO_2, Wind

Notes- (1) *Type of Sampling*:

PM10	=	Particulate Matter ≤ 10 micrometers (reference method)	bsp	=	Atmospheric Particles (by nephelometer)
$(PM10)_{eq}$	=	Particulate Matter ≤ 10 micrometers (equivalent method)	O_3	=	Ozone
CO	=	Carbon Monoxide	SO_2	=	Sulfur Dioxide
PM2.5	=	Particulate Matter ≤ 2.5 micrometers	TSP/Pb	=	Total Suspended Particulates and Lead
Wind	=	Wind Direction & Speed	Temp	=	Air Temperature
			dT	=	delta Temperature

(2) * Station operated by Washington State Department of Ecology.

1992 SAMPLING NETWORK

Location	*Type of Sampling*		
South Park, 723 S Concord St, Seattle, Wa	PM_{10}		
James St & Central Ave, Kent, Wa	PM_{10}	$(PM_{10})_{eq}$	$PM_{2.5}$, bsp, Wind
* Highway 410, 2 miles east of Enumclaw, Wa (seasonal)			O_3
* Charles L Pack Forest, La Grande, Wa (seasonal)			O_3
South Hill, 9616 128th St E, Puyallup, Wa	PM_{10}	$(PM_{10})_{eq}$	Wind
* 5225 Tower Drive NE, Northeast Tacoma, Wa			Wind, Temp
27th St NE & 54th Ave NE, Northeast Tacoma, Wa	PM_{10}		bsp, SO_2, Wind
2340 Taylor Way, Tacoma, Wa	PM_{10}		
2301 Alexander Ave, Tacoma, Wa	PM_{10}		SO_2, Wind
Fire Station #12, 2316 E 11th St, Tacoma, Wa	PM_{10}		$PM_{2.5}$, bsp, Wind
* 1101 Pacific Ave, Tacoma, Wa		CO	
Meadowdale, 7252 Blackbird Dr NE, Kitsap Co, Wa	PM_{10}	$(PM_{10})_{eq}$	Wind

Notes- (1) *Type of Sampling*:

PM_{10}	=	Particulate Matter ≤ 10 micrometers (reference method)	bsp	=	Atmospheric Particles (by nephelometer)
$(PM_{10})_{eq}$	=	Particulate Matter ≤ 10 micrometers (equivalent method)	O_3	=	Ozone
CO	=	Carbon Monoxide	SO_2	=	Sulfur Dioxide
$PM_{2.5}$	=	Particulate Matter ≤ 2.5 micrometers	Temp	=	Air Temperature
Wind	=	Wind Direction & Speed			

(2) * Station operated by Washington State Department of Ecology.

POLLUTANT STANDARDS INDEX

The Pollutant Standards Index (PSI) provides a nationally uniform method to report daily air quality levels. In cooperation with the Washington State Department of Ecology, the Puget Sound Air Pollution Control Agency began reporting the PSI in 1980 for the Everett, Seattle, and Tacoma areas.

Measured pollutant levels during each day convert to a scale that shows if there are potential health effects. This Index scale, ranging from zero to 500, categorizes air quality by the following descriptions:

from	0	to	50,	Good;
from	51	to	100,	Moderate;
from	101	to	199,	Unhealthful;
from	200	to	299,	Very Unhealthful;
from	300	to	500,	Hazardous.

The table below shows the pollutant concentration and the averaging period associated with each PSI value that is a break-point between Index categories. PSI values for pollutant concentrations between break-points are determined by linear interpolation.

Whenever the PSI is greater than 100, a measured pollutant level has exceeded the national primary air quality standard established to protect health. An index value of 200 means the pollutant concentration has reached the "Alert" level in the Washington Episode Avoidance Plan.

Every day the concentration of each pollutant within the areas of Everett, Seattle and Tacoma determines an Index value. For each area, the pollutant with the highest Index value determines the PSI on that day. Highest values usually occur near heavy traffic or an industrial area.

Since high ozone levels occur some distance downwind of Everett, Seattle or Tacoma on hot summer afternoons, the Agency reports the ozone PSI value in a downwind area during the months from May through September. For 1992, the maximum ozone PSI value of 90 occurred near Enumclaw on July 30.

Tables that follow summarize the daily PSI values for Everett, Seattle, and Tacoma. The 1992 summary table shows for each month: the number of days in each PSI interval, the maximum Index, the date of the maximum and the pollutant determining the maximum value.

A 1980 through 1992 summary table shows for each year the number of days in each air quality category and the number of days each pollutant determined the PSI. For all the Unhealthful days each year (Index values greater than 100), this summary also tabulates the pollutant responsible. The right-hand columns list the highest PSI value for each year.

Pollutant Concentration for Each PSI Break-point Value

PSI Value	CO *8 hr Avg* (*ppm*)	PM10 *24 hr Avg* ($\mu g/m^3$)	SO_2 *24 hr Avg* (*ppm*)	O_3 *1 hr Avg* (*ppm*)
50	4.5	50	0.03	0.06
100	9.0	150	0.14	0.12
200	15.0	350	0.30	0.20
300	30.0	420	0.60	0.40
400	40.0	500	0.80	0.50
500	50.0	600	1.00	0.60

POLLUTANT STANDARDS INDEX

1992

EVERETT

Number of Days in Each PSI Interval during Each Month

AIR QUALITY	(PSI Interval)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
GOOD	(0 to 50)	18	7	10	21	11	11	12	13	11	18	24	24	180
MODERATE	(51 to 100)	13	22	21	9	20	19	19	18	19	13	6	7	186
UNHEALTHFUL	(101 to 199)	0	0	0	0	0	0	0	0	0	0	0	0	0
VERY UNHEALTHFUL	(200 to 299)	0	0	0	0	0	0	0	0	0	0	0	0	0
Maximum PSI each month		89	100	100	89	78	78	78	78	89	67	67	71	100
Date		6th#	4th#	2nd	1st#	1st#	5th#	15th#	11th#	10th	6th#	25th	3rd	Feb 4#
Pollutant		CO	CO	CO	CO	CO	CO	CO	CO	CO	CO	CO	PM	CO

SEATTLE

Number of Days in Each PSI Interval during Each Month

AIR QUALITY	(PSI Interval)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
GOOD	(0 to 50)	8	9	9	21	28	27	29	28	21	18	21	19	238
MODERATE	(51 to 100)	23	19	22	9	3	3	2	3	9	13	9	12	127
UNHEALTHFUL	(101 to 199)	0	1	0	0	0	0	0	0	0	0	0	0	1
VERY UNHEALTHFUL	(200 to 299)	0	0	0	0	0	0	0	0	0	0	0	0	0
Maximum PSI each month		100	167	78	68	58	67	56	57	89	89	78	78	167
Date		18th	3rd	4th	2nd	20th	12th	10th#	13th	28th#	19th	25th	4th	Feb 3
Pollutant		CO	CO	CO	PM	PM	CO	CO	PM	CO	CO	CO	CO	CO

TACOMA

Number of Days in Each PSI Interval during Each Month

AIR QUALITY	(PSI Interval)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
GOOD	(0 to 50)	17	15	11	27	26	30	30	31	25	25	22	26	285
MODERATE	(51 to 100)	14	14	20	3	5	0	1	0	5	6	8	5	81
UNHEALTHFUL	(101 to 199)	0	0	0	0	0	0	0	0	0	0	0	0	0
VERY UNHEALTHFUL	(200 to 299)	0	0	0	0	0	0	0	0	0	0	0	0	0
Maximum PSI each month		89	100	87	71	78	45	56	46	100	65	70	70	100
Date		20th	3rd	25th	2nd	6th	23rd	17th	25th	29th	23rd	25th	4th	Feb 3
Pollutant		CO	CO	PM	PM	PM	PM	PM	PM	CO	PM	PM	PM	CO

PM = Particulate Matter; CO = Carbon Monoxide; SO2 = Sulfur Dioxide.

Earliest date of occurrence

POLLUTANT STANDARDS INDEX

1980 - 1992

EVERETT

	Days in Each Air Quality Category				Pollutant Determining the PSI						Highest Value		
					All Days			Unhealthful Days					
	Good	Moderate	Unhealthful	Very Unhealthful	PM	CO	SO2	PM	CO	SO2	PSI	Date	Pollutant
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
Totals	3326	1392	19	0	1822	2684	231	0	19	0			

SEATTLE

	Days in Each Air Quality Category				Pollutant Determining the PSI						Highest Value		
					All Days			Unhealthful Days					
	Good	Moderate	Unhealthful	Very Unhealthful	PM	CO	SO2	PM	CO	SO2	PSI	Date	Pollutant
1980	73	275	18	0	95	270	1	1	17	0	194	Jan 23	PM
1981	69	267	28	1	109	254	2	5	24	0	213	Jan 15	CO
1982	86	268	10	1	96	264	5	1	10	0	214	Feb 6	PM
1983	98	258	9	0	101	261	3	0	9	0	183	Jan 28	CO
1984	146	218	2	0	111	242	13	2	0	0	103	Dec 6	PM
1985	150	202	10	3	156	206	3	6	7	0	204	Dec 12	PM
1986	130	226	8	1	113	246	6	1	8	0	206	Jan 7	PM
1987	120	238	7	0	119	246	0	3	4	0	184	Feb 6	PM
1988	215	146	5	0	67	298	1	2	3	0	150	Dec 3	CO
1989	231	134	0	0	129	233	3	0	0	0	100	Jan 19#	CO
1990	239	126	0	0	141	218	6	0	0	0	100	Jan 18	CO
1991	256	109	0	0	141	216	8	0	0	0	100	Dec 15#	CO
1992	238	127	1	0	105	260	1	0	1	0	167	Feb 3	CO
Totals	2051	2594	98	6	1483	3214	52	21	83	0			

TACOMA

	Days in Each Air Quality Category				Pollutant Determining the PSI						Highest Value		
					All Days			Unhealthful Days					
	Good	Moderate	Unhealthful	Very Unhealthful	PM	CO	SO2	PM	CO	SO2	PSI	Date	Pollutant
1980	83	271	12	0	256	107	3	4	8	0	160	Apr 12	PM
1981	74	278	10	3	222	137	6	1	12	0	227	Jan 12	CO
1982	119	242	4	0	255	101	9	0	4	0	167	Dec 30	CO
1983	140	222	3	0	228	128	9	1	2	0	137	Dec 23	PM
1984	162	198	6	0	207	149	10	0	6	0	117	Jan 19#	CO
1985	140	213	12	0	252	109	4	1	11	0	165	Dec 13	PM
1986	161	197	7	0	247	114	4	2	5	0	167	Oct 23	CO
1987	173	177	13	2	227	136	2	5	10	0	220	Feb 5	CO
1988	226	132	8	0	184	175	7	3	5	0	183	Jan 27	CO
1989	260	103	2	0	217	121	27	0	2	0	117	Nov 30#	CO
1990	289	75	1	0	237	87	41	1	0	0	118	May 5	PM
1991	282	82	1	0	268	85	12	0	1	0	117	Jan 31	CO
1992	285	81	0	0	256	83	27	0	0	0	100	Feb 3#	CO
Totals	2394	2271	79	5	3056	1532	161	18	66	0			

Earliest date of occurrence

PARTICULATE MATTER

Introduction

Particulate matter as a general term includes small particles of dust, soot, organic matter and compounds containing sulfur, nitrogen, and metals. In July 1987, the U. S. EPA changed the national particulate matter standards from Total Suspended Particulates (TSP) to only that portion of particulate matter with particle diameters smaller than or equal to 10 micrometers (PM_{10}). The levels for both the national primary and secondary standards are: 150 $\mu g/m^3$ for a 24 hour average and 50 $\mu g/m^3$ annual arithmetic mean. The PM_{10} standards also include calculation formulas to statistically determine if the standards are attained (40 CFR Part 50, Appendix K).

Particulate Sources and Air Quality

Particulates directly enter the air from industrial operations, from auto, bus and truck traffic, from fuel combustion including wood stoves and fireplaces, from construction, and from other sources. These emissions into the air change daily due to intermittent industrial operations, equipment upset or breakdown, traffic cycles and building heating requirements. Gaseous transformation products in the air like sulfates, nitrates, and some organics are also components of particulate matter. The wind acts to disperse and transport airborne particulate matter. Ambient particulate levels change from day to day in response both to what enters the air and to the variations in weather.

Sampling Methods

Reference methods designated by the U. S. EPA to measure PM_{10} all draw outside air first through an inlet that removes particulates larger than 10 micrometers and then through a filter that collects the remaining particulate matter (PM_{10}). Sampling for a single measurement continues for 24 hours under time clock control and the required sampling period occurs from midnight to midnight.

After the sampling has completed as scheduled, the pre-weighed, sampled filter must be manually removed. Following conditioning in a controlled environment for 24 hours to remove moisture effects, the sampled filter is weighed again on a precision balance and the weight of particulate matter collected during the sample period is calculated. The volume of air sampled, corrected to standard temperature and pressure conditions, is calculated from the flow rate and sampling time. The ambient PM_{10} concentration for the specific location and sampling time is calculated by dividing the weight (mass) of collected particulate by the volume of air sampled. The PM_{10} concentration is reported in micrograms per standard cubic meter.

The U. S. EPA has designated three methods as *equivalent methods* for the measurement of PM_{10}; two use a measurement principle based on beta-ray attenuation; one uses a tapered element oscillating microbalance. All three equivalent methods are automated and continuous so that PM_{10} values may be immediately determined and transmitted to a central computer. These methods also measure consecutive daily values without the need for manual servicing following each sampling day.

During 1992, the Puget Sound Air Pollution Control Agency operated five equivalent method PM_{10} beta attenuation instruments at locations that receive impacts from wood smoke. These were collocated with one or more manual, reference method instrument(s) to enable data comparison. Summary statistics between the methods at these five locations appear on page 11. Results document correlation coefficients exceeding .95 at all of the locations with the number of paired samples ranging from sixty to about three-hundred as determined by the sampling schedule for the reference method.

The integrating nephelometer continuously measures the light scattering extinction coefficient. A component of the scattering coefficient due to dry particles, (b_{sp}), generally shows good correlation to PM_{10} values and to visibility. The b_{sp} values are reported as a scattering coefficient per meter times 10^{-4}. Operating a nephelometer at a site concurrent with a reference method enables development of a relationship between the two methods for that site.

Summary of Data

During 1992, PM_{10} data in the Puget Sound Region was measured at fourteen locations, but seven of these sites were equipped only with a single manual reference method sampler. PM_{10} measurement usually occurred each sixth day at these locations for a total of about sixty PM_{10} values during the year.

Continuous PM_{10} data was obtained at seven locations that were equipped with additional reference method samplers and/or equivalent method monitors. Two of these continuous sites are industrial locations and five of the sites are primarily wood smoke monitoring locations. The industrial locations have operated since the PM_{10} standard was adopted and the wood smoke area monitoring began more recently.

Since adoption of the PM_{10} standard in 1987, none of the annual PM_{10} values have exceeded the annual PM_{10} standard. This means the Puget Sound Region is in compliance with the annual PM_{10} standard.

Under the Federal regulation, (40 CFR Part 50, Appendix K), the last three years of data must be used to determine compliance with the 24 hour average PM_{10} standard. This regulation requires attainment to be determined by statistically adjusting for days without data and then calculating the average number of days per year exceeding the standard at a particular location for the last three years. If this "expected" number of days above the standard exceeds one, then the PM_{10} standard has not been attained; the location is out of compliance with the 24 hour average PM_{10} standard.

The 24 hour average PM_{10} standard has been met everywhere in the Puget Sound Region for the last four calendar years, therefore the Region is in compliance with the daily (24 hour average) PM_{10} standard. A single daily value at a Tacoma port area station during 1990 exceeded the level of the 150 $\mu g/m^3$ daily standard, but this was not a violation of the standard because measurements occur each day at this site and none of the other values exceeded the level of the standard.

Charts on the following pages summarize PM_{10} data beginning in the first year following the PM_{10} standard adoption. Column graphs for the seven stations with continuous data present a PM_{10} history starting either in 1988 or with the beginning of data at each site.

Separate charts for industrial sites and wood smoke sites show the annual arithmetic averages and maximum daily values. These charts show compliance with both the annual and 24 hour average PM_{10} standards for both types of monitoring locations. One can see the PM_{10} levels in the industrial areas have been and continue to be higher than those in the wood smoke areas.

An additional set of charts shows the number of days when each of these stations exceeded the 75 $\mu g/m^3$ "impaired air quality" trigger level established in Washington State law. During the heating season beginning the last part of October and continuing into March, certain indoor burning in fireplaces and wood stoves is prohibited upon formal declaration that a period of "impaired air quality" is in effect.

Tables following the charts summarize for each station the 1992 PM_{10} data from both reference and equivalent methods and b_{sp} values from nephelometer measurements.

PARTICULATE MATTER (PM_{10})

Reference (Hi Vol Andersen/GMW 1200)
versus Equivalent (Beta Attenuation Andersen FH62I-N) Statistics
1992

Location	No. of Collocated Samples	Intercept of Regression Relationship	Slope of Regression Relationship	Correlation Coefficient
Marysville JHS, 1605 7th St Marysville, Wa	119	-1.3537	1.0260	.9770
17711 Ballinger Way NE Lake Forest Park, Wa	303	-1.3753	1.0401	.9684
James St and Central Ave Kent, Wa	297	.3045	.9397	.9511
South Hill, 9616 128th St E Puyallup, Wa	61	-2.6466	1.0580	.9732
Meadowdale, 7252 Blackbird Dr NE Kitsap County, Wa	60	-2.7958	1.0388	.9771

Notes

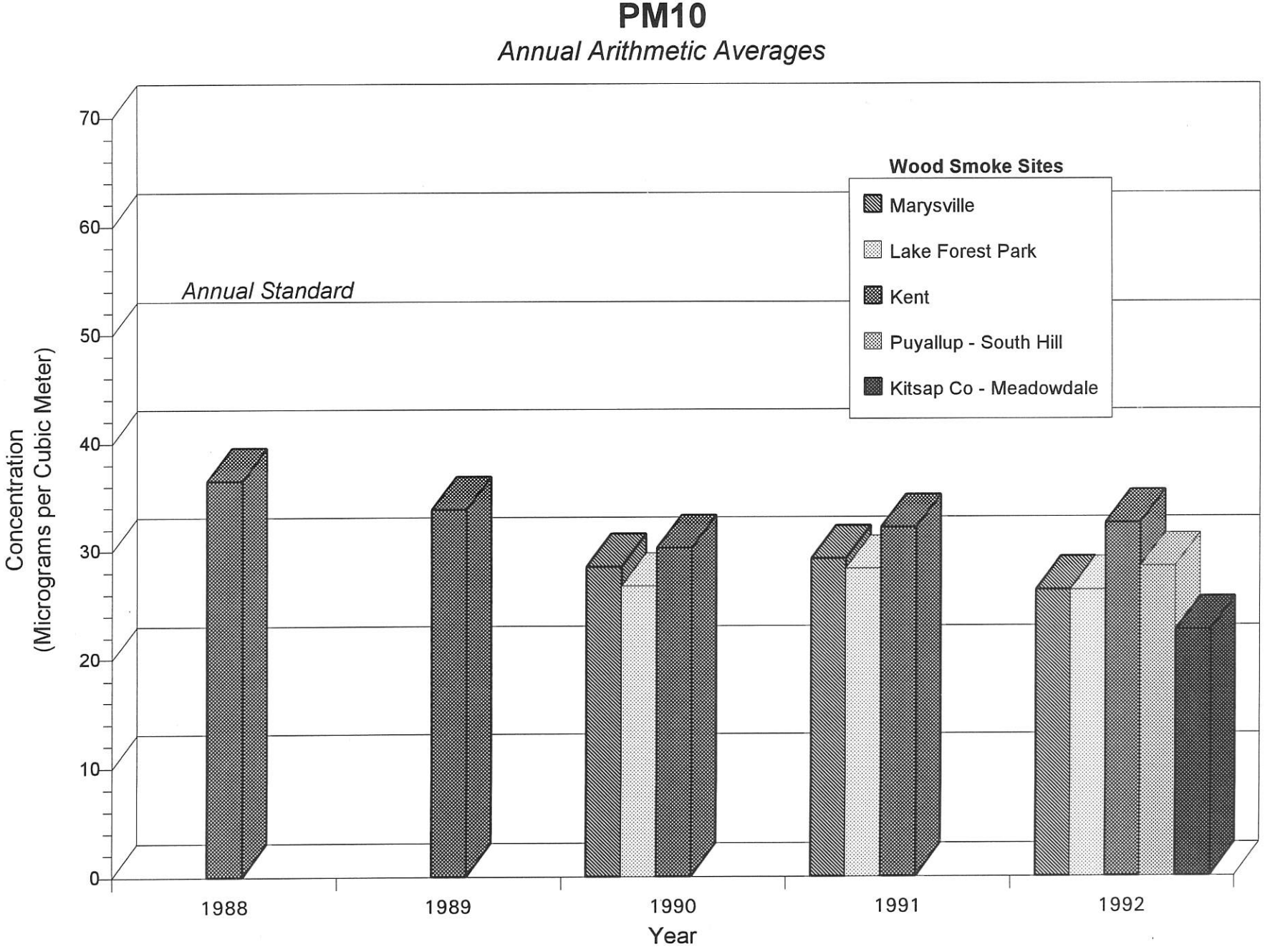
1. For this statistical analysis, the Reference PM_{10} value is the dependent variable.

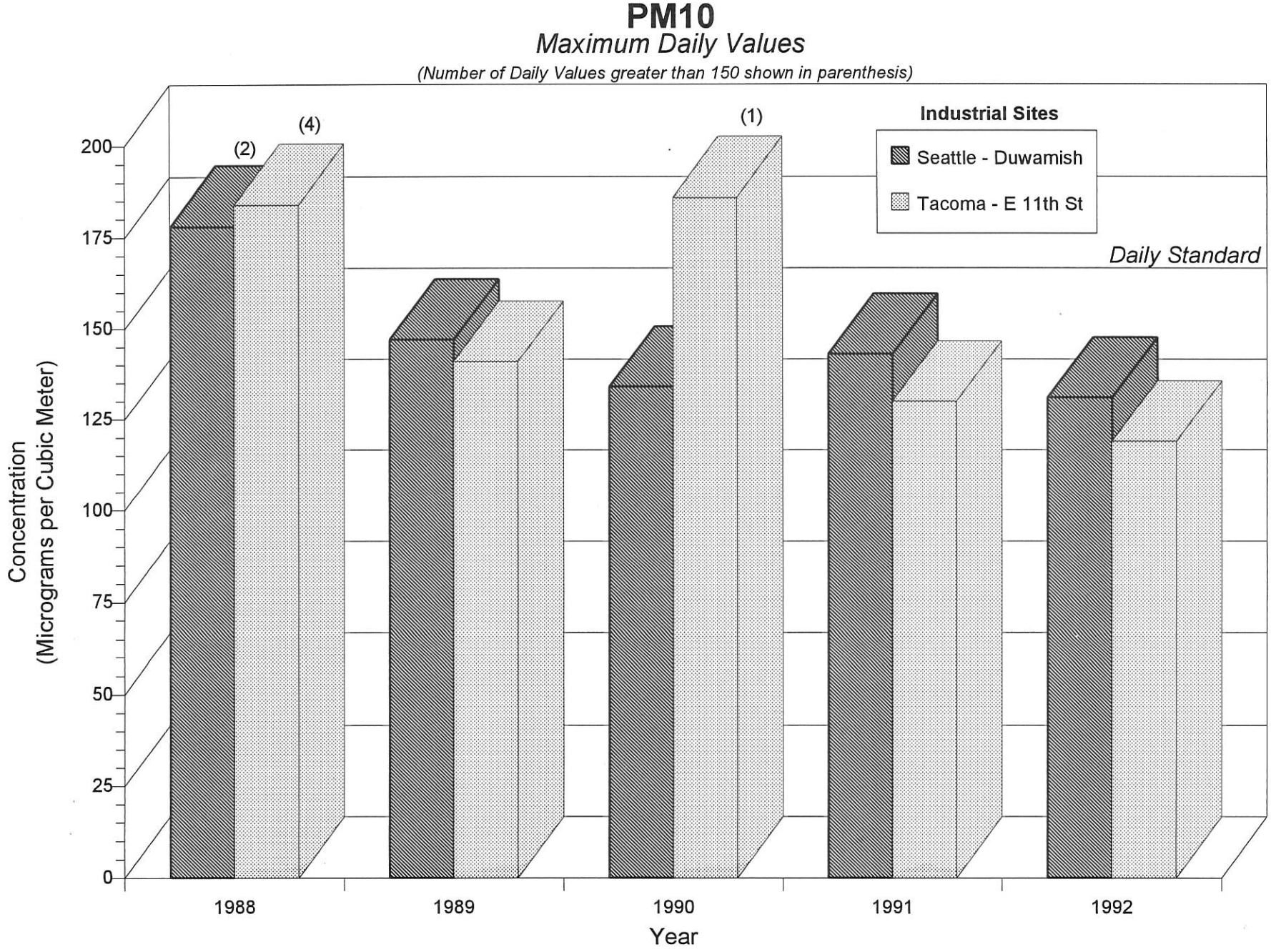
2. For this data set, the Beta Attenuation Monitors were set to the re-calibrated foil value shown in parenthesis. This setting was verified every month.
   Foil No. 586 = 1210 (1575)
   Foil No. 680 = 1859 (2420)

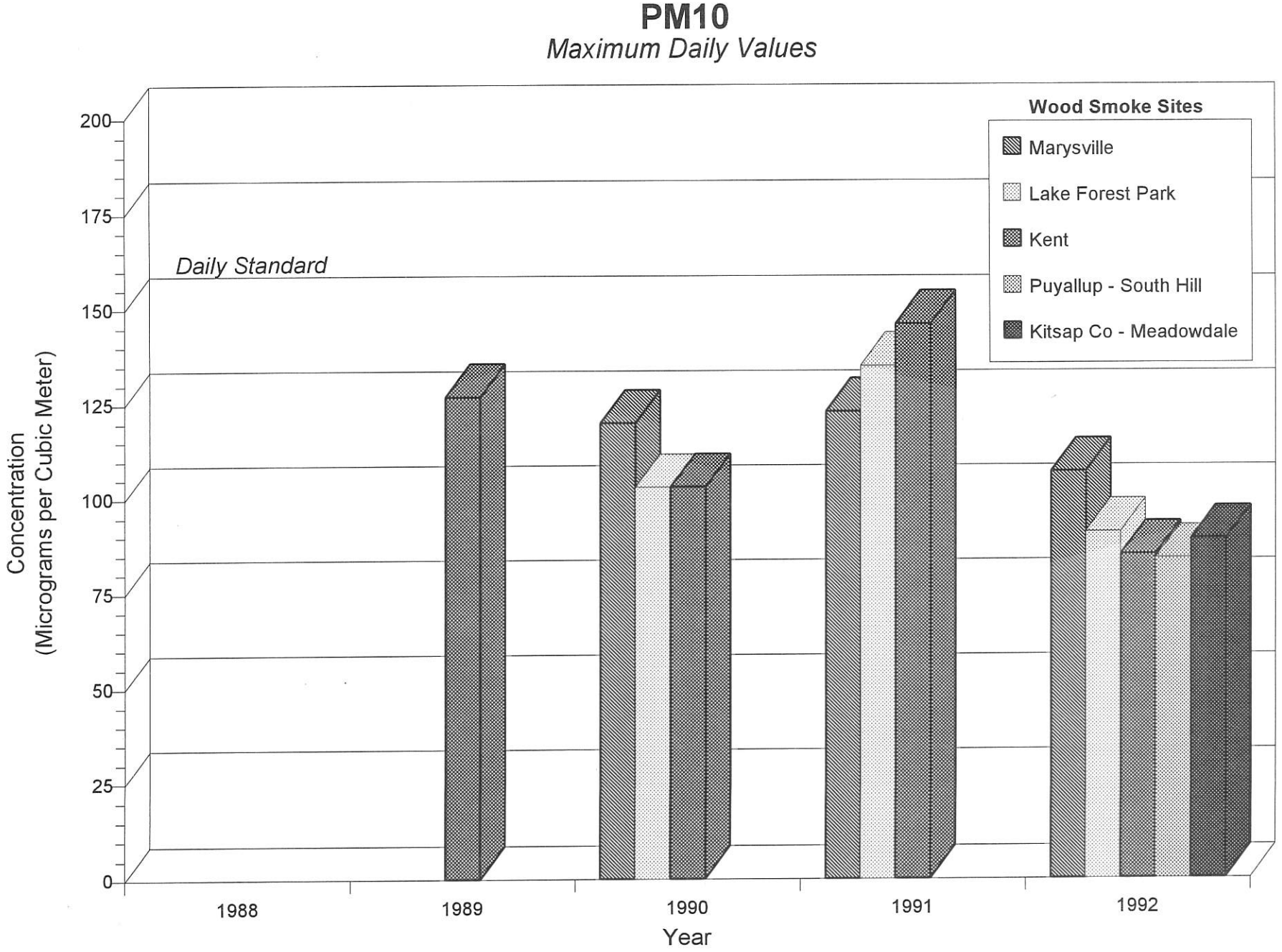
3. A flow rate audit was performed on each Beta Attenuation Monitor and each Reference Method Hi Vol Sampler every month.

PM10

Annual Arithmetic Averages

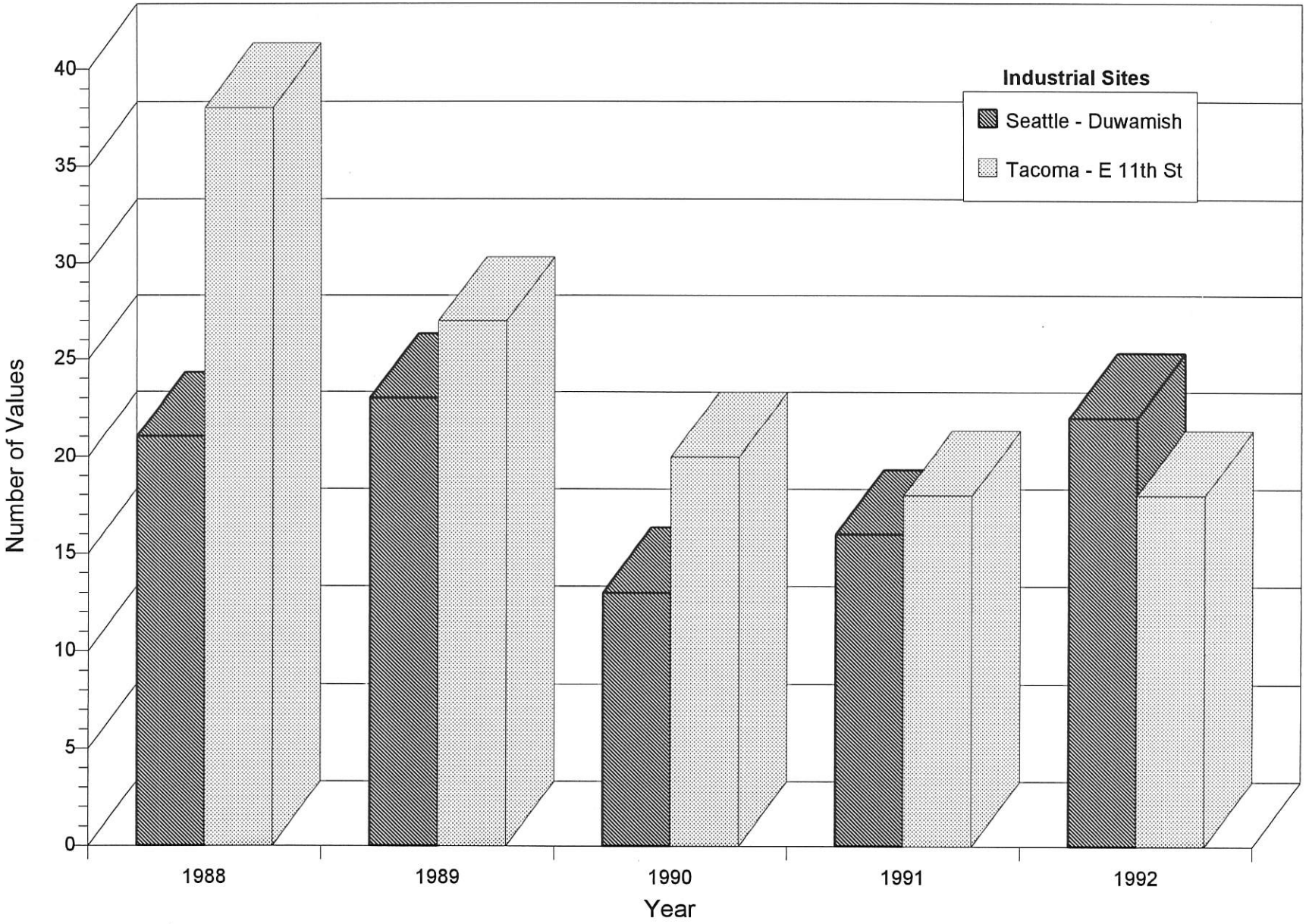

PM10
Annual Arithmetic Averages
Annual Standard
Wood Smoke Sites
Marysville
Lake Forest Park
Kent
Puyallup - South Hill
Kitsap Co - Meadowdale
Concentration
(Micrograms per Cubic Meter)
70
60
50
40
30
20
10
0
1988
1989
1990
1991
1992
Year


PM10
Maximum Daily Values
(Number of Daily Values greater than 150 shown in parenthesis)
Industrial Sites
Seattle - Duwamish
Tacoma - E 11th St
Daily Standard
(2)
(4)
(1)
200
175
150
125
100
75
50
25
0
Concentration
(Micrograms per Cubic Meter)
1988
1989
1990
1991
1992
Year


PM10
Maximum Daily Values
Wood Smoke Sites
Marysville
Lake Forest Park
Kent
Puyallup - South Hill
Kitsap Co - Meadowdale
Daily Standard
Concentration
(Micrograms per Cubic Meter)
200
175
150
125
100
75
50
25
0
1988
1989
1990
1991
1992
Year

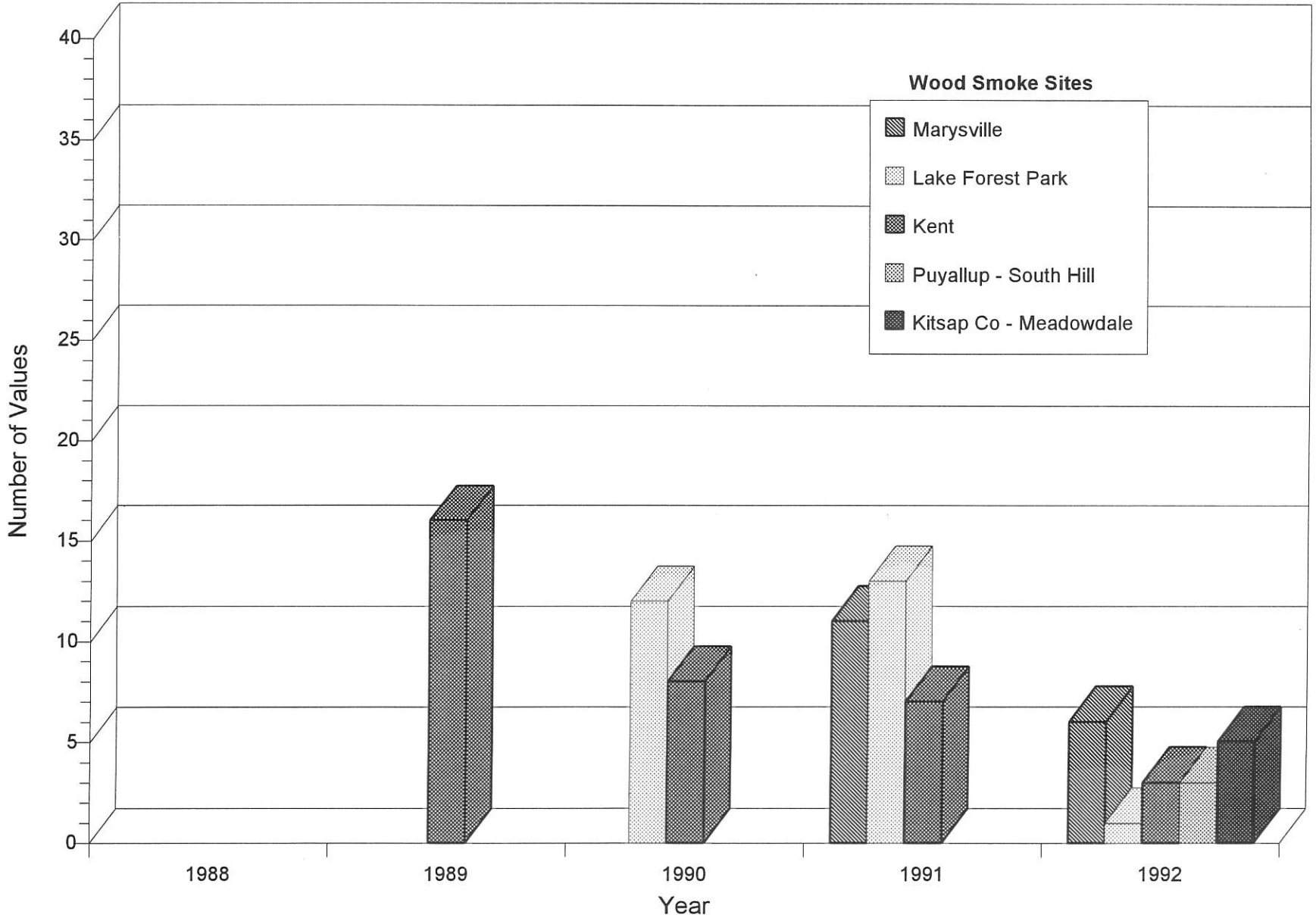
PM10

Number of Daily Values Greater than or Equal to 75 micrograms per cubic meter



PM10

Number of Daily Values Greater than or Equal to 75 micrograms per cubic meter



PARTICULATE MATTER (PM10)
Micrograms per Standard Cubic Meter

Sampling Method: Reference - Hi Vol ANDERSEN/GMW 1200 Quartz Fiber filters

1992

Location	Number of Values	Quarterly Arithmetic Averages 1st	2nd	3rd	4th	Year Arith Mean
Marysville JHS, 1605 7th St, Marysville, Wa	121	35.2	21.3	21.9	26.8	26.3
Hoyt Ave & 26th St, Everett, Wa	61	29.0	23.7	21.7	20.3	23.7
504 Bellevue Way NE, Bellevue, Wa	74	30.2	17.5	18.7	21.0	21.9
17711 Ballinger Way NE, Lake Forest Park, Wa	303	36.2	20.1	18.5	30.2	26.3
Harbor Island, 3400 13th Ave SW, Seattle, Wa	58	46.2	29.7	25.9	30.5	33.1
Duwamish, 4752 E Marginal Way S, Seattle, Wa	354	53.1	32.7	31.1	34.5	37.9
South Park, 723 S Concord St, Seattle, Wa	61	44.5	25.2	24.1	22.7	29.1
James St & Central Ave, Kent, Wa	297	42.4	28.9	29.6	28.9	32.5
South Hill, 9616 128th St E, Puyallup, Wa	61	45.9	25.5	22.9	19.5	28.5
27th St NE & 54th Ave NE, Northeast Tacoma, Wa	61	40.0	39.8	31.1	25.1	34.0
2340 Taylor Way, Tacoma, Wa	58	46.6	26.6	24.8	25.7	30.9
2301 Alexander Ave, Tacoma, Wa	147	38.5	26.5	25.7	28.9	29.9
Fire Station #12, 2316 E 11th St, Tacoma, Wa	355	51.1	29.6	28.7	36.4	36.5
Meadowdale, 7252 Blackbird Dr NE, KitsapCo, Wa	61	34.0	17.7	16.3	22.5	22.6

Notes
(1) Nationally scheduled particulate matter sampling occurs each sixth day. Quarterly averages are shown only when at least one data value exists for 75 percent or more of the six day intervals.
(2) Annual averages are shown only if there are at least three quarterly averages.

Summary of Maximum and 2nd High Observed Concentrations

Location	Jan 7 Tue	Jan 8 Wed	Jan 18 Sat	Jan 19 Sun	Jan 20 Mon	Feb 4 Tue	Feb 12 Wed	Feb 27 Thu	Mar 11 Wed	Mar 13 Fri	Mar 25 Wed	May 6 Wed	Dec 2 Wed
Marysville JHS, 1605 7th St, Marysville, Wa	96	--	--		--	--		--	--				66
Hoyt Ave & 26th St, Everett, Wa	49	--	--		--	--		--	--	57	49		
504 Bellevue Way NE, Bellevue, Wa			63			--		--	--	61			
17711 Ballinger Way NE, Lake Forest Park, Wa		69	--	70									
Harbor Island, 3400 13th Ave SW, Seattle, Wa	79	--	--		--	--		--	--	75			
Duwamish, 4752 E Marginal Way S, Seattle, Wa		114						131					
South Park, 723 S Concord St, Seattle, Wa		--	--		--	--	74	--	--	76			
James St & Central Ave, Kent, Wa	85	79	--										--
South Hill, 9616 128th St E, Puyallup, Wa	77	--	--	84	--	--		--	--				
27th St NE & 54th Ave NE, Northeast Tacoma, Wa		--	--		--	--		--	--		124	105	
2340 Taylor Way, Tacoma, Wa	81	--	--	75	--	--		--	--				
2301 Alexander Ave, Tacoma, Wa	76	--		--	--	76	--	81	--	--	--	--	--
Fire Station #12, 2316 E 11th St, Tacoma, Wa					119				98				
Meadowdale, 7252 Blackbird Dr NE, KitsapCo, Wa	77	--	--		--	--		--	--	51			

-- Indicates no sample on specified day

PARTICULATE MATTER (PM10)
Micrograms per Standard Cubic Meter

Sampling Method: Reference - Hi Vol ANDERSEN/GMW 1200 Quartz Fiber filters

Jan - Mar, 1992

Summary of Observations Equal To or Greater Than 75

Location	Jan 7 Tue	Jan 8 Wed	Jan 9 Thu	Jan 18 Sat	Jan 19 Sun	Jan 20 Mon	Feb 3 Mon	Feb 4 Tue	Feb 11 Tue	Feb 26 Wed	Feb 27 Thu	Feb 28 Fri	Mar 2 Mon	Mar 9 Mon	Mar 10 Tue
Marysville JHS, 1605 7th St, Marysville, Wa	96	--	--	--		--		--	--	--	--	--	--	--	
Harbor Island, 3400 13th Ave SW, Seattle, Wa	79	--	--	--		--	--	--	--	--	--	--	--	--	--
Duwamish, 4752 E Marginal Way S, Seattle, Wa	87	114		80		104	104	104	97	80	131	113	77	79	92
South Park, 723 S Concord St, Seattle, Wa		--	--	--		--	--	--	--	--	--	--	--	--	--
James St & Central Ave, Kent, Wa	85	79		--											
South Hill, 9616 128th St E, Puyallup, Wa	77	--	--	--	84	--	--	--	--	--	--	--	--	--	--
27th St NE & 54th Ave NE, Northeast Tacoma, Wa		--	--	--		--	--	--	--	--	--	--	--	--	--
2340 Taylor Way, Tacoma, Wa	81	--	--	--	75	--	--	--	--	--	--	--	--	--	--
2301 Alexander Ave, Tacoma, Wa	76	--			--	--	--	76		--	81	--	--	--	
Fire Station #12, 2316 E 11th St, Tacoma, Wa	84	94	78	84	84	119		84			91	92		91	87
Meadowdale, 7252 Blackbird Dr NE, KitsapCo, Wa	77	--	--	--		--	--	--	--	--	--	--	--	--	--

-- Indicates no sample on specified day

Mar - Dec, 1992

Summary of Observations Equal To or Greater Than 75

Location	Mar 11 Wed	Mar 13 Fri	Mar 14 Sat	Mar 23 Mon	Mar 25 Wed	Apr 1 Wed	Apr 2 Thu	May 6 Wed	Sep 29 Tue	Sep 30 Wed	Oct 23 Fri	Oct 27 Tue	Nov 25 Wed	Dec 4 Fri
Marysville JHS, 1605 7th St, Marysville, Wa	--		--	--		--	--		--		--		--	--
Harbor Island, 3400 13th Ave SW, Seattle, Wa	--	75	--	--		--	--		--	--	--		--	--
Duwamish, 4752 E Marginal Way S, Seattle, Wa	90	91		77		76	86		98	90			84	103
South Park, 723 S Concord St, Seattle, Wa	--	76	--	--		--	--		--	--	--		--	--
James St & Central Ave, Kent, Wa			77								--			
South Hill, 9616 128th St E, Puyallup, Wa	--		--	--		--	--		--	--	--		--	--
27th St NE & 54th Ave NE, Northeast Tacoma, Wa	--		--	--	124	--	--	105	--	--	--		--	--
2340 Taylor Way, Tacoma, Wa	--		--	--		--	--		--	--	--		--	--
2301 Alexander Ave, Tacoma, Wa	--	--		--	--	--		--		--	--		--	--
Fire Station #12, 2316 E 11th St, Tacoma, Wa	98	77					92				80	75	90	89
Meadowdale, 7252 Blackbird Dr NE, KitsapCo, Wa	--		--	--		--	--		--	--	--		--	--

-- Indicates no sample on specified day

PARTICULATE MATTER (PM10)
Micrograms per Standard Cubic Meter

Sampling Method: Equivalent -BetaAtten ANDERSEN FH62I-N Glass Fiber strip

1992

Location	Number of Values	Quarterly Arithmetic Averages 1st	2nd	3rd	4th	Year Arith Mean
Marysville JHS, 1605 7th St, Marysville, Wa	364	38.1	23.0	23.7	29.5	28.6
17711 Ballinger Way NE, Lake Forest Park, Wa	366	34.9	20.6	20.3	29.9	26.4
James St & Central Ave, Kent, Wa	366	39.5	31.0	32.9	28.7	33.0
South Hill, 9616 128th St E, Puyallup, Wa	366	40.5	25.1	25.9	27.4	29.7
Meadowdale, 7252 Blackbird Dr NE, KitsapCo, Wa	360	33.1	19.4	19.9	29.6	25.5

Notes
(1) Nationally scheduled particulate matter sampling occurs each sixth day. Quarterly averages are shown only when at least one data value exists for 75 percent or more of the six day intervals.
(2) Annual averages are shown only if there are at least three quarterly averages.

1992

Summary of Maximum and 2nd High Observed Concentrations

Location	Jan 6 Mon	Jan 18 Sat	Jan 19 Sun	Apr 2 Thu	May 20 Wed	Nov 24 Tue	Nov 25 Wed	Dec 4 Fri
Marysville JHS, 1605 7th St, Marysville, Wa	100	107						
17711 Ballinger Way NE, Lake Forest Park, Wa		91	76					
James St & Central Ave, Kent, Wa				76	79			
South Hill, 9616 128th St E, Puyallup, Wa			77			77		
Meadowdale, 7252 Blackbird Dr NE, KitsapCo, Wa							89	83

-- Indicates no sample on specified day

1992

Summary of Observations Equal To or Greater Than 75

Location	Jan 6 Mon	Jan 7 Tue	Jan 8 Wed	Jan 18 Sat	Jan 19 Sun	Feb 4 Tue	Feb 5 Wed	Apr 2 Thu	May 20 Wed	Nov 24 Tue	Nov 25 Wed	Dec 3 Thu	Dec 4 Fri
Marysville JHS, 1605 7th St, Marysville, Wa	100	96		107		78	76					92	
17711 Ballinger Way NE, Lake Forest Park, Wa				91	76								
James St & Central Ave, Kent, Wa								76	79				
South Hill, 9616 128th St E, Puyallup, Wa					77					77			
Meadowdale, 7252 Blackbird Dr NE, KitsapCo, Wa			78							75	89		83

-- Indicates no sample on specified day

ATMOSPHERIC PARTICLES
(bsp (X 10 Exp-4)/M)
1992

Location	Monthly Arithmetic Averages												No. of 1 Hour Samples	Year Arith Mean
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hoyt Ave & 26th St, Everett, Wa	.44	.61	.97	.38	.45				.43	.56	.59	.47	7842	.52
17711 Ballinger Way NE, Lake Forest Park, Wa	.94	.84	.98	.38	.35	.22	.28		.36	.62	.80	.71	8461	.57
Duwamish, 4752 E Marginal Way S, Seattle, Wa	.78	.92	1.13	.43	.35	.28	.40	.44	.47	.62	.67	.43	8678	.58
James St & Central Ave, Kent, Wa	.95	.95	1.19	.39	.43	.30	.40	.41	.39	.66	.77	.56	8542	.61
27th St NE & 54th Ave NE, Northeast Tacoma, Wa	.67	.77	.92	.35	.36	.26	.31	.33	.34	.52	.62	.46	8692	.49
Fire Station #12, 2316 E 11th St, Tacoma, Wa	1.05	1.05	1.16		.34	.24	.31	.34	.39	.71	.87	.67	8364	.64

1992

Statistical Summary

Location	No. of 1 Hour Samples	Frequency Distribution - Percent												1 Hour Max	Arith Mean	Arith Std Dev
		5	10	20	30	40	50	60	70	80	90	95	99			
Hoyt Ave & 26th St, Everett, Wa	7842	.1	.2	.2	.3	.3	.4	.5	.6	.8	1.1	1.4	1.9	4.04	.52	.41
17711 Ballinger Way NE, Lake Forest Park, Wa	8461	.1	.1	.2	.2	.3	.4	.5	.6	.8	1.3	1.7	3.1	7.52	.57	.61
Duwamish, 4752 E Marginal Way S, Seattle, Wa	8678	.2	.2	.2	.3	.3	.4	.5	.6	.8	1.2	1.6	2.5	5.91	.58	.50
James St & Central Ave, Kent, Wa	8542	.1	.2	.2	.3	.3	.4	.5	.7	.9	1.3	1.7	2.5	4.55	.61	.53
27th St NE & 54th Ave NE, Northeast Tacoma, Wa	8692	.1	.1	.2	.2	.3	.3	.4	.5	.7	1.1	1.4	2.2	3.75	.49	.45
Fire Station #12, 2316 E 11th St, Tacoma, Wa	8364	.1	.2	.2	.3	.3	.4	.5	.7	1.0	1.5	2.0	2.8	5.13	.64	.62

CARBON MONOXIDE

Introduction

As a group, motor vehicles emit more carbon monoxide than any other source. For Puget Sound Region cities, motor vehicles contribute significantly in all cases of high carbon monoxide ambient levels.

The occasions with high ambient levels of carbon monoxide occur mainly during autumn and winter months near congested motor vehicle traffic. Traffic congestion occurs with afternoon commuting and concentrated shopping during holidays. Stable weather and light wind often exist during periods when levels are high. This weather condition temporarily reduces the means to disperse carbon monoxide that is emitted into the air.

Pollutant Standards Index and Washington State Episode Levels

The level of the 8 hour average standard is 9 parts per million (ppm), and this is equivalent to 100 on the Pollutant Standards Index scale. PSI values exceeding 100 are termed "Unhealthful". An 8 hour average of 15 ppm equals 200 on the PSI scale. Index values of 200 to 299 are described as "Very Unhealthful".

Episode criteria are specified in the Washington Episode Plan (Washington Administrative Code 173-435). The Alert stage is reached when the ambient carbon monoxide concentration reaches 15 ppm for an 8 hour average, and meteorological conditions are such that the carbon monoxide concentration can be expected to remain at or above that level for 12 or more hours, or to recur within 24 hours unless control actions are taken. Correspondingly, the carbon monoxide concentration for the Warning stage is 30 ppm for an 8 hour average, and for the Emergency stage is 40 ppm for an 8 hour average.

Summary of 1992 Data

The table in this section summarizes the six highest 1 hour and 8 hour average carbon monoxide levels at each station during 1992 as obtained from Department of Ecology data summaries. The Federal regulation, (40 CFR Part 50), directs that comparison of the data with the standards (in ppm) be made in terms of integers with fractional parts of 0.5 or greater rounding up. Further, the ambient concentration at a site shall not exceed the level of the standard more than once per year.

No stations except the Seattle University District station measured carbon monoxide values that exceeded the level of the 8 hour average standard. Since this occurred only once at this location, none of the stations in the Puget Sound Region violated the 8 hour average standard during 1992.

Multi-Year Summary

Multi-year graphs for carbon monoxide present column charts to show the historical trend. For the longest term sampling sites in the cities of Seattle, Everett, Bellevue and Tacoma, one chart shows the number of days on which the 8 hour average exceeded 9 ppm for each year from 1979 to 1992. A companion chart graphs the value that was the second high 8 hour average for each of those years. If the second high 8 hour average equals or exceeds 9.5 ppm, this violates the standard.

For all cities, the data acquired since 1979 show that carbon monoxide values have improved, though there is some variability from year to year. As documented in previous annual data summaries, the first complete year of carbon monoxide data for the Seattle 5th Avenue and James Street station was 1972. The results at this station have improved from exceeding the primary standard 112 days in 1972 and 130 days in 1973, to zero exceedances during 1987 through 1992.

To show the standard has been attained for any station, the U. S. EPA requires that the number of cases exceeding the level of the standard averaged over a two year period not exceed one per year. The charts show that for the last two years the carbon monoxide levels have achieved the standards. The significant improvement from levels in the mid 1970's is due mainly to the Federal emission standards for new motor vehicles and to the program requiring regular testing of vehicle emissions to assure compliance with these standards.

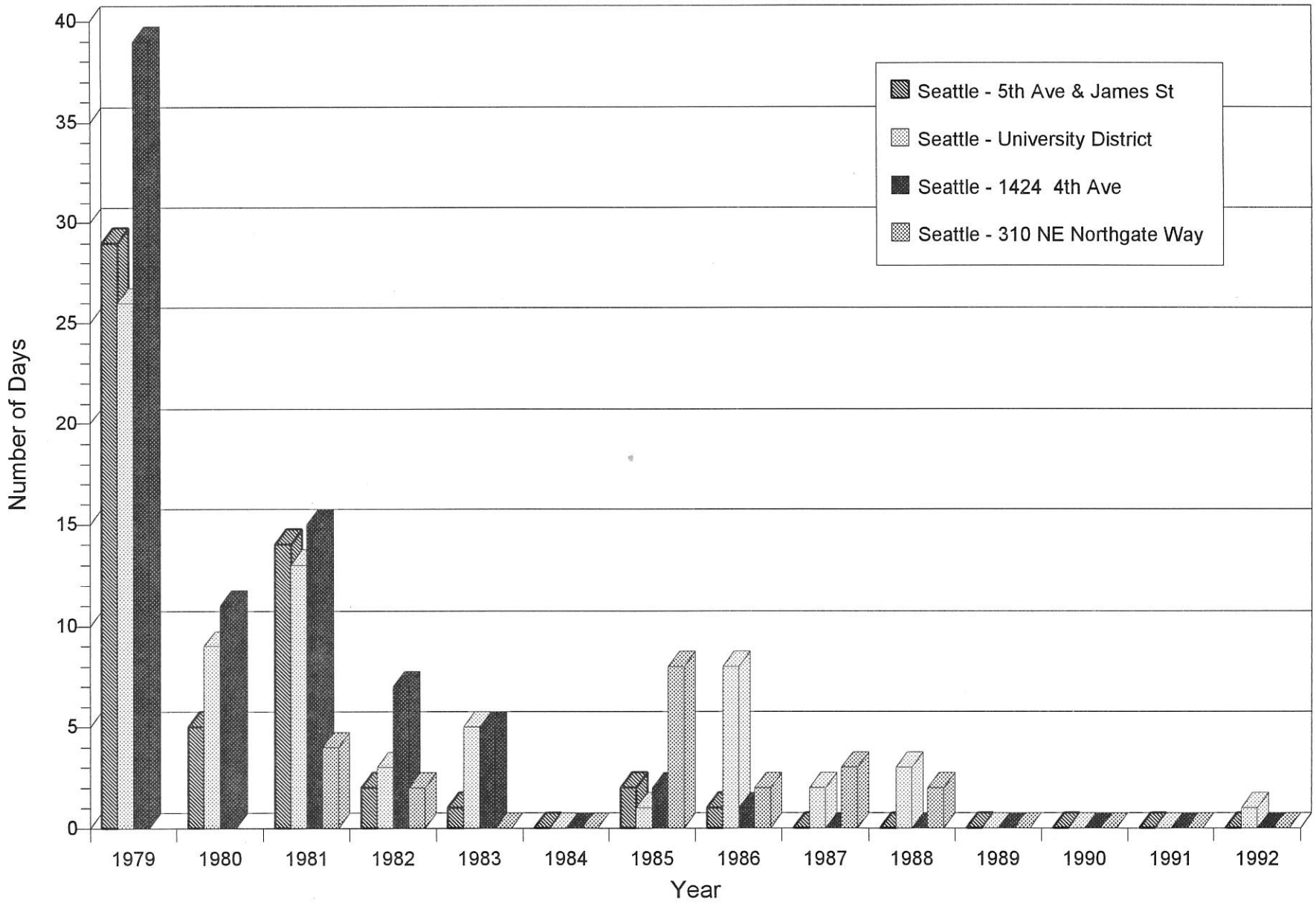
CARBON MONOXIDE
(Parts per Million)
1992

Location / Continuous Sampling Period(s)	Six Highest Concentrations						Number of 8 Hour Averages Exceeding 9 ppm	Number of Days 8 Hour Average Exceeded 9 ppm
	1 Hour Average			8 Hour Average				
	Value	Date	End Time	Value	Date	End Time		
Broadway & Hewitt Ave, Everett, Wa	16.1	3 Feb	1900	9.0	4 Feb	2300	0	0
1 Jan-31 Dec	14.2	4 Feb	0900	8.7	2 Mar	1900		
	13.9	4 Feb	1700	8.5	10 Feb	1900		
	13.0	7 Jan	1900	8.4	6 Jan	1900		
	12.6	4 Feb	0800	8.0	1 Apr	2000		
	12.5	7 Jan	1800	7.9	7 Jan	1900		
622 Bellevue Way NE, Bellevue, Wa	11.9	3 Feb	1800	8.1	3 Feb	2300	0	0
1 Jan-31 Dec	10.7	3 Feb	1900	7.3	18 Jan	2400		
	10.0	3 Feb	2000	6.7	25 Nov	2400		
	9.8	18 Jan	1900	6.1	4 Feb	2400		
	9.2	25 Nov	1800	6.0	4 Dec	2400		
	9.1	18 Jan	2000	5.9	6 Feb	2400		
Northgate, 310 NE Northgate Way, Seattle, Wa	14.0	3 Feb	0900	8.4	18 Jan	2200	0	0
1 Jan-31 Dec	12.5	29 Sep	0800	8.1	11 Feb	1400		
	10.7	11 Feb	0800	7.5	3 Feb	2300		
	10.6	12 Feb	0900	7.1	3 Feb	1400		
	10.4	3 Feb	0800	6.9	11 Feb	2300		
	10.2	18 Jan	1700	6.7	29 Sep	1300		
University Dist, 1307 NE 45th St, Seattle, Wa	17.5	3 Feb	1900	12.9	4 Feb	0200	1	1
1 Jan-31 Dec	17.1	3 Feb	2200	9.2	18 Jan	2100		
	15.3	3 Feb	2300	8.1	3 Feb	1400		
	13.3	3 Feb	2100	8.1	29 Sep	1900		
	12.9	3 Feb	2000	8.0	28 Feb	2000		
	12.3	3 Feb	0900	7.8	20 Jan	1900		
1424 4th Ave, Seattle, Wa	10.3	3 Feb	2200	6.9	3 Feb	2300	0	0
1 Jan-31 Dec	9.7	3 Feb	1800	5.9	3 Feb	1400		
	9.3	9 Apr	1300	5.7	4 Feb	1400		
	9.0	3 Feb	1000	5.7	10 Feb	1900		
	8.9	27 Feb	2000	5.5	7 Feb	2300		
	8.4	3 Feb	0900	5.5	12 Feb	1500		
5th Ave & James St, Seattle, Wa	11.2	24 Feb	1700	8.0	3 Feb	2200	0	0
1 Jan-31 Dec	11.0	3 Feb	1800	7.5	3 Feb	1400		
	10.7	3 Feb	1000	7.3	27 Feb	2100		
	10.6	3 Feb	0900	6.5	30 Sep	1900		
	10.3	29 Sep	1600	6.4	4 Feb	1400		
	9.6	4 Dec	0900	6.2	11 Feb	1900		
1101 Pacific Ave, Tacoma, Wa	15.8	27 Feb	1800	9.3	3 Feb	1800	0	0
1 Jan-2 Apr; 15 Apr-31 Dec	14.1	28 Feb	1800	8.9	29 Sep	2200		
	13.9	3 Feb	1800	8.3	28 Feb	1900		
	13.3	26 Feb	1800	8.2	12 Feb	1600		
	12.5	3 Feb	1600	8.0	28 Sep	2200		
	11.8	20 Jan	1900	7.7	27 Feb	2000		

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.

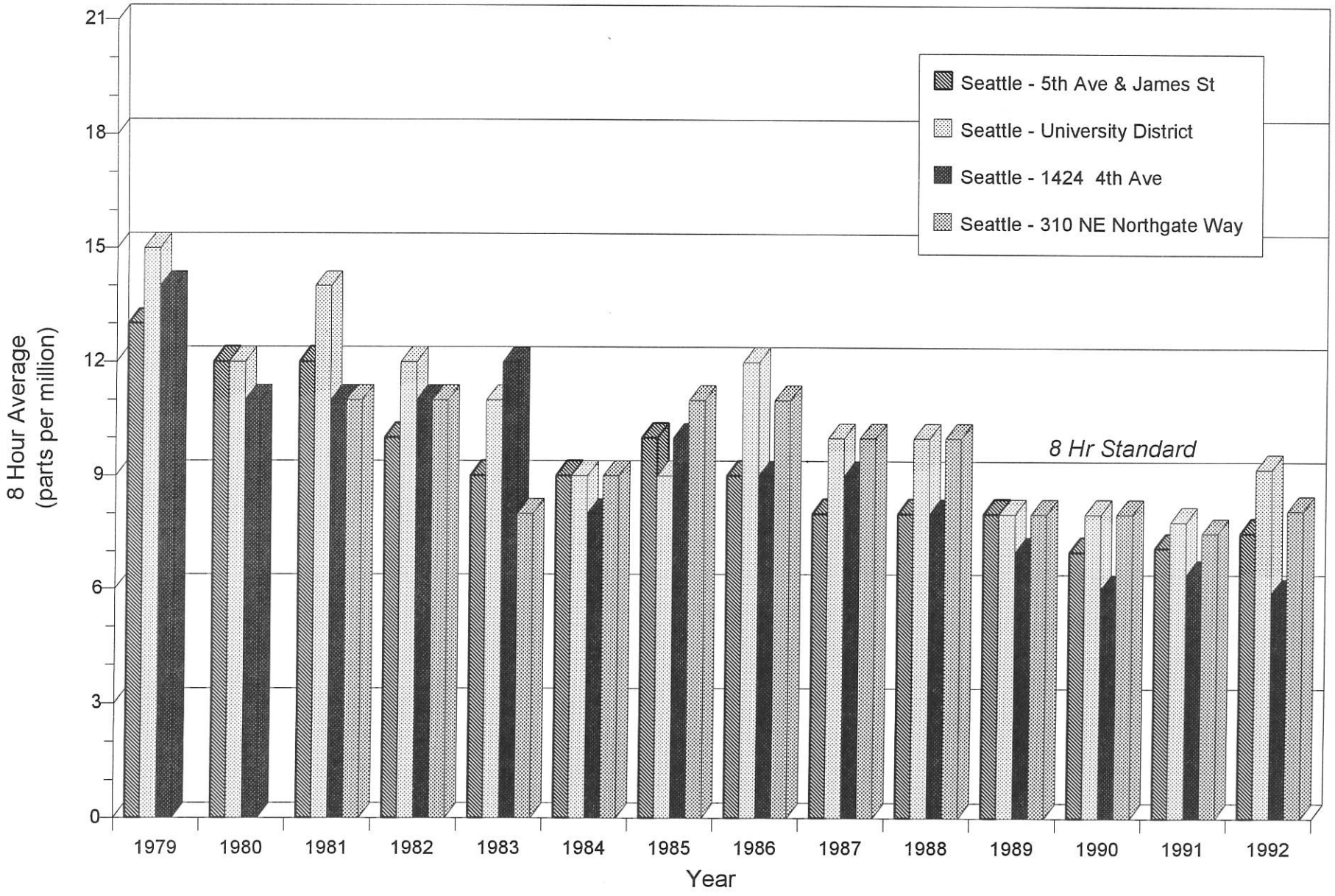
CARBON MONOXIDE

Number of Days 8 Hour Average Exceeded 9 ppm



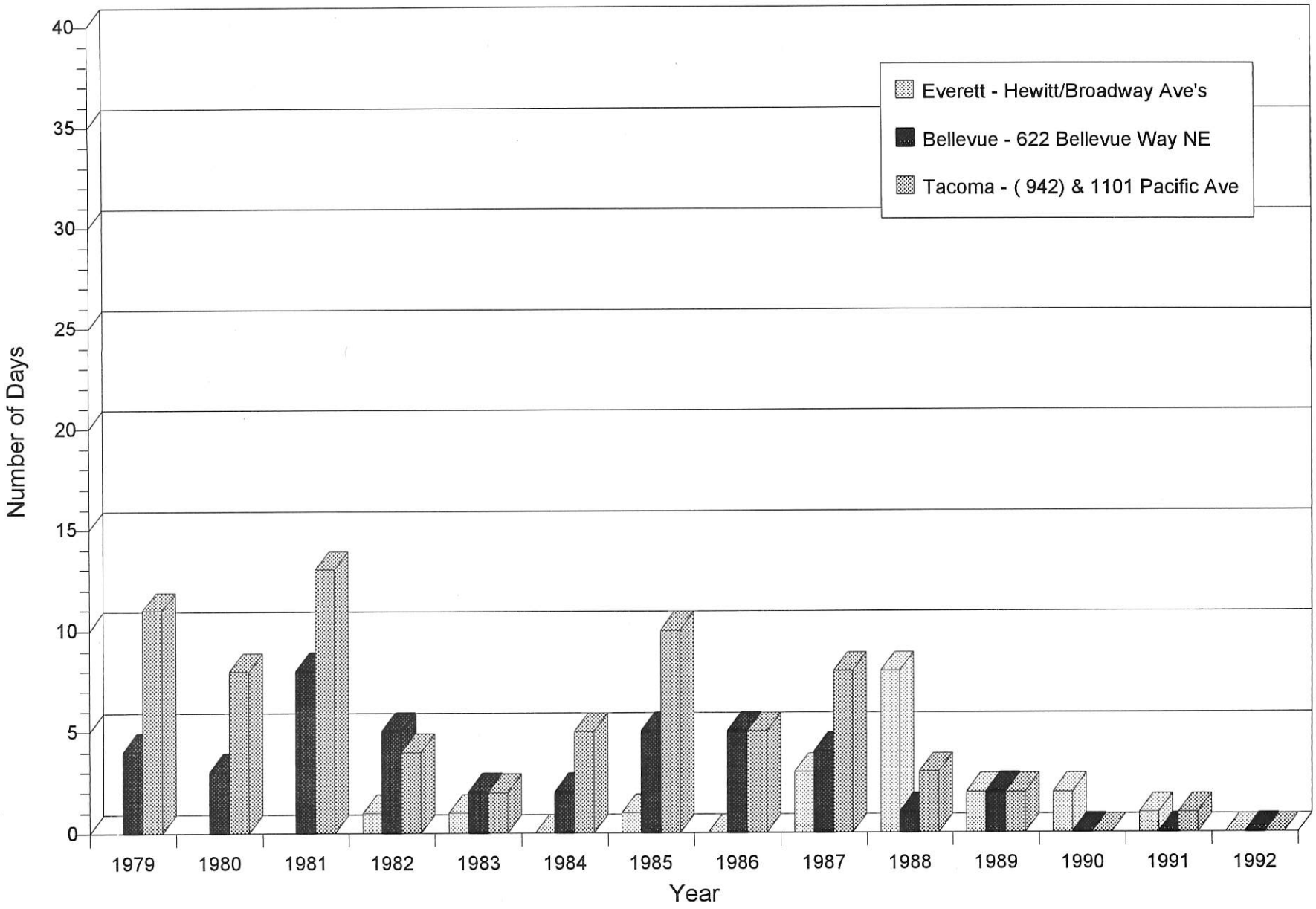
CARBON MONOXIDE

Second High 8 Hour Average



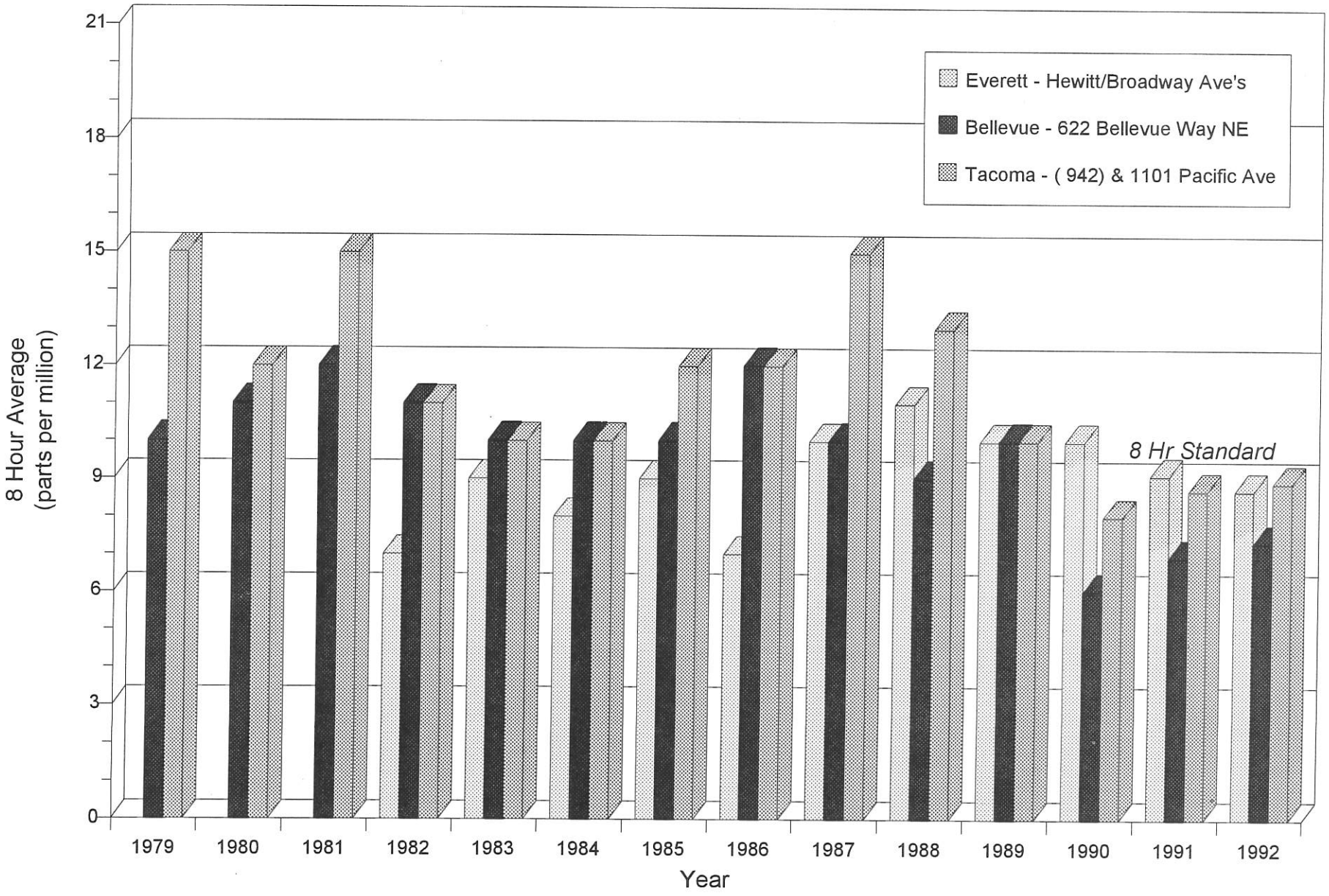
CARBON MONOXIDE

Number of Days 8 Hour Average Exceeded 9 ppm



CARBON MONOXIDE

Second High 8 Hour Average



OZONE

Introduction

The principal oxidant found in photochemical smog is ozone, a very reactive form of oxygen. Most photochemical oxidants result from chemical reactions in the ambient air between nitrogen oxides and volatile organic compounds (VOC) that take place under intense sunlight.

The highest ozone levels occur on hot summer afternoons, since this is the period of most intense radiant energy from sunlight. However, even with strong sunlight, ozone levels would be low without the precursor nitrogen oxide and VOC pollutants emitted from human activities.

On any given day the photochemical reactions continue for several hours and generally produce maximum ozone levels between noon and early evening at locations miles away from the sources of nitrogen oxides and VOC. Each day after nightfall the high ozone levels diminish because the photochemical effect ends. However, the photochemical smog is such a complex mixture that significant ozone levels sometimes continue for hours into the night.

In the Puget Sound Region the highest ozone levels occur from mid May to mid September on the few hot days favorable for significant photochemical activity. These high values develop when urban area emissions are trapped beneath a nighttime and morning temperature inversion followed during the day by very high temperatures. Light northerly winds often develop on these hot days. As a result, the highest ozone values normally occur south to southeast of the major cities or source areas.

Ozone Standard and Summary of Data

The U. S. EPA has set the level of the ozone standard at a value of 0.12 ppm. According to the Federal regulation (40 CFR Part 50, Appendix H), the standard is attained when the expected number of days per calendar year with a maximum hourly average concentration above 0.12 ppm is one day or less. If an "exceedance" means a day on which the maximum 1 hour average is higher than 0.12 ppm, the standard is attained when the expected number of exceedances is equal to or less than one. If no data are missing, the expected number of exceedances is the average number of measured exceedances per year at a particular location for the last three years.

When some data for a given year are missing, the number of exceedances in that year must be adjusted to estimate the true number. The estimate is calculated using the number of measured exceedances, the number of required monitoring days, the number of days with a measured maximum value and the number of days determined to be less than the level of the standard. The required ozone monitoring season in Washington state is the period from April 1 through October 31 each year.

For each year the estimated number of exceedances is always equal to or greater than the measured number of exceedances. For stations where no exceedances are measured, the estimate is zero. The expected number of exceedances is then the average of the annual estimates for the last three years.

The 1992 ozone summary table on the following page lists the six highest daily maximum 1 hour averages for each monitoring location. There were no exceedances of the ozone standard at any site during 1991 and 1992. However, for the three year period ending with 1992, the expected number of ozone exceedances calculates to be 1.3 days for the Enumclaw location; all other ozone monitoring locations calculate to be 1.0 or fewer days. The Enumclaw site is out of compliance with the ozone standard due to exceedances during 1990.

Pollutant Standards Index

A one hour average ozone value of 0.12 ppm is equivalent to 100 on the Pollutant Standards Index scale. Since the high ozone levels occur some distance downwind of major cities, ozone never determines the Index for Everett, Seattle or Tacoma. The highest ozone values occur at outlying locations such as Lake Sammamish, Enumclaw or La Grande. For 1992, the maximum ozone level occurred July 30 and was described as "moderate" on the Index scale.

OZONE
(Parts per Million)
1992

Location / Continuous Sampling Period(s)	Six Highest Daily Maximum 1 Hour Averages			Estimated No. of Days Daily Maximum 1 Hour Average Exceeded .12 ppm			No. of Days Daily Maximum 1 Hour Average Expected To Exceed .12 ppm
	Value	Date	End Time	1990	1991	1992	
20050 SE 56th, Lake Sammamish State Park, Wa 1 Apr-31 Oct	.094 .092 .090 .088 .083 .082	24 May 13 Aug 27 Jun 30 Jul 31 Jul 5 May	1500 1400 1500 1600 1500 1700	1.0	0.0	0.0	0.3
Highway 410, 2 miles east of Enumclaw, Wa 1 Apr-31 Oct	.108 .104 .101 .098 .098 .097	30 Jul 13 Aug 17 Jul 24 May 24 Jun 23 Jun	1600 1500 1600 1600 1600 1600	3.8	0.0	0.0	1.3
Charles L Pack Forest, La Grande, Wa 1 Apr-31 Oct	.103 .097 .097 .096 .095 .090	30 Jul 22 Jun 17 Jul 16 Jul 24 May 18 Jul	1700 1700 1700 1700 1600 1500	2.9	0.0	0.0	1.0

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.

LEAD

The ambient air quality standard for lead is 1.5 $\mu g/m^3$ averaged over one calendar quarter. In urban areas lead emissions to the air come principally from automobile exhaust. Industrial area lead emissions come mostly from stationary sources such as primary and secondary nonferrous smelters. As shown below, lead concentrations measured in the Puget Sound Region during 1992 were lower than the ambient standard. These current ambient lead levels are significantly lower than levels existing during the 70's, due primarily to the phase down of lead in gasoline. The lead levels at the Harbor Island station still document some effect from the nearby site of a secondary lead smelter that ceased operation several years ago.

LEAD
Micrograms per Standard Cubic Meter

Sampling Method: Standard High Volume Quartz Fiber filters

1992

Location	Monthly Arithmetic Averages												No. Of Obs.	Year Arith Mean
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
5701 8th Ave NE, Seattle, Wa	.04	.04	.04	.03	.07	.03	.03	.02	.03	.03	.04	.01	56	.03
Harbor Island, 2555 13th Ave SW, Seattle, Wa	.19	1.19	.09	.21	.15	.68	.13	.23	.26	.19	.34	.56	62	.35

Location	Quarterly Arithmetic Averages			
	1st	2nd	3rd	4th
5701 8th Ave NE, Seattle, Wa	.04	.04	.03	.03
Harbor Island, 2555 13th Ave SW, Seattle, Wa	.49	.35	.21	.36

Summary of Individual 24 Hour Average Lead Values

Location	Highest Value		Values Higher than .50	
	Value	Date	Value	Date
5701 8th Ave NE, Seattle, Wa	.26	18 May		
Harbor Island, 2555 13th Ave SW, Seattle, Wa	4.43	18 Feb	4.43	18 Feb
			2.46	8 Dec
			1.36	17 Jun
			.98	3 Sep
			.97	20 Nov
			.89	11 Jun
			.82	4 Aug
			.69	5 Jun
			.69	21 Oct
			.59	18 May

SULFUR DIOXIDE

Sulfur dioxide is a common air pollutant regulated under a national standard. Local sulfur dioxide standards have been in effect since 1968. The national, state and local sulfur dioxide standards are summarized on page 48. Sulfur dioxide enters the air mainly from industrial processes and from the combustion of sulfur-containing fuels such as coal and oil. In the Puget Sound Region, the four main industrial areas with sulfur dioxide point sources are the Everett Port area, Seattle Harbor Island-Duwamish Valley area, Tacoma Port area and the Bremerton Naval Shipyard. Reactions in the air partially convert sulfur dioxide to other sulfur compounds such as sulfuric acid and various sulfate salts. The tables below summarize sulfur dioxide data collected during 1992.

SULFUR DIOXIDE
(Parts per Million)
1992

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		
Hoyt Ave & 26th St, Everett, Wa	.004	.007	.007	.005	.006	.006	.007	.008	.006	.006	.004	.005	8639	.006
Duwamish, 4752 E Marginal Way S, Seattle, Wa	.011	.011	.010	.009	.010	.009	.009	.008	.008	.009	.009	.011	8423	.010
27th St NE & 54th Ave NE, Northeast Tacoma, Wa	.014	.011	.010	.008	.006	.006	.007	.009	.011	.011	.010	.011	8623	.010
2301 Alexander Ave, Tacoma, Wa	.009	.010	.008	.007	.007	.007	.008	.009	.011	.011	.010	.009	8676	.009

Maximum and Second Highest Concentrations for Various Averaging Periods

Location / Continuous Sampling Periods(s)	1 Hour Average			3 Hour Average			24 Hour Average		
	Value	Date	End Time	Value	Date	End Time	Value	Date	End Time
Hoyt Ave & 26th St, Everett, Wa	.053	3 Jul	2100	.041	3 Jul	2200	.017	12 Aug	2200
1 Jan-31 Dec	.051	10 Feb	1300	.035	22 Sep	1700	.016	31 Jul	1400
Duwamish, 4752 E Marginal Way S, Seattle, Wa	.089	7 Jul	1200	.069	26 Dec	1300	.031	22 Dec	1600
1 Jan-31 Dec	.089	22 Nov	0500	.063	15 Jan	1800	.027	27 Dec	0300
27th St NE & 54th Ave NE, Northeast Tacoma, Wa	.111	23 Oct	0900	.083	27 Feb	0900	.044	27 Feb	1100
1 Jan-31 Dec	.110	19 Jan	0600	.079	23 Oct	1000	.040	30 Sep	0900
2301 Alexander Ave, Tacoma, Wa	.093	4 Dec	1300	.074	4 Dec	1400	.026	30 Sep	0800
1 Jan-31 Dec	.085	26 Feb	1200	.063	29 Sep	1200	.024	28 Feb	2300

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 sulfur dioxide was measured using the continuous ultraviolet fluorescence method.

QUALITY ASSURANCE

Introduction

Quality Assurance (QA) includes all activities involved with obtaining valid data and documenting the quality of the data. Quality Assurance is an integral part of all monitoring activities. Some specific QA activities are: selection of methods and analyzers; installation of equipment; calibration; zero and span checks and adjustments; control checks, limits and corrective actions; maintenance; recording and validating data; and documentation of quality control information.

The Agency participates in audit programs conducted independently by the U. S. Environmental Protection Agency and the Washington State Department of Ecology. For the EPA, this consists of (1) Agency participation in EPA's national performance audits, and (2) occasional on-site audits of some Agency monitoring equipment by EPA or a designated representative. Each quarter the Department of Ecology also independently performs audits on Agency monitoring equipment at various locations.

Precision and Accuracy Audits

The QA program requirements are established in Title 40, Code of Federal Regulations, Part 58. The important QA characteristics that the regulations require to be developed and reported are *precision* and *accuracy*. In simple terms, *precision* means the ability to repeat a measurement of the same, known sample at a different time; *accuracy* means the agreement between a measurement and the true value.

At a minimum, each instrument measuring a pollutant at a location must be audited for precision at least every two weeks and for accuracy at least once per year. For each audit, the percentage difference between the instrument indicated concentration and the true concentration is calculated.

Each calendar quarter the average and the standard deviation of these percentage differences are calculated. These two statistics are then pooled for all audits involving the same parameter.

Probability Limits

The Federal regulation requires summary of the precision and accuracy audit results by computing the 95 percent probability limits for each pollutant from the weighted average percentage difference, D, and the pooled standard deviation, S_a, as follows:

$$\text{Upper 95 Percent Probability Limit} = D + 1.96\,(S_a)$$

$$\text{Lower 95 Percent Probability Limit} = D - 1.96\,(S_a)$$

These upper and lower limits reflect data quality by establishing that, with 95 percent probability, the data values during the audit period fall within the limits. As an example, if the average of the percentage differences is zero and the standard deviation of the percentage differences is 4.1 percent, the upper and lower 95 percent probability limits are respectively +8 and -8 percent.

Agency Precision and Accuracy

For most Agency monitoring locations precision audits are performed each week and accuracy audits are completed each month or each quarter. The table following this page summarizes the precision and accuracy probability limits by quarter for all air monitoring data that the Agency originated in 1992.

For each parameter, the type of audit, (accuracy or precision), is followed by a brief phrase description of the audit process or the actual measurement point that is audited. The number of audits and the lower and upper probability limits (of percentage differences) are presented for each quarter. Wind sensor audits report the quarterly audit of the direction system for the cardinal points and the quarterly audit of the speed system at one of the controlled rates of shaft rotation.

DATA QUALITY ASSESSMENT
1992

Lower and Upper 95 Percent Probability Limits of Percent Differences

Parameter & Type of Audit	Number of Stations	*Audit Results by Quarter*											
		1st			*2nd*			*3rd*			*4th*		
		Number of Audits	Prob. Limits Lwr (%)	Prob. Limits Upr (%)	Number of Audits	Prob. Limits Lwr (%)	Prob. Limits Upr (%)	Number of Audits	Prob. Limits Lwr (%)	Prob. Limits Upr (%)	Number of Audits	Prob. Limits Lwr (%)	Prob. Limits Upr (%)
Particulate Matter (PM10)	13												
(Reference Method)													
Accuracy													
Flow Rate		83	-4	3	75	-4	4	91	-5	5	76	-5	2
Precision													
Collocated Samples		26	-8	6	25	-6	1	28	-7	3	21	-5	4
Particulate Matter (PM10)	5												
(Equivalent Method)													
Accuracy													
Flow Rate		15	-2	6	15	-7	3	15	-7	3	15	-5	11
Sulfur Dioxide	4												
Accuracy													
Level 1		15	-4	10	9	-5	9	10	-5	9	14	-4	12
Level 2		15	-4	11	9	-5	10	10	-3	8	14	-4	10
Level 3		15	-4	11	9	-3	8	10	-3	8	14	-4	10
Level 4		3	-11	13	2	1	2	2	-1	7	2	0	5
Precision													
One point check		52	-4	10	52	-3	9	53	-3	8	63	-4	8
Atmospheric Particles	6												
(Nephelometer)													
Precision													
One point check		76	-4	8	75	-4	5	75	-2	3	84	-3	5
Wind	10												
Direction													
Accuracy													
90 degrees (E)		10	0	0	9	-1	1	10	-1	1	10	-1	0
180 degrees (S)		10	-1	0	9	0	1	10	0	1	10	-1	1
270 degrees (W)		10	0	1	9	0	0	10	-1	1	10	-1	1
360 degrees (N)		10	0	0	9	0	0	10	0	0	10	0	0
Speed													
Accuracy													
11 mph (1000 rpm)		10	-1	1	9	-1	1	10	-1	1	10	-1	1

AIR POLLUTION EPISODES and IMPAIRED AIR QUALITY PERIODS

Introduction

The policy and rules for air pollution episode avoidance and for restrictions on the use of solid fuel burning devices during periods of "impaired air quality" are established by the Washington Clean Air Act and implemented by state and local regulations. Legislative amendments significantly revised these rules effective in mid 1990.

Air Pollution Episodes

The Washington Clean Air Act defines air pollution episodes and the policy for establishing an avoidance plan in RCW 70.94.710 through 70.94.730. The Washington State Department of Ecology has adopted WAC 173-435 which implements an episode avoidance plan.

The "First" or "Forecast" stage of the Episode Plan may be declared by the Department of Ecology when an air stagnation advisory is issued by the National Weather Service or there is equivalent indication of stagnant atmospheric conditions and conditions are forecast to persist for 24 hours. During 1992, the Department of Ecology declared the "Forecast" stage of an air pollution episode that included the Puget Sound Region for one period as follows:

10:00 am, Wednesday, February 5 -
4:00 pm, Friday, February 7.

Impaired Air Quality Periods

The Washington Clean Air Act defines two stages of "impaired air quality" in RCW 70.94.473. A *first stage* of "impaired air quality" is reached when PM_{10} is at an ambient level of 75 $\mu g/m^3$ measured on a 24 hour average or when carbon monoxide is at an ambient level of 8 ppm measured on an 8 hour average.

During a first stage of "impaired air quality", any person in a residence or commercial establishment which has an adequate source of heat without burning wood shall not burn wood in any solid fuel burning device except those certified as described in RCW 70.94.473 or a pellet stove either certified or issued an exemption by the U. S. Environmental Protection Agency.

A *second stage* of "impaired air quality" is reached when PM_{10} is at an ambient level of 105 $\mu g/m^3$ measured on a 24 hour average. When a second stage of "impaired air quality" is in effect, any person in a residence or commercial establishment which has an adequate source of heat without burning wood shall not burn wood in any solid fuel burning device.

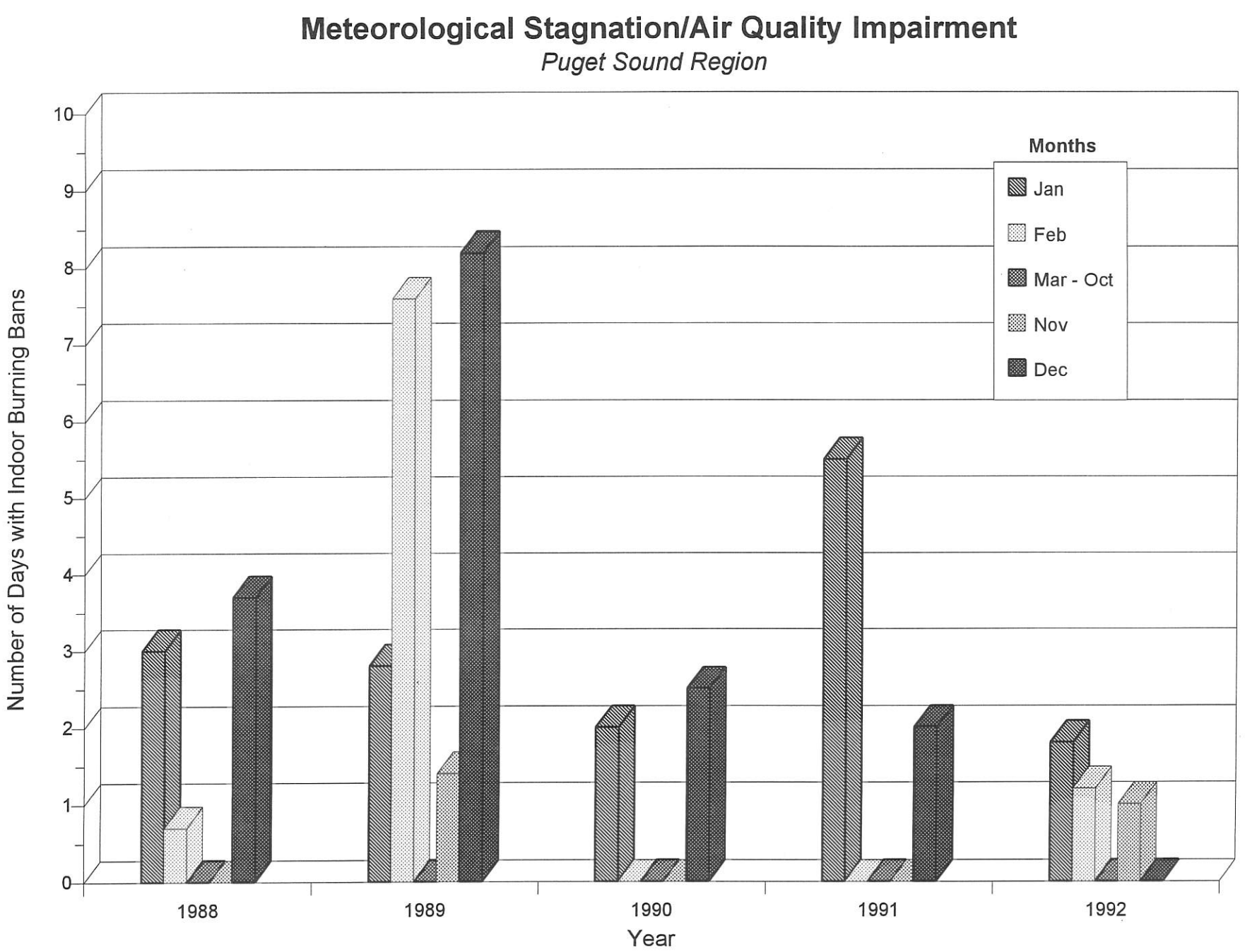
During 1992, "impaired air quality" was in effect in the Puget Sound Region as follows:

Stage	Dates/Counties
1	2:30 pm, Wednesday, January 8 - 9:30 am, Thursday, January 9; (King, Pierce, Snohomish & Kitsap)
1	2:30 pm, Sunday, January 19 - 2:30 pm, Monday, January 20; (King, Pierce & Snohomish)
1	10:00 am, Wednesday, February 5 - 2:30 pm, Thursday, February 6; (King, Pierce & Snohomish)
1	2:30 pm, Wednesday, November 25 - 2:30 pm, Thursday, November 26. (Kitsap)

Along with the restrictions on the use of solid fuel burning devices as outlined above, all outdoor fires are prohibited during any period of "impaired air quality".

Air Quality Impairment Chart

The following graph displays occurrences of air quality impairment beginning in January 1988 when indoor burning restrictions were first applied. The number of days is determined from the total number of hours of prohibited indoor burning divided by 24. Results for January, February, November and December are displayed individually. The March - October category shows that no burn bans have ever occurred during those spring through fall months.


Meteorological Stagnation/Air Quality Impairment
Puget Sound Region
Number of Days with Indoor Burning Bans
0
1
2
3
4
5
6
7
8
9
10
1988
1989
1990
1991
1992
Year
Months
Jan
Feb
Mar - Oct
Nov
Dec

WIND ANALYSIS

Wind Data

Everyone has a qualitative sense of surface wind and some effects produced by the wind. The wind direction helps identify the sources or source areas affecting a specific location.

From an air pollution standpoint, low wind speed poorly dilutes pollutants and is therefore associated with higher air pollutant concentrations. During a stable, temperature inversion condition, the wind is often light or calm. When this condition persists, the natural process that effectively disperses pollutants is greatly diminished, and pollutant levels are higher near the source areas.

Wind Speed Averages

The table below presents monthly and annual average wind speed computed from hour average wind speed at various locations. These average values are sometimes used to compare locations or different months. Air stagnation episodes are not exposed by this analysis unless episode conditions predominate during most of a month.

Wind Roses

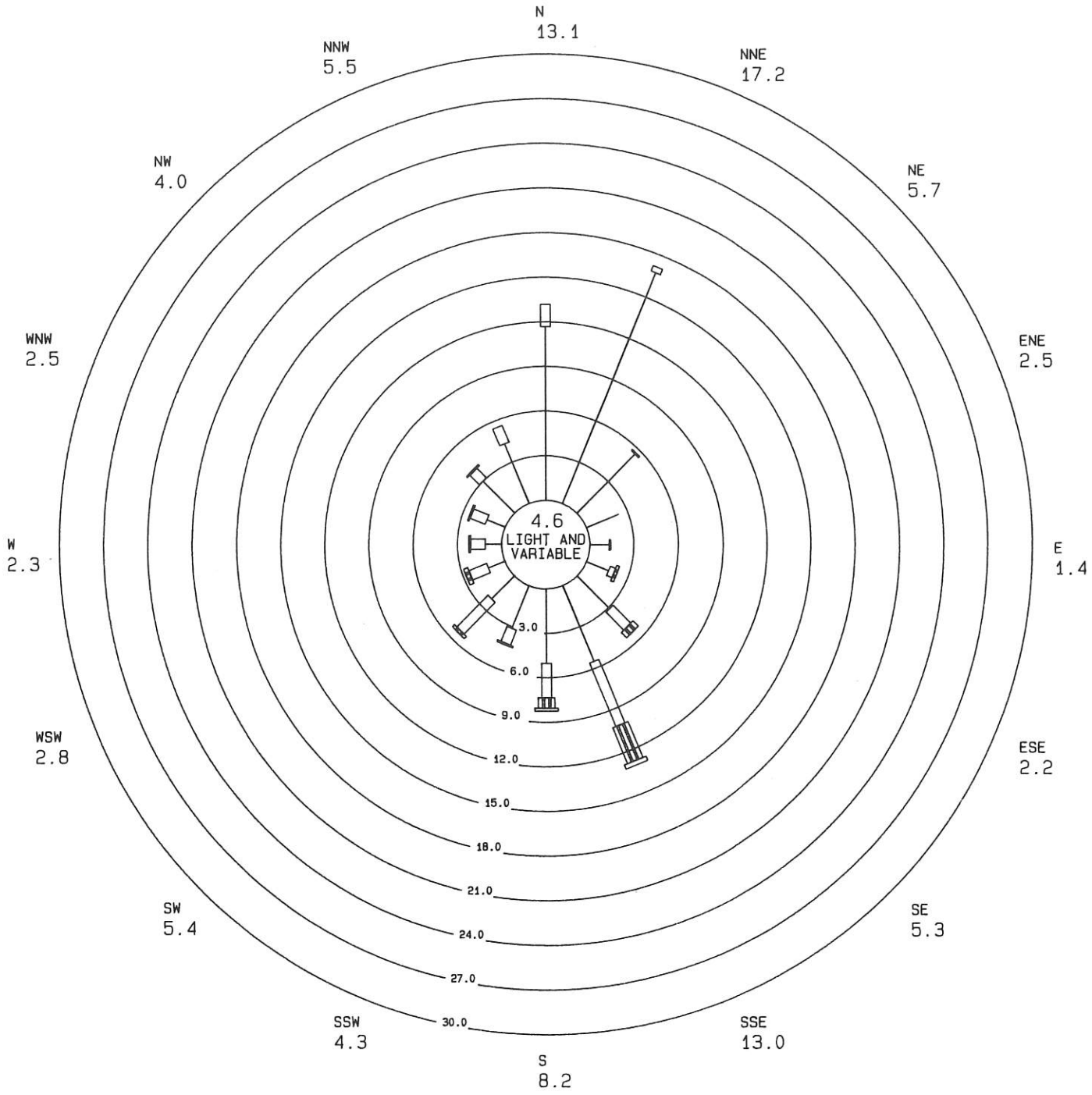
A wind rose is a quantitative graphical summary of the wind direction and speed for a given time. The following wind rose graphs show the number of observations or hours, expressed as a percentage, that had a particular direction and speed during the summary period.

The wind rose spokes or arms represent 16 points of the compass and are labeled by wind direction. The percentage of time the wind blew *from* a given direction (without regard to speed) is expressed numerically beneath that direction on the perimeter of each rose.

For a particular wind direction the length of each segment of a spoke represents the percentage of time the wind speed was within a specific speed interval. If summed for all wind directions, the result would provide the percentage of all hours the wind speed was measured within a particular interval. The percentage of time during which the wind was light and variable shows in the center of the rose.

WIND SPEED
(Miles per Hour)
1992

Location	Monthly Arithmetic Averages												No. of 1 Hour Samples	Year Arith Mean
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Marysville JHS, 1605 7th St, Marysville, Wa	4.6	3.0	2.6	4.3	3.5	3.7			3.4	3.0	3.2	3.5	8198	3.4
Hoyt Ave & 26th St, Everett, Wa	5.9	4.5	3.9	5.0	4.9	4.7	4.2	4.2	4.6	4.5	4.8	5.0	8779	4.7
17711 Ballinger Way NE, Lake Forest Park, Wa	2.9	2.2	2.0	3.4	2.7	2.7	2.2	2.5	2.5	2.0	2.4	2.6	8765	2.5
Duwamish, 4752 E Marginal Way S, Seattle, Wa	5.0	3.6	3.4	5.2	4.8	4.7	4.3	4.3	4.6	4.0	4.1	5.5	8778	4.5
James St & Central Ave, Kent, Wa	4.1	3.1	2.9	4.6	4.2	4.0	3.7	3.6	3.8	2.9	3.3	4.7	8778	3.7
South Hill, 9616 128th St E, Puyallup, Wa	3.2	1.7	1.4	2.7	2.5	2.2	2.1	1.9	2.4	1.7	2.2	2.7	8771	2.2
27th St NE & 54th Ave NE, Northeast Tacoma, Wa	4.3	3.6	3.7		4.0	3.3	3.3	3.4	3.5	3.2	2.8	4.5	8126	3.6
2301 Alexander Ave, Tacoma, Wa	5.0	3.7	3.8	5.7	5.9	5.5	5.2	5.1	5.3	3.9	4.0	5.3	8777	4.9
Fire Station #12, 2316 E 11th St, Tacoma, Wa	5.1	3.8	3.9	5.7	5.8	5.5	5.3	5.1	5.3	3.9	4.1	5.5	8775	4.9
Meadowdale, 7252 Blackbird Dr NE, KitsapCo, Wa	2.5	1.5	1.3	2.2	2.0	1.9	1.7	1.7	1.8	1.6	1.5	2.1	8758	1.8



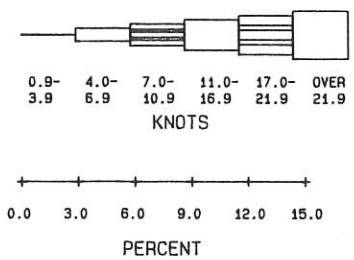
HOUR AVERAGE SURFACE WINDS

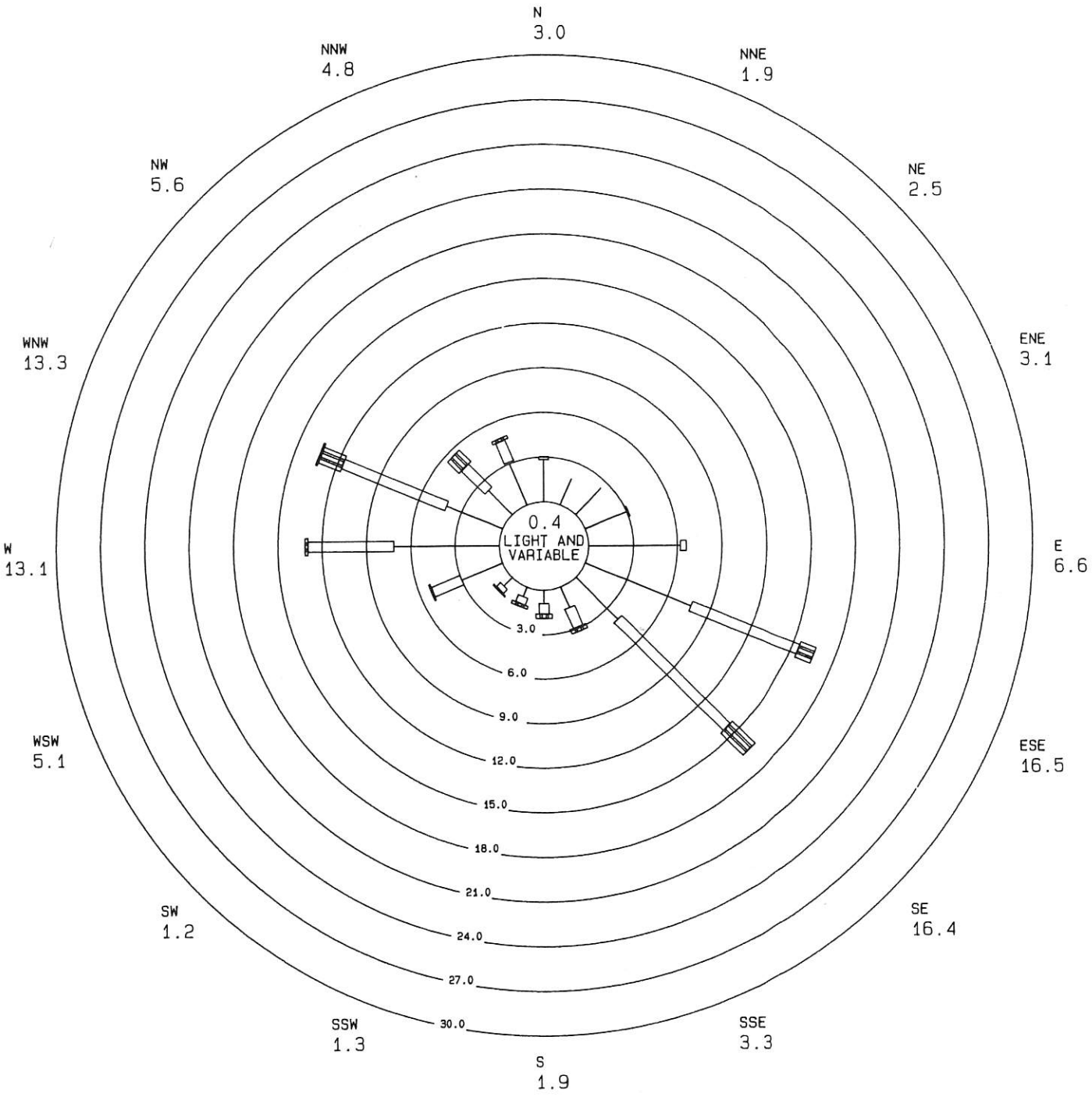
PERCENTAGE FREQUENCY OF OCCURRENCE

STATION LOCATION- PUGET SOUND AIR POLLUTION CONTROL AGENCY
Marysville JHS, 1605 7th St, Marysville, Wa

INCLUSIVE DATES- ALL MONTHS 1992

TOTAL OBSERVATIONS- 8, 198





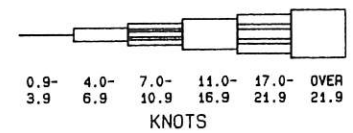
HOUR AVERAGE SURFACE WINDS

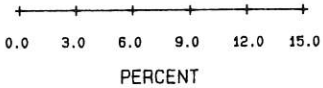
PERCENTAGE FREQUENCY OF OCCURRENCE

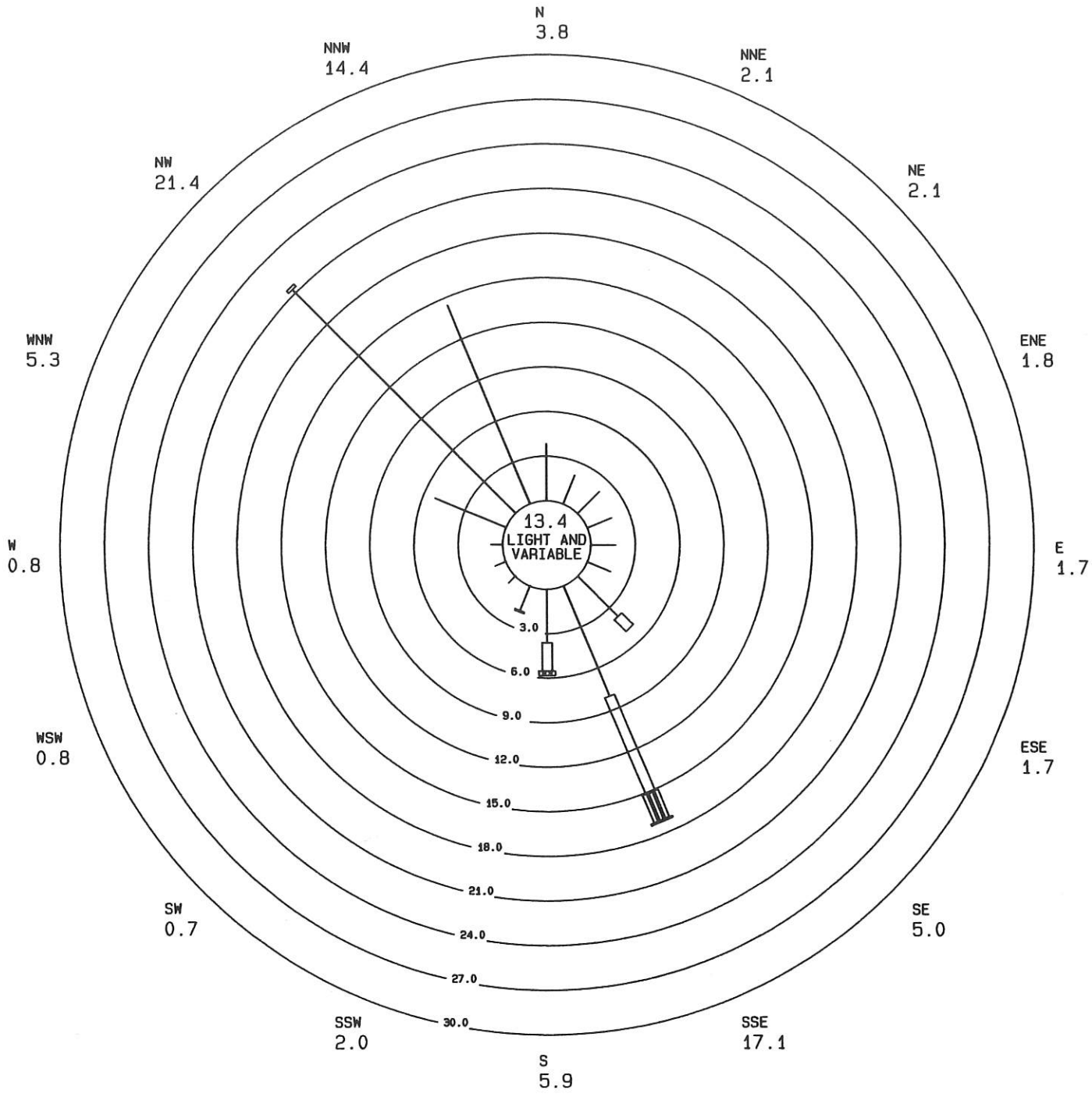
STATION LOCATION- PUGET SOUND AIR POLLUTION CONTROL AGENCY
Hoyt Ave & 26th St, Everett, Wa

INCLUSIVE DATES- ALL MONTHS 1992

TOTAL OBSERVATIONS- 8,779







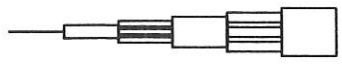
HOUR AVERAGE SURFACE WINDS

PERCENTAGE FREQUENCY OF OCCURRENCE

STATION LOCATION- PUGET SOUND AIR POLLUTION CONTROL AGENCY
17711 Ballinger Way NE, Lake Forest Park, Wa

INCLUSIVE DATES- ALL MONTHS 1992

TOTAL OBSERVATIONS- 8,765

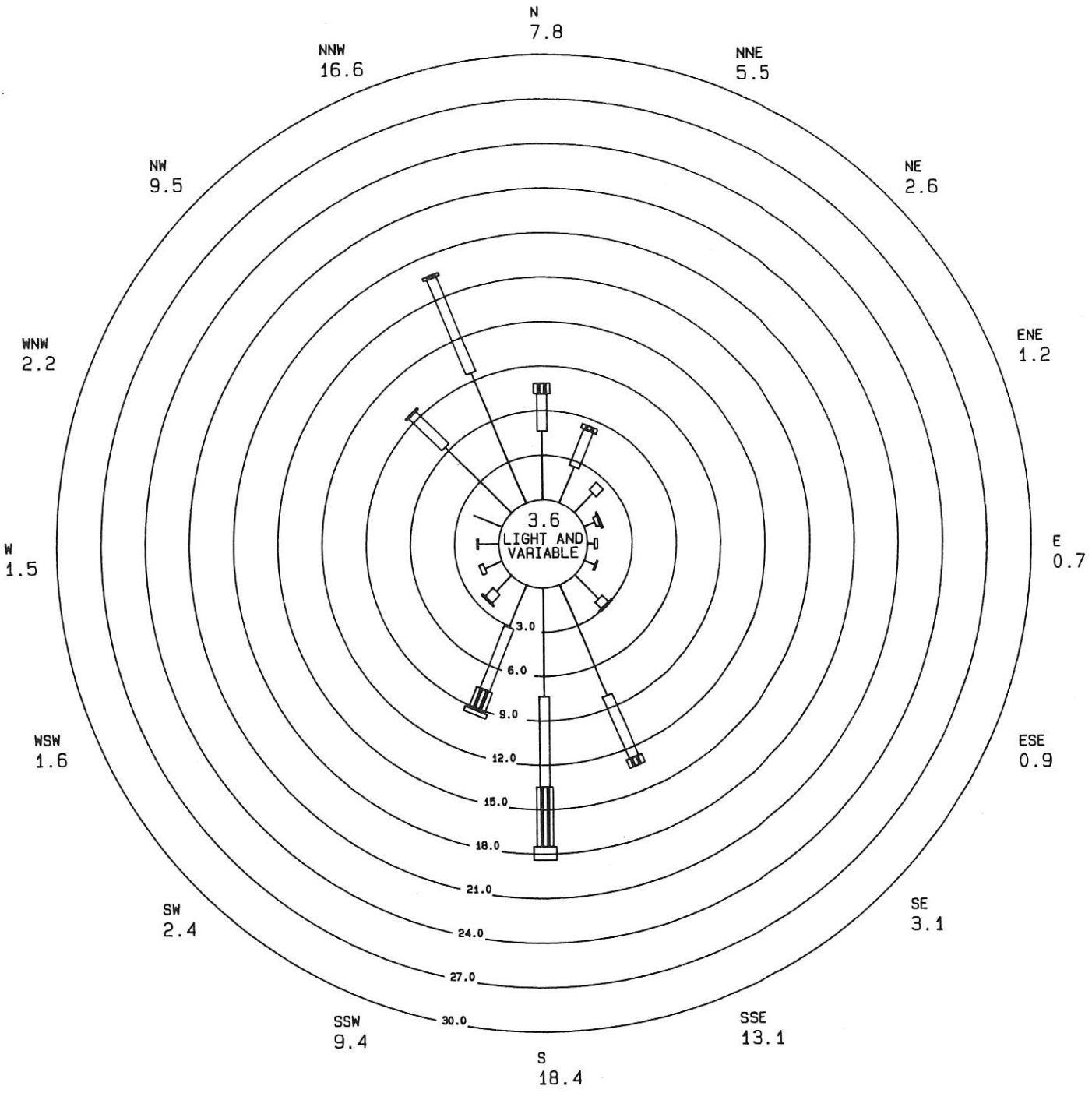


0.9- 3.9	4.0- 6.9	7.0- 10.9	11.0- 16.9	17.0- 21.9	OVER 21.9

KNOTS

0.0 3.0 6.0 9.0 12.0 15.0

PERCENT



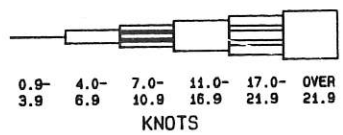
HOUR AVERAGE SURFACE WINDS

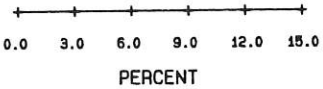
PERCENTAGE FREQUENCY OF OCCURRENCE

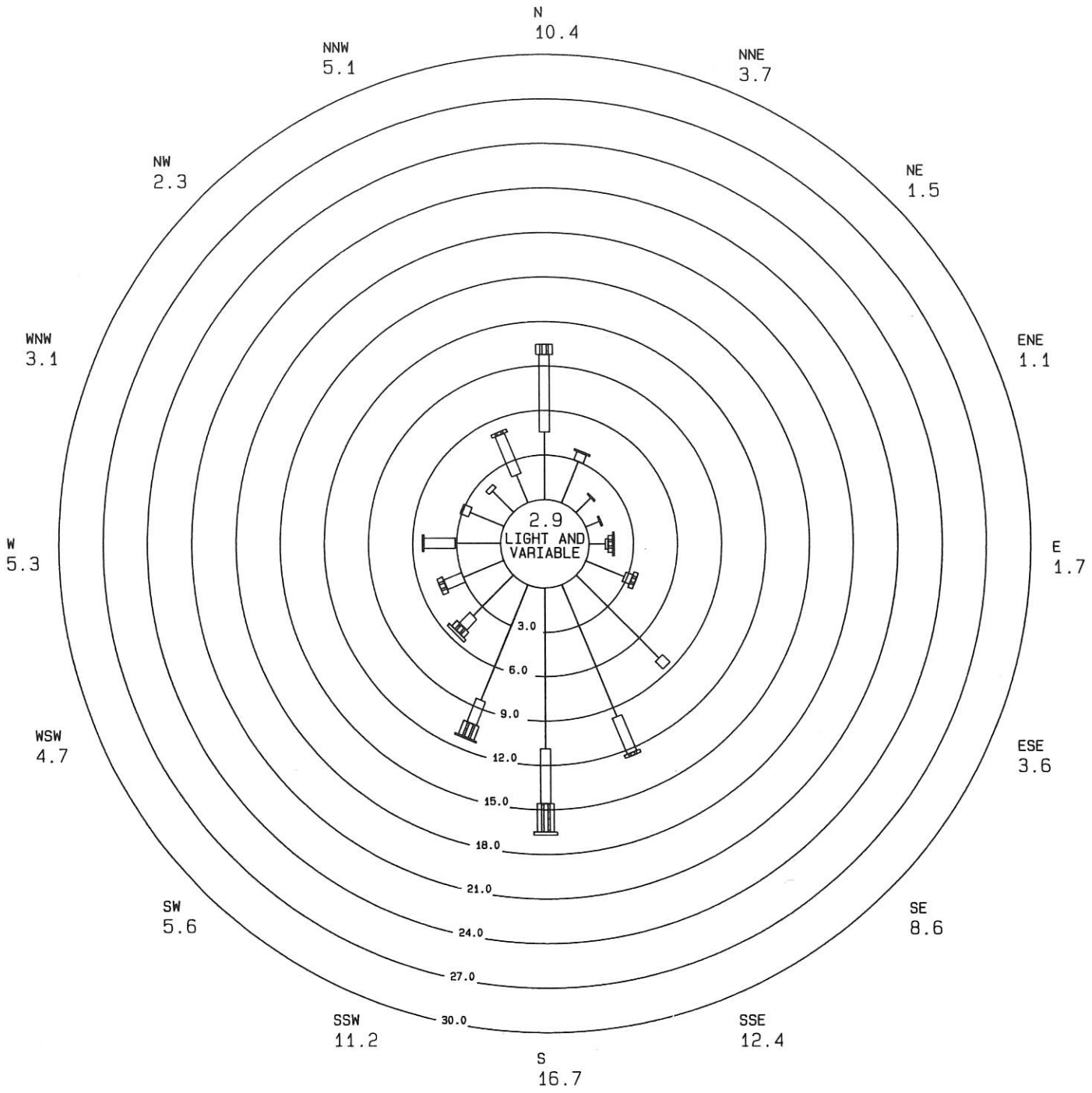
STATION LOCATION- PUGET SOUND AIR POLLUTION CONTROL AGENCY
Duwamish, 4752 E Marginal Way S, Seattle, Wa

INCLUSIVE DATES- ALL MONTHS 1992

TOTAL OBSERVATIONS- 8,778







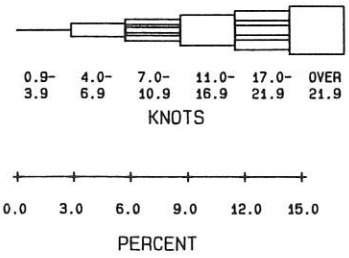
HOUR AVERAGE SURFACE WINDS

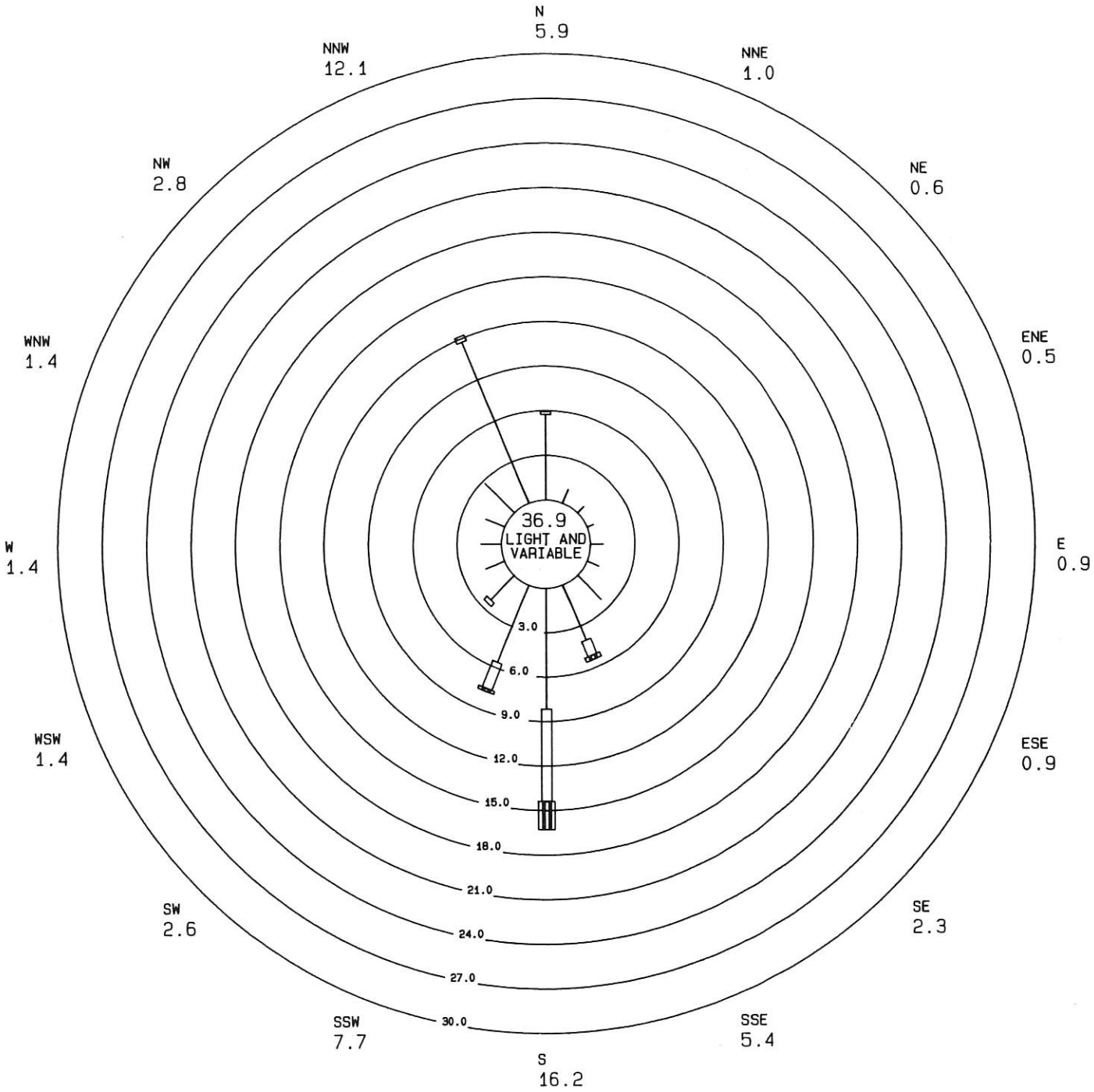
PERCENTAGE FREQUENCY OF OCCURRENCE

STATION LOCATION- PUGET SOUND AIR POLLUTION CONTROL AGENCY
James St & Central Ave, Kent, Wa

INCLUSIVE DATES- ALL MONTHS 1992

TOTAL OBSERVATIONS- 8,778





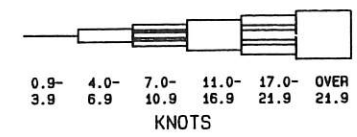
HOUR AVERAGE SURFACE WINDS

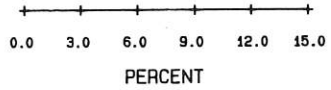
PERCENTAGE FREQUENCY OF OCCURRENCE

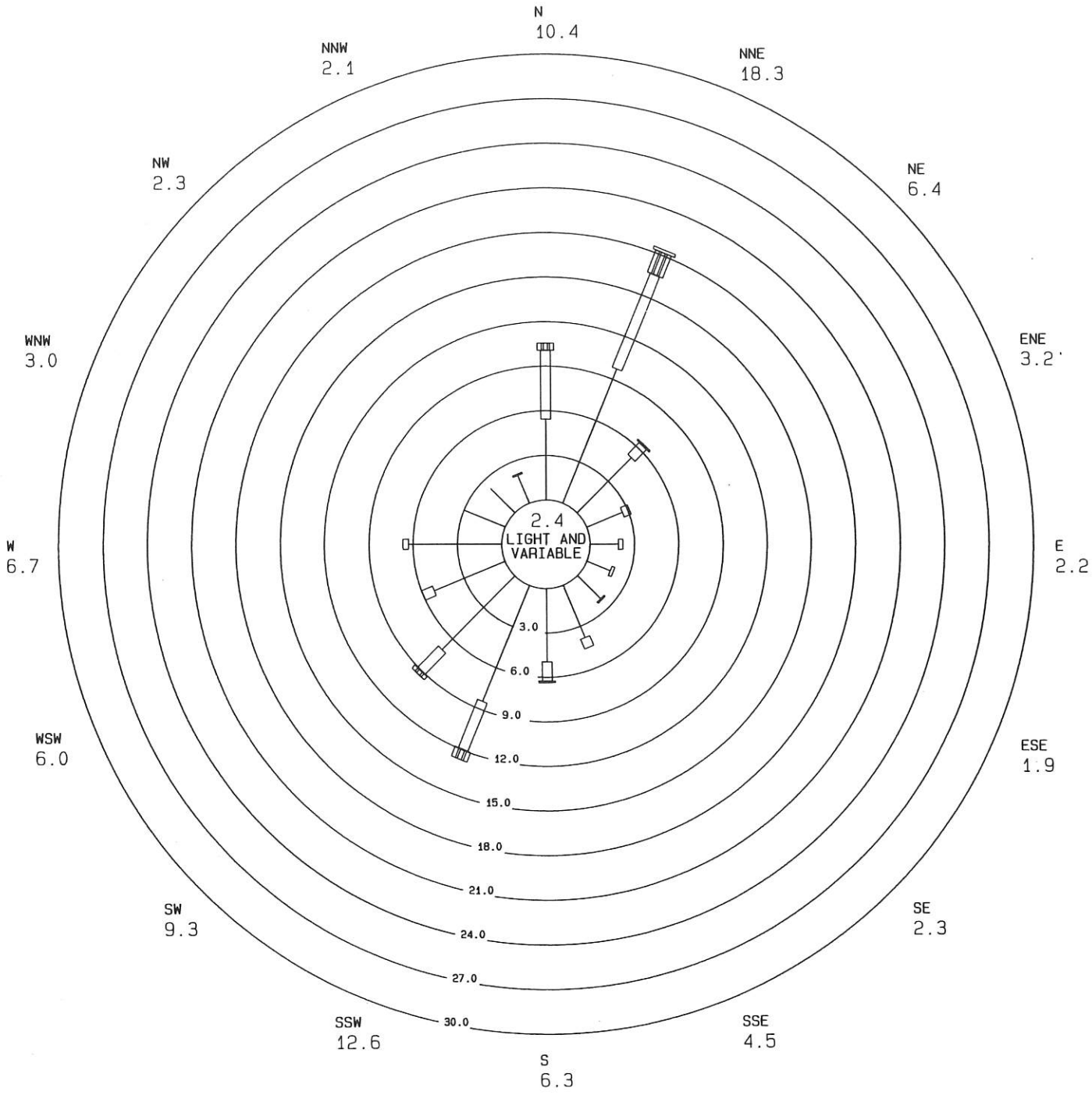
STATION LOCATION- PUGET SOUND AIR POLLUTION CONTROL AGENCY
South Hill, 9616 128th St E, Puyallup, Wa

INCLUSIVE DATES- ALL MONTHS 1992

TOTAL OBSERVATIONS- 8,771







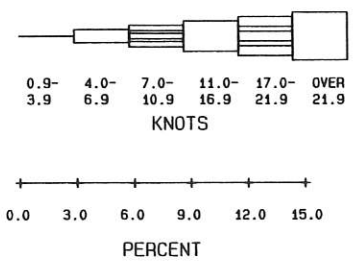
HOUR AVERAGE SURFACE WINDS

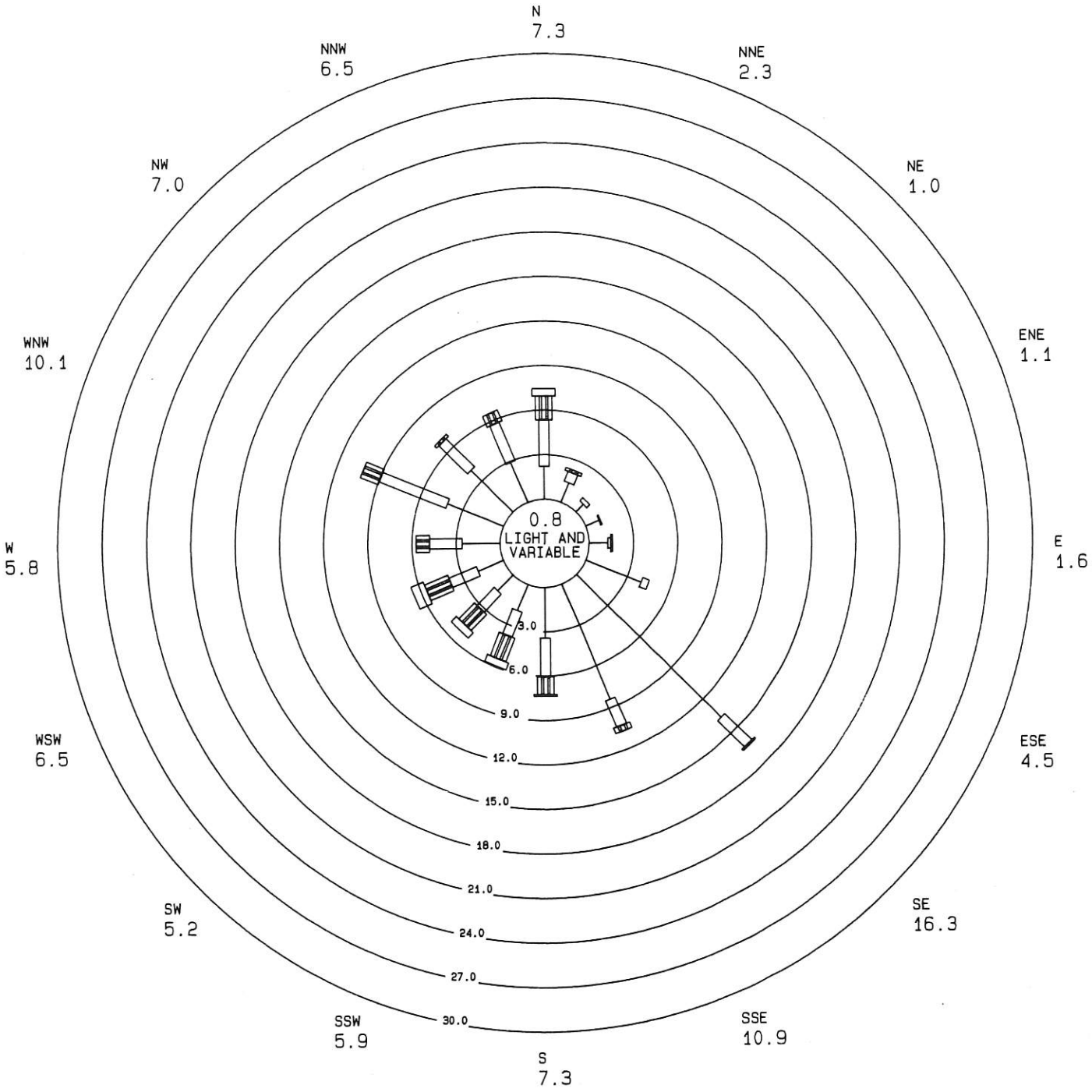
PERCENTAGE FREQUENCY OF OCCURRENCE

STATION LOCATION- PUGET SOUND AIR POLLUTION CONTROL AGENCY
27th St NE & 54th Ave NE, Northeast Tacoma, Wa

INCLUSIVE DATES- ALL MONTHS 1992

TOTAL OBSERVATIONS- 8,126





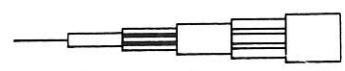
HOUR AVERAGE SURFACE WINDS

PERCENTAGE FREQUENCY OF OCCURRENCE

STATION LOCATION- PUGET SOUND AIR POLLUTION CONTROL AGENCY
2301 Alexander Ave, Tacoma, Wa

INCLUSIVE DATES- ALL MONTHS 1992

TOTAL OBSERVATIONS- 8,777

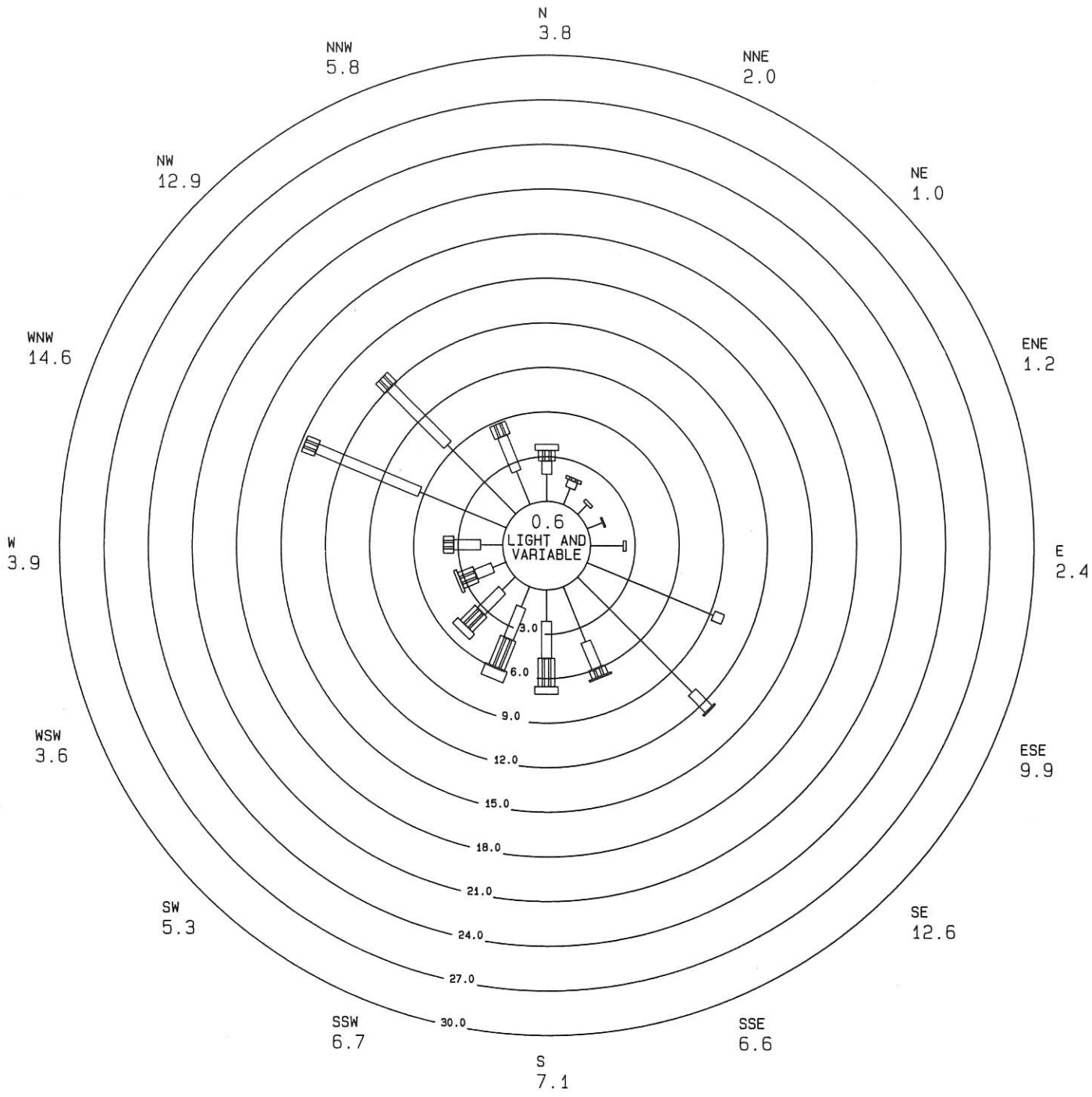


0.9- 3.9 | 4.0- 6.9 | 7.0- 10.9 | 11.0- 16.9 | 17.0- 21.9 | OVER 21.9

KNOTS

0.0 3.0 6.0 9.0 12.0 15.0

PERCENT



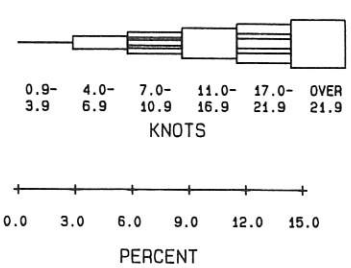
HOUR AVERAGE SURFACE WINDS

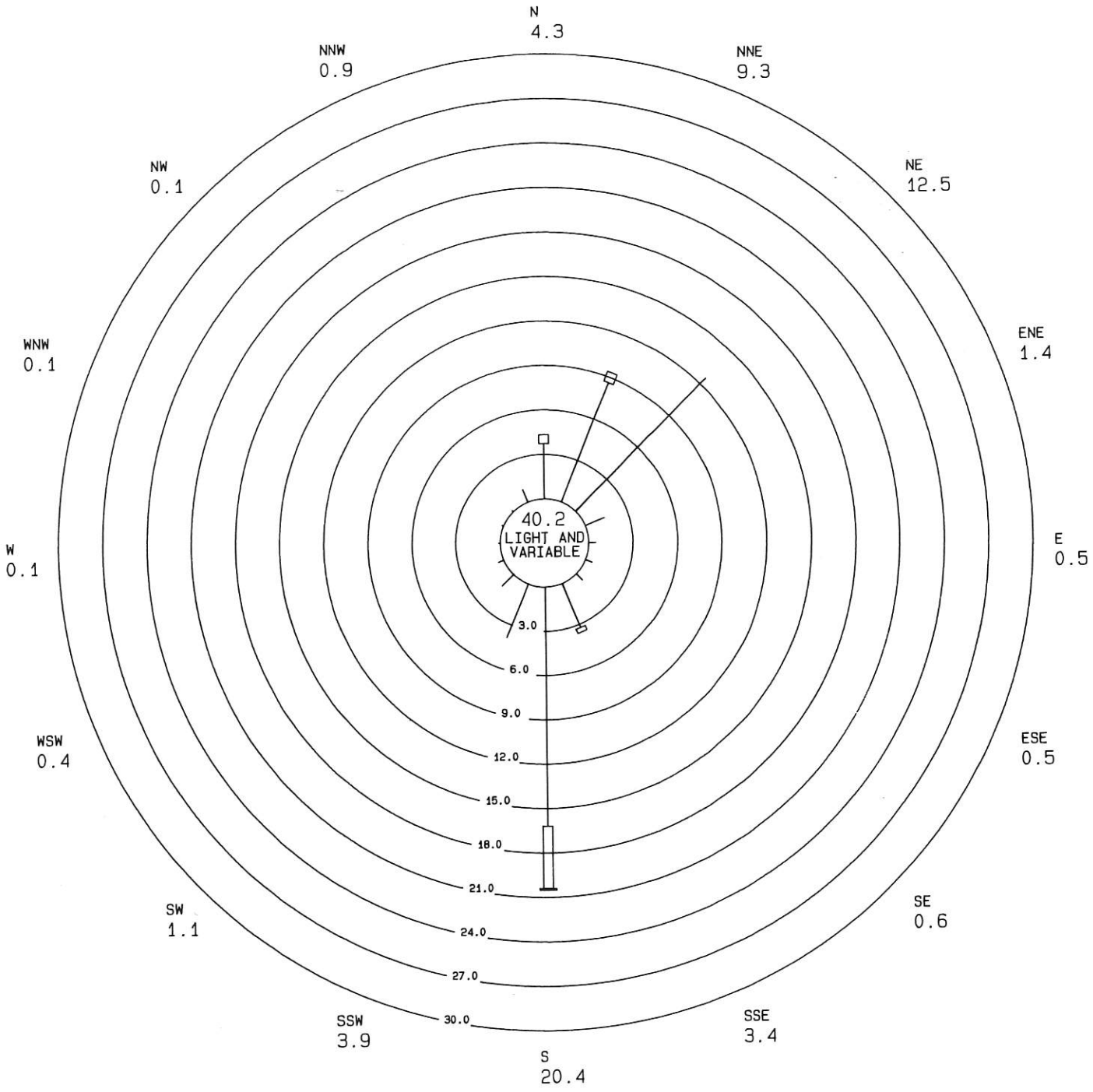
PERCENTAGE FREQUENCY OF OCCURRENCE

STATION LOCATION- PUGET SOUND AIR POLLUTION CONTROL AGENCY
Fire Station #12, 2316 E 11th St, Tacoma, Wa

INCLUSIVE DATES- ALL MONTHS 1992

TOTAL OBSERVATIONS- 8, 775





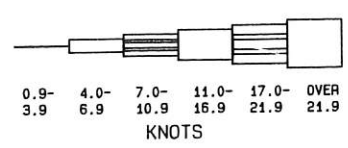
HOUR AVERAGE SURFACE WINDS

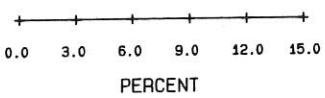
PERCENTAGE FREQUENCY OF OCCURRENCE

STATION LOCATION- PUGET SOUND AIR POLLUTION CONTROL AGENCY
Meadowdale, 7252 Blackbird Dr NE, KitsapCo, Wa

INCLUSIVE DATES- ALL MONTHS 1992

TOTAL OBSERVATIONS- 8,758





CHARACTERISTICS AND EFFECTS OF AMBIENT AIR POLLUTANTS

Carbon Monoxide

Carbon monoxide is a colorless, odorless, toxic gas commonly formed when carbon-containing fuel is not burned completely. The automobile internal combustion engine is a principal source of carbon monoxide. Carbon monoxide chemically combines with the hemoglobin in the red blood cells to decrease the oxygen-carrying capacity of the blood. It also weakens the contractions of the heart, thus reducing the amount of blood pumped throughout the body. Additionally it can affect the functioning of the lungs and brain. People with heart disease and pregnant women are particularly at risk because of the effects of carbon monoxide.

Particulate Matter (PM_{10} and TSP)

Particulate matter consists of small discrete solid or aerosol particles dispersed in the air. Particulate matter with an aerodynamic diameter of less than or equal to 10 micrometers is referred to as PM_{10}. Total Suspended Particulates (TSP) includes PM_{10} and larger suspended particulates. Transportation, industrial activity and wood burning are major sources of particulate matter. Particulates one micrometer or less in diameter are especially associated with a variety of adverse effects on public health and welfare. The small particles can be breathed deeply into the lungs. Particulate in the respiratory tract may produce injury by itself, or it may act in conjunction with gases to increase the effect on the body. The elderly, those suffering from respiratory illness, and young children are especially prone to the deleterious effects of particulates. Soiling of buildings and other property, and reduced visibility are further results of high particulate matter levels.

Ozone

Ozone is a pungent-smelling, colorless gas produced in the atmosphere when nitrogen oxides and volatile organic compounds chemically react under the effect of strong sunlight. It is a pulmonary irritant that affects lung tissues and respiratory functions. Ozone impairs the normal function of the lung and, at concentrations between 0.15 and 0.25 ppm, causes lung tightness, coughing and wheezing. Other oxidants that often accompany ozone cause eye irritation. Persons with chronic respiratory problems, such as asthma, seem most sensitive to increases in ozone concentration. In contrast, ozone is beneficial when it occurs naturally, very high in the atmosphere, miles above the earth, where it protects us from harmful ultraviolet radiation.

Sulfur Dioxide

Sulfur dioxide is a colorless, corrosive gas, that has a bitter taste, but no appreciable smell between 0.3 to 1.0 ppm. Industrial sites such as smelters, paper mills, power plants and steel manufacturing plants are the main sources of sulfur dioxide pollution. The presence of sulfur dioxide in the ambient air has been associated with a variety of respiratory diseases and increased mortality rates. When sulfur dioxide is inhaled with small particles, the effect on health is increased. Inhalation of sulfur dioxide can cause increased airway resistance by constricting lung passages.

Lead

Particles of lead or its compounds enter the air from vehicle exhaust and from industries that smelt or process the metal. Lead affects humans in numerous ways, but the greatest impacts appear to be on the blood-forming system, the nervous system, and the kidneys. It affects some people more than others. Young children from one to five years old are particularly sensitive to lead exposure. The standard for lead in air is intended to prevent most children from exceeding blood lead levels of 30 micrograms per deciliter of blood.

Nitrogen Dioxide

Nitrogen dioxide is a poisonous, brownish gas that, along with being a strong oxidizing agent, quickly reacts with water vapor to form corrosive nitric acid. Nitrogen dioxide is formed as the result of high temperature fuel combustion and subsequent atmospheric reactions. The presence of nitrogen dioxide in ambient air has been connected with a range of respiratory diseases. Further, nitrogen dioxide plays an essential role in the production of ozone.

AMBIENT AIR QUALITY STANDARDS

POLLUTANT	NATIONAL Primary	NATIONAL Secondary	WASHINGTON STATE	PUGET SOUND REGION
CARBON MONOXIDE				
8 Hour Average	9 ppm		9 ppm	9 ppm
1 Hour Average	35 ppm		35 ppm	35 ppm
PARTICULATE MATTER (PM10)				
Annual Arithmetic Average	50 $\mu g/m^3$	50 $\mu g/m^3$	50 $\mu g/m^3$	50 $\mu g/m^3$
24 Hour Average [a]	150 $\mu g/m^3$	150 $\mu g/m^3$	150 $\mu g/m^3$	150 $\mu g/m^3$
PARTICULATE MATTER (TSP)				
Annual Geometric Average			60 $\mu g/m^3$	60 $\mu g/m^3$
24 Hour Average			150 $\mu g/m^3$	150 $\mu g/m^3$
OZONE				
1 Hour Average [b]	0.12 ppm	0.12 ppm	0.12 ppm	0.12 ppm
SULFUR DIOXIDE				
Annual Average	0.03 ppm		0.02 ppm	0.02 ppm
30 Day Average				0.04 ppm
24 Hour Average	0.14 ppm		0.10 ppm	0.10 ppm [c]
3 Hour Average		0.50 ppm		
1 Hour Average [d]			0.25 ppm	0.25 ppm
1 Hour Average			0.40 ppm	0.40 ppm [c]
5 Minute Average [e]				1.00 ppm
LEAD				
Calendar Quarter Average	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$		1.5 $\mu g/m^3$
NITROGEN DIOXIDE				
Annual Average	0.053 ppm	0.053 ppm	0.053 ppm	0.053 ppm

Notes

(1) ppm = parts per million.

(2) $\mu g/m^3$ = micrograms per cubic meter.

(3) Annual, Quarter and 30 Day standards never to be exceeded; shorter term standards not to be exceeded more than once per year unless noted.

a - Standard attained when expected number of days per year with a 24 hour concentration above 150 $\mu g/m^3$ is equal to one or less.

b - Standard attained when expected number of days per year with an hourly average above 0.12 ppm is equal to one or less.

c - Sulfur Dioxide short-term standard never to be exceeded.

d - Not to be exceeded more than twice in seven days.

e - Not to be exceeded more than once in eight hours.

AIR QUALITY UNITS CONVERSION TABLE

Air quality standards for gases are defined in terms of micrograms (μg) or milligrams (mg) per cubic meter as well as in parts per million (ppm). As this data summary expresses measurements for gaseous pollutants in terms of ppm, the following conversion table is for the convenience of those who wish to interpret our results in terms of μg/cubic meter or mg/cubic meter. These conversion factors from the Federal Register assume a pressure of 760 millimeters Hg and a temperature of 25 degrees C.

Pollutant	*Multiply ppm by*	*To Obtain*
Carbon Monoxide	1.145	mg/cubic meter
Ozone	1961	μg/cubic meter
Sulfur Dioxide	2619	μg/cubic meter
Nitrogen Dioxide	1880	μg/cubic meter