Merritt Air Quality Management Plan

Developed by the Merritt Air Quality Stakeholder Committee

May 2007

City of Merritt, British Columbia Photo: Ruth Tolerton

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Executive Summary

The City of Merritt requested that a process be developed to improve air quality in Merritt. To meet this request, an Air Quality Stakeholder Committee comprised of industry, the public, government agencies and non-government organizations worked for about a year to develop this Air Quality Management Plan. The pollutants that are targeted in this plan are microscopic particles that originate from many sources including burning, industry, vehicles and wind-blown dust. Many scientific studies have confirmed that these microscopic particles are detrimental to health.

The Plan provides a goal of reducing the average annual concentration of particles less than 2.5 microns (millionths of a metre) in size (usually referred to as $PM_{2.5}$ or smoke) to only 5 micrograms per cubic metre. It also provides a goal of reducing the extreme concentrations of these particles to only 13 micrograms per cubic metre.

The Plan also provides a goal of reducing the concentrations of particles that are less than 10 microns in size (usually referred to as PM_{10} and mostly made up of microscopic dust particles). This goal is to limit the number of exceedances of the provincial objective to less than 4% of the days each year. It also provides a goal of reducing the average annual concentration of these particles to only 20 micrograms per cubic metre.

The details of these goals of reducing $PM_{2.5}$ and PM_{10} will be refined as additional data is received from a new air quality monitoring program that was started in Merritt in 2006.

Emissions from many sources of $PM_{2.5}$ and PM_{10} need to be reduced to meet the goals outlined above. The Plan provides twenty-two recommendations to meet these goals including reducing emissions from industry, domestic wood stoves, open burning, roadways and construction sites.

The decision process used by the Merritt Air Quality Stakeholder Committee was based on the excellent cooperation between many groups and agencies that had one common goal – to improve air quality in Merritt. Implementation of this Plan is the next step in this process and will benefit from this continued cooperation to achieve a cleaner and healthier environment for all citizens. The Merritt Air Quality Stakeholder Committee looks forward to working with the City of Merritt and stakeholders to implement this Plan.

Introduction

This Air Quality Management Plan provides a path for improving air quality in Merritt through an ongoing process of reducing, or preventing increases, in emissions. Poor air quality can be a significant health risk, degrade visibility and negatively affect tourism. The cumulative impacts of air emissions can also limit opportunities for local or regional economic expansion.

This Plan focuses on airborne particles less than 10 microns (millionths of a metre) in diameter (labelled PM_{10}). PM_{10} particles can be subdivided into a fine fraction and coarse fraction. The fine fraction consists of particles of 2.5 microns in diameter (or less), labelled $PM_{2.5}$. Such particles are mostly associated with smoke and haze, so this document refers to them simply as "smoke." The coarse fraction of PM_{10} includes particles of 2.5 to 10 microns in diameter. These are mostly microscopic dust particles, so are referred to here simply as "dust."

The seven appendices to this Plan provide more detailed information on air quality in Merritt including management recommendations, air quality statistics and graphs, health effects of particulate matter, online resources and air quality monitoring.

Air Quality Management Planning Process

This Plan was developed by the Merritt Air Quality Stakeholder Committee, a committee chaired and supported by the City of Merritt, British Columbia. It is based upon input from the public, industry, governments, forest professionals and health professionals. The fifteen members of the Air Quality Stakeholder Committee are listed in Appendix 1.

Concerns from the public and council led to the organization of an Air Quality Public Forum that was held in Merritt on April 5, 2006. This Forum helped identify some of the key issues that are addressed in this Management Plan. The Forum consisted of presentations on the sources, concentration and health effects of particulate matter (smoke and dust) as well as a question and answer session between the audience and the presenters. About one hundred people attended the Forum and the Air Quality Open House that preceded it. Questions from the audience at this Forum included the following:

- What are the sources and health effects of dust and smoke?
- Is there a potential for increased smoke and dust resulting from pine beetle-infested forests?
- What are the health effects of the smoke from the beehive burner and are there plans for the burner to be phased out?
- Is truck idling is a significant source of air pollutants in the city?
- Can urban planning be used to enforce a buffer zone between industrial areas and care facilities or residential areas?
- Are pesticides a source of toxic air pollutants in Merritt?
- What causes the haze in and around Merritt?
- Will there be any airshed planning in Merritt?

The Merritt Air Quality Stakeholder Committee was formed following the Air Quality Public Forum. The Committee held monthly meetings throughout 2006 and early 2007 to address the air quality concerns from the Forum and from the report *Air Quality in Merritt*. This work included

identifying the sources of particulates in the City, developing a comprehensive list of air quality issues and providing recommendations to address each issue, and formed the basis of this Air Quality Management Plan.

Goals and Targets of the Merritt Air Quality Management Plan

The Goals of the Merritt Air Quality Management Plan are to:

1. **Minimize the risk to public health from smoke and dust pollution**
2. **Improve visibility**
3. **Prevent future deterioration and work towards continuous improvement of air quality**

To meet these goals, $PM_{2.5}$ and PM_{10} at all current monitoring sites should remain at the current concentrations or be reduced. The Committee chose as future target concentrations the lowest values of $PM_{2.5}$ and PM_{10} that had been previously measured in Merritt. Targets to manage both short-term elevated concentrations as well as annual average concentrations were selected. Note that lower average concentration targets are associated with greater health benefits because averages are associated with a reduction in the overall human exposure to particulate matter. Table 3 in the Appendix (*Historical Measurements and Future Targets of Particulates*) provides both the past concentrations of $PM_{2.5}$ as well as these future targets out to 2012. Table 4 in the Appendix does the same for PM_{10}. Data collected in 2006 was not used for this assessment because of the different types of monitors used and the short time period of measurements. However, the data collected starting in 2006 from these monitors will be used to refine the interim targets below.

$PM_{2.5}$ Target Concentrations:

1. **An extreme $PM_{2.5}$ target is set at thirteen micrograms per cubic metre**. This is an extreme annual concentration, called the ninety-eighth percentile[1]. Thirteen micrograms per cubic metre is similar to extreme concentrations measured in nearby Kamloops during recent low wildfire years. See Figure 1 for comparison of particulate concentrations at Merritt, Kamloops and Chilliwack.
2. **An average $PM_{2.5}$ target is set at five micrograms per cubic metre.** This is an average annual concentration and reflects the overall exposure to $PM_{2.5}$ during a year. Five micrograms per cubic metre is similar to average concentrations measured in Merritt in 1999 and 2000. It is also similar to average Kamloops concentrations measured during low wildfire years.

PM_{10} concentrations:

1. **An extreme PM_{10} target is set to limit exceedances of the Provincial Objective to less than 4% of the days by 2012.** This provincial objective is 50 micrograms per cubic metre (24-hour average).

[1] The ninety-eighth percentile is the daily average concentration of $PM_{2.5}$ during the year that was exceeded on only two percent of the days during the year. The Canada-Wide Standard (CWS) for PM2.5 is 30 ug/m3, based on an annual 98th percentile averaged over 3 consecutive years. Limited monitoring in Merritt suggests that levels are well below the CWS, but this will be re-assessed when more monitoring data becomes available.

2. **An average PM_{10} target is set at 20 micrograms per cubic metre.** This is an average annual concentration. 20 micrograms per cubic metre is similar to average concentrations measured in Merritt from 1999 to 2001 when the log yard at the Aspen Planers Mill was not operating. It is also similar to average concentrations measured in Kamloops from 1994 to 2005.

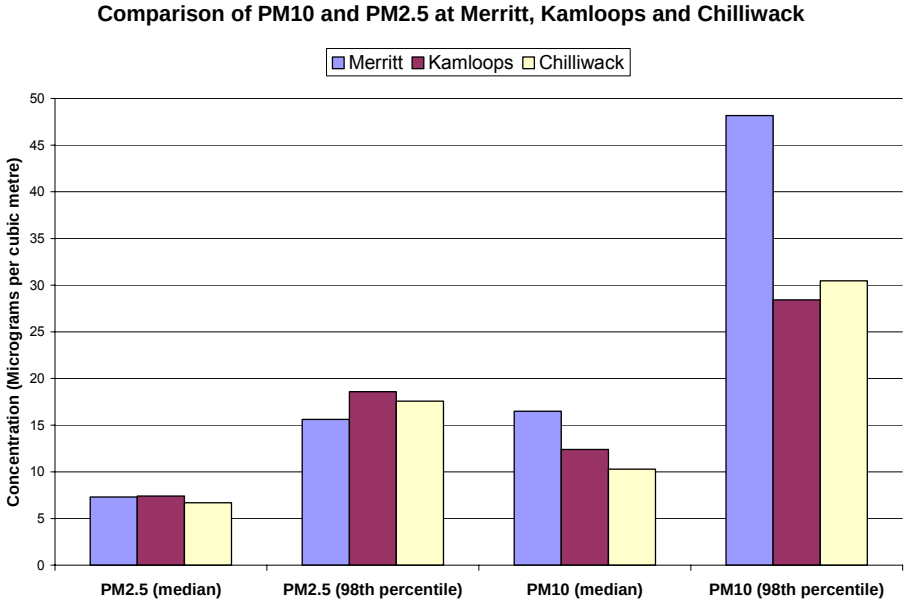

Figure 1. Comparison of the hourly (as opposed to daily in Tables 3 & 4) concentrations of PM2.5 (smoke) and PM10 (smoke and dust) at Merritt, Kamloops and Chilliwack. The median and 98th percentiles of these concentrations suggest that the concentration of dust is considerably higher in Merritt, while the concentration of smoke is about the same in each community. The 98th percentile is a measure of extremely high concentrations. Data is from May 1999 to June 2000.

Sources of Air Pollutants in Merritt

Table 1 contains the estimated emissions of various air pollutants in and around Merritt. This information is based on the B.C. Ministry of Environment inventory of emissions for the province, valid for the year 2000. These pollutants are estimated to have been emitted within the hatched area in Figure 3.

Analysis of the inventory in Table 1 and other data suggests that the microscopic dust particles (the coarse component and generally the largest part of PM_{10}) originate from:

- Industry, including fine sawdust from wood manufacturing and dust from exposed log yards
- Dust produced by the crushing by vehicles of winter traction material (sand, silt and gravel) that has been placed on roads and that is subsequently suspended in the air by wind and vehicles.
- Dust from construction, development sites and open areas
- Wind erosion from forest, grassland and agricultural areas
- Logging trucks that deposit mud onto Merritt roads
- Repeated cycling of dust into the atmosphere by road traffic and industrial equipment

Similarly, the main sources of smoke and haze ($PM_{2.5}$) in order of importance are:

- Residential wood heating
- Merritt industrial sites (including Tolko Industries' beehive burner),
- Vehicles – on and off road
- open burning of forestry and agricultural debris,
- wildfires

Table 1 An inventory of emissions for the City of Merritt and the surrounding area developed by the B.C. Ministry of Environment for the year 2000. Units are tonnes per year. Area emissions are only gross estimates. $PM_{2.5}$ emissions in the inventory for space heating (36 tonnes/year) are likely incorrect and have been ignored in the analysis in this Plan.

PERMIT NUMBER	FACILITY	Carbon monoxide	Nitrogen oxides	Sulphur oxides	Volatile organic compounds	Particulates	PM10	PM25
2410	Aspen Planers Ltd.	1.24	6.24	0.03	3.76	13.49	7.36	2.74
2412	Ardew Wood Products Ltd.	0.71	3.56	0.02	2.80	14.07	7.10	2.82
2414	Aspen Planers Ltd.	2.05	10.25	0.06	0.54	78.60	32.17	16.27
	Tolko Merritt	464.1	7.9	0.4	46.3	111.4	52.1	27.2
	Total Point Sources	**468.1**	**27.95**	**0.51**	**53.4**	**217.56**	**98.73**	**49.03**
AREA DESC. 2	**AREA_DESCRIPTION**							
Area	Agriculture	0.00	0.00	0.00	13.22	45.30	20.17	2.53
Area	Fuel Marketing	0.00	0.00	0.00	17.99	0.00		
Area	Landfill	0.00	0.00	0.00	4.61	1.14	0.41	0.11
Area	Miscellaneous	0.28	0.01	0.00	2.80	3.04	2.11	1.81
Area	Miscellaneous Burning	22.12	1.23	0.17	5.83	4.16	3.96	3.93
Area	Other	0.00	0.00	0.00	0.00	16.84	1.47	0.54
Area	Solvent Evaporation	0.00	0.00	0.00	44.47	0.00		
Area	Space Heating	220.27	12.31	2.56	50.13	38.77	36.59	36.47[2]
	Widlfires	19.01	0.36	0.01	0.73	3.58	2.79	2.47
	Residential Wood Heating	282.69	4.82	0.69	71.01	55.52	52.48	52.44
	Total Area Sources	**544.38**	**18.73**	**3.43**	**210.80**	**168.35**	**119.99**	**100.30**
Mobile	Brake Lining	0.00	0.00	0.00	0.00	0.57	0.56	0.24
Mobile	Heavy-Duty Vehicles	41.74	121.53	2.25	6.83	4.17	4.17	3.85
Mobile	Light-Duty Vehicles	1109.72	62.19	2.03	80.87	0.93	0.92	0.81
Mobile	Off-Road	1053.47	127.69	3.66	101.93	12.31	12.31	11.84
Mobile	Tire Wear	0.00	0.00	0.00	0.00	0.44	0.44	0.11
	Total Mobile Sources	**2204.92**	**311.42**	**7.95**	**189.63**	**18.43**	**18.40**	**16.85**
Road Dust	Road Dust	0.00	0.00	0.00	0.00	1643.36	339.60	76.09
	Total Emissions	**2753.30**	**350.20**	**11.48**	**407.53**	**1936.30**	**524.62**	**215.07**

The beehive burner (Figure 2) is perceived by Merritt residents to be a large source of smoke and haze and is a cause of numerous complaints about air quality. The beehive burner also degrades the views of the city and the surrounding mountains and is a cause of general visibility reduction in the Nicola Valley. According to Table 1, about 49 tonnes of $PM_{2.5}$ are emitted by the burner, almost one quarter of the estimated total $PM_{2.5}$ emissions in Merritt.

Figure 2 The Beehive Burner operated by Tolko Industries in Merritt, B.C.

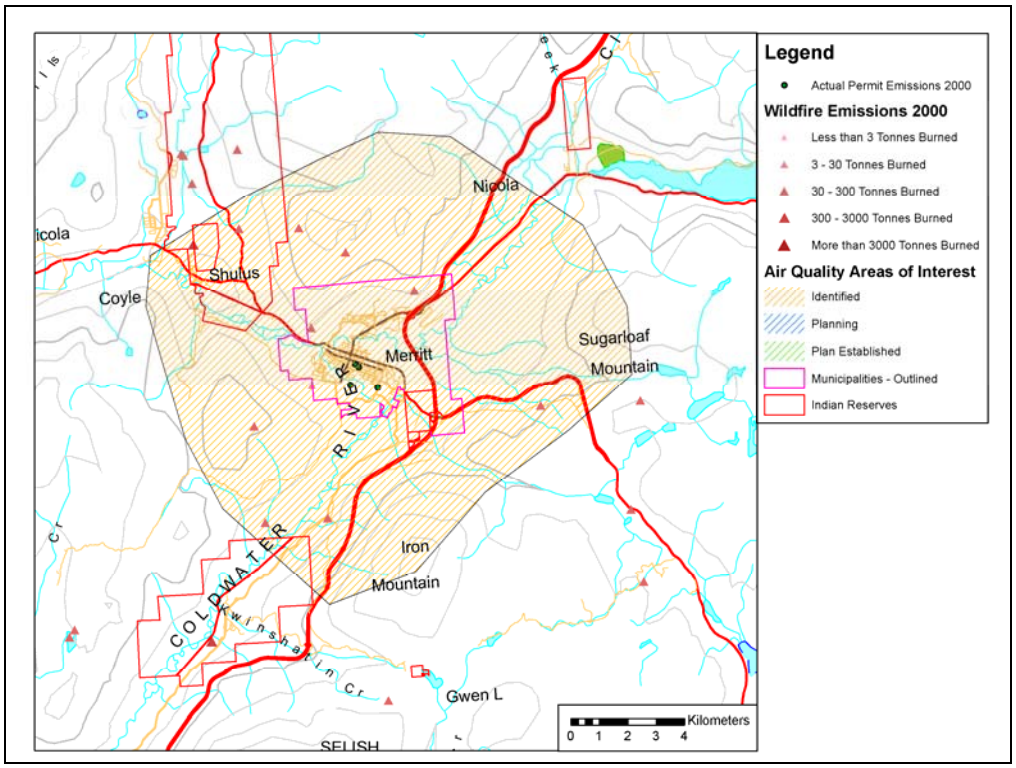

Figure 3. The City of Merritt and surrounding area. Pollutants in Table 1 are estimated to have been emitted within the hatched area.

Strategies, Recommendations and Implementation of the Management Plan

The strategy of the Merritt Air Quality Stakeholder Committee was to identify the major sources of $PM_{2.5}$ and PM_{10} and then develop a list of recommended actions to reduce emissions from these sources. The major sources were identified using the emission inventory in Table 1 and other information. The list of recommended actions s is in Appendix II.

The Committee also identified a need for an implementation, feedback and monitoring phase for this Management Plan. The description of each phase is as follows:

Implementation Phase

Implementation of the Merritt Air Quality Management Plan will be a process where each agency and company develops plans and procedures for each recommendation in Appendix II within their area of responsibility. Agencies and companies responsible for individual tasks are listed in the final column of Table 2 in Appendix II. The agencies and companies include:

- Ardew Forest Products
- Aspen Planers
- B.C. Ministry of Environment
- B.C. Ministry of Forests
- City of Merritt
- Interior Health Authority
- Thompson Nicola Regional District
- Tolko Industries

The detailed plans and procedures developed by each of these agencies and companies should be finalized within three months of this Plan being passed by City Council. Each individual plan and procedure should include:

- A timetable for implementation of individual procedures and tasks
- An annual report to the Merritt Air Quality Stakeholder Committee from each company and agency that outlines what has been accomplished.
- A process to anticipate and take steps to prevent new air quality problems from developing
- Securing funding to implement the plans and procedures

Part of the implementation phase of the Plan should include ways to inform and educate the public about air quality in Merritt. These ways could include an air quality section on the City web site, a second air quality forum, and/or an air quality newsletter. Also, the City of Merritt should incorporate elements of this plan into their Official Community Plan, particularly those recommendations that relate to zoning.

Feedback Phase

Comments and advice will be actively sought from the Council, public and other stakeholders after the implementation of the Merritt Air Quality Management Plan. This will be used to further improve the plan.

Monitoring Phase

After the Feedback Phase, the Merritt Air Quality Management Plan will be continually monitored to identify the effectiveness of the Plan's air quality recommendations, to ensure that these recommendations are having the desired results and to verify that the air quality recommendations reflect the best possible practices.

We, the undersigned, agree to work together to achieve the goals of this Merritt Air Quality Management Plan to the fullest extent possible.

City of Merritt	Date	Ardew Forest Products	Date
Thompson Nicola Regional District	Date	Nicola Tribal Association	Date
Tolko Industries	Date	Interior Health Authority	Date
Aspen Planers	Date	B.C. Ministry of Forests	Date
B.C. Ministry of Environment	Date	B.C. Lung Association	Date
Merritt Seniors Association	Date	John Smit, community member	Date

Appendix I Merritt Air Quality Stakeholder Committee Members

Members of the Merritt Air Quality Stakeholder Committee (December, 2006):

Ron Sherwood	Councillor, City of Merritt, Committee Chair
Ralph Adams	B.C. Ministry of Environment
Clare Audet	Interior Health Authority
Lou Bouwmeester	Tolko Industries Ltd.
Shawn Boven	Public Works Manager, City of Merritt
Al Crane	B.C. Forest Service
Richie Gage	BC Lung Association
Herb Graham	TNRD Director Area "N"
Erin MacGregor	City of Merritt
David Matteucci	Fire Chief, City of Merritt
Hal O'Keefe	Seniors Citizens Representative
Joe Post	TNRD Director Area "M"
Tracy Sampson	Nicola Tribal Association
John Smit	Forestry Consultant; Community Member
Brenda Stockford	Aspen Planers Ltd.
Eric Taylor	Air Quality Meteorologist, B.C. Ministry of Environment

The Merritt Air Quality Stakeholder Committee met monthly from May 2006 through April 2007 to develop this management plan.

Appendix II Air Quality Recommendations

Table 2. Recommendations to improve air quality in Merritt (2007 to 2011)

Issue	Recommended action	Cost	Potential to improve air quality	Year	Comments / Action
Smoke from Industrial sites	Aspen Planers: A hogger system is being engineered to convert waste wood to hog fuel for use by pulp mills, with a view to eventually eliminate the need to send waste wood to the burner. A hogger system can be described as a mechanical shredder or grinder that reduces large wood scraps to smaller pieces.	Industry funding	Med.	2007	Aspen Planers - Based on minutes of Nov. 1, 2006 meeting of Air Quality Committee.
Smoke from Industrial sites	Ardew Wood Products smoke management: • Internally utilizing planermill trim ends will reduce Ardew contribution to burner by 50% (January 2007) • More fully utilize wood to reduce waste. • Divert waste wood to Tolko's hog system if burner is phased out.	Industry funding	Med.	2007	Ardew Wood Products - Based on letter from Ardew Wood products, November 2006
Smoke from Industrial sites	NMV Lumber smoke management: • Distributing waste wood and sawdust to ranchers and residents for their use • No additional action planned	n/a	n/a	n/a	NMV - Based on letter from NMV Lumber, November 2006

Issue	Recommended action	Cost	Potential to improve air quality	Year	Comments / Action
Smoke from Industrial sites	Tolko Industries smoke management: • The long term goal is to eliminate the Beehive Burner – no timetable yet • 50% of waste wood that previously would have been burned is now being shipped as hog fuel to pulp mills, reducing the burner operation to only two weeks out of three. (September 2006) • A further reduction in waste from Ardew Forest Products and Aspen Planers will reduce the burner operation to two weeks out of every four. (February 2007) • A plan is being developed to convert all remaining wood waste to saleable product using a hog system. This project has not yet been approved by Tolko management.	Industry funding	High	2007 - ≈ 2009	Tolko - Based on letter from Tolko Industries, November 2006
Buffer zone between industrial and residential areas	Official Community Plan and Zoning bylaws should establish regulations to ensure that all future residential development occurs far enough away from current and future industrial sites so that pollutants (smoke and dust) from industrial sites will not negatively affect the health of residents.	Requires budgeting	High	2007-2009	City of Merritt

Issue	Recommended action	Cost	Potential to improve air quality	Year	Comments / Action
Air Quality Monitoring	Initiate a new air quality monitoring program in Merritt, including: • Install two Partisol air quality monitors to measure $PM_{2.5}$ and PM_{10} at the Coquihalla Gillis House Extended Care Facility • Install a $PM_{2.5}$ (smoke) Partisol monitor north of the beehive burner (Parcel St.) • Install a PM_{10} (fine dust and smoke) Partisol monitor south of industrial sites (west end of Houston St.). • Install a tower and a continuous wind monitor at the Parcel Street location. • Install a camera to provide time lapse photography of industrial sites. • Cooperation between the City of Merritt and the B.C. Ministry of Environment in the installation of each Partisol monitor. • Changing of filters of each monitor by the City • Installing equipment to allow wind information and photographs to be accessed remotely by the Ministry of Environment. • Continuous monitoring of $PM_{2.5}$ (2008 or 2009)	$$	High	2006	Ministry of Environment and City of Merritt: Installation of equipment started in August, 2006. All equipment should be fully operational by early 2007. / Min. of Environment – E. Taylor

Issue	Recommended action	Cost	Potential to improve air quality	Year	Comments / Action
Domestic smoke	Using all communication tools including a public forum, brochures, newspapers, radio and TV, and in collaboration with the Ministry of Environment and the B.C. Lung Association, educate the public on: • the proper use of wood stoves to reduce emissions • the purchase of stoves that meet current emission standards • The City should consider implementing a wood stove change-out program	Requires budgeting	Med.	2007	City of Merritt
Domestic smoke	Develop municipal legislation to mandate the proper use of wood stoves and to restrict their use during poor air quality days where there are other sources of heat. (Only when data from continuous monitoring of $PM_{2.5}$ is available.)	Requires budgeting	Low	08[3]	City of Merritt
Domestic smoke	Develop municipal legislation to mandate the installation of stoves that meet current emission standards when replacing stoves or installing stoves for the first time in a residence. Emission standards are those published by the Canadian Standards Association or the U.S. Environmental Protection Agency.	Requires budgeting	Med.	2007	City of Merritt
Domestic smoke	Develop municipal legislation to ban the use of outdoor wood-fired boilers	Requires budgeting	Low, but potentially high in the future	2007	City of Merritt

[3] Wood stove operations can only be managed when continuous $PM_{2.5}$ monitoring is installed in Merritt.

Issue	Recommended action	Cost	Potential to improve air quality	Year	Comments / Action
Domestic smoke	Maintain ban on backyard burning and restrict any exceptions to times when the atmospheric ventilation and wind conditions are conducive to minimizing smoke in the community	0	Low	2007	City of Merritt
Controlled burning	Ensure that forestry companies follow the OBSCR and burn only when ventilation conditions are GOOD and when wind is forecast to carry smoke away from urban areas	$	Low	2007	Ministry of Forests and Range
Controlled burning	Encourage the burning of small fires by the forest industry, maintaining high temperatures so that smoke is minimized and the fire can be out well before sunset.	$	Med.	2007	Ministry of Forests and Range
Vehicle emissions	• Encourage or legislate the reduction of idling time for trucks and other vehicles. • Educate the public and industry on reduction of idling to improve air quality. (Refer to the recent transportation bylaw that addresses this issue.)	Requires budgeting	Low	2007	Legislation in being developed. /City of Merritt

Issue	Recommended action	Cost	Potential to improve air quality	Year	Comments / Action
Dust from roads in spring	Reduce road dust from winter road traction material by: • Spreading snow melting chemicals on roads prior to major snow events • Reducing amount of material put on roads in winter • Educating the public about existing road maintenance policy (to avoid complaints about too little material) • Removing excess material from local roads in late winter. • Explore the costs and benefits of using low-dust road traction material	$	High	2007	Not practical to remove material much earlier in the spring /City of Merritt
Dust from industrial sites:	Reduce dust from unpaved areas in Industrial sites • Identify specific sources of dust in spring and summer in industrial yards • Wet down log yards and other unpaved areas in a sustainable manner (i.e. without toxic substances), perhaps with calcium chloride	Industry funding	High	2007	Tolko Aspen Planers Ardew Forest Products
Dust from industrial sites:	Pave log yards and other bare areas, particularly industrial roadways. Reclaimed road traction materials from the Ministry of Transportation or the City could be used in the paving process.	Industry funding	High	2008	Tolko, Aspen Planers and Ardew Forest Products. Aspen Planers is planning to pave all areas soon.

Issue	Recommended action	Cost	Potential to improve air quality	Year	Comments / Action
Dust from industrial sites:	• Improve industrial systems to minimize the emissions of sawdust. For example, install baghouses in sawmills. • Improve the system at Aspen Planers for the filling of chip trucks to avoid fugitive emissions. Also avoid the spilling of excess sawdust on the outside of the trucks.	Industry funding	Low	2008	Tolko Aspen Planers Ardew Forest Products
Dust from industrial sites:	Reduce mud from logging trucks in the city • Removal of mud from logging trucks before entering Merritt • Re-route the trucks outside of Merritt to reduce mud on vehicles • Install cattle guards could help with mud reduction • Pave the logging roads near the highway • Install wheel spray systems to clean logging trucks leaving the log yards with mud on wheels.	Industry funding	High	2007 and 2008	Tolko Aspen Planers Ardew Forest Products
Summer dust from city roads	Reduce summer dust emitted from road borders, which consist of dirt and gravel that provide drainage during heavy rains • Install storm drainage systems as required and then pave the dirt and gravel borders of roads, • For those areas where paving is currently impractical, apply magnesium chloride or modify the surfaces of the dirt and gravel borders to minimize dust emissions	Requires budgeting	High	2008-2011	City of Merritt

Issue	Recommended action	Cost	Potential to improve air quality	Year	Comments / Action
Summer dust events	Reduce summer dust events (other than road dust) from the Active Mountain Development site (MMMF) and new developments on the south side of industrial areas: • Water down sources of dust the Active Mountain Development Site grounds early each morning and throughout the day. (TNRD jurisdiction), including using magnesium chloride • Enforce existing bylaws that specify the watering down of construction sites	Requires budgeting	Med.	2007	• Active Mountain Development Site management • City of Merritt
Dust from soil erosion by water and wind	Eliminate erosion from wind and water that is causing soil and dust to move on to roadways adjacent to commercial/residential sites that are both developed and in the process of being developed.	Requires budgeting	Med	2007	• City of Merritt

Appendix III Air Quality Monitoring

The locations of Merritt air quality monitoring stations, some of which have operated since 1990, are in Figure 4.

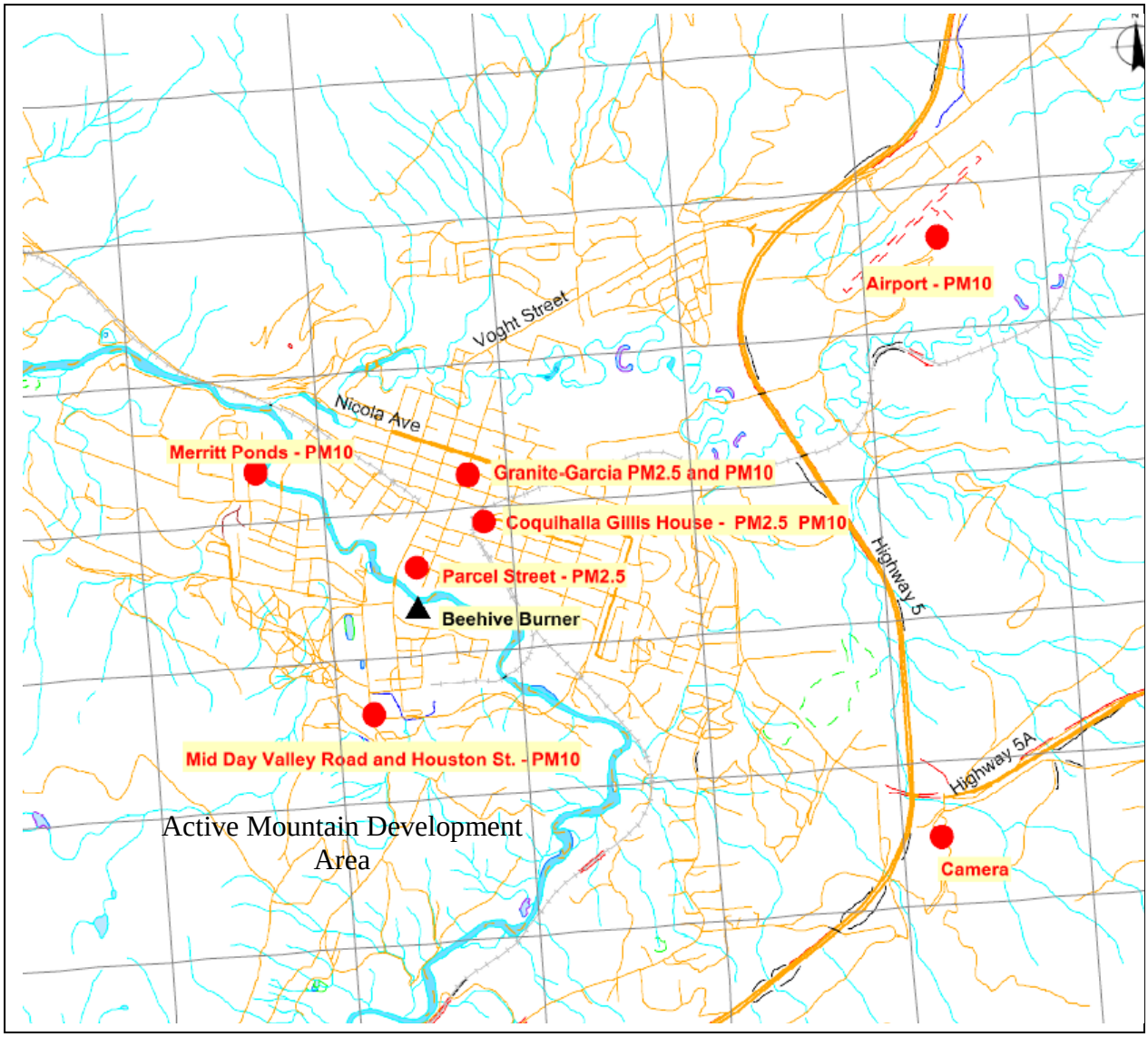

Figure 4. Air pollutant monitoring sites in Merritt. The monitoring site at Granite and Garcia Streets operated from 1990 to 2004. Stations at Merritt Ponds and the Airport operated during an intensive monitoring program from 1999-2000, when hourly observations were also made at Granite and Garcia Streets. Beginning in the fall of 2006, a meteorological tower at the Parcel Street site has been measuring hourly wind, temperature and humidity. Stations at Coquihalla Gillis House, Parcel Street and at the corner of Mid Day Valley Road and Houston Street began operating in 2006 and 2007. Time lapse photography began in early 2007 with a camera at the intersection of Highways 5 and 5A pointed at the industrial area.

Past monitoring: PM_{10} concentrations were measured at the corner of Granite and Garcia streets in Merritt from 1990 until 2004. An intensive hourly monitoring program was carried out in 1999 and 2000[4] at this site, and observations were also made at the airport and the Merritt ponds site during this period. The intensive monitoring program included hourly measurements of various pollutants including PM_{10} and $PM_{2.5}$ as well as hourly wind and temperatures. Analysis of the particulate concentrations suggested that both smoke and dust are at concentrations that can negatively affect health and degrade visibility. The analysis also suggested that, while the concentration of smoke in some areas of Merritt is similar to that in many other communities in British Columbia, certain residential areas near the beehive burner are probably experiencing higher smoke concentrations. A previous analysis showed that dust concentrations are significantly higher in Merritt than in other B.C. communities[5].

Current Monitoring: As a result of these analyses, the Ministry of Environment and the City of Merritt have established a new air quality monitoring program. The goals of this program are to:

1. Improve our understanding of the sources of smoke and dust in Merritt,
2. Improve our understanding of the concentration of smoke in the residential area near the beehive burner, which was identified as an area of concern in the report *Air Quality in Merritt*[5].

This new monitoring program was initiated in August 2006 and utilizes four Partisol Monitors to measure $PM_{2.5}$ and PM_{10} as well as a camera to monitor the industrial sites. Partisols are programmed to operate for 24 hours every sixth day. The types of monitoring equipment and their locations (Figure 4) are:

- A $PM_{2.5}$ monitor is located about 500 metres north of the beehive burner in a residential area at the south end of Parcel Street.
- A meteorological tower is located at the Parcel Street site to measure hourly temperature, humidity and wind speed and direction.
- Both a $PM_{2.5}$ and a PM_{10} monitor are located at the Coquihalla Gillis House extended care facility, about one kilometre northeast of the beehive burner.
- A PM_{10} monitor is located near the corner of Houston Street and Midday Valley Road. This location is southwest of the industrial areas but north of the Active Mountain Entertainment development site.
- An automated camera near the Tourist Information Building to the southeast of Merritt that takes photographs of industrial sites and the surrounding areas of the city at regular intervals throughout the day.

[4] *Air Quality in Merritt*. Report on an analysis of air quality in Merritt, B.C. Ministry of Environment. March 2006.
[5] Merritt had the highest mean concentration of PM_{10} out of 32 B.C. communities. From Particulate Matter in British Columbia, A Report on PM_{10} and $PM_{2.5}$ Mass Concentrations up to 2000. B.C. Ministry of Environment. Table 4, page 41.

Appendix IV Trends and Other Statistics

The graphs in this appendix show annual trends of particulate concentrations and monthly and hebdomadal graphs to identify months or days of the week when concentrations were highest in Merritt. There are several types of graphs:

- **PM_{10} graphs (yellow background)**: The annual exposure to concentrations of PM_{10} above a certain health reference level at each monitoring site (Figures 5 through 8) is plotted in the yellow-background graphs, along with the percent of days in each year that the daily average PM_{10} concentration exceeded the Level B objective of 50µg/m^3.

- **$PM_{2.5}$ graph (yellow background)**: The annual exposure to concentrations of $PM_{2.5}$ above a certain health reference level is plotted in the yellow-background graph (Figure 13), along with the 98^{th} percentile of the daily average concentration in each year.

- **PM_{10} and $PM_{2.5}$ box plot graphs (blue boxes**): These show the median values and the distribution of the concentrations for each month of the year and for each day of the week.

In the box plot graphs in this appendix, the center horizontal line in each box marks the median of the concentration sample during the month or the day on the x axis. The height of each box shows the range within which the central 50% of the particulate concentrations fall, with the box edges (called hinges) at the first and third quartiles.

To describe the information contained in a box plot, we must define a few terms. Hspread is comparable to the interquartile range or midrange. It is the absolute value of the difference between the values of the two hinges. Fences define outside and far outside values and are defined as follows:

Lower inner fence	=	lower hinge - (1.5 • (Hspread))
Upper inner fence	=	upper hinge + (1.5 • (Hspread))
Lower outer fence	=	lower hinge - (3 • (Hspread))
Upper outer fence	=	upper hinge + (3 • (Hspread))

The whiskers show the range of observed values that fall within the inner fences. In other words, they show the range of values that fall within 1.5 Hspreads of the hinges. Because the whiskers extend to observed values and the fences need not correspond to observed values, the whiskers do not necessarily extend all the way to the inner fences. Values between the inner and outer fences are plotted with asterisks. Values beyond the outer fences, called far outside values, are plotted with empty circles.

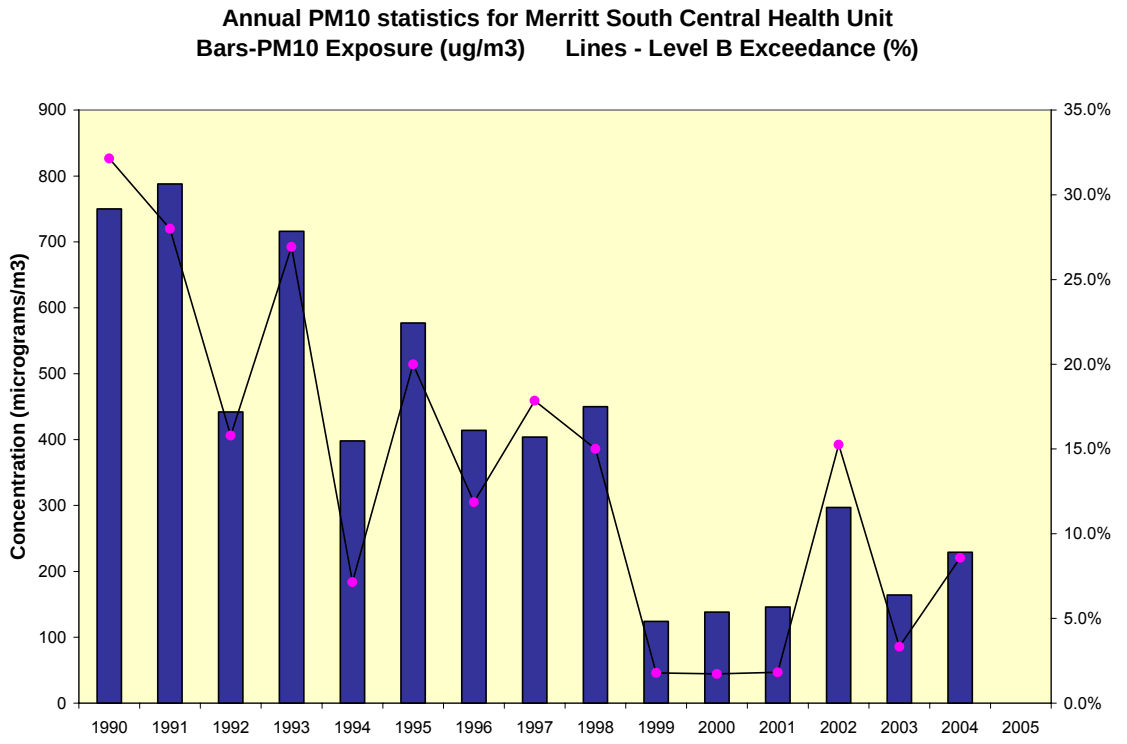

Figure 5. PM10 concentrations at the Merritt South Central Health Unit, gathered between 1990 and 2004. The bars are a measure of the annual exposure of Merritt residents to PM10. Daily exposure is the number of full 10 micrograms per cubic metre/m3 increments that exceed a threshold of 20 µg/m^3. Annual exposure is the sum of these daily exposures. The lines are the percent of days during which the average PM_{10} concentration exceeds the B.C. objective of 50 µg/m^3 (referred to here as "Level B") Both exposure and Level B exceedances dropped dramatically when the current sawmill at Aspen Planers was not operating between 1999 and 2001.

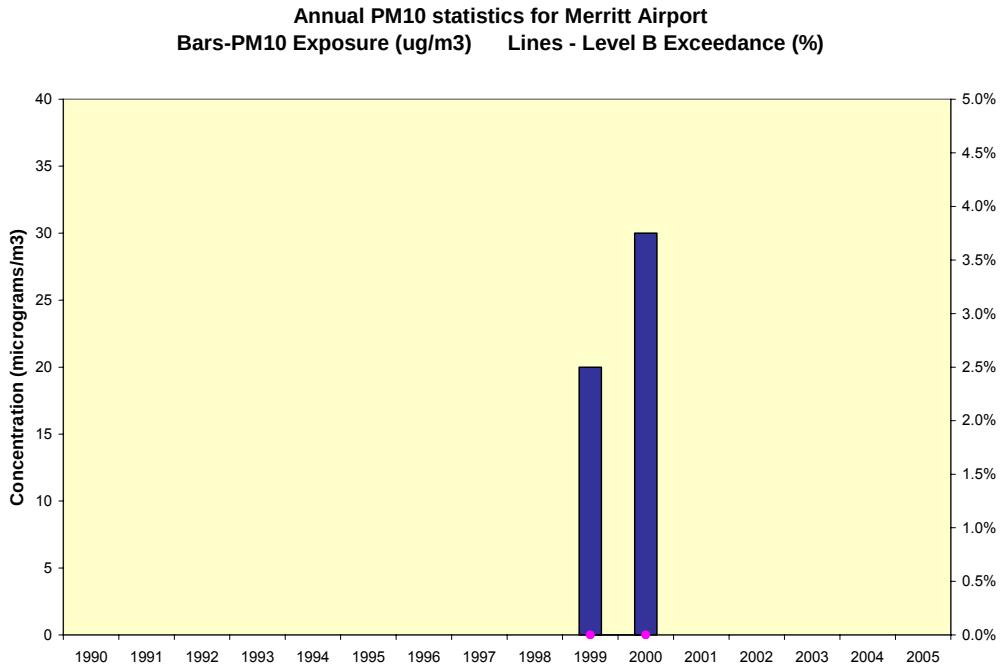

Figure 6. Merritt Airport - Annual PM10 exposure in 1999 and 2000

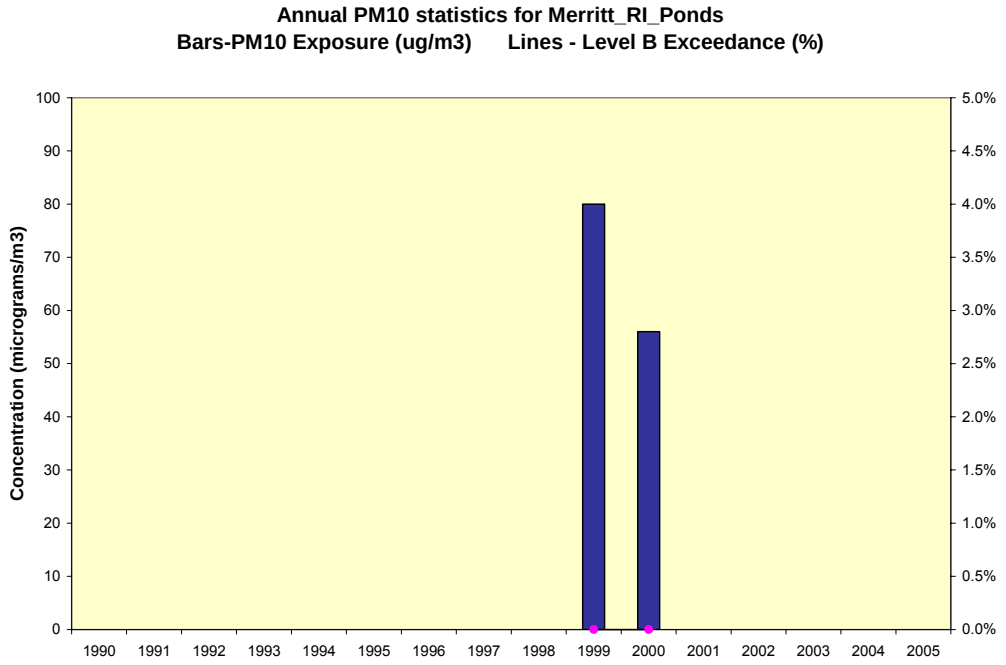

Figure 7. Merritt Ponds - Annual PM10 exposure in 1999 and 2000

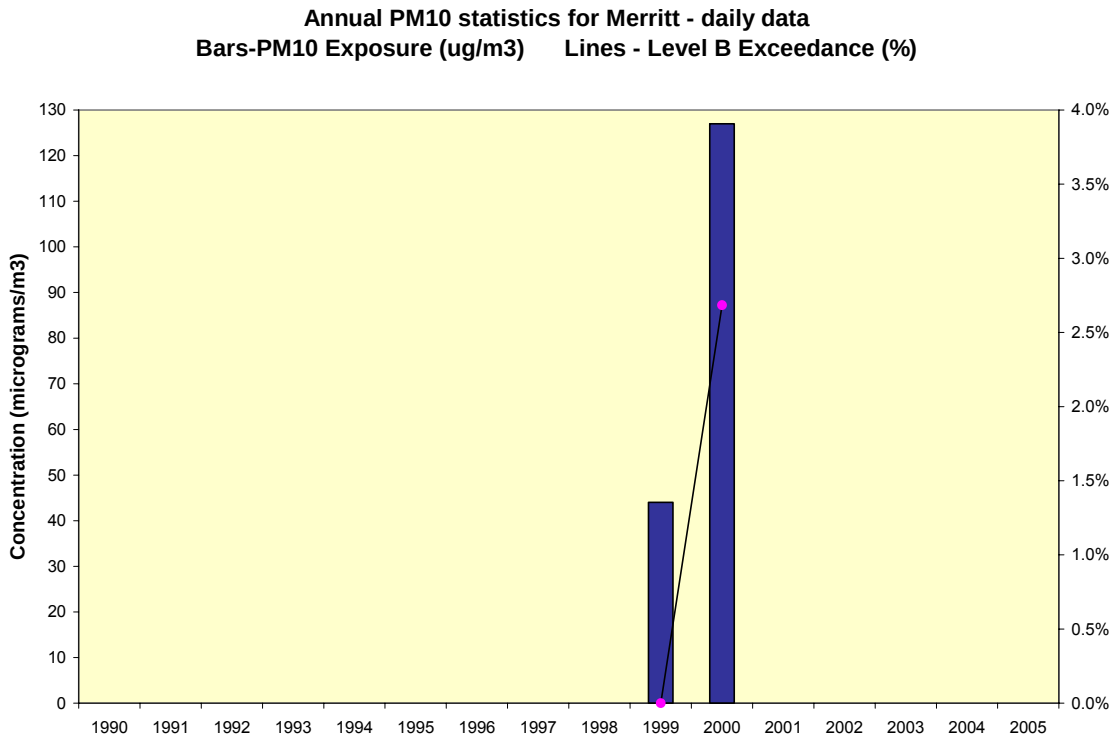

Figure 8. Merritt – Granite and Garcia Streets - Annual PM10 exposure in 1999 and 2000

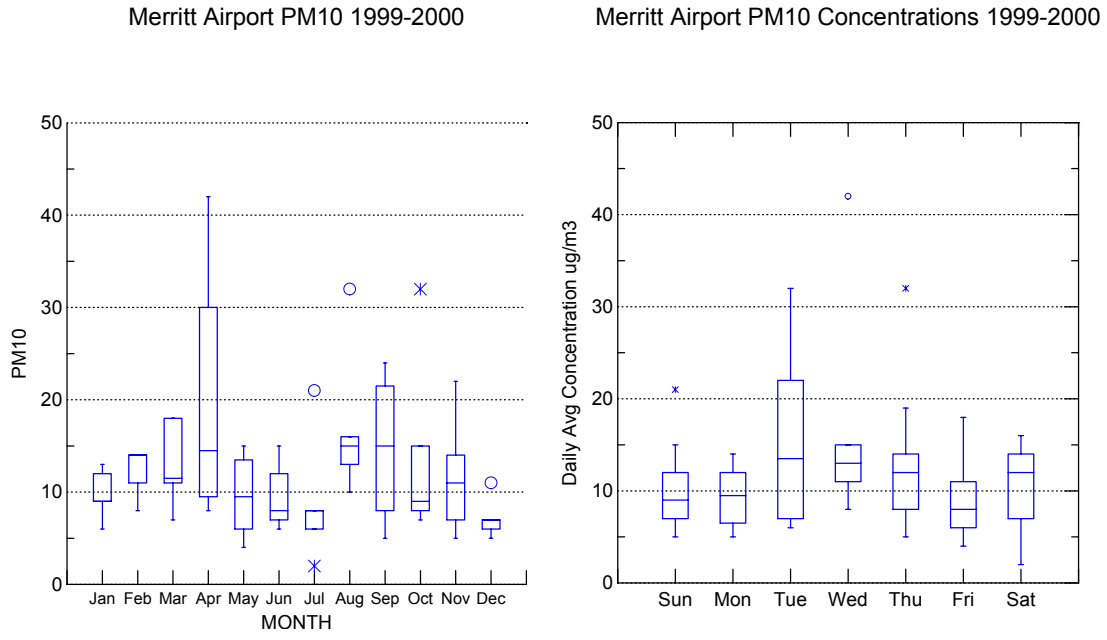

Figure 9. Box plots of monthly and hebdomadal (weekday) PM_{10} concentrations – Merritt Airport. The highest PM_{10} mean and extreme concentrations occurred in April, probably from dust from winter traction material and strong springtime winds. Concentrations were also highest in mid- week, suggesting vehicle traffic is a factor in producing dust. Box plots interpretation is described in Appendix III.

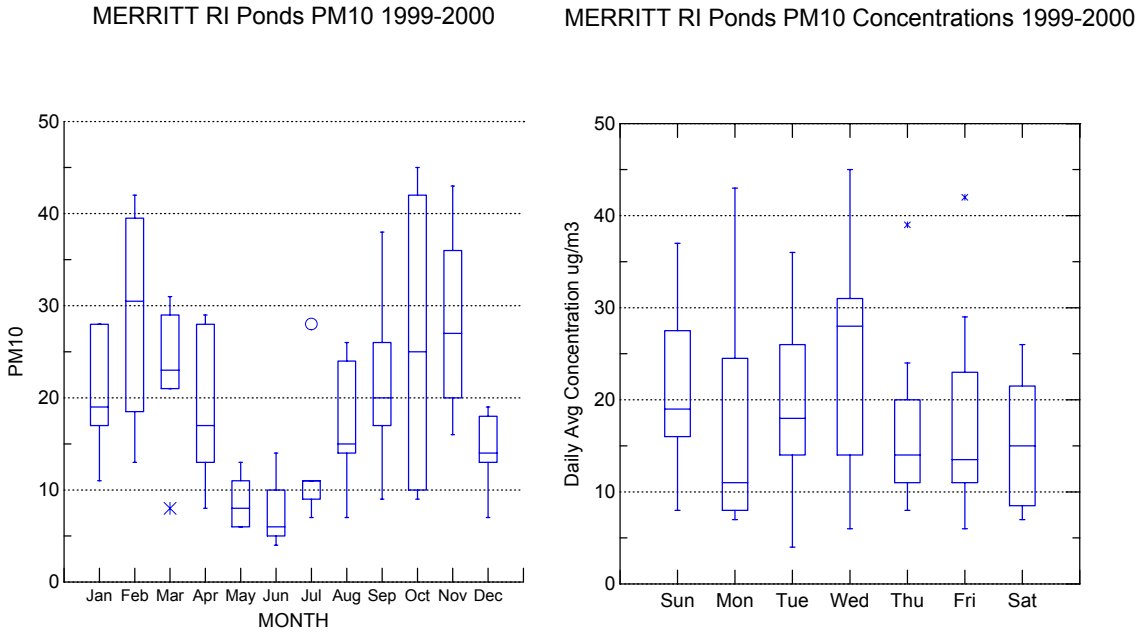

Figure 10. Box plots of monthly and hebdomadal (weekday) PM_{10} concentrations – Merritt Ponds. The highest PM_{10} mean and extreme concentrations occurred in February, probably from dust from winter traction material and strong springtime winds. Mean concentrations were also highest on Wednesday, suggesting vehicle traffic, perhaps associated with the sewage treatment ponds, is a factor in producing dust.

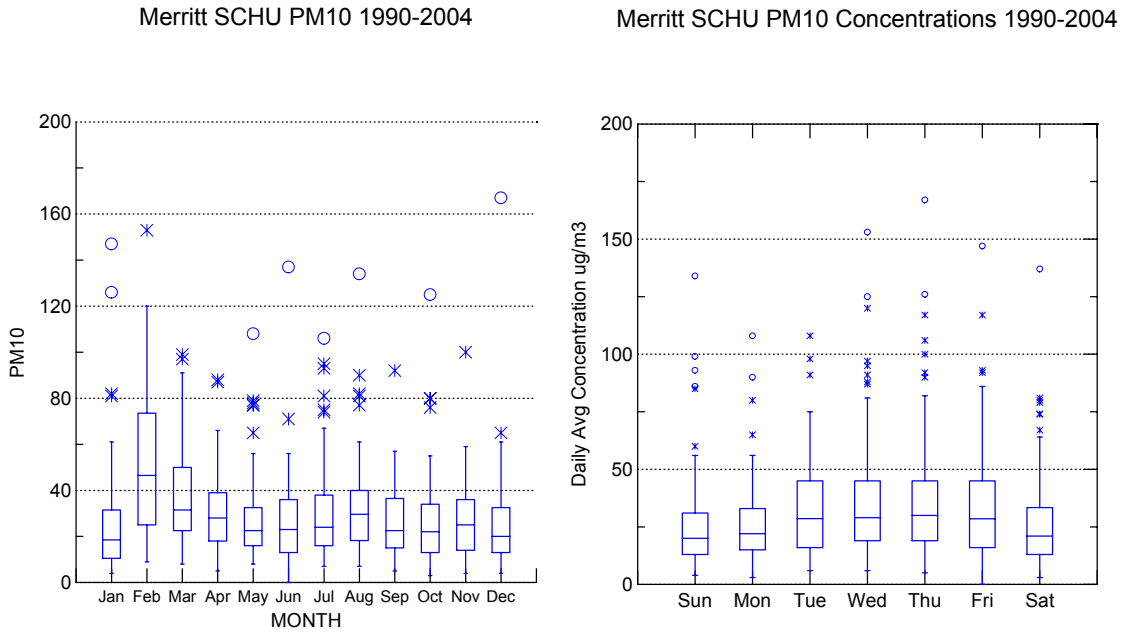

Figure 11. Box plots of monthly and hebdomadal (weekday) PM10 concentrations – Merritt South Central Health Unit, from 1990 to 2004. The highest PM10 mean and extreme concentrations occurred in February, probably from dust from winter traction material and strong late winter winds. Concentrations were also slightly higher from Tuesday through Friday, suggesting vehicle traffic is a factor in producing dust.

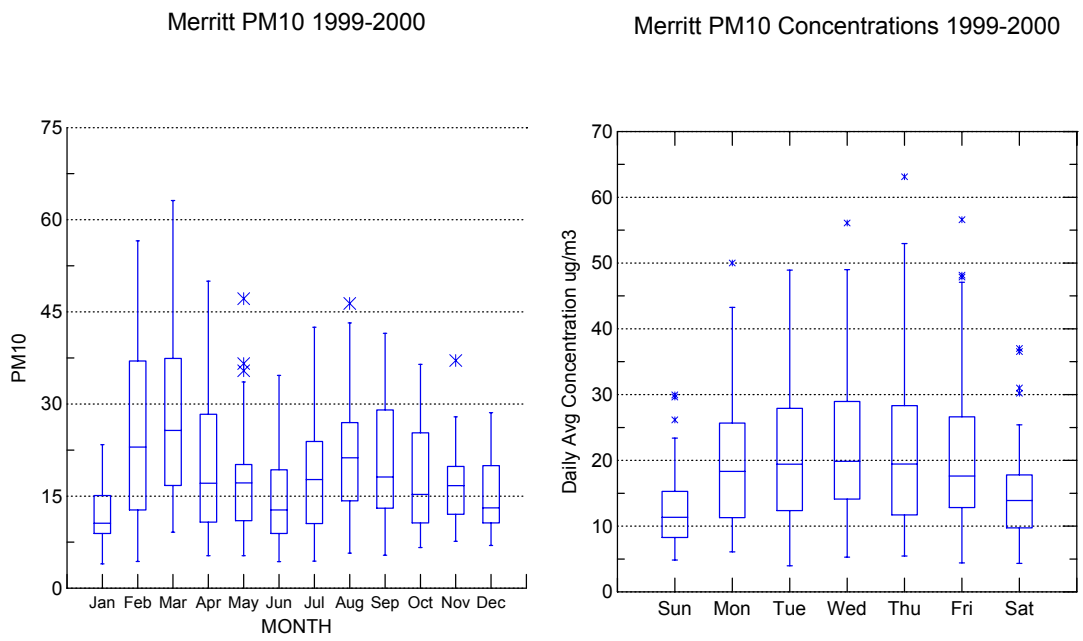

Figure 12. Box plots of monthly and hebdomadal (weekday) PM10 concentrations – Merritt – Granite and Garcia streets during intensive monitoring program 1999 and 2000. The highest PM10 mean and extreme concentrations occurred in February and March, probably from dust from winter traction material and strong late winter springtime winds. Concentrations were also highest in mid- week, suggesting vehicle traffic is a factor in producing dust.

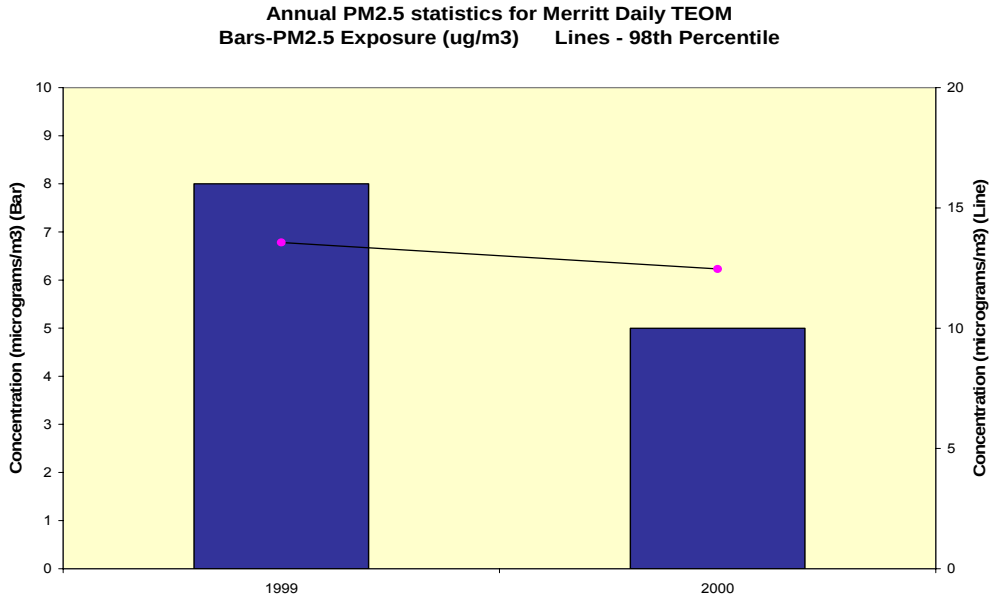

Figure 13. $PM_{2.5}$ concentrations at the Merritt South Central Health Unit from May 1999 to June 2000. The bars are a measure of the annual exposure of Merritt residents to $PM_{2.5}$. Daily exposure is the number of full 10 micrograms per cubic metre/m3 increments that exceed a threshold of 20 µg/m^3. Annual exposure is the sum of these daily exposures. The lines are the percent of days during which the average PM_{10} concentration exceeds the B.C. Level B objective of 50 µg/m^3.

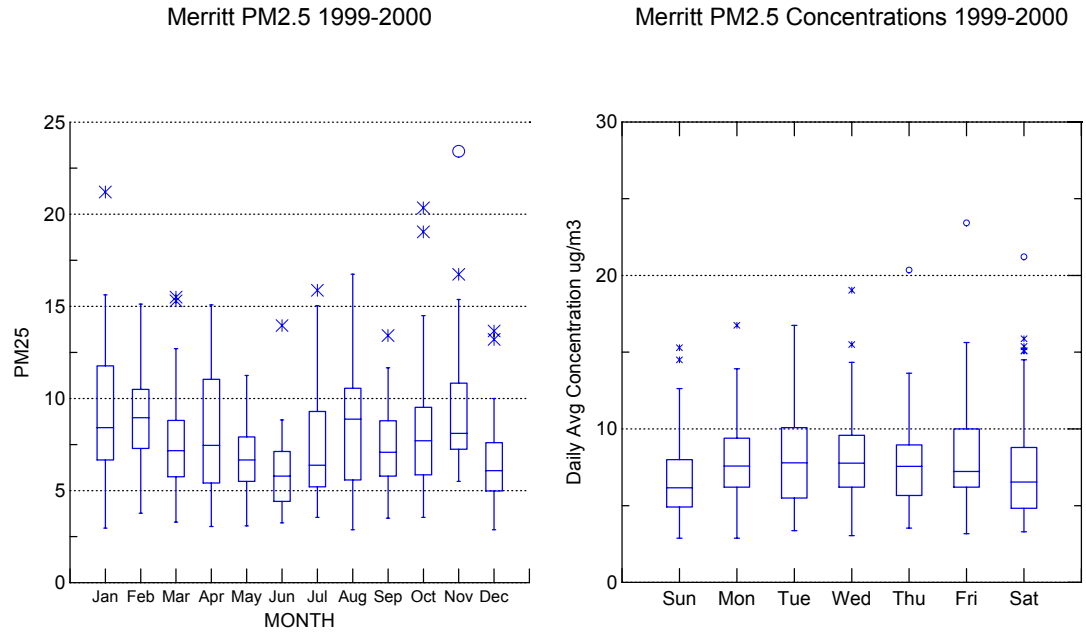

Figure 14. Box plots of monthly and hebdomadal (weekday) $PM_{2.5}$ concentrations – Merritt at Granite and Garcia Streets during the intensive monitoring program in 1999 and 2000. The highest $PM_{2.5}$ mean concentrations occurred in January and November, probably from the extensive use of wood stoves. Other high concentrations occurred in August, likely from wildfire smoke. On an annual basis, very little difference in concentrations occurred during the week.

Appendix V Health Effects of Airborne Particles

In Merritt, airborne dust particles (the coarse fraction of PM_{10}) are likely composed primarily of rock and soil. When inhaled, most dust particles are deposited in the upper portion of the respiratory tract airways (nose, mouth, and throat). Dust has been shown to aggravate cough, phlegm, rhinitis and asthma and to produce other upper airway symptoms[6].

In Merritt, the smallest airborne particles ($PM_{2.5}$) are likely associated with smoke and haze. These extremely small solid and liquid particles unfortunately contain various chemicals, some of which are toxic and which include sulphates, nitrates, organic carbon and elemental carbon. Smoke and haze particles are mostly a by-product of burning wood and fossil fuels. They are also produced by atmospheric chemical reactions involving volatile organic compounds (VOCs), sulphur dioxide (mostly from industry), nitrogen oxides (from vehicles and burning) and ammonia (from agriculture). VOCs are hydrocarbons and related gases. They are emitted both by humans and by natural sources, including coniferous trees.

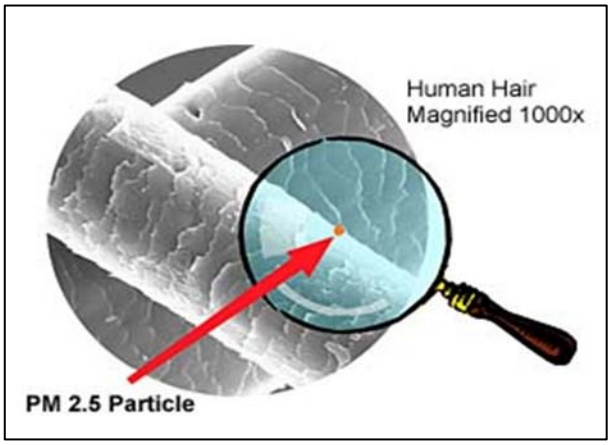

Figure 15 $PM_{2.5}$ particles are less than 2.5 microns in diameter. They are so small that 30 of them side-by-side would barely equal the width of the human hair in this magnified photograph. Coarse particles are primarily dust and are between 2.5 and 10 microns in diameter but they are still much smaller than the width of a human hair.

In his 2003 annual report, the British Columbia Provincial Health Officer indicated that smoke and haze particles ($PM_{2.5}$) are more hazardous to health than dust particles since they are inhaled more deeply, and tend to deposit in the airways and tissues of the lungs. $PM_{2.5}$ particles can even enter the blood stream. They contribute to chronic lung conditions and have specifically been shown to aggravate asthma, bronchitis, respiratory infections, and cardiac conditions. $PM_{2.5}$ particles have also been shown to increase the risk of lung cancer and depressed lung function. Research has shown that there is no threshold below which $PM_{2.5}$ has no health effects. Therefore reducing smoke concentrations by any amount can improve health[7] and is the most cost-effective way to reduce the adverse health effects associated with air quality in Merritt.

[6] *Human Health Effects of the Coarse Fraction of Particulate Matter: Update in Support of the Canada-Wide Standards for Particulate Matter and Ozone*. Prepared for the Canadian Council of Ministers of the Environment March 2003

[7] *Every Breath You Take…. Provincial Health Officer's Annual Report 2003, Air Quality in British Columbia, a Public health Perspective*. B.C. Ministry of Health Services, Office of the Provincial Health Officer. Page 13. and *A Citizen's Guide to Air Pollution*, David Bates, Robert Caton, 2002.

Appendix VI Online Resources for Managing Air Quality

Air Protection Section, Ministry of Environment	http://www.env.gov.bc.ca/air/airquality/index.html
A Guide for Cleaner Air	http://www.cleanairkit.ca/
B.C. Lung Association	http://www.bclung.ca/
Clean Air Online	http://www.pyr.ec.gc.ca/air/index_e.htm
Dust Management	http://www.env.gov.bc.ca/air/airquality/pdfs/roaddustbmp_june05.pdf

Appendix VII Historical Measurements and Future Targets of Particulates

Table 3 Historical concentrations and interim future targets of daily PM2.5 concentrations for Merritt. $PM_{2.5}$ concentrations were measured at Merritt from May 1999 to June 2000 using a TEOM monitor and from August to December 2006 using a Partisol monitor. Interim future $PM_{2.5}$ targets are based on TEOM measurements, and use the "keeping clear areas clean" principle to ensure that $PM_{2.5}$ concentrations do not increase. These targets will be compared to an average of the future $PM_{2.5}$ concentrations measured using Partisol monitors at Coquihalla Gillis House and at the foot of Parcel Street. These interim targets could be revised as more monitoring data becomes available. Historical Kamloops $PM_{2.5}$ concentrations are provided for comparison.

Daily $PM_{2.5}$ Concentrations		98th percentile (micrograms per cubic metre)		Average (mean) (micrograms per cubic metre)	
		Merritt Granite & Garcia	**Kamloops** Brocklehurst	**Merritt** Granite & Garcia	**Kamloops** Brocklehurst
Historical Measurements	1998		19.5		5.6
	1999	13.6	16.0	4.8	4.7
	2000	12.5	18.7	5.1	5.6
	2001		13.3		5.3
	2002		20.3		6.7
	2003		40.7		7.9
	2004		18.0		5.7
	2005		13.2		4.7
	2006[10]	23.3(Gillis House) 47.3 (Parcel St.)	(25.7-Federal Bldg) 18.9	8.9 (Gillis House) 18.5 (Parcel St.)	(7.5-Federal Bldg) 5.3
Interim Targets	*2007*				
	2008	***13***		***5.5***	
	2009				
	2010	***13***		***5.3***	
	2011				
	2012	***13***		***5.0***	

[10] The 2006 $PM_{2.5}$ concentrations that were measured at Coquihalla Gillis House, at the foot of Parcel Street in Merritt (see Figure 15) and at the Kamloops Federal Building using a Partisol Monitor are not directly comparable to previous concentrations that were measured using a TEOM monitor. Also, 2006 averages and 98th percentiles are based on a limited set of data since particulate monitoring did not start until late in 2006.

Table 4. Historical PM_{10} concentrations and future target concentrations in Merritt. Both the annual exceedance of the Level B standard (50 micrograms per cubic metre, 24 hour average) and the annual average of PM10 (mostly dust) concentrations dropped dramatically from 1999 to 2001 when the Aspen Planers yard was not operating. Interim future PM_{10} targets are based on previous low annual concentrations from 1999 to 2001. These interim targets could be revised as more monitoring data becomes available. The targets will be compared to future measruements at the monitoring sites at Coquihalla Gillis House monitoring site. Concentrations were measured using Hi-Vol monitors except for 2006 when a Partisol monitor was used. Kamloops PM_{10} concentrations are shown for comparison.

Daily PM_{10} Concentrations		**Annual Exceedance of Standard (%)**		**Average (mean)** (micrograms per cubic metre)	
		Merritt Granite & Garcia	**Kamloops** Federal Building	**Merritt** Granite & Garcia[11]	**Kamloops** Federal Building
Historical Measurements	1990	32.1%	6.8%	42.6	25.3
	1991	28.0%	8.8%	42.7	25.2
	1992	15.8%	3.4%	33.4	23.0
	1993	26.9%	11.7%	43.4	30.1
	1994	7.1%	1.7%	32.3	20.7
	1995	20.0%	3.4%	36.5	20.8
	1996	11.9%	3.3%	32.6	21.9
	1997	17.9%	3.3%	30.4	22.5
	1998	15.0%	3.3%	32.4	22.3
	1999	**1.8%**	0.0%	**21.1**	20.7
	2000	**1.7%**	0.0%	**19.9**	18.5
	2001	**1.8%**	0.0%	**21.7**	20.4
	2002	15.3%	0.0%	26.5	19.8
	2003	3.3%	3.0%	23.1	22.6
	2004	8.6%		26.9	
	2005				
	2006	12.0% (Gillis House)		21.9 (Gillis House)	
Interim Targets	*2007*				
	2008	***8%***		***22***	
	2009				
	2010	***6%***		***21***	
	2011				
	2012	***4%***		***20***	

[11] PM_{10} concentrations were measured at Coquihalla Gillis House in 2006, not at the corner of Granite and Garcia Streets, and measurements were only made from August through December. Also, 2006 measurements are not directly comparable to previous concentrations because the types of monitoring instruments used are not the same.