British Columbia Ministry of Water, Land and Air Protection

Lower Mainland Region

Ambient PM_{10} Monitoring Report
Sechelt, B.C.
1999 - 2001

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1.0 INTRODUCTION

1.1 Background

The Municipality of Sechelt (Sechelt) has undergone rapid development in recent years resulting in an increase in potential sources of airborne particulate matter. Potential sources include those directly associated with development activities (i.e. land clearing, open burning, construction), as well as sources that typically increase as a result of such development (i.e., woodstove burning, commercial/industrial air discharges, transportation). As a result of recent expansion, inhalable particulate matter (also referred to as PM_{10}[1]) has become a concern in the Sechelt area and the need to quantify ambient particulate matter has been identified. To that end, the Ministry of Water, Land and Air Protection (WLAP) commenced ambient particulate sampling in Sechelt in June 1999. The objectives of the sampling program were to quantify ambient PM_{10} for comparison to the Ambient Air Quality Objectives and to collect data for assessment of ambient PM_{10} trends in the Sechelt area. This report presents results from the initial 31 months of the sampling program (June 1999 to December 2001).

1.2 The Municipality of Sechelt

Sechelt is located on the south coast of British Columbia approximately 50 kilometres northwest of the City of Vancouver (Figure 1.0, right inset).

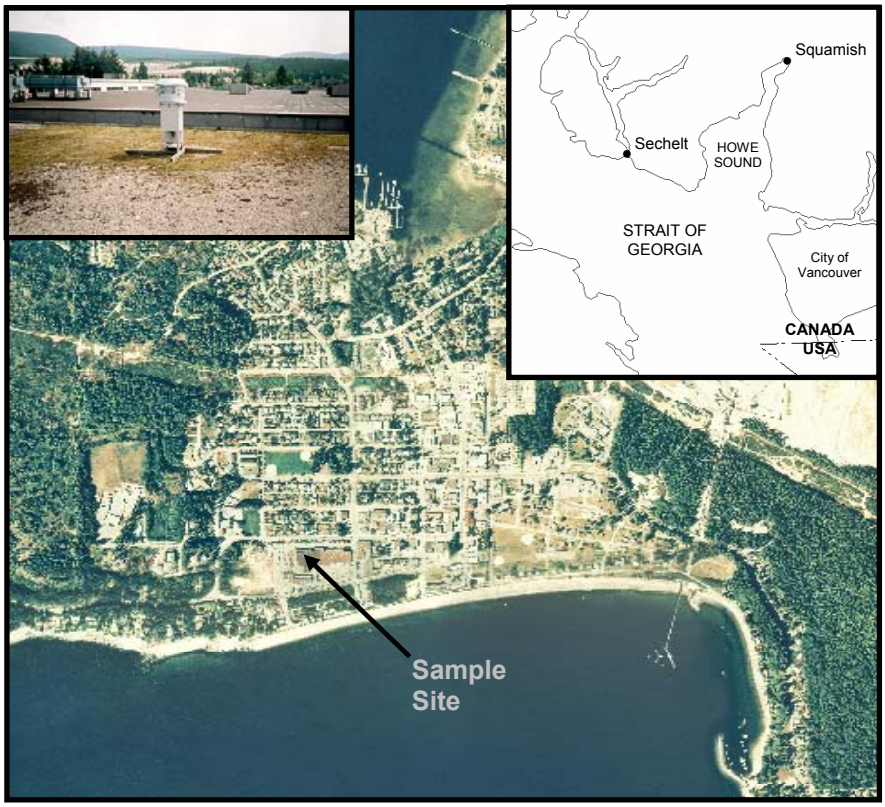

FIGURE 1.0. Location of the Sechelt PM_{10} sampler. Left inset is photograph of the sampler on the roof of the Trail Bay Center Mall. Right inset is Sechelt location map.

[1] PM_{10} refers to particulate matter having an aerodynamic diameter of less than 10 micrometres (μm).

Sechelt was incorporated in 1956 and encompasses approximately 48 square kilometres with a population of 8,499 in the year 2000. Data from the 1996 Census indicates the retail trade, construction, and service industries employ the largest number of people in Sechelt.[2]

1.3 PM_{10}

PM_{10} occurs both naturally and anthropogenically[3]. Natural sources include windblown soil, pollen, spores and marine aerosols; anthropogenic sources include industrial processing, transportation, and wood smoke from home heating. PM_{10} has been identified as the most important ambient air pollutant in British Columbia with studies suggesting an association between increased ambient PM_{10} concentrations and negative health effects, including mortality. Particulate matter greater than 10μm is generally not of concern as these larger particles collect in the nose and throat and are subsequently eliminated from the body via sneezing, coughing, nose blowing or digestion. PM_{10} eludes such defence mechanisms and penetrates into the lungs thus posing a threat to human health. Generally, the smaller the inhaled particle, the deeper it can be breathed into the lung; thus, it is the finer fraction of PM_{10} that deposits deepest in the lung. This fraction of PM_{10} is referred to as "fine particulate matter" or $PM_{2.5,}$ and consists of particulate matter having an aerodynamic diameter of less than 2.5μm. Health impacts associated with fine particulate matter include irritation of the respiratory tract, aggravation of existing respiratory conditions (i.e. bronchial asthma, pulmonary emphysema), and contribution to the development of chronic bronchitis. Studies suggest there is an increased risk of mortality with increasing concentrations of ambient PM_{10}.[4] A threshold PM_{10} concentration for which impacts to human health do not occur has not been determined.[5]

1.4 Air Quality Objectives

The Provincial Ambient Air Quality Objectives define ambient air concentrations intended to be protective of human health and the environment. The Provincial Ambient Air Quality 24-hour PM_{10} Objective is 50 micrograms per cubic metre ($\mu g/m^3$).

The Canadian Environmental Protection Act Federal/Provincial Working Group on Air Quality Objectives and Guidelines (Federal/Provincial Working Group) develops National Ambient Air Quality Objectives for airborne pollutants[5]. The mandate of the Federal/Provincial Working Group is to protect people and the environment from the adverse effects associated with airborne pollutants. Based on the review of epidemiological studies, the Federal/Provincial Working Group recommends a 24-hour "Reference Level" of $25\mu g/m^3$ for PM_{10}.

Sampling results from the Sechelt PM_{10} sampling program were compared to the Federal/Provincial Working Group 24-hour PM_{10} Reference Level of $25\mu g/m^3$ and the Provincial Ambient Air Quality 24-hour PM_{10} Objective of $50\mu g/m^3$. For purposes of this report, the above-noted Reference/Objective Levels are collectively referred to as Ambient Air Quality Objectives. As previously noted, a threshold PM_{10} concentration for which impacts to human health do not occur has not been determined; accordingly, impacts to human health and the environment may be occurring at concentrations below the Ambient Air Quality Objectives.

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2 **BC Stats. 2001.** Community Facts: Sechelt District Municipality. Victoria, B.C.

3 anthropogenic - caused or produced by humans

4 **Vedal, S. 1995.** Health effects of inhalable particles: implications for British Columbia. Prepared for the Air Resources Branch of the Ministry of Environment, Lands and Parks. Victoria, B.C.

5 **Canadian Environmental Protection Act/Federal Provincial Working Group on Air Quality Objectives and Guidelines. 1998.** National Ambient Air Quality Objectives for Particulate Matter. Part 1 - Science Assessment Document: Executive Summary. Minister of Public Works and Government Services, Ottawa, Ont.

2.0 SAMPLING PROGRAM

2.1 Sampler Setup and Operation

PM_{10} sampling commenced June 11, 1999 and continues to date. Ambient PM_{10} can be quantified using a variety of continuous and non-continuous particulate samplers.[6] For the Sechelt PM_{10} sampling program, a Sierra-Anderson HiVol sampler was set up on the roof of the Trail Bay Centre Mall (civic address 5755 Cowrie Street) in Sechelt, B.C (Figure 1.0). The Trail Bay Centre Mall location was chosen as it allows for representative ambient air samples to be obtained while providing a secure location requisite for a long-term monitoring program. The sampler is operated according to the National Air Pollution Surveillance (NAPS) network 6-day sampling cycle (i.e. sampling every 6th day). The NAPS 6-day cycle allows for each day of the week to be equally sampled over the duration of a long-term monitoring program. On the designated sample date, the HiVol sampler runs continuously for 24-hours (midnight to midnight). When sampling, the HiVol draws air at a rate of approximately 1.13 cubic metres per minute (m^3/min) through the circular "head" portion of the sampler. The circular intake allows for air to be sampled in all directions from the sampler. Sampled air passes through a size selective inlet and PM_{10} is collected on a pre-weighed 8 x 10 inch teflon-coated glass fibre filter. The used sample filter is sent to a laboratory for conditioning and analysis with PM_{10} results reported in $\mu g/m^3$.

Representatives from the Coast Garibaldi Health Unit have been operating the HiVol sampler on behalf of WLAP. WLAP is responsible for maintenance and calibration of the sampler, as well as the operating costs associated with running the sampler (i.e. sample filters, laboratory analysis etc.). The Trail Bay Centre Mall provides the power to run the sampler.

2.2 Data Capture

The WLAP State of the Environment Reporting Office (SERO) reviews data collected by various ministry programs in disciplines such as wildlife, groundwater, species-at-risk, air quality and domestic waste. The SERO prepares comprehensive public reports on environmental conditions and trends within the province.[7] For data from a NAPS 6-day sampling schedule to be utilized by the SERO, a minimum of 75 percent of data must be collected for 11 months of the reporting year.

3.0 RESULTS AND DISCUSSION

PM_{10} results from 1999, 2000 and 2001 are provided in Appendix A, B and C, respectively; results are expressed as $\mu g/m^3$ over the 24-hour sampling period. The 1999, 2000 and 2001 results are also presented graphically in Figures 2.0, 3.0 and 4.0, respectively.

Annual summary statistics, including arithmetic mean, minimum, maximum and 95-percentile concentrations are provided in the text. The **arithmetic mean**, or mean, is obtained by summing the concentrations for the sample period and dividing by the number of sample days in the sample period. The **95-percentile** is that concentration for which 95 percent of the concentrations within the sample period are equal to or less than. For example, if $10\mu g/m^3$ is the 95th Percentile, then 95 percent of all concentrations are less than or equal to $10\mu g/m^3$.

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6 **Chung, A., D.P.Y. Chang, M.J. Kleeman, K.D. Perry, T.A. Cahill, D. Dutcher, E.M. McDougall, K.S. Stround. 2001.** Comparison of real-time instruments used to monitor airborne particulate matter. *Journal of Air & Waste Management.* 51:109-120.

7 **State of the Environment Reporting Home Page.** http://wlapwww.gov.bc.ca/soerpt/index.html

3.1 1999

In 1999, 30 of a possible 34 samples were collected over the seven-month sampling period. The minimum and maximum 24-hour PM_{10} concentrations were 4 and 69$\mu g/m^3$, respectively, with a mean 24-hour concentration of 13.1$\mu g/m^3$. The 95-percentile concentration was 32.5$\mu g/m^3$. Results from 1999 are presented graphically in Figure 2.0.

Three of the 1999 samples exceeded the Federal/Provincial Working Group Reference Level of 25$\mu g/m^3$ with 1 of the 3 samples exceeding the Provincial Ambient Air Quality Objective of 50$\mu g/m^3$. The above-noted exceedances occurred on July 17th (33$\mu g/m^3$), August 4th (69$\mu g/m^3$) and August 10th (32$\mu g/m^3$). It should be noted that re-roofing activities took place in close proximity to the sampler in July and August 1999 resulting in elevated levels of measured particulate matter. Therefore, the above-noted exceedances are not likely representative of ambient PM_{10} concentrations.

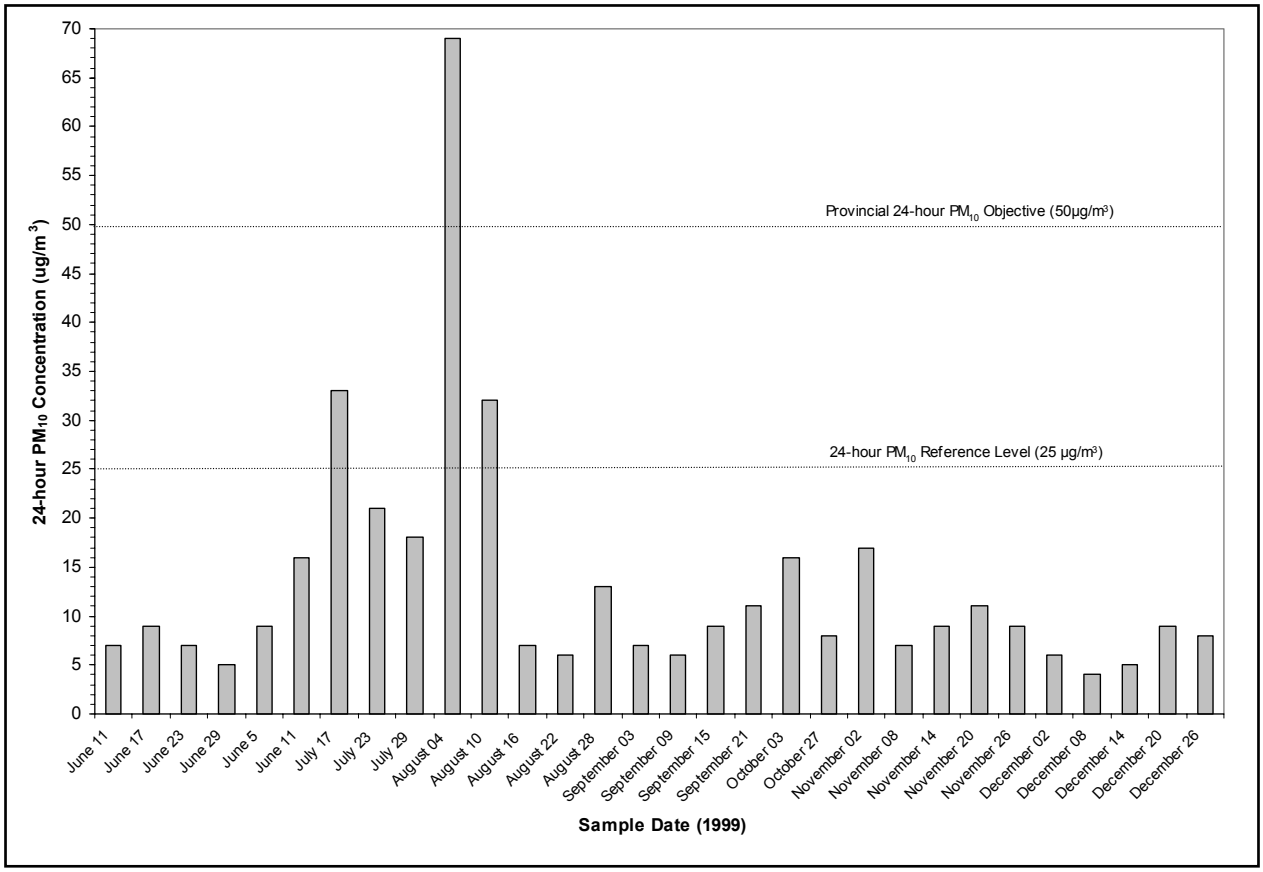

FIGURE 2.0. Results from 1999 PM_{10} sampling at Trail Bay Mall, Sechelt, B.C.

3.2 2000

In 2000, 57 of a possible 61 samples were collected. The minimum and maximum 24-hour PM_{10} concentrations were 4 and 25$\mu g/m^3$, respectively, with a mean 24-hour concentration of 9.8$\mu g/m^3$. The 95-percentile concentration was 17$\mu g/m^3$. Results from 2000 are presented graphically in Figure 3.0.

None of the 2000 samples exceeded the Air Quality Objectives.

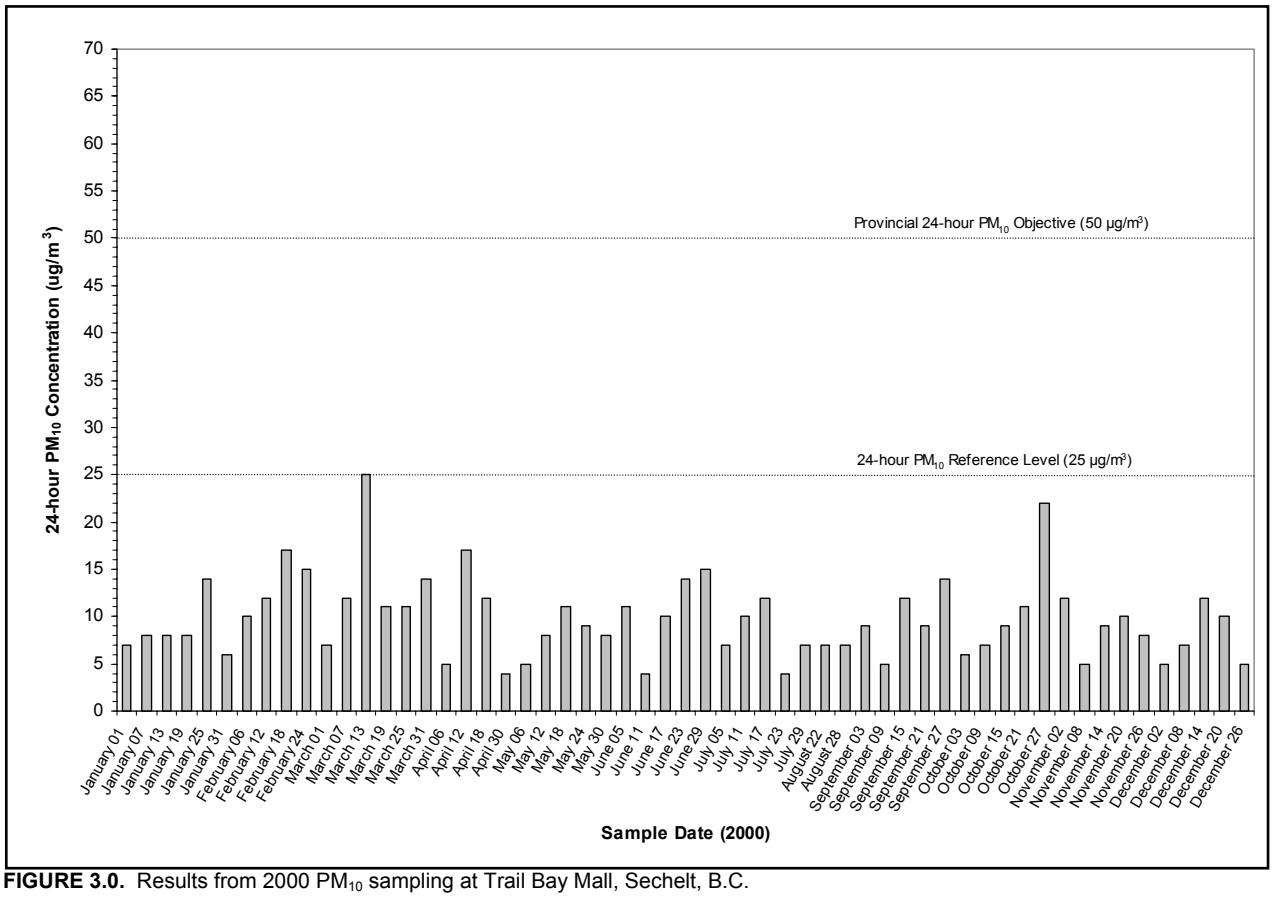

FIGURE 3.0. Results from 2000 PM_{10} sampling at Trail Bay Mall, Sechelt, B.C.

3.3 2001

In 2001, 56 of a possible 61 samples were collected. The minimum and maximum 24-hour PM_{10} concentrations were 3 and 19$\mu g/m^3$, respectively, with a mean 24-hour concentration of 8.2 $\mu g/m^3$. The 95-percentile concentration was 12.2 $\mu g/m^3$. These values represent a decrease in PM10 concentrations from 2000 levels. Results from 2001 are presented graphically in Figure 4.0.

None of the 2001 samples exceeded the Air Quality Objectives.

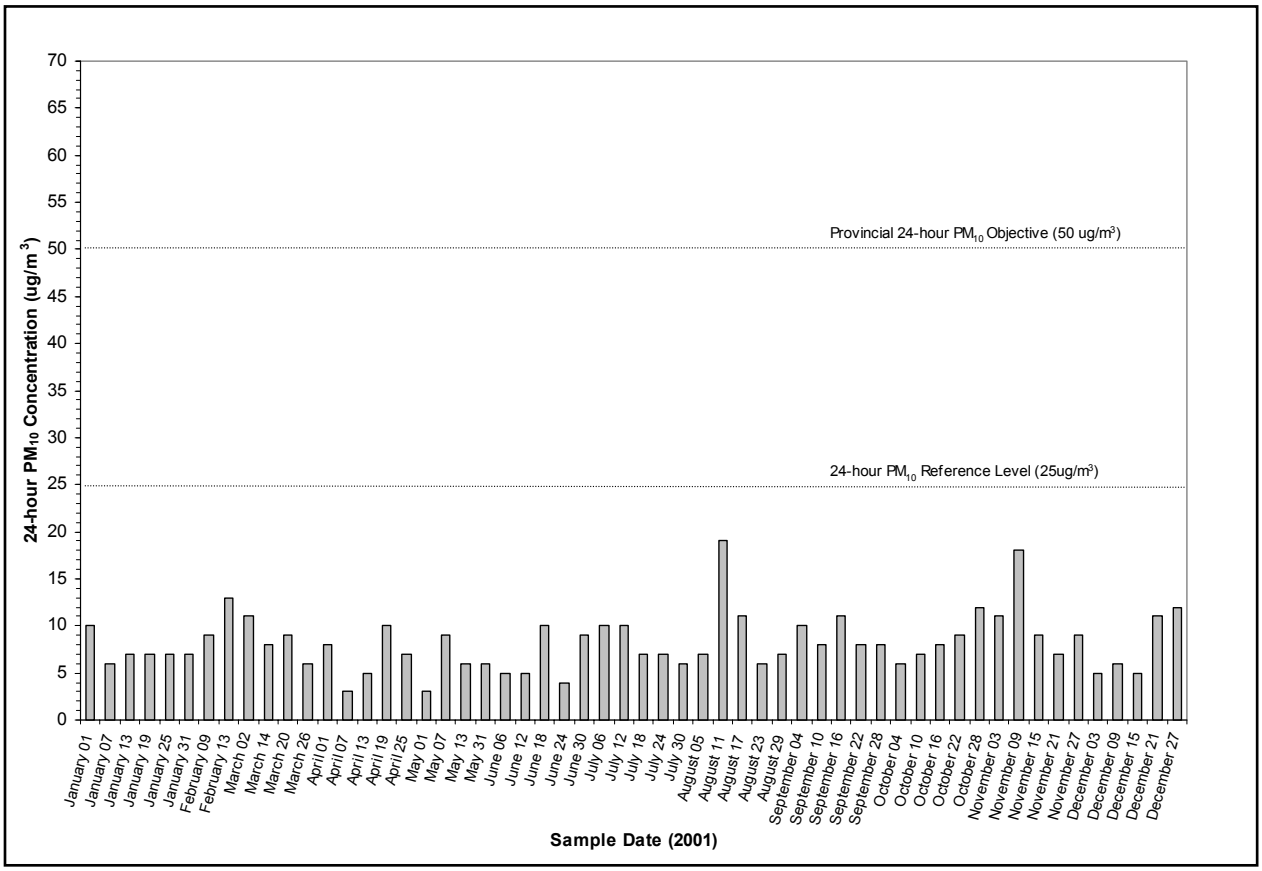

FIGURE 4.0. Results from 2001 PM_{10} sampling at Trail Bay Mall, Sechelt, B.C.

3.4 Comparison with Other PM_{10} Sampling Programs

Figure 5.0 shows the mean 2000 and 2001 24-hour PM_{10} concentrations at Sechelt, Powell River, Langdale, Squamish, Kitsilano (Vancouver) and Chilliwack. The comparison sites chosen are representative of other coastal communities, urban centres and rural communities. It should be noted that PM_{10} sampling at the 5 comparison sites utilized a different type of PM_{10} sampler but, for purposes of this report, differences in operating principles between the samplers were not sufficient to preclude comparison of data among the sites. Data from the comparison sites (see Appendix D) were obtained for the same sample dates as the Sechelt HiVol sampler.

Concentrations in Sechelt are significantly lower than those in major urban centres (e.g. Kitsilano) or near major point sources (Squamish). Referring to Figure 5.0, the 2000 mean 24-hour PM_{10} concentration in Sechelt (9.8μg/m^3) was greater than Powell River (8.1μg/m^3) but less than Langdale (10.1μg/m^3), Squamish (14.9 μg/m^3), Chilliwack (13.1μg/m^3) and Kitsilano (13.6μg/m^3). The 2001 mean PM_{10} concentration in Sechelt was the same as Powell River (8.2μg/m^3) and less than Langdale (9.5μg/m^3), Squamish (13.1μg/m^3), Chilliwack (12.8μg/m^3) and Kitsilano (12.7μg/m^3).

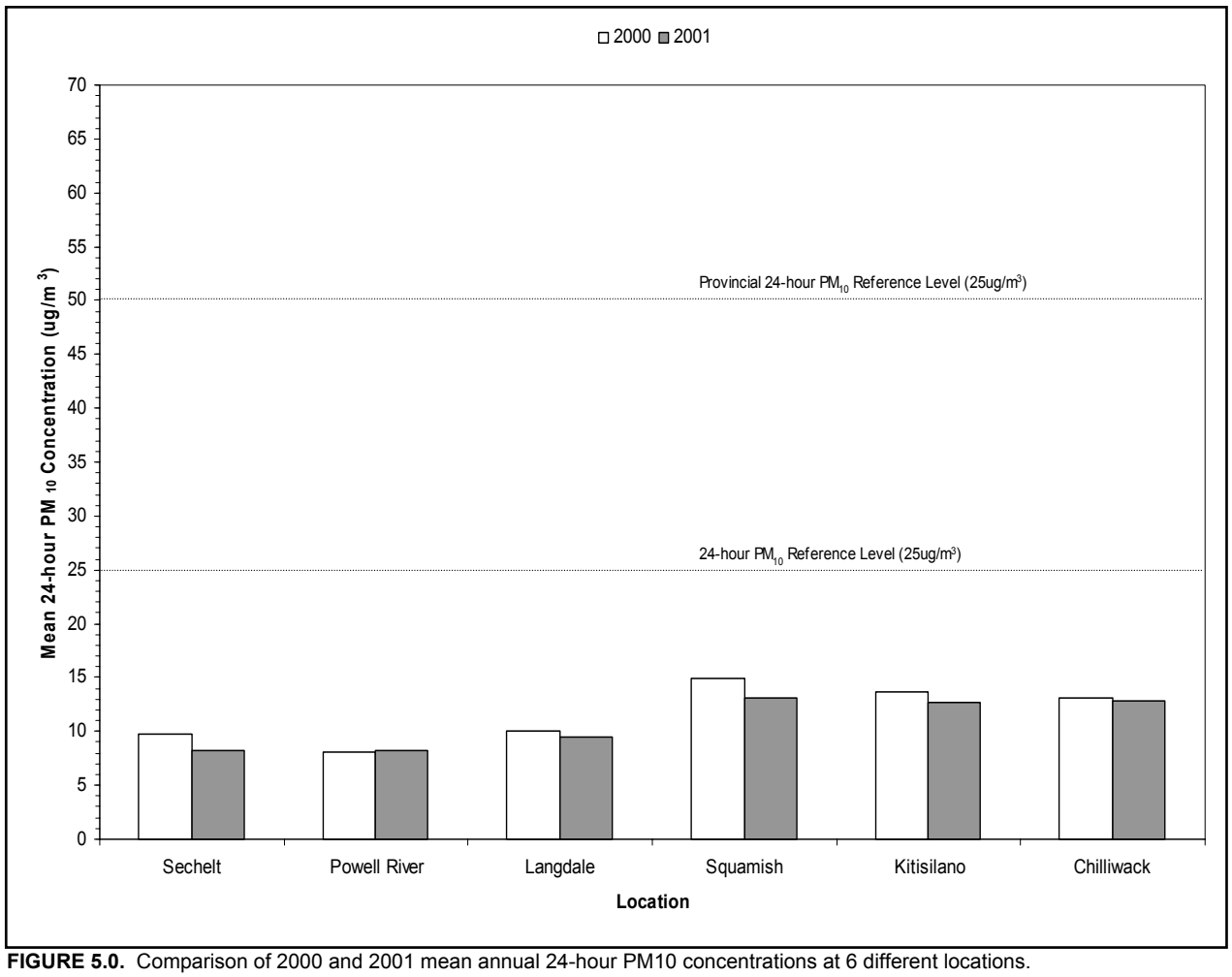

FIGURE 5.0. Comparison of 2000 and 2001 mean annual 24-hour PM10 concentrations at 6 different locations.

4.0 SUMMARY

In June 1999, the Ministry of Water, Land and Air Protection commenced PM_{10} sampling in Sechelt, B.C. Between June 1999 and December 2001, 143 samples were collected, 30 in 1999, 57 in 2000, and 56 in 2001. Ambient 24-hour PM_{10} concentrations during this 31 month period ranged between 3 and 69$\mu g/m^3$ with a mean 24-hour PM_{10} concentration of 9.8$\mu g/m^3$.

The Federal/Provincial Working Group 24-hour PM_{10} Reference Level of 25$\mu g/m^3$ was exceeded for 2 percent of all samples, and the Provincial Ambient Air Quality 24-hour PM_{10} Objective of 50$\mu g/m^3$ was exceeded for less than 1 percent of all samples. The above-noted exceedances occurred in July and August 1999, but are not likely representative of ambient PM_{10} concentrations due to nearby re-roofing activities likely resulting in elevated levels of particulate matter in close proximity to the sampler. Suspect results aside, the Ambient Air Quality Objectives have not been exceeded in Sechelt since commencement of the sampling program.

PM_{10} sampling results indicate ambient PM_{10} concentrations in Sechelt decreased in 2001. The mean 24-hour PM_{10} concentration decreased from 9.8$\mu g/m^3$ in 2000 to 8.2$\mu g/m^3$ in 2002, with a corresponding decrease in the 95-percentile PM_{10} concentration from 17$\mu g/m^3$ to 12.2$\mu g/m^3$. Results also 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 2002 sampling program will be provided early in 2003. WLAP would like to thank the Coast Garibaldi Health Unit for their efficient operation of the HiVol sampler on behalf of the WLAP, and the Trail Bay Centre Mall for accommodating the sampler.

APPENDIX A
SECHELT TRAIL BAY MALL
1999 PM_{10} RESULTS

Month	Date	$\mu g/m^3$ (24 hr. avg.)
June	11	7
	17	9
	23	7
	29	5
July	05	9
	11	16
	17	33
	23	21
	29	18
August	04	69
	10	32
	16	7
	22	6
	28	13
September	03	7
	09	6
	15	9
	21	11
	27	no sample
October	03	16
	09	no sample
	15	no sample
	21	no sample
	27	8
November	02	17
	08	7
	14	9
	20	11
	26	9
December	02	6
	08	4
	14	5
	20	9
	26	8

APPENDIX B

SECHELT TRAIL BAY MALL

2000 PM_{10} RESULTS

Month	Date	µg/m³ (24 hr. avg.)	Month	Date	µg/m³ (24 hr. avg.)
January	01	7	July	05	7
	07	8		11	10
	13	8		17	12
	19	8		23	4
	25	14		29	7
	31	6			
February	06	10	August	04	no sample
	12	12		10	no sample
	18	17		16	no sample
	24	15		22	7
March	01	7		28	7
	07	12	September	03	9
	13	25		09	5
	19	11		15	12
	25	11		21	9
	31	14		27	14
April	06	5	October	03	6
	12	17		09	7
	18	12		15	9
	24	no sample		21	11
	30	4		27	22
May	06	5	November	02	12
	12	8		08	5
	18	11		14	9
	24	9		20	10
	30	8		26	8
June	05	11	December	02	5
	11	4		08	7
	17	10		14	12
	23	14		20	10
	29	15		26	5

APPENDIX C
SECHELT TRAIL BAY MALL
2001 PM_{10} RESULTS

Month	Date	µg/m³ (24 hr. avg.)	Month	Date	µg/m³ (24 hr. avg.)
January	01	10	July	06	10
	07	6		12	10
	13	7		18	7
	19	7		24	7
	25	7		30	6
	31	7			
February	06	no sample	August	05	7
	12	no sample		11	19
	18	9		17	11
	24	13		23	6
March	02	11		29	7
	08	no sample	September	04	10
	14	8		10	8
	20	9		16	11
	26	6		22	8
April	01	8		28	8
	07	3	October	04	6
	13	5		10	7
	19	10		16	8
	25	7		22	9
May	01	3		28	12
	07	9	November	03	11
	13	6		09	18
	19	no sample		15	9
	25	no sample		21	7
	31	6		27	9
June	06	5	December	03	5
	12	5		09	6
	18	10		15	5
	24	4		21	11
	30	9		27	12

APPENDIX D
COMPARISON SITES
PM_{10} DATA

2000	24-hour PM_{10} (ug/m^3)				
	Powell River	Squamish	Kitsilano	Chilliwack	Langdale
January 01	6.0	8.6	7.0	4.5	4.2
January 07	5.5	8.5	12.3	14.4	6.6
January 13	4.7	5.1	10.5	7.7	7.0
January 19	6.8	no data	16.7	14.0	5.4
January 25	7.9	12.5	14.5	9.0	8.5
January 31	5.8	12.1	8.1	9.6	6.4
February 06	4.6	10.0	9.2	7.5	9.3
February 12	7.8	13.8	11.9	9.8	8.2
February 18	9.5	17.2	19.5	16.3	10.8
February 24	8.3	12.2	11.0	10.6	9.0
March 01	5.7	8.3	9.0	6.8	6.2
March 07	8.2	16.0	15.4	17.5	7.8
March 13	5.0	9.0	10.3	7.9	12.1
March 19	8.5	9.5	8.4	8.5	7.7
March 25	7.8	11.8	12.8	16.2	9.7
March 31	7.8	20.3	15.8	18.9	14.0
April 06	6.5	8.1	9.0	8.0	6.0
April 12	13.8	30.3	22.5	28.0	15.9
April 18	11.0	22.1	17.8	17.5	11.3
April 30	4.6	7.9	8.3	6.6	7.7
May 06	4.6	7.9	7.0	6.3	5.8
May 12	6.3	11.6	11.1	7.4	8.3
May 18	8.5	21.8	25.3	18.4	11.9
May 24	6.5	15.1	15.0	18.5	9.0
May 30	8.0	15.2	11.1	11.8	10.9
June 05	8.2	19.9	18.9	17.3	13.0
June 11	4.0	7.3	5.1	5.4	4.5
June 17	9.6	22.2	19.6	15.2	12.6
June 23	12.8	22.2	20.4	18.4	15.9
June 29	8.3	32.4	17.5	25.1	17.1
July 05	7.3	16.6	18.0	14.4	10.4
July 11	7.5	22.3	17.0	18.2	13.4
July 17	8.6	33.5	17.4	24.4	10.8
July 23	4.5	7.8	7.0	7.7	6.0
July 29	10.7	13.6	9.4	11.4	9.4
August 22	7.8	16.9	14.1	14.4	10.6
August 28	10.3	17.5	12.2	11.9	10.3
September 03	9.9	19.1	15.1	15.0	16.1
September 09	5.2	9.1	11.2	8.3	9.6
September 15	14.7	28.3	16.7	21.7	19.2
September 21	6.4	8.6	8.6	9.8	15.3
September 27	6.6	10.6	9.4	9.0	7.5
October 03	11.5	17.3	15.3	16.8	11.1
October 09	13.1	10.0	9.9	12.7	11.5
October 15	6.5	14.3	9.8	10.9	9.6
October 21	10.4	17.0	13.3	12.6	10.8
October 27	14.6	19.5	19.6	30.2	16.5
November 02	16.1	21.9	16.8	10.5	15.5
November 08	7.1	12.5	11.5	6.9	8.8
November 14	8.7	12.0	19.4	15.1	8.2
November 20	11.5	13.0	17.3	18.7	12.2
November 26	5.4	7.1	9.8	6.2	6.7
December 02	5.7	8.5	13.7	10.8	7.8
December 08	9.1	16.2	13.8	14.3	11.4
December 14	8.6	12.4	16.2	18.3	7.8
December 20	4.3	no data	19.5	9.9	6.8
December 26	4.5	no data	10.8	6.6	no data

APPENDIX D cont'd…

2001	24-hour PM_{10} (ug/m^3)				
	Powell River	Squamish	Kitsilano	Chilliwack	Langdale
January 01	9.0	no data	13.9	13.2	no data
January 07	4.8	no data	25.9	8.5	no data
January 13	8.7	13.0	11.6	14.8	7.0
January 19	8.6	13.4	14.3	12.8	10.3
January 25	6.8	9.5	11.5	8.7	6.4
January 31	5.9	8.4	15.1	11.6	8.2
February 06	6.5	5.8	8.7	9.7	3.8
February 12	5.8	17.8	14.5	15.8	6.1
February 18	8.2	14.2	12.8	9.7	9.1
February 24	7.6	13.8	9.1	7.5	7.5
March 02	8.8	11.8	11.4	9.3	9.0
March 08	8.3	10.9	9.5	12.3	8.0
March 14	8.2	11.9	12.8	13.5	7.7
March 20	7.0	8.2	10.0	10.6	7.5
March 26	9.2	8.7	9.1	8.0	6.8
April 01	10.3	8.3	10.2	11.4	6.9
April 07	6.6	9.8	10.3	11.2	7.1
April 13	11.1	8.7	8.9	7.0	7.8
April 19	9.9	13.9	15.5	15.7	11.4
April 25	6.1	12.8	12.5	12.3	9.6
May 01	5.8	8.4	7.1	8.2	6.5
May 07	9.4	22.8	18.3	21.2	14.5
May 13	8.0	10.3	10.0	11.0	8.0
May 19	8.7	8.9	9.1	9.4	6.0
May 25	7.9	11.4	12.2	11.4	8.0
May 31	5.9	14.8	10.4	12.4	9.0
June 06	6.0	14.3	11.3	7.9	7.8
June 12	12.3	11.5	10.2	8.0	8.7
June 18	10.0	19.2	13.6	15.2	12.7
June 24	8.1	11.9	11.4	11.3	8.2
June 30	11.9	20.1	15.0	19.2	14.5
July 06	11.0	22.9	16.3	18.7	11.0
July 12	10.8	26.0	17.7	28.5	11.7
July 18	15.3	14.0	11.3	12.2	11.4
July 24	7.4	15.9	8.2	12.5	7.1
July 30	9.0	13.6	11.7	12.9	9.1
August 05	6.1	12.5	11.1	12.1	11.2
August 11	17.0	37.8	24.9	30.1	21.6
August 17	11.3	17.8	12.4	15.3	11.9
August 23	7.7	6.2	9.5	8.3	9.1
August 29	6.4	16.5	11.1	18.1	13.9
Sept 04	8.1	14.0	14.3	13.4	12.7
Sept 10	10.4	21.6	15.1	no data	13.0
Sept 16	14.2	21.5	14.4	18.0	15.1
Sept 22	5.9	11.7	12.5	10.5	9.5
Sept 28	6.2	12.8	16.0	11.1	11.5
Oct 04	9.4	16.1	12.9	14.2	10.9
Oct 10	6.0	9.0	12.6	8.3	6.7
Oct 16	8.1	20.5	10.6	11.3	8.2
Oct 22	4.3	6.9	7.8	6.7	5.6
Oct 28	8.2	9.1	11.3	8.1	8.8
Nov 03	7.5	10.5	18.4	18.2	13.9
Nov 09	4.7	7.8	24.6	8.3	10.2
Nov 15	8.1	7.3	11.3	6.4	10.3
Nov 21	no data	7.8	9.5	6.7	9.1
Nov 27	6.6	9.2	10.8	6.3	8.1
Dec 03	8.6	14.4	13.3	12.9	10.9
Dec 09	5.7	8.2	8.8	8.9	5.6
Dec 15	4.4	8.1	7.2	6.4	7.0
Dec 21	5.1	11.0	16.8	10.2	7.3
Dec 27	5.1	8.9	14.9	56.8	11.8