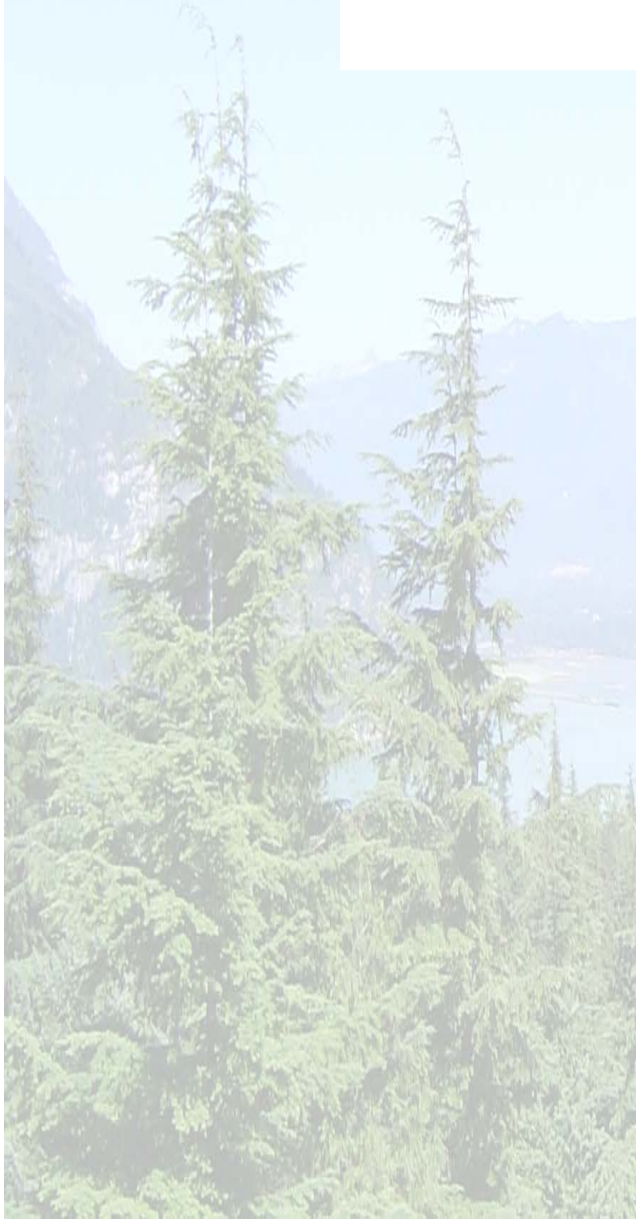
BRITISH COLUMBIA

Ministry of Water, Land & Air Protection

LOWER MAINLAND REGION

Ambient PM_{10} Monitoring
Sechelt BC
2002 Update



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Ambient PM_{10} Monitoring
Sechelt BC
2002 Update

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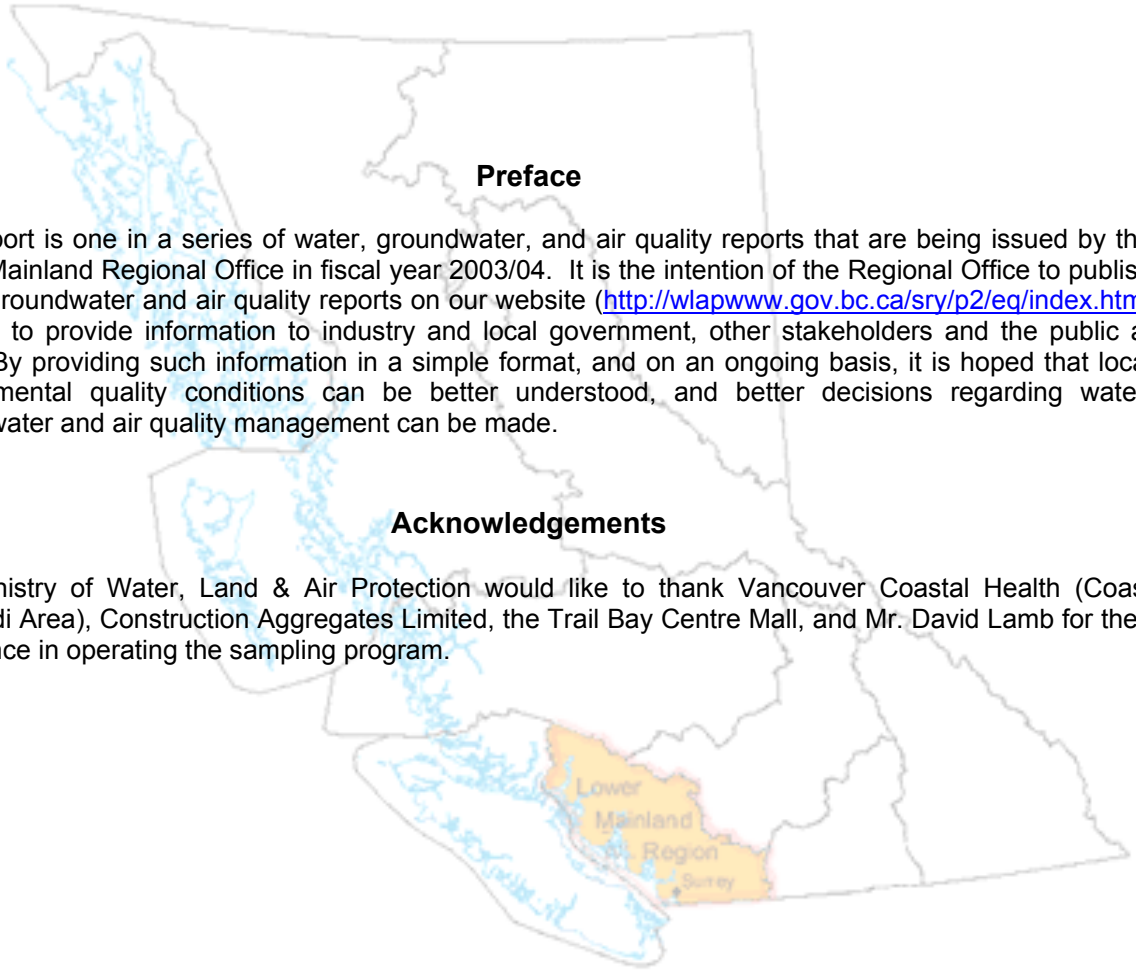

Preface

This report is one in a series of water, groundwater, and air quality reports that are being issued by the Lower Mainland Regional Office in fiscal year 2003/04. It is the intention of the Regional Office to publish water, groundwater and air quality reports on our website (http://wlapwww.gov.bc.ca/sry/p2/eq/index.htm) in order to provide information to industry and local government, other stakeholders and the public at large. By providing such information in a simple format, and on an ongoing basis, it is hoped that local environmental quality conditions can be better understood, and better decisions regarding water, groundwater and air quality management can be made.

Acknowledgements

The Ministry of Water, Land & Air Protection would like to thank Vancouver Coastal Health (Coast Garibaldi Area), Construction Aggregates Limited, the Trail Bay Centre Mall, and Mr. David Lamb for their assistance in operating the sampling program.

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1.0 INTRODUCTION

In September 2002, the Ministry of Water, Land & Air Protection (WLAP) released a report[1] summarizing results of PM_{10} sampling undertaken in Sechelt, British Columbia (BC) between 1999 and 2001. In addition to providing results of PM_{10} sampling, the report discussed PM_{10} and potential human health impacts associated with PM_{10} exposure, detailed the PM_{10} sampling methodology utilized in Sechelt, compared Sechelt PM_{10} sampling results with provincial *Ambient Air Quality Objectives* and federal *Reference Levels*, and compared Sechelt PM_{10} sampling results with PM_{10} sampling results from other communities in BC. Readers are encouraged to review the above-noted report to obtain background information on the Sechelt PM_{10} monitoring program.

The objective of this update report is to summarize PM_{10} data collected in 2002, compare 2002 data to provincial *Ambient Air Quality Objectives* and federal *Reference Levels*[2], compare 2002 data with previous years of PM_{10} data from Sechelt, and to compare 2002 PM_{10} sampling with 2002 PM_{10} results from other communities in British Columbia.

2.0 RESULTS AND DISCUSSION

Sampling results for 2002 are tabled in Appendix A and presented graphically in Figure 1.0.

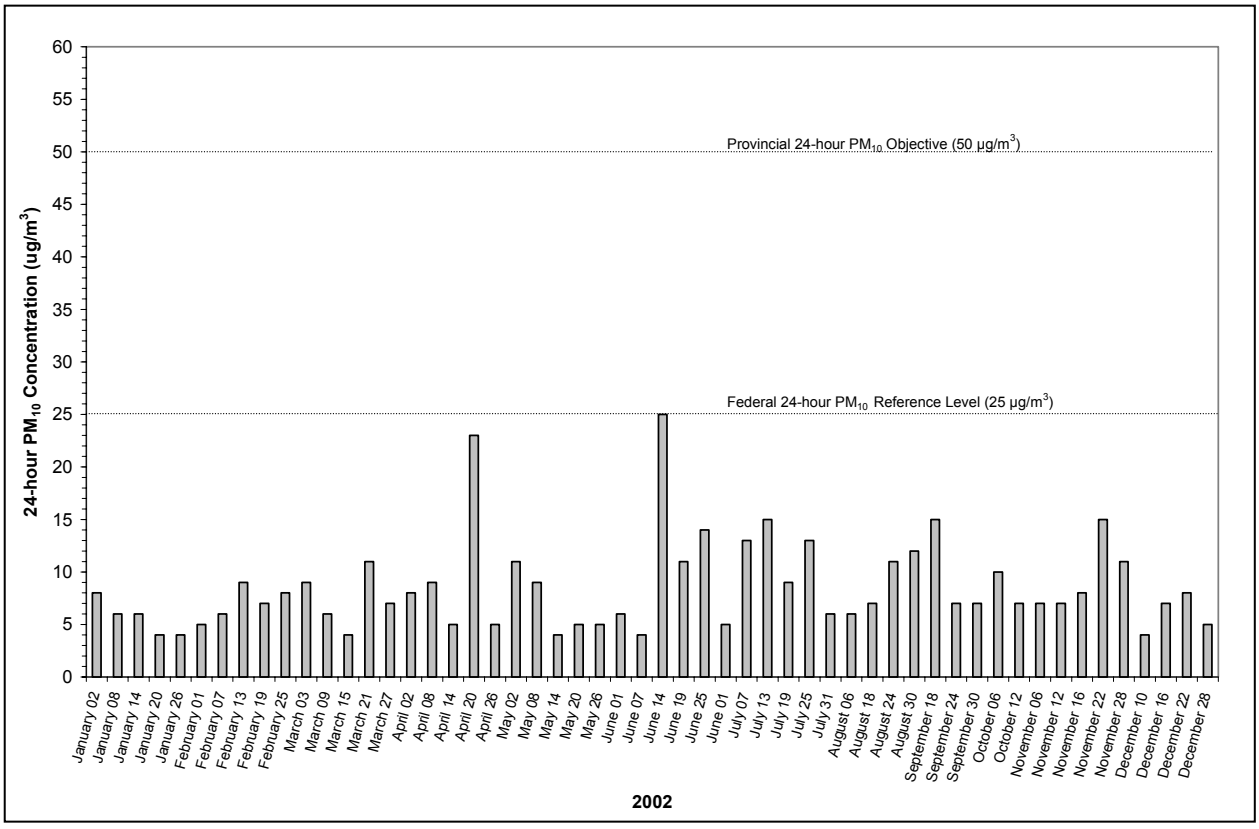

FIGURE 1.0 Results from 2002 PM_{10} sampling at Trail Bay Centre Mall, Sechelt, BC

1 **Shead, R.M. 2002.** Ambient PM_{10} Monitoring Report, Sechelt, BC 1999-2001. Ministry of Water, Land & Air Protection, Surrey, BC http://wlapwww.gov.bc.ca/sry/p2/air_quality/sechelt_report.pdf

2 *Air Quality Objectives* are levels intended to ensure long-term protection of public health and the environment. *Reference Levels* are health based levels at which statistically significant adverse effects on human health can be detected.

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In 2002, 54 of a possible 61 samples were collected. The minimum and maximum 24-hour PM_{10} concentrations were 4 and 25 μg/m^3, respectively, with a mean 24-hour concentration of 8.5 μg/m^3. The 95-percentile concentration was 15 μg/m^3. None of the 2002 samples exceeded provincial *Ambient Air Quality Objectives* or federal *Reference Levels*

2.1 Comparison with Other Sampling Years

Minimum, maximum and mean values from the Sechelt PM_{10} sampling program for the years 1999 through 2002 are presented in Figure 2.0.

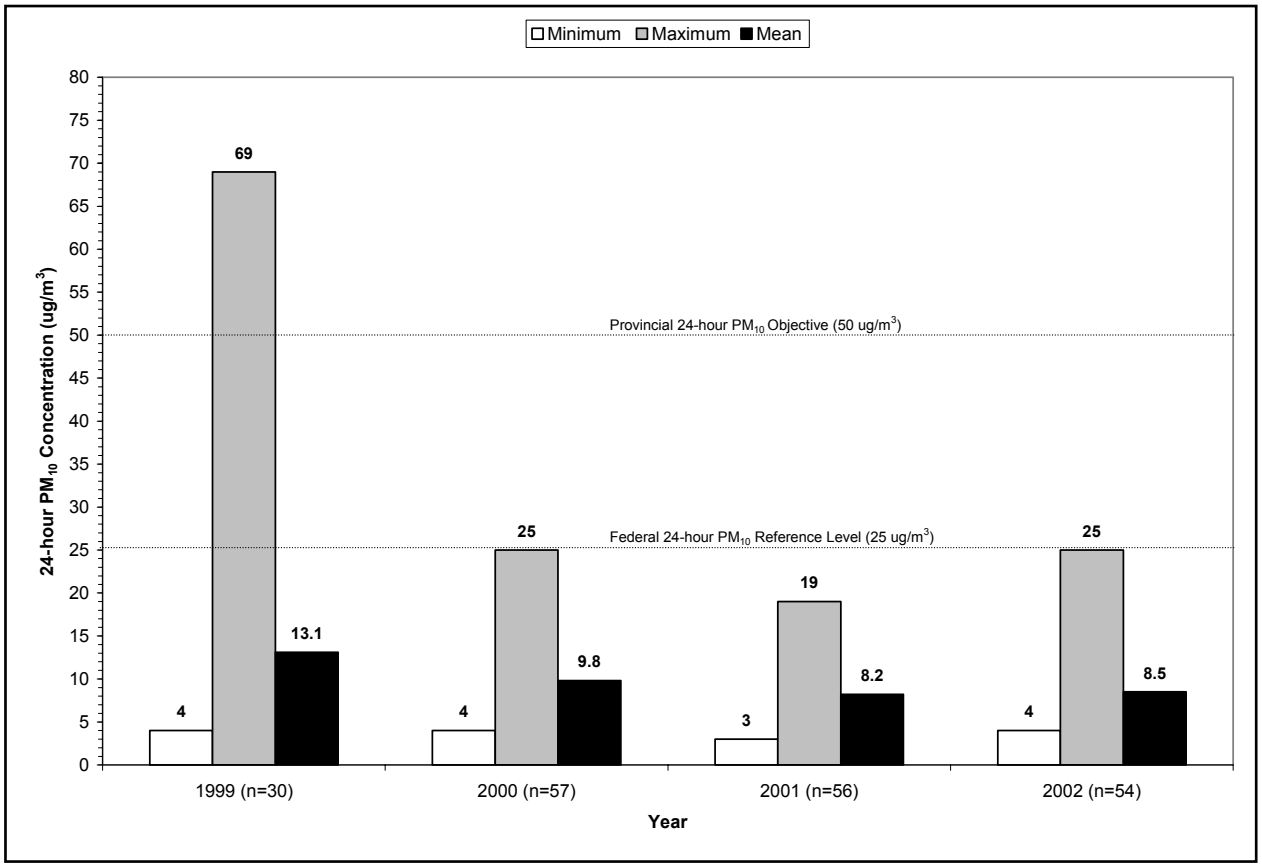

FIGURE 2.0 Comparison of Minimum, Maximum and Mean 24-hour PM_{10} concentrations in Sechelt for 1999-2002

A complete year of sampling was not undertaken in 1999 and nearby re-roofing activities in July and August 1999 resulted in elevated levels of particulate matter in close proximity to the sampler. As a result, the 1999 data set is not considered to be representative of ambient PM_{10} concentrations for that year and the data are precluded from yearly trend analysis.

Referring to Figure 2.0, the mean 24-hour PM_{10} concentration decreased from 9.8 μg/m^3 in 2000 to 8.2 μg/m^3 in 2001, the decrease (approximately 16 percent) is statistically significant ($p<0.05$). The mean 24-hour PM_{10} concentration increased from 8.2 μg/m^3 in 2001 to 8.5 μg/m^3 in 2002; the increase was approximately 3.6 percent, but is not statistically significant ($p>0.05$).

The mean can be influenced by extreme values and the mean value is often "pulled" (referred to as skewed) in the direction of extreme values. Another statistic used to describe the centre of the data set, the median, is resistant to the influence of extreme values because it is simply the middle value of the data set. The median 24-hour PM_{10} concentrations for 2000, 2001 and 2002 were 9.0 $\mu g/m^3$, 8.0 $\mu g/m^3$ and 7.0 $\mu g/m^3$, respectively. As expected, the median values were less than the mean values for 2000 (9.0 vs 9.8 $\mu g/m^3$), 2001(8.0 vs. 8.2 $\mu g/m^3$) and 2002 (7.0 vs 8.5 $\mu g/m^3$).

Sechelt PM_{10} data for 2000, 2001 and 2002 are compared in Figure 3.0 using boxplots. A description of boxplots is provided in Appendix C. Values utilized to construct the boxplots in Figure 3.0 are summarized in Table 1.0.

TABLE 1.0 VALUES UTILIZED TO CONSTRUCT FIGURE 3.0 BOXPLOTS

Parameter	Year (all units in ug/m^3)		
	2000 (n=57)	2001 (n=56)	2002 (n=54)
Minimum	4	3	4
Maximum	25	19	25
25-Percentile	7	6	5
Median (50-Percentile)	9	8	7
75-Percentile	12	10	11
Upper Notch Limit	10.0	8.8	8.3
Lower Notch Limit	8.0	7.2	5.7

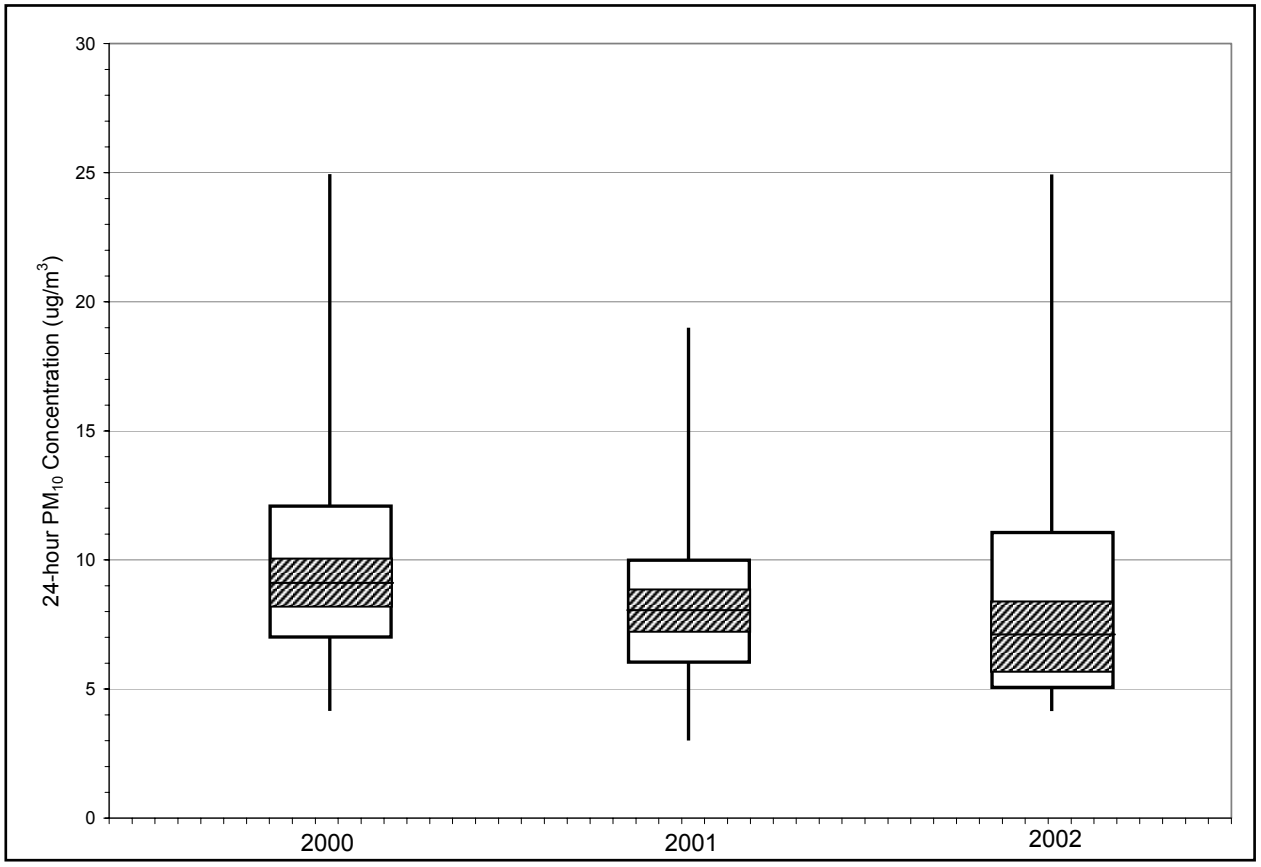

FIGURE 3.0 Boxplot comparison of Sechelt PM_{10} data for 2000, 2001 and 2002.

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Referring to Figure 3.0, the notch limits overlap for all three data sets indicating median PM_{10} values in Sechelt have not significantly varied (at the 5 percent level of significance) in the last 3 sample years.

2.2 Comparison with Other PM_{10} Sampling Programs

Figure 4.0 shows the mean 24-hour PM_{10} concentrations at Sechelt, Powell River, Langdale, Squamish, Kitsilano (Vancouver) and Chilliwack for 2000, 2001 and 2002. Data from the comparison sites were obtained for the same sample dates as the Sechelt HiVol sampler. The comparison sites chosen are representative of other coastal and rural communities.

The 2002 PM_{10} data indicates ambient PM_{10} data concentrations in Sechelt continue to be lower than those in major urban centres (e.g. Kitsilano) or near major point sources (e.g Squamish). In 2002, the mean 24-hour PM_{10} concentration in Sechelt (8.5 $\mu g/m^3$) was greater than Powell River (7.7 $\mu g/m^3$) and less than Langdale (10.7 $\mu g/m^3$), Squamish (13.7 $\mu g/m^3$), Chilliwack (13.6 $\mu g/m^3$) and Kitsilano (13.1 $\mu g/m^3$). A similar trend is observed when comparing 2000 and 2001 data sets among the above sites.

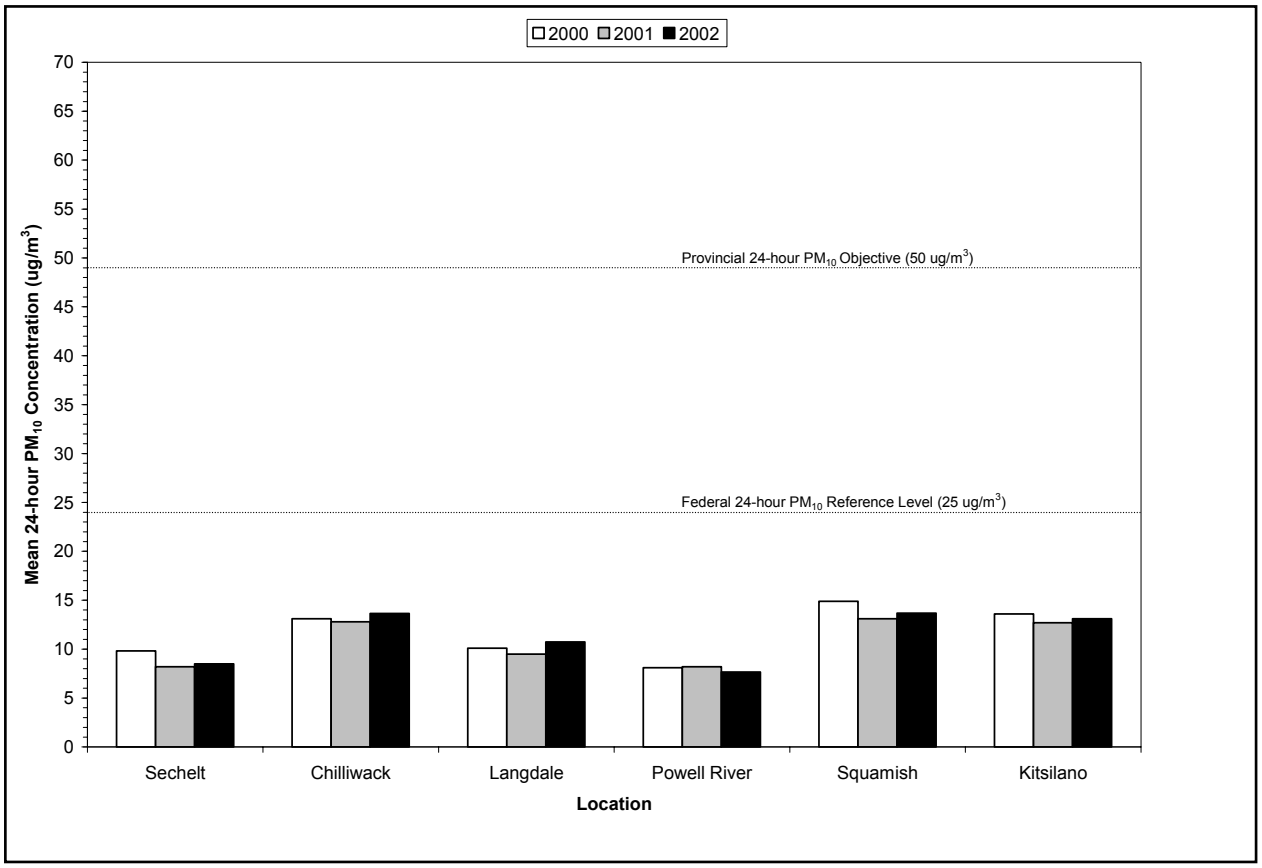

FIGURE 4.0 Comparison of 2000, 2001 and 2002 mean annual 24-hour PM_{10} concentrations at 6 different locations. Results based on 54 samples (one 24 hour sample taken every 6 days).

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3.0 SUMMARY

PM_{10} monitoring in Sechelt between 2000 and 2002 indicates:

- annual mean PM_{10} levels have not increased
- ambient PM_{10} levels are below provincial *Air Quality Objectives* and federal *Reference Levels*
- PM_{10} levels in Sechelt are below levels observed in major urban centres or near point sources

Between January and December 2002, 54 PM_{10} samples were collected. Ambient 24-hour PM_{10} concentrations during this 12 month period ranged between 4 and 25 $\mu g/m^3$ with a mean 24-hour PM_{10} concentration of 8.5 $\mu g/m^3$. The Provincial Ambient Air Quality 24-hour PM_{10} Objective of 50 $\mu g/m^3$ and the Federal 24-hour PM_{10} Reference Level of 25 $\mu g/m^3$ were not exceeded in any of the samples.

PM_{10} sampling results indicate ambient PM_{10} concentrations in Sechelt increased in 2002, but the increase was not statistically significant ($p>0.05$). The mean 24-hour PM_{10} concentration increased from 8.2 $\mu g/m^3$ in 2002 to 8.5 $\mu g/m^3$ in 2003, with a corresponding increase in the 95-percentile PM_{10} concentration from 12.2 $\mu g/m^3$ to 15 $\mu g/m^3$. Similar to results from 2000 and 2001, the 2002 sampling results indicate ambient PM_{10} concentrations are generally lower in Sechelt relative to other areas such as Squamish, Langdale, Vancouver, and Chilliwack.

WLAP will continue PM_{10} sampling in Sechelt and results of the 2003 sampling program will be provided in 2004.

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APPENDIX A
SECHELT TRAIL BAY MALL
2002 PM_{10} RESULTS

Month	Date	µg/m³ (24 hr. avg.)	Month	Date	µg/m³ (24 hr. avg.)
January	02	8	July	01	5
	08	6		07	13
	14	6		13	15
	20	4		19	9
	26	4		25	13
				31	6
February	01	5	August	06	6
	07	6		12	no sample
	13	9		18	7
	19	7		24	11
	25	8		30	12
March	03	9	September	05	no sample
	09	6		11	no sample
	15	4		18*	15
	21	11		24*	7
	27	7		30*	7
April	02	8	October	06*	10
	08	9		12*	7
	14	5		17	no sample
	20	23		23	no sample
	26	5		31*	no sample
May	02	11	November	06*	7
	08	9		12*	7
	14	4		16	8
	20	5		22	15
	26	5		28	11
June	01	6	December	04	no sample
	07	4		10	4
	14*	25		16	7
	19	11		22	8
	25	14		28	5

* incorrect sample date (non NAPS)

APPENDIX B
COMPARISON SITES
PM_{10} DATA

Sample Date		24-hour PM_{10} (ug/m^3)				
		Chilliwack	Langdale	Powell River	Squamish	Kitsilano
January	02	8	9	6	9	10
	08	6	5	6	8	9
	14	8	8	6	11	12
	20	4	7	5	6	6
	26	7	5	4	4	7
February	01	16	6	6	11	12
	07	9	8	5	7	10
	13	23	9	9	14	15
	19	7	8	7	7	8
	25	25	5	8	12	14
March	03	16	11	7	13	13
	09	11	9	6	15	11
	15	8	4	5	4	8
	21	13	10	9	17	11
	27	9	9	8	7	9
April	02	11	9	7	9	11
	08	10	11	7	9	13
	14	7	1	4	3	6
	20	25	19	14	26	26
	26	21	10	6	17	17
May	02	12	8	8	9	10
	08	16	12	10	--	15
	14	6	5	4	4	7
	20	9	10	5	7	12
	26	8	12	7	--	10
June	01	15	10	6	17	11
	07	9	9	5	7	18
	13	31	20	18	37	26
	19	10	11	8	13	13
	25	24	27	11	33	17
July	01	8	7	5	11	8
	07	15	17	11	20	18
	13	27	20	10	22	18
	19	13	8	5	15	10
	25	32	15	7	37	17
	31	15	9	7	19	15
August	06	10	11	6	14	12
	18	20	14	9	25	16
	24	26	18	14	30	20
	30	26	9	10	19	13
September	18	16	17	8	21	19
	24	17	15	6	23	11
	30	8	10	9	10	13
October	06	16	12	8	15	14
	12	13	22	9	15	14
November	06	7	8	6	13	11
	12	7	9	6	8	10
	16	8	11	10	8	14
	22	28	15	8	9	14
	28	15	14	10	14	28
December	10	9	8	8	9	11
	16	7	9	6	6	9
	22	8	11	6	12	19
	28	4	5	10	3	8
Number of Samples		54	54	54	52	56
Mean		13.6	10.7	7.7	13.7	13.1

Boxplots (Figure A1) visually depict elements of the data set such as the center of the data set (i.e. median), the variation and symmetry of the data set about the centre (represented by the height of the box and the proportion of the two box halves), and the presence/absence/magnitude of extreme ("outlier") values (represented by the minimum and maximum values).[1] A boxplot is constructed using the minimum, maximum, 25-percentile, median (50-percentile), and 75-percentile values[2] of the data set. Various data sets (e.g. data sets from different years) can be placed beside each other and compared visually.

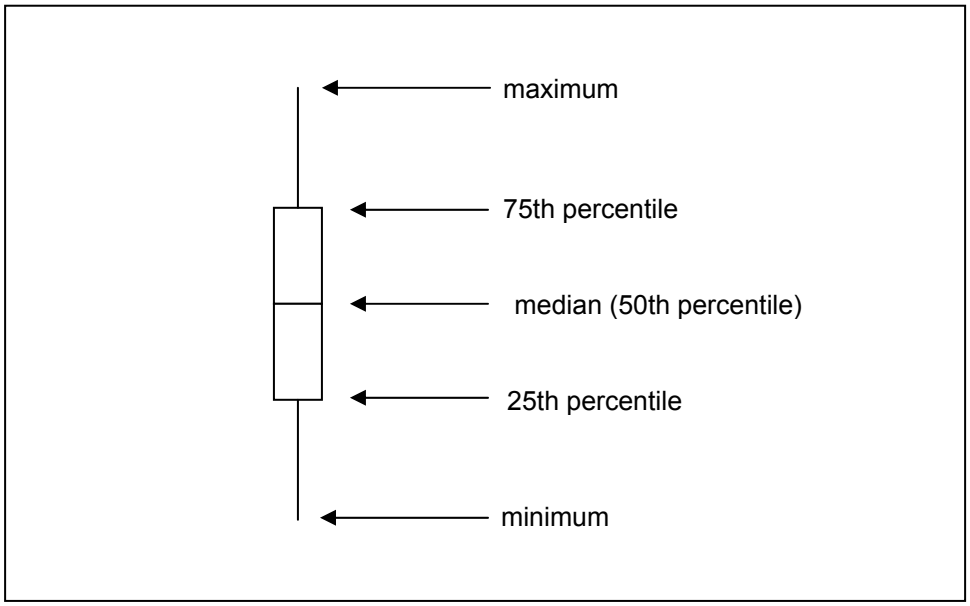

FIGURE C1. Boxplot

Because the actual median value can never be known with absolute certainty (due to sampling error, analytical error etc.), confidence intervals are constructed to incorporate the uncertainty and show a range of values where the true median value is likely to occur[3]. Boxplot 'notch limits' (Figure C2) depict the 95 percent confidence interval for the median, that is, they delineate the range of values of the data set where there is a 95 percent probability of finding the median value.

Notch limits are calculated using the following equations:

$$\text{Lower Notch Limit} = \text{Median} - \frac{[\ 1.57 \times (75 \text{ percentile} - 25 \text{ percentile})\ ]}{\sqrt{\text{sample size}}}$$

$$\text{Upper Notch Limit} = \text{Median} + \frac{[\ 1.57 \times (75 \text{ percentile} - 25 \text{ percentile})\ ]}{\sqrt{\text{sample size}}}$$

[1] **Helsel D.R. and R.M. Hirsch. 2003.** Statistical Methods in Water Resources. United States Geological Survey, Techniques of Water-Resources Investigations Book 4, Chapter A3. http://water.usgs.gov/pubs/twri/twri4a3/pdf/twri4a3-new.pdf

[2] The 25, 50 and 75 percentile values are the values for which 25, 50 and 75 percent, respectively, of the concentrations within the data set are equal to or less than.

[3] **Gibbons, R.D. 2003.** A Statistical Approach for Performing Water Quality Impairment Assessments. J. of the American Water Resources Association. 39(4): 841-849

Comparison of boxplot notch limits allows one to determine if the medians differ significantly between years. If the notch limits of 2 boxplots overlap then median values are considered not to be different at the 5 percent level of significance (i.e. there is a 5 percent chance that the observed results occurred by luck or chance).[4]

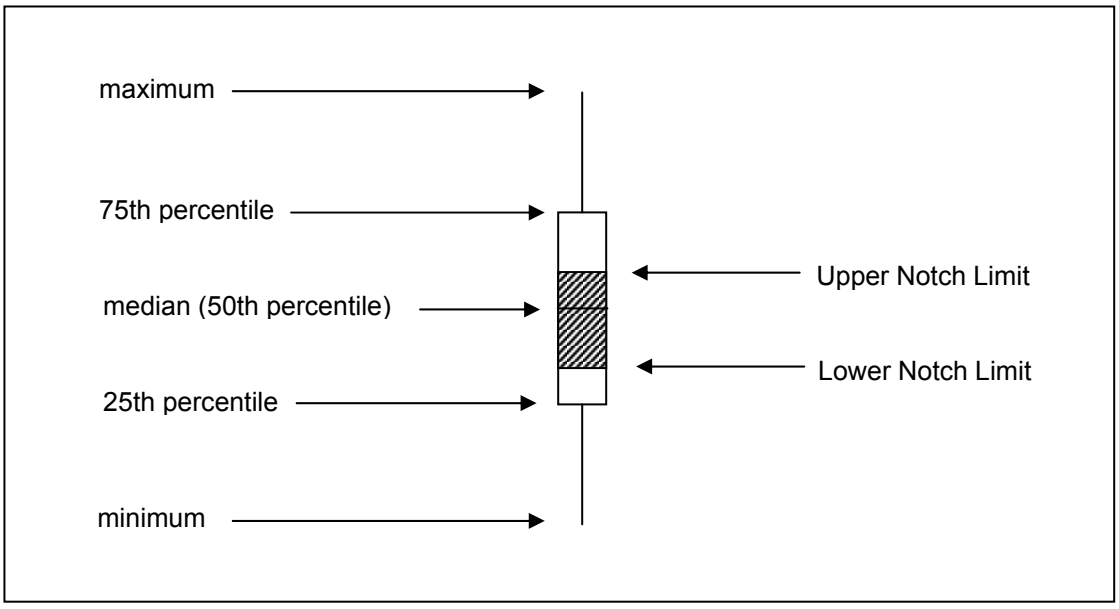

FIGURE C2. Boxplot with Notch Limits

[4] **Reckhow, K.H., K. Kepford, W.W. Hicks. 1993.** Methods for the Analysis of Lake Water Quality Trends. EPA 841-R-93-003