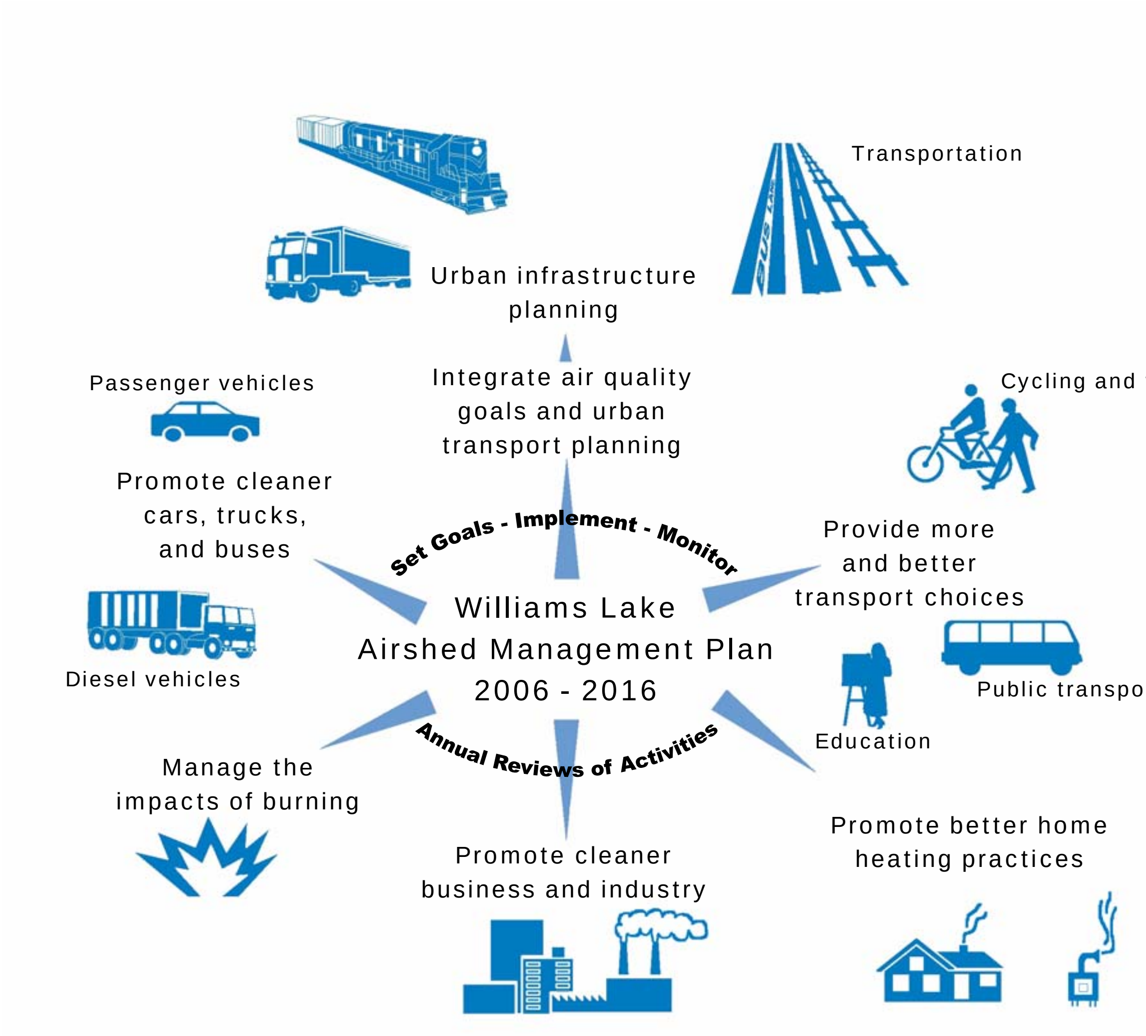
Williams Lake Airshed Management Plan



"We are ***all*** part of the air quality solution."

Williams Lake Air Quality Roundtable

Williams Lake in the winter time: pollutants trapped by temperature inversion.

Cover Adapted from *Action for Air: The NSW Government's 25-Year Air Quality Management Plan*, NSW Environment Protection Authority, 1998.

July 6, 2006

To: Williams Lake City Council, Cariboo Regional District Board, and residents of the Williams Lake area

Enclosed is the Williams Lake Airshed Management Plan as prepared by the Williams Lake Air Quality Roundtable. Within it you will find the results of a three-year air quality assessment which formed the scientific basis for the development of this plan. You will also find the resulting 28 recommendations which apply to all sectors of the community.

As you are aware, this airshed plan was developed through a voluntary, multi-stakeholder, community driven process. The recommendations were developed by consensus and those who actively participated in the development of this document are proud to present it to you.

Sincerely,

Bert Groenenberg
Chair, Williams Lake Air Quality Roundtable

On behalf of:

E. Ma and M. Skellet - Tolko Industries Ltd.
P. French and B. Lawrence - City of Williams Lake
P. Ranson - Cariboo Fire Centre, Ministry of Forests
E. Plain and N. Zirnhelt - Ministry of Environment
B. Topping - EPCOR Williams Lake Power Plant
S. Davis and R. Sleeman - West Fraser Timber Co. Ltd.
D. Manning - Interior Health
D. Hutchins and D. Kirk – Interior Roads
H. Berkholtz – Pinnacle Pellet Ltd.
S. Zacharias – Cariboo Regional District
V. Hoffman – Jackpine Group
N. Antifaeff - Ministry of Transportation

Table of Contents

EXECUTIVE SUMMARY 2
1. INTRODUCTION 7
1.1 Air Quality in Williams Lake 7
2. THE PLANNING PROCESS 8
2.1 Recent Initiatives to Improve Air Quality 10
3. AIR QUALITY ASSESSMENT 12
3.1 Air Pollution Sources in Williams Lake 12
3.2 Air Quality Monitoring 15
3.3 Air Quality Modelling 20
3.4 Source Apportionment 21
3.5 Priority Air Pollutants in Williams Lake 22
3.5.1 Fine Particulate Matter 23
3.6 Other Air Quality Parameters 26
3.6.1 Ground Level Ozone (O3) & Nitrogen Oxides (NOx) 26
3.7 Air Quality Assessment Summary – Key Findings 29
4. HEALTH EFFECTS OF PM_{10} AND $PM_{2.5}$ 33
5. WHAT THE PLAN WILL ACHIEVE 36
5.1 Chart of Clean Air Goals 2006-2016 36
5.2 Airshed Management Plan Recommendations 37
5.2.1 General 37
5.2.2 Permitted Operations 37
5.2.3 Mitigation of Dust from Paved and Unpaved Sources 37
5.2.4 Backyard/Open Burning 38
5.2.5 Wood Burning Appliances 39
5.2.6 Transportation 41
5.2.7 Community and Regional Planning 41
5.2.8 Public Education 42
5.2.9 Air Quality Monitoring and Future Research 43
6. IMPLEMENTATION OF THE WILLIAMS LAKE AIRSHED MANAGEMENT PLAN 43
7. BACKGROUND INFORMATION 44
7.1 Supporting Documents 44
7.2 Rationale for Recommendations 44
8. APPENDICES 65
A. Glossary 65
B. References on the Health Effects of Air Pollution 68
C. General References on Air Quality 69
D. Contact Information and Websites 70

EXECUTIVE SUMMARY

Air Quality

Our air quality needs improvement. In fact, in 2005 Williams Lake recorded the first and sixth highest level of fine particulate air pollution in the province out of 38 communities where continuous monitoring is conducted (residential locations). The levels recorded are a concern from a public health perspective. While air quality is considerably better in Williams Lake as a result of the phase-out of the wood waste burners through the early to mid 1990's, there is room for improvement. Good planning now will help maintain and improve our air quality in the future.

Airshed Planning Process

Airshed management planning in Williams Lake is a process aimed at improving air quality. It is overseen by the Williams Lake Air Quality Roundtable and the goal is to tackle virtually all sources of air pollution from backyard residential burning to large industrial sources. The airshed management planning process was initiated to address community air pollution concerns related to the health of local residents, and to facilitate future economic development in the region. The Williams Lake Air Quality Roundtable is composed of a cross section of the community and includes representatives from local industry, local and provincial government, regional and community health authorities, and environmental groups.

It should be recognized that although Williams Lake's air quality needs improvement, local industry and government have made efforts in recent years to reduce air pollution. While these initiatives have resulted in some improvement, air quality monitoring indicated the need for further action which led to the development of the Williams Lake Airshed Management Plan.

It was determined early on in the planning process that a thorough, scientific understanding was needed of what was causing the air quality problem in Williams Lake, in order to develop appropriate recommendations. Therefore, an air quality assessment was started. This assessment consisted of four major components: air quality monitoring, an emissions inventory, computer dispersion modelling, and source apportionment.

Air Quality Monitoring

Although there has been monitoring of the air in Williams Lake dating back to the 1980's, the monitoring network needed to be enhanced for the air quality assessment. This involved installing additional stations with *state of the art* equipment capable of monitoring fine particulates.

In order to evaluate air quality in Williams Lake, air quality monitoring data is compared to air quality objectives and guidelines that have been developed by the provincial and federal governments. Williams Lake is currently in compliance with the Canada-Wide Standard for fine particulate matter less than 2.5 micrometers in diameter (termed $PM_{2.5}$) as well as Ozone. Nitrogen Dioxide levels are also well below federal objective levels. However, the BC air quality objective for fine particulate matter less than 10 micrometers in diameter (termed PM_{10}) and both federal health reference levels for fine particulates (both PM_{10} and $PM_{2.5}$) are often exceeded in the community.

Emissions Inventory

In order to improve air quality in Williams Lake, an important first step was to determine the nature and quantity of substances being released into the atmosphere. Emissions from all sources within the Williams Lake airshed boundaries were inventoried for the year 2000.

Emissions from five major source categories were examined for common air pollutants, including: carbon monoxide (CO), nitrogen oxides (NOx), sulphur oxides (SOx), volatile organic compounds (VOCs), total particulate (TPT), particulate matter less than 10 micrometers in diameter (PM_{10}), and particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$). The seven source groups included: permitted sources, commercial sources, mobile sources, residential sources, unpaved road dust, paved road dust, and natural sources.

The emissions inventory indicates that permitted sources are responsible for the highest total loading for all pollutants emitted in the airshed except for carbon monoxide which comes mostly from vehicles. Road dust is also a significant contributor to fine particulates.

It should be emphasized that the emissions inventory values represent the total loading (tonnes/year) of pollutants into the airshed. This does not necessarily mean that the source with the highest total loading will have the largest impact on air quality. Computer dispersion modelling is the tool used to determine the relative impacts of the various sources.

Computer Dispersion Modelling

Following the completion of an emissions inventory, a computer dispersion model was used to predict what impact each emission source had on the airshed (e.g. industrial, commercial, transportation, residential). When pollutants are discharged to the atmosphere their dispersion is complex. Concentrations resulting at a given location will vary by pollutant type, the temperature of the emission, and of course wind speed and direction among other factors. Computer air quality dispersion modelling is a technique used to calculate the concentrations of pollutants at various locations throughout the airshed.

Modelling in conjunction with monitoring (used to verify model performance) is very useful in providing a complete picture of the impacts over the entire area of interest from one particular source, or from a variety of sources. The model can be used to manage sources in the region by determining the effects on air quality of reducing or increasing emissions from a particular sector.

Local impacts can be attributed to the responsible sources and the most cost beneficial method to improve air quality in different areas of the airshed can be determined. The model can also be used for future modelling work as new industrial projects are proposed for the airshed, or as the community emissions change.

Source Apportionment

Source apportionment was used to determine which sources or source types are contributing the most to pollutant levels at any one location in the airshed. In the case of the Williams Lake source apportionment work, the output from the computer dispersion modelling was used to do this for PM_{10} and $PM_{2.5}$.

Relative contributions from the seven major source groups were examined. In addition, each sector could be further broken down to see which source was dominant within that sector, thereby assisting with the development of management recommendations. It should be noted that wood stoves were broken out separately from the residential source group to better differentiate between wood stove and other residential source impacts in different areas of the airshed. Relative impacts from land clearing burning and contributions from secondary particles were also included in this analysis for $PM_{2.5}$.

The air quality assessment has determined that the primary thing that drives poor air quality episodes in the Williams Lake area is fine particulate matter (PM_{10} and $PM_{2.5}$). This includes particles from both natural sources (such as pollen, dust from soil erosion, forest fires, etc.) and from man-made sources (such as home heating devices, road dust, automobiles, open burning, and industrial processes).

Health Effects

Recent health and medical studies have shown that PM_{10} and $PM_{2.5}$ particles (either by themselves or in combination with other air pollutants) may have extensive and serious human health impacts (Vedal, 1995; CEPA/FPAC, 1999; Bates et al, 2003). These health effects include such things as premature death, increased hospital visits, worsening respiratory symptoms and disease, and decreased lung function. Individuals with chronic obstructive pulmonary or cardiovascular disease, asthmatics, the elderly and children are most at risk. It is important to note that of the two, $PM_{2.5}$ carries even greater health impacts than PM_{10} because of its ability to penetrate to the deepest regions of our lungs.

Recommendations

After the completion of the three-year air quality assessment, 28 recommendations were developed for improving air quality, specifically with regard to PM_{10} and $PM_{2.5}$. These recommendations pertain to improvements in air quality by all sectors: industry, municipal and regional governments, business owners, and local residents. Many of the recommendations are based on public education rather than the introduction of new bylaws. The recommendations range from public education on backyard burning and home heating, to improved dust control and reductions in emission levels by industry. The recommendations to improve air quality are outlined in section 5.2 of the airshed plan, and the detailed rationale behind many of these recommendations can be found in section 7.2.

Implementation

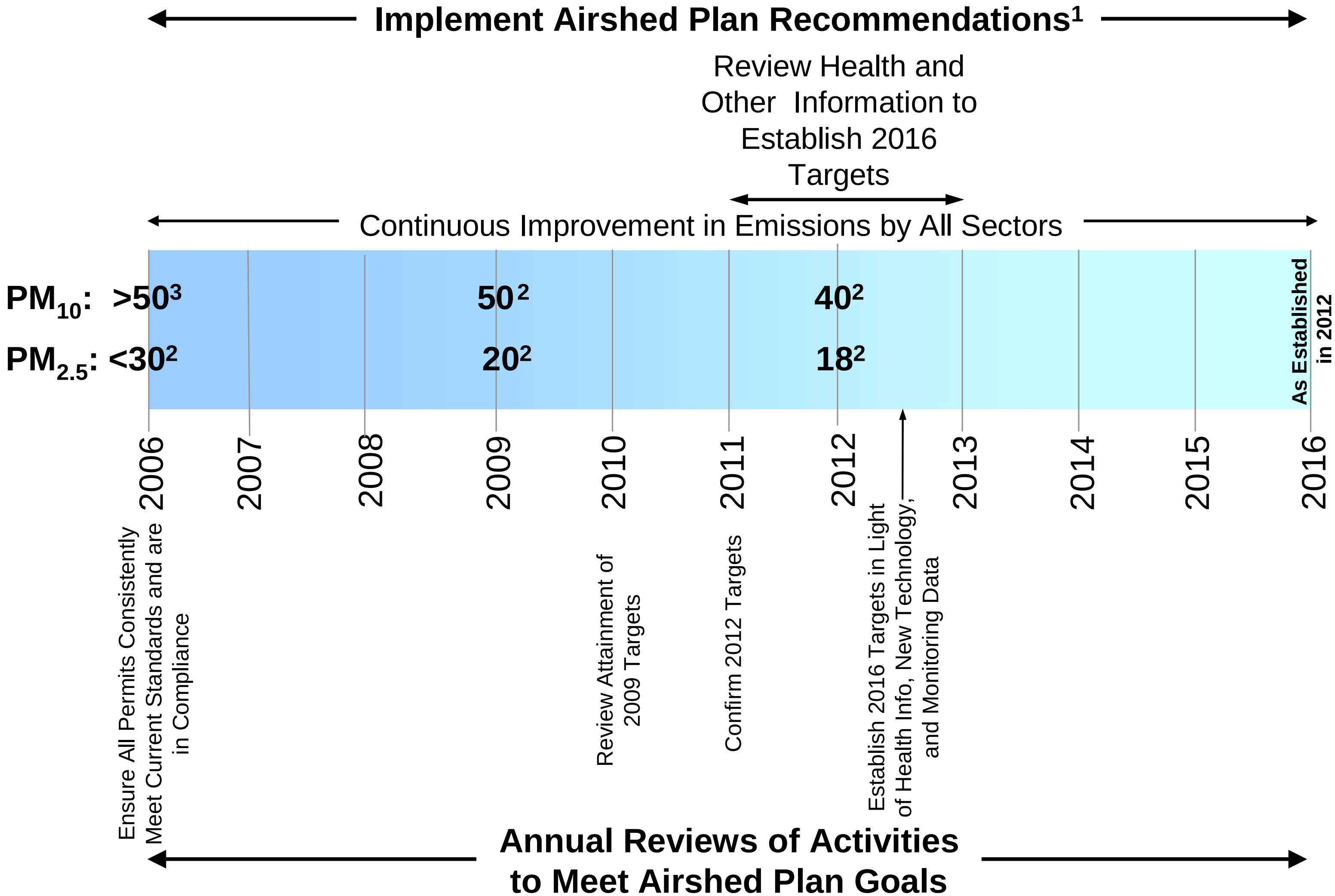
In order to implement the Williams Lake Airshed Management Plan, the Williams Lake Air Quality Roundtable (WLAQR) will request an annual written update from all stakeholders on their activities and plans with regard to their contribution toward the goals of the airshed plan.

It is anticipated that the WLAQR will issue an annual progress report to the community, and the Ministry of Environment will update the community annually on air quality. The Williams Lake Airshed Management Plan will be reviewed and updated on an ongoing basis.

It is expected that long term monitoring of air quality over the implementation period of 2006 to 2016 will demonstrate improvements to the ambient air. This timeframe is necessary because, based on the air quality assessment, it will take the combined effect of all of the recommendations being implemented to result in an improvement. It is necessary to maintain the existing air monitoring network for effective trend assessment.

The Williams Lake Airshed Management Plan also includes periodic reviews of progress toward meeting air quality goals, and is represented by the chart of clean air goals on the following page.

Williams Lake Airshed Plan 2006 - 2016



1: Incorporate into community and industry planning as opportunities arise.

2: µg/m^3; based on a 24-hour average, and achievement is based on the 98th percentile ambient measurement annually, averaged over 3 consecutive years (allows for 7 days of exceedance per year).

3: µg/m^3; 24-hour average not to be exceeded.

1. INTRODUCTION

The Williams Lake Airshed is situated in the centre of the Cariboo region. The City of Williams Lake is a community of approximately 11,153 people which has approximately 25,122 people in the census area (2001 Census Data Statistics Canada). It is located 238 kilometres south of Prince George and 540 kilometres north of Vancouver on the interior plateau of British Columbia. The city itself is located in a valley at the west end of Williams Lake. The city of Williams Lake is primarily supported by the wood products industry although agriculture, mining, power generation, and tourism are also important to the local economy.

The largest part of the city is situated at the west end of Williams Lake, and is in a northwest-southeast orientation within the valley. There are local plateaus on either side of the valley that rise some 300-400 m from the valley floor. This provides a topographical situation that is conducive to forming night time or winter time temperature inversions which can trap pollutants in the valley bottom.

The Williams Lake Airshed refers to the mass of air contained in Williams Lake and the immediate surrounding communities of the Cariboo Regional District, and particularly that air mass contained and affected by the natural topographical features of the Williams Lake valley. The Williams Lake Air Quality Roundtable has defined this area on a map which can be seen in section 3.2. These boundaries are not all encompassing as there will be times when winds will transport pollutants from outside the airshed into the Williams Lake area (e.g. smoke from forest fires).

1.1 Air Quality in Williams Lake

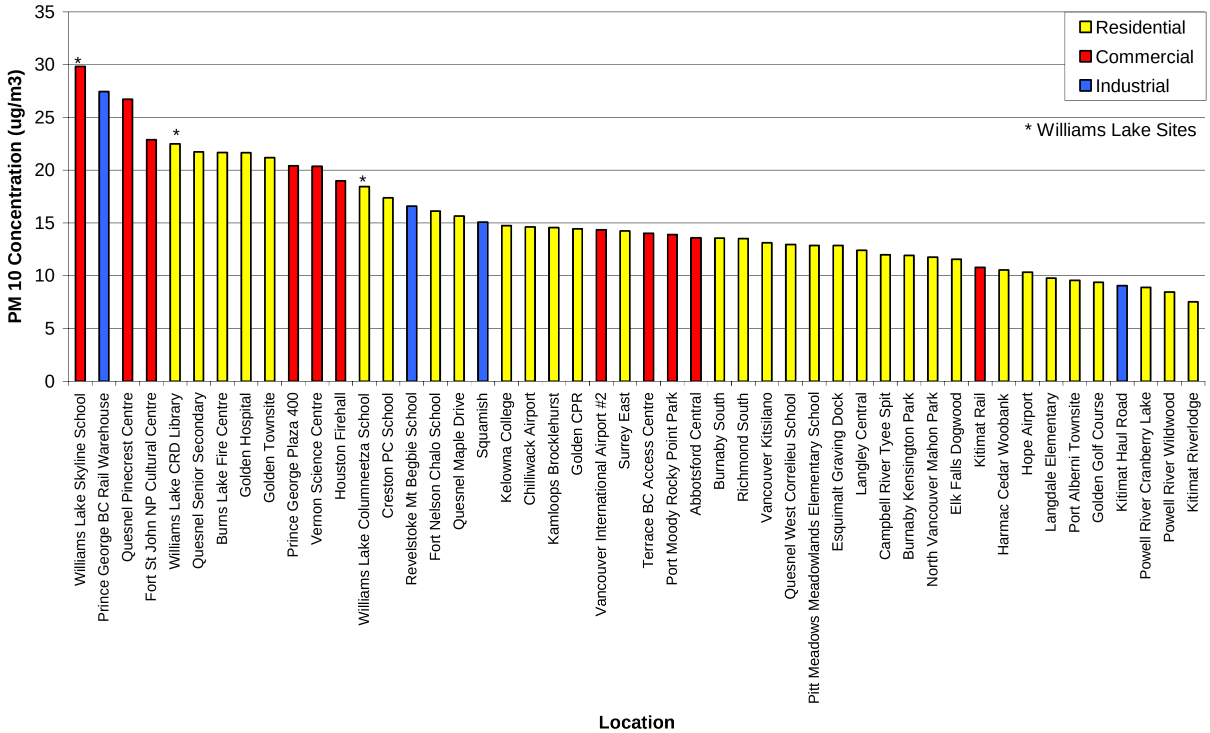
Our air quality needs improvement. In fact, in 2005 Williams Lake recorded the first and sixth highest level of fine particulate air pollution in the province out of 38 communities where continuous monitoring is conducted (residential locations). The levels recorded are a concern from a public health perspective. While air quality is considerably better in Williams Lake as a result of the phase-out of the wood waste burners, there is room for improvement. Good planning now will help maintain and improve our air quality in the future.

The levels recorded in Williams Lake are a concern from a public health perspective. Research has shown that the following health outcomes are linked to poor air quality:

- increases in hospitalizations and emergency room visits due to asthma, chronic bronchitis, emphysema, other respiratory conditions; as well as heart conditions;
- days absent from work or school and days of restricted activity;
- decreases in lung function of children and asthmatic adults;
- reduced lung capacity in children; and
- increases in total mortality, as well as in mortality from respiratory or cardiac disease.

Additional information on health effects can be found in section 4.0 and Appendix B.

Continuous Annual Averages Across BC – 2005
(PM_{10} - fine particulates less than 10 micrometers in diameter)



The atmosphere's ability to disperse and dilute air pollutants is limited in the City of Williams Lake because of the local topography that creates a bowl encompassing the downtown area. The topography limits wind movement which leads to frequent inversions that trap pollutants near the valley floor. As a result, the air pollution potential in the downtown area is high. On a bad day visibility degradation can be severe.

Studies conducted over the last few years have determined that the Williams Lake air quality problem is the result of the combined impact of a large number of sources. Air pollution comes from many sources, not just major industrial sources. As a result, we are *all* part of the air quality solution.

2. THE PLANNING PROCESS

Airshed management planning in Williams Lake is a process aimed at improving air quality. It is overseen by a multi-stakeholder committee and the goal is to tackle virtually all sources of air pollution from backyard residential burning to large industrial sources. Activities under the process include:

- additional monitoring of pollution sources;
- identifying present air pollution problems;
- producing an airshed management plan to identify short term and long term steps for improving air quality in the community; and
- implementing these management solutions while maintaining jobs.

The airshed management planning process was initiated to address community air pollution concerns related to the health of local residents, and to facilitate future economic development in the region. The Williams Lake airshed management planning process is addressing the region's health concerns by measuring pollutants of concern on a continuous basis and identifying the sources that contribute to poor air quality. Through this process, recommendations have been made to reduce the overall pollutant levels in the community. On the economic development front, an improvement in air quality is desirable in order to encourage the development of value-added industry and tourism, and to promote the region to prospective employees and persons entering retirement.

Public participation has been encouraged throughout the planning process. The community of Williams Lake has a committee known as the Air Quality Roundtable that guided the development of the Williams Lake Airshed Management Plan. The Roundtable is composed of a cross section of the community and includes representatives from local industry, local and provincial government, regional and community health authorities, environmental groups, and concerned citizens groups. The Williams Lake Environmental Society presently chairs the Roundtable.

Members of the Williams Lake Air Quality Roundtable include:

Cariboo Regional District	City of Williams Lake
Chamber of Commerce	EPCOR Williams Lake Power Plant
Interior Health	Interior Roads
Jackpine Group	Ministry of Environment
Ministry of Forests	Ministry of Transportation
Parallel Wood Products Ltd.	Pinnacle Pellet WL Inc.
Tolko Industries Ltd.	United Concrete and Gravel Ltd.
West Fraser Timber Co. Ltd.	Williams Lake Construction Association
Williams Lake Environmental Society	Williams Lake Plywood

Funding for the air quality assessment and the development of an airshed management plan came from the following partners: Ministry of Environment, City of Williams Lake, Cariboo Regional District, Interior Health (formerly Cariboo Community Health Services Society), and Human Resource Development Canada.

2.1 Recent Initiatives to Improve Air Quality

It should be recognized that although Williams Lake air quality needs improvement, local industry and government have made efforts in recent years to reduce air pollution as outlined in the following table.

Chronology of Efforts to Reduce Air Pollution in Williams Lake

1990	• Wood waste burners in Williams Lake reduced in number from 9 down to 5.
1991	• Non-continuous fine particulate monitoring begins in Williams Lake at two locations.
1992	• Construction of the Williams Lake Power Plant begins.
1993	• Continuous fine particulate monitoring begins in Williams Lake • Start-up of the Williams Lake Power Plant. • Begin phase-out of all bee-hive burners in Williams Lake. • Open Burning Smoke Control Regulation introduced by the provincial government with the intent to reduce smoke emissions and minimize impacts from open burning.
1994	• Solid Fuel Burning Domestic Appliance Regulation introduced by the provincial government, banning the retail sale of non-CSA/EPA emissions certified stoves. • Cariboo Air Quality Management Committee formed. • Upgrades made at Williams Lake Plywood including better treatment of emissions from the sanding area (bag house replaces cyclones).
1995	• Phase-out of the final bee-hive burner in Williams Lake.
1996	• Non-continuous fine particulate monitoring network enhanced – now monitoring at four locations in Williams Lake
1998	• City of Williams Lake implements a 'No Open Burning Policy' within City Boundaries. • City paves road to Scout Island.
1999	• Funding partnership formed for a six-year project to develop airshed management plans in both Quesnel and Williams Lake. • Air Resources Officer hired for the region, to allow for enhanced air monitoring capability.
2000	• Airshed management planning initiated as a way to improve air quality in the City of Williams Lake. • Formation of the Williams Lake Air Quality Roundtable. • Initiated regular Air Quality Index (AQI) reporting to the public, via fax to the media in Williams Lake each morning. • City of Williams Lake hard-surfaces Frizzi Road. • High traffic alley between Lakeview and Windmill paved. • The City starts using Magnesium Chloride as a dust suppressant and wetting agent. This has allowed for sweeping to begin earlier in the year.
2001	• Air quality monitoring network enhanced by the installation of two continuous PM_{10} and two continuous $PM_{2.5}$ analyzers to help quantify combustion source contributions to PM_{10} levels. Williams Lake's particulate monitoring capacity increased to three collocated continuous $PM_{10/2.5}$ stations. • Public information brochure developed for Williams Lake. Mail-outs on process sent out to public. • Road Dust sub-committee formed out of the pressing need to address spring time road dust. • Emissions inventory completed for Williams Lake Airshed.

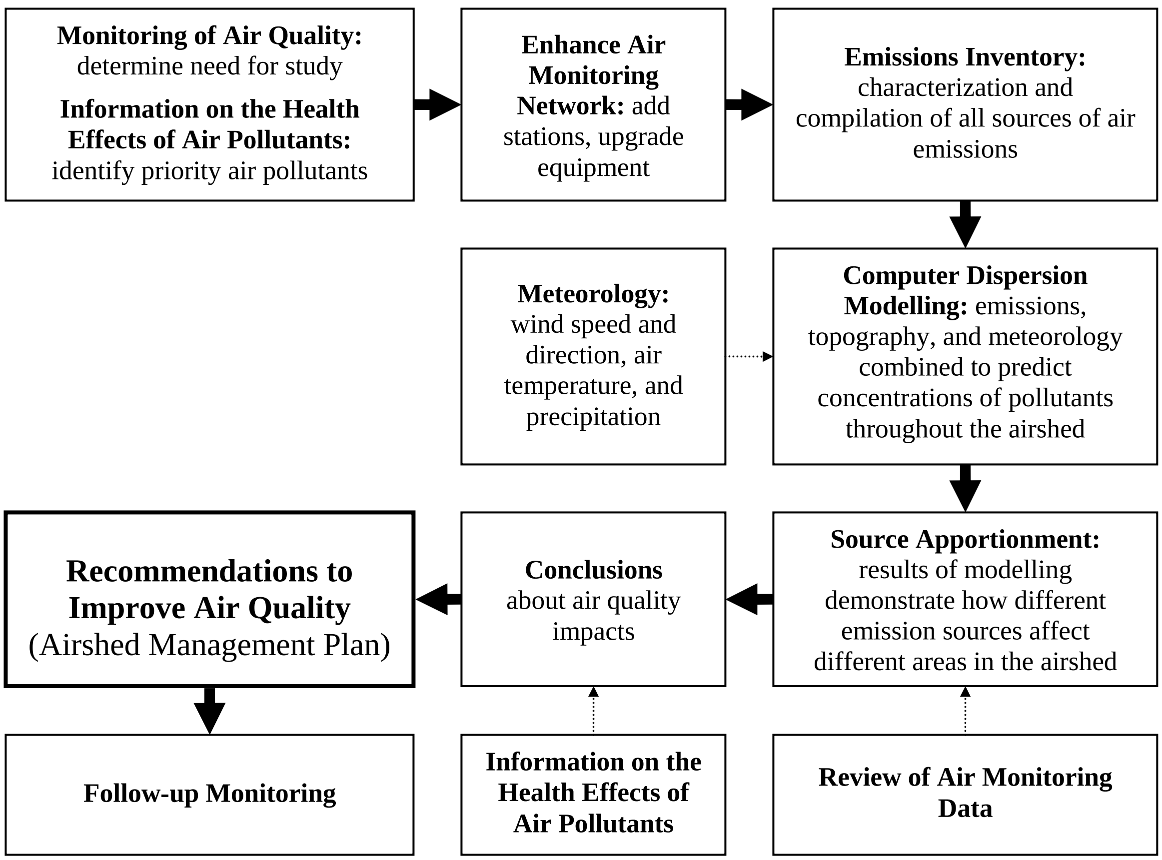
Year	Initiatives
	• Hwy 20 sweeping agreement in place for area between Williams Lake River bridge and the golf course turn-off. Hwy 20 is swept three times a week, usually between midnight and 3am.
2002	• Woodstove exchange program initiated, allowing consumers a 15% discount when they exchange an old woodstove for an appliance that is CSA/EPA **emissions** certified. • West Fraser (Williams Lake Plywood) installs wet electrostatic precipitator controls on the veneer dryer emissions. Emissions substantially reduced.
2003	• Woodstove survey completed for city of Williams Lake to provide more detailed information on current woodstove usage. • Background report on the current status of air quality in the City of Williams Lake completed. • Woodstove exchange program offered once again. • Williams Lake Power Plant now incinerates wood waste from community landfill – reduces need for backyard burning in fringe areas.
2004	• City of Williams Lake passes Fire Protection and Control Bylaw No. 1947 which prohibits open burning within city limits. • CALMET/CALPUFF computer modelling system introduced as a powerful diagnostic/planning tool for analysing data from the Williams Lake airshed. • School District 27 participates in the Federal school bus diesel retrofit program to reduce diesel emissions from its fleet. • Vehicle emissions clinic hosted by the Williams Lake Environmental Society. • Smoke Management Plan developed for the Williams Lake Forest District. • West Fraser applies Calcium Chloride to haul roads to reduce dust.
2005	• Source apportionment study completed using output from CALPUFF dispersion model. • Air quality assessment of the Williams Lake Airshed completed. • Hard surfacing of 500 m section leading out of Tolko (Creekside/Lakeview division) logyard completed to reduce track-out onto Highway 20. • Williams Lake Power Plant makes arrangement with Transportation and Highways to take roadside slash material – replaces the prior practice of open burning along side the highway. • Woodstove exchange program offered once again. • Williams Lake Power Plant agrees to take wood waste from area log home builders – eliminates open burning at these commercial sites. • Ministry of Transportation hard surfaces 4 km of White Road. • Increase frequency of road sweeping and watering at all three Tolko sites. This includes access roads, parking lots, and log yard access roads. • Implemented a Magnesium Chloride program for access / log yard roads at Soda Creek Division starting in spring 2005. Reduced dust and tracking of material onto paved roads. • Pinnacle Pellet employs dust reduction measures around plant site including the extension of the shavings storage area to reduce wind-blown dust, and regular sweeping around the facility to control fugitive emissions. • Manual and automatic sprinkler systems installed in high dust locations at Tolko Creekside and Lakeview Divisions.
2006	• City of Williams Lake passes anti-idling policy for all it's fleet vehicles

While the initiatives above have resulted in some improvement in air quality, monitoring indicated the need for further action which led to the development of the Williams Lake Airshed Management Plan.

3. AIR QUALITY ASSESSMENT

It was determined early on in the planning process that a thorough, scientific understanding was needed of what was causing the air quality problem in Williams Lake, in order to develop appropriate recommendations. Although single large stacks may seem to be an obvious cause, topography, wind speed, and wind direction all interplay with emissions to determine impacts. For example, a large heated source of pollutants will impact different parts of the airshed than road dust which is released at ground level. The following diagram illustrates the major components of the air quality assessment. The key findings of this three-year study can be found in section 3.7.

Major Components of the Air Quality Assessment Process



3.1 Air Pollution Sources in Williams Lake

In order to manage air quality in Williams Lake, an important initial step was to determine the nature and quantity of substances being released into the atmosphere. An emission inventory is an accounting of air contaminants released into the air over the calendar year for a specific geographic area. In this case, emissions from all sources within the Williams Lake airshed boundaries were inventoried for the year 2000.

Emissions from seven major source categories were examined for each criteria air pollutant. Note that an emissions inventory is not based on air quality monitoring results from a community. Instead it is based on either directly measured emission values (i.e. stack measurements) or best estimates of emissions from all different source types. For further information on how the inventory was produced, please refer to the report: *Inventory of Common Air Contaminants Emitted in the Williams Lake Airshed for the Year 2000* (Plain, 2002).

The air contaminants included in the emissions inventory are carbon monoxide (CO), nitrogen oxides (NOx), sulphur oxides (SOx), volatile organic compounds (VOCs), total particulate (TPT), particulate matter less than 10 micrometers in diameter (PM_{10}), and particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$). The source categories examined are described below:

Permitted sources include all point sources in the Williams Lake airshed that are *permitted* under the Ministry of Environment Environmental Management Act to discharge air contaminants. All of the 17 permitted sources in the Williams Lake airshed have been included in this assessment. These sources can be grouped into the following major categories: sawmill & planing mill products industry, softwood veneer and plywood industry, value added millwork industries, asphalt industry, ready-mix concrete industry, electrical industrial equipment industries, and petroleum products – wholesale.

Commercial sources include emissions from the following source categories: oil and gas industry, land clearing burning, restaurants, light industry, welding shops, space heating, agriculture, landfills, building construction/demolition, gravel pits, bakeries, asphalt application, dry cleaning, metal degreasing, printing inks, glues adhesives and sealants, and paint applications.

Mobile Sources include emissions from the following source categories: aircraft, marine (boats), rail (trains), light duty vehicles, heavy duty vehicles, and off-road vehicles. This includes emissions from cars and trucks.

Residential sources include emissions from the following source categories: woodstoves, backyard burning, tobacco, barbecues, natural gas heating, structural fires, fuel oil heating, LPG (Liquified Petroleum Gas) heating, lawn equipment, and consumer products.

Unpaved road dust from unpaved section of Soda Creek Road west of Williams Lake; unpaved log yards and haul roads at mills in the Glendale industrial area and near the Williams Lake outlet; unpaved roads on Fox Mountain; Bond Lake Road; Mission Road from Sugarcane reserve to Hwy 97.

Paved road dust includes all paved areas in the airshed.

Natural sources include emissions of volatile organic compounds (VOCs) and nitrogen oxides (NOx) from vegetation.

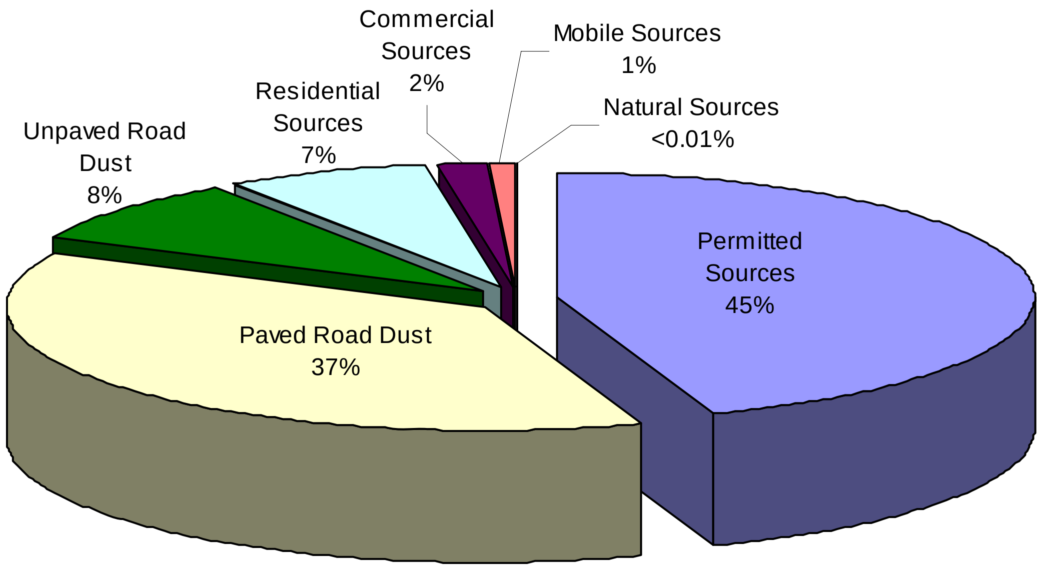
To view individual contributions within each source group, see the report: *Inventory of Common Air Contaminants Emitted in the Williams Lake Airshed for the Year 2000* (Plain, 2002). This report also describes the methods used to calculate emissions from the different sources and source groups in the airshed.

The following table shows the total loading in tonnes per year of major pollutants from all emission sources in the Williams Lake airshed. The two accompanying charts provide a visual breakdown for the PM_{10} and $PM_{2.5}$ categories.

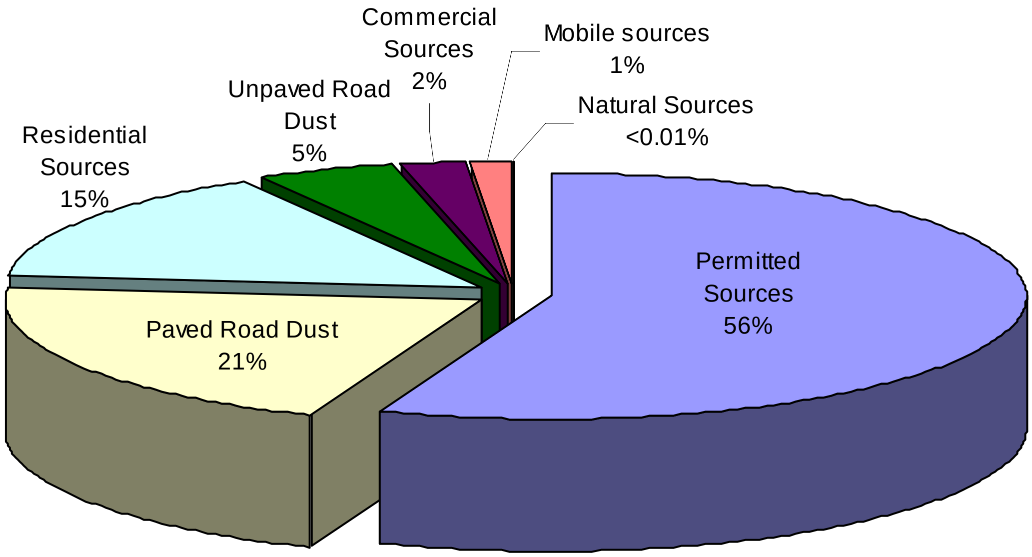
Summary of Air Emissions by Category - 2000 (Tonnes/Year)

	CO	NOx	SOx	VOC	TPT	PM_{10}	$PM_{2.5}$
Permitted Sources	970.15	934.64	54.50	610.05	1456.92	779.14	436.74
Commercial Sources	151.01	12.61	8.53	150.47	135.09	29.15	17.08
Residential Sources	934.49	20.89	3.71	366.36	124.32	124.18	117.91
Natural Sources	0.06	1.57	0.00	433.43	0.01	0.01	0.01
Mobile sources	1377.42	296.32	13.95	149.17	12.79	12.09	10.28
Paved Road Dust					2710.96	650.12	161.45
Unpaved Road Dust					318.86	143.48	37.85
TOTAL (Tonnes/Year)	3433.14	1266.03	80.69	1709.47	4758.94	1738.17	781.31

PM_{10} Emissions from All Sources in the Williams Lake Airshed (Percent of Total)



$PM_{2.5}$ Emissions from All Sources in the Williams Lake Airshed (Percent of Total)



The emissions inventory indicates that permitted sources are responsible for the highest total loading for all pollutants emitted in the airshed except for carbon monoxide which comes mostly from vehicles. Road dust is also a significant contributor to particulate matter.

It should be emphasized that the emissions inventory values represent the total loading (tonnes/year) of pollutants into the airshed. This does not necessarily mean that the source with the highest total loading will have the largest impact on air quality. There are many factors to consider in this regard such as meteorology, source location (valley bottom, plateau, etc.), source characteristics (high release vs. a ground level release, heated vs. non-heated emissions, etc.), topography, etc. Computer dispersion modelling is the tool used to determine these impacts (see section 3.3).

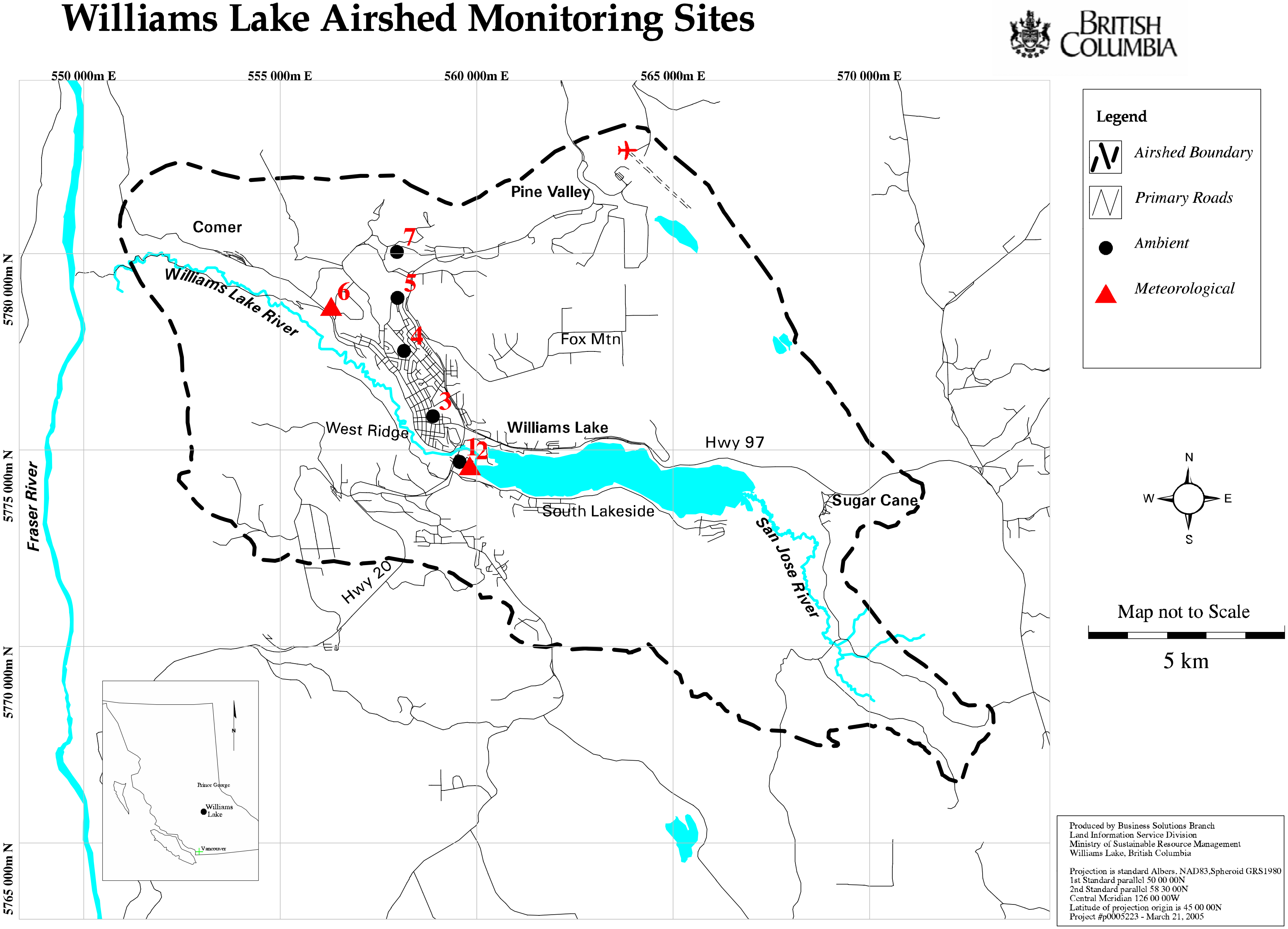
3.2 Air Quality Monitoring

Although there had been monitoring of the air in Williams Lake dating back to the 1980's, the monitoring network needed to be enhanced for the air quality assessment. This involved installing additional stations with *state of the art* equipment capable of monitoring fine particulates.

The Skyline School monitoring site uses cutting edge technology to continuously sample ambient air for fine particulates less than 10 and 2.5 micrometers in diameter. Data is collected hourly by a central polling system.

All of the continuous air quality monitoring stations are shown on the following map and the air contaminants monitored at each of the stations are listed on the following page. For more detailed information about the equipment used to monitor air quality in Williams Lake, see the *Williams Lake Airshed Management Planning Background Air Quality Report* (Schutte, Newton, Plain, 2003).

Williams Lake Airshed Monitoring Sites



Meteorological and Ambient Air Monitoring Sites in Williams Lake

Site #	Location	Description of Monitoring
1	Williams Lake Skyline School	Continuous monitoring of PM_{10}, $PM_{2.5}$. Historically, non-continuous PM_{10} was monitored at this site using the National Air Pollution Surveillance (NAPS) schedule, a one in six day sampling program.
2	Canadian Tire	Continuous monitoring of wind speed, wind direction, Temperature, and Relative Humidity.
3	Cariboo Regional District/Library	Continuous monitoring of PM_{10}, and $PM_{2.5}$.
4	Columneetza Secondary School	Continuous monitoring of PM_{10}, $PM_{2.5}$, Ozone (to end of 2002, and Nitrogen Oxides.
5	Williams Lake Water Tower	Non-continuous monitoring of PM_{10} using the NAPS schedule.
6	Williams Lake 168 Mile Road	Non-continuous monitoring of PM_{10} using the NAPS schedule.
7	Glendale School	Continuous monitoring of wind speed, wind direction, temperature, and Relative Humidity.
-	Williams Lake Fire Hall (discontinued in 2001)	Historically, non-continuous PM_{10} and $PM_{2.5}$ was monitored using the NAPS schedule.

In order to evaluate air quality in Williams Lake, air quality monitoring data was compared to air quality objectives and guidelines that have been developed by the provincial and federal governments. The provincial government currently has a 24-hour average air quality objective for PM_{10}. It does not, however, have an air quality objective for $PM_{2.5}$. For further information of how these provincial objectives are applied, please see the glossary. The federal government has created a Canada-Wide Standard for $PM_{2.5}$ and ozone. This standard is used as a **minimum** and is applied to Canada's most polluted cities. It is not a standard that we are allowed to pollute up to.

Besides these objectives, there are the health reference levels for PM_{10} and $PM_{2.5}$ which were developed by the Canadian Environmental Protection Act (CEPA) Federal/Provincial Working Group on Air Quality Objectives and Guidelines. It should be noted that these federal health reference levels for PM_{10} and $PM_{2.5}$ are not official air quality standards. Rather, the federal science assessment document states that "these levels are estimates of the lowest ambient $PM_{10}/PM_{2.5}$ levels at which statistically significant increases in health responses can be detected based upon available data and current technology. The [health] reference levels should not be interpreted as a threshold of effects, or levels [below] which health impacts do not occur" (CEPA/FPAC, 1999). This indicator of environmental health was also used in the air quality assessment, as a portion of the population will be affected at these levels.

The following table summarizes the provincial and federal air quality objectives which apply to the pollutants that are currently measured in the Williams Lake airshed.

Air Quality Guidelines and Objectives for Air Contaminants

Air Contaminant	**Provincial Objectives**		**Federal Objectives**		**NAAQ**
	Level A	Level B	Health Reference Level*	Canada-Wide Standard**	Level B
PM_{10}					
24-hour average	–	50 µg/m^3	25 µg/m^3	–	–
$PM_{2.5}$					
3-year average of 98th percentile 24-hour avg.; 3 consecutive years	–	–	–	30 µg/m^3	–
24-hour average	–	–	15 µg/m^3	–	–
Ozone					
8-hour daily max; based on 4th highest annual value averaged over 3 consecutive years	–	–	–	125 µg/m^3 (65 ppb)	–
1-hour average					160 µg/m^3
24-hour average					50 µg/m^3
Annual average					30 µg/m^3
NO_2					
1-hour average					400 µg/m^3
24-hour average					200 µg/m^3
Annual average					100 µg/m^3

* Not a threshold of health effects - there is no risk-free level of PM. Not a formal standard.
** Maximum acceptable level; not a standard that we are allowed to pollute up to.

Depending on the monitoring location, concentrations of PM_{10} were found to exceed the federal health reference level up to 33% of the time between 2000 and 2005, and the provincial Level B objective up to 6% of the time. Over the same period, $PM_{2.5}$ concentrations were found to exceed the federal health reference level up to 11% of the time, depending on location, but were in compliance with the Canada-Wide Standard at all monitoring locations.

From 1995-2002 ozone measurements in Williams Lake were below the Canada Wide Standard of 65ppb (based on the 4th highest 8-hour annual value, averaged over three consecutive years). Hourly values between 1995 and 2002 were above the federal Level A objective between 0.5% and 1.8% of the time. The hourly Level B objective was not exceeded during that period. Nitrogen dioxide levels measured in Williams Lake are well below all of the federal Level A objectives.

Key findings from the air quality data analysis are summarized in section 3.7. For more detailed information on ambient air quality in Williams Lake, please refer to the *Williams Lake Airshed Management Planning Background Air Quality Report* (Schutte, Newton, Plain, 2003).


3.3 Air Quality Modelling

Following the completion of an emissions inventory, a computer dispersion model was used to predict what impact each emission source has on the airshed (e.g. industrial, commercial, transportation, residential). When pollutants are discharged to the atmosphere their dispersion is complex. Concentrations resulting at a given location will vary by pollutant type, the temperature of the emission, and of course wind speed and direction among other factors.

Computer air quality dispersion modelling is a technique used to calculate concentrations of pollutants at various locations throughout the airshed. These models combine mathematical representations of what we know about atmospheric processes with what we know about emissions, the land-use in an area, the topography, and the meteorological conditions.

Some people may ask, "Why can't we just measure the impact in the environment with air monitors?" With modelling, calculations can be made at thousands of locations for the price of a single set of measurements at a monitor. Monitors cannot be located everywhere and may miss the maximum concentrations as a result of emissions from a particular source. Modelling in conjunction with monitoring (used to verify model performance) is very useful in providing a complete picture of the predicted impacts over the entire area of interest from one particular source or from a variety of sources.

The CALPUFF dispersion model was used in the Williams Lake airshed dispersion modelling exercise as it is well suited to the rugged terrain in the area. This model can handle all types of sources and is particularly good at handling stagnant or calm wind conditions. Computer dispersion modelling was used to examine pollutant concentrations at different time scales (predictions of hourly concentrations, 24-hour average concentrations, annual average concentrations, etc.), and was used to predict how often the ambient air quality objectives were exceeded throughout the airshed.

A total of 14 industrial facilities were modelled in the Williams Lake airshed. Most facilities (e.g. saw mills) have numerous discharges to account for in the model. Each of these is referred to as a point source. In total there were 73 individual point sources modelled in the Williams Lake airshed. A total of 55 area sources were also modelled. Area sources included such things as mobile emissions (i.e. vehicle emissions/dust), commercial sources, residential sources, and natural sources. Concentrations for each pollutant were predicted at approximately 3300 locations.

The CALPUFF model encompassed a 25 by 28 kilometre area centered over the City of Williams Lake. For more information, see the complete dispersion modelling report entitled *CALPUFF Modelling for the Williams Lake Airshed* (Schutte, Jain, and Walsh, 2005).

There are many other benefits to using an air quality model for airshed management planning. For example, the model can be used to manage sources in the region by determining the effects on air quality of reducing or increasing emissions from a particular sector. Local impacts can be attributed to the responsible sources and the most cost beneficial method to improve air quality in different areas of the airshed can be determined. The model can also be used for future modelling work as new industrial projects are proposed for the airshed, or as the community emissions change in size, spatially, or temporally.

3.4 Source Apportionment

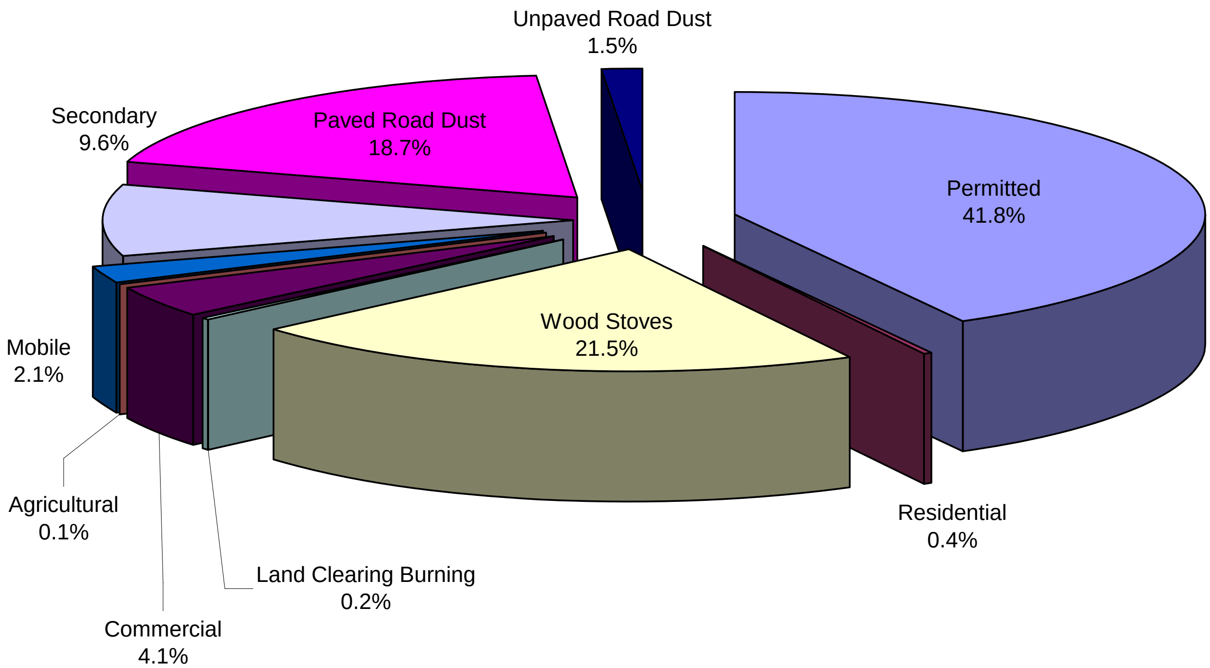
Source apportionment is used to determine which sources or source types are contributing the most to pollutant levels at any one location in the airshed. In the case of the Williams Lake source apportionment work, the output from the computer dispersion modelling was used to do this for PM_{10} and $PM_{2.5}$.

The predicted concentrations for PM_{10} and $PM_{2.5}$ that resulted from each emission source in the airshed were extracted from the CALPUFF model for fifteen locations. These concentrations were then totalled and pie charts and tables were produced to show the relative contribution (mass and in percent of total) of each source to the total.

Relative contributions from the following source groups were examined: agriculture, commercial, mobile, residential, permitted, paved road dust, unpaved road dust. Descriptions of the sources contained in each source group can be found in section 3.1. It should be noted that for this exercise wood stoves were broken out separately from the residential source group to better differentiate between wood stove and other residential source impacts in different areas of the airshed. Relative impacts from land clearing burning were also examined and contributions from secondary particles (chemically formed sulphate and nitrate particles) were also included in the analysis for $PM_{2.5}$.

The following chart provides an example of the output that results from this kind of analysis.

$PM_{2.5}$ Source Apportionment as Modelled for a Residential Location



In addition, each sector could be further broken down to see which source was dominant within that sector thereby assisting with the development of management recommendations. For further information, please refer to the report entitled *Fine Particulate Source Apportionment Update for the Williams Lake Airshed Based on Calpuff Modelling* (Koscher, Schutte, 2005).

3.5 Priority Air Pollutants in Williams Lake

The air quality assessment has determined that the main thing that drives poor air quality episodes in the Williams Lake area is fine particulate matter (PM_{10} and $PM_{2.5}$). Based on this finding and current health information, PM_{10} and $PM_{2.5}$ were identified as priority air pollutants.

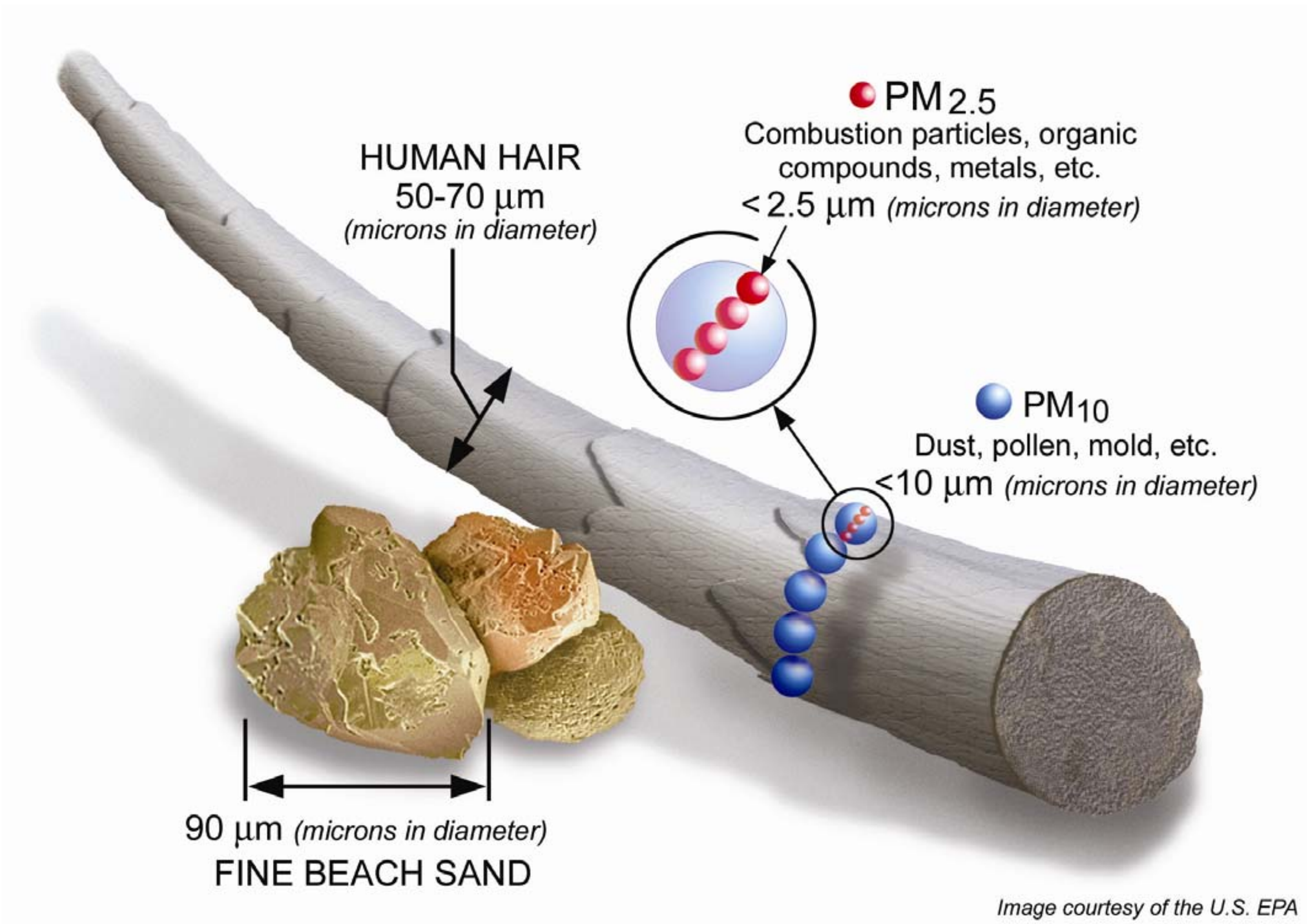
There is a wide variety of natural and man-made sources of fine particulate in the Williams Lake area. Some sources include wind blown dust, pollens and spores, windblown agricultural soils, road and construction dust, industrial processes, sawmill cyclones, wild fires, prescribed burns, open burning, backyard burning, home and commercial heating (primarily woodstoves), automobile/truck and train emissions (especially diesel), quarrying activities, etc.

The following sections describe each of the priority air pollutants and their general trends. For more detailed information, please refer to the *Williams Lake Airshed Management Planning Background Air Quality Report* (Schutte, Newton, Plain, 2003) – see section 7.1 for a list of supporting documents.

3.5.1 Fine Particulate Matter

Suspended particulate matter refers to airborne solid and liquid particles, except pure water, ranging size from 0.005 µm (micrometers) to 100 µm in diameter (CEPA/FPAC, 1999). These particles vary in chemical composition, size and shape, depending on the sources contributing to it. Suspended particulate can originate from natural sources such as pollen, dust from soil erosion, volcanic activity, forest fires, etc. and from man-made sources such as home heating devices, automobiles, open burning, and industrial processes. Particles larger than 10 µm, such as flyash, settle out close to the emission source relatively soon after being emitted. Particles less than 10 µm (PM_{10}) and less than 2.5 µm ($PM_{2.5}$) can remain suspended in the atmosphere for long periods of time and can travel great distances from the emission source depending on weather conditions.

Large suspended particulates may cause an aesthetic nuisance or irritation problem, however, fine particulates (PM_{10}, and in particular, $PM_{2.5}$) have the greatest effect on human health as they are inhaled deep into the lung cavity – see section 4.0 for more information on health effects. The main effects of particulate matter on vegetation are reduced growth and productivity.



PM_{10} and $PM_{2.5}$ Size Comparison

PM_{10} is divided into a coarse and fine fraction, as particles in each fraction generally differ in chemical composition, source and behaviour in the air. The fine fraction of PM_{10} includes particles 2.5 micrometers (µm) in diameter and less. This size fraction is composed mainly of combustion source particles (i.e. truck and car exhaust, diesel emissions, smoke, industrial emissions, etc.) and secondary particles, i.e. particles formed from physical and chemical reactions involving gases such as oxides of nitrogen and sulphur, with ammonia, and/or volatile organic compounds (VOCs). Particles less than 2.5 µm in diameter have been identified as the primary source of health effects because of their ability to penetrate to the deepest regions of our lungs. These particles are also very efficient at scattering/absorbing light, and are responsible for regional haze and smog. A good air quality indicator is regional visibility. The presence of fine particles in the air reduces the distance at which we can see the colour, clarity and contrast of far away objects because the particles in the atmosphere scatter and absorb light. For instance, when we notice a blue or brown haze in the airshed, chances are that $PM_{2.5}$ and PM_{10} levels are building and air quality is less than perfect.

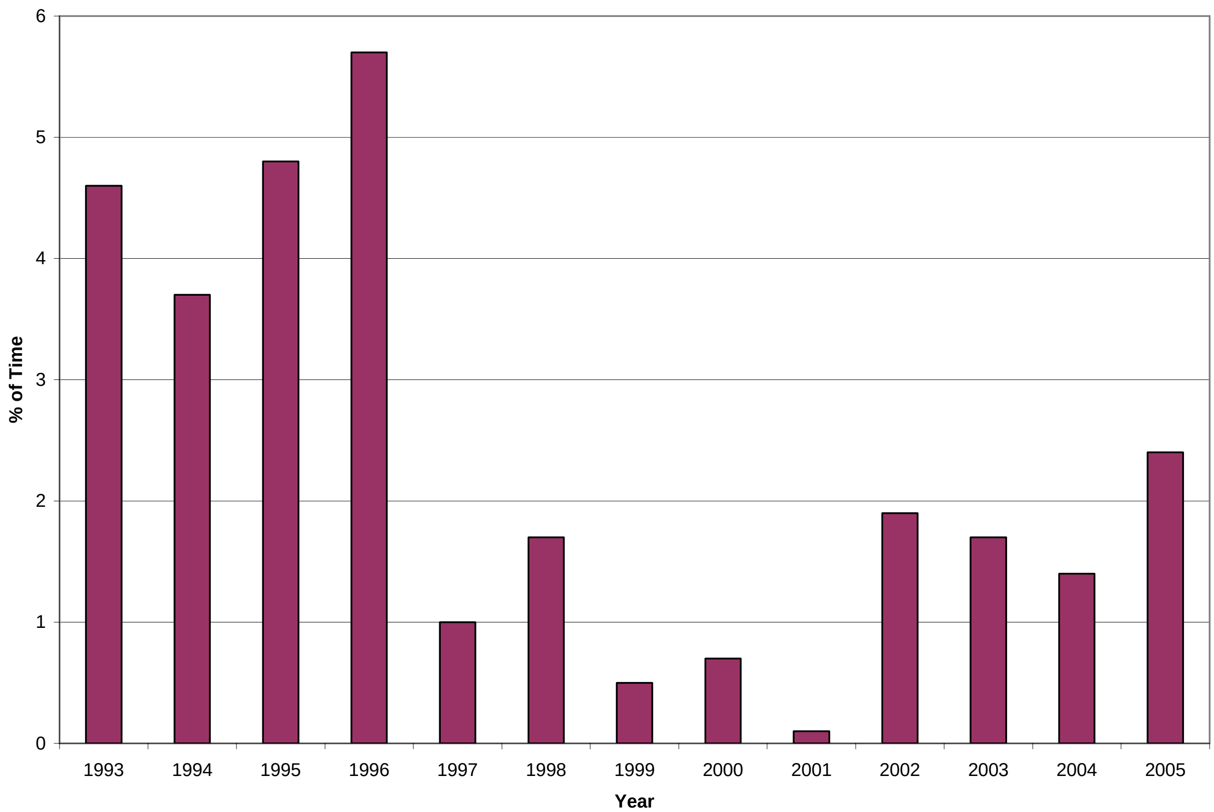
Beehive burners in Williams Lake in the 1980's. A large source of fine particulate air pollution.

The coarse fraction of PM_{10} includes particles between 2.5 and 10 micrometers in diameter. This is the size fraction most often associated with natural sources such as soil particles (i.e. windblown dust); grinding processes (i.e. road dust, quarrying, agricultural tilling, etc.); and fibres (i.e. cyclone emissions, tire rubber, ground up vegetative matter, etc.).

It should be noted that the chemical and physical composition of PM_{10} and $PM_{2.5}$ will vary depending on location, time of year, and weather conditions.

Since the year 2000, depending on the monitoring location, concentrations of PM_{10} exceeded the federal health reference level up to 33% of the time, and the provincial Level B objective up to 6% of the time (see section 3.7 for further details). However, since continuous PM_{10} monitoring began in 1993, there has been a demonstrated improvement in PM_{10} trends in the Williams Lake airshed. For instance there has been a decrease in the amount of time that the provincial Level B PM_{10} objective is exceeded in Williams Lake. However, it should be noted that even a one percent exceedance level in a year means that air quality is considered poor for 3-4 days.

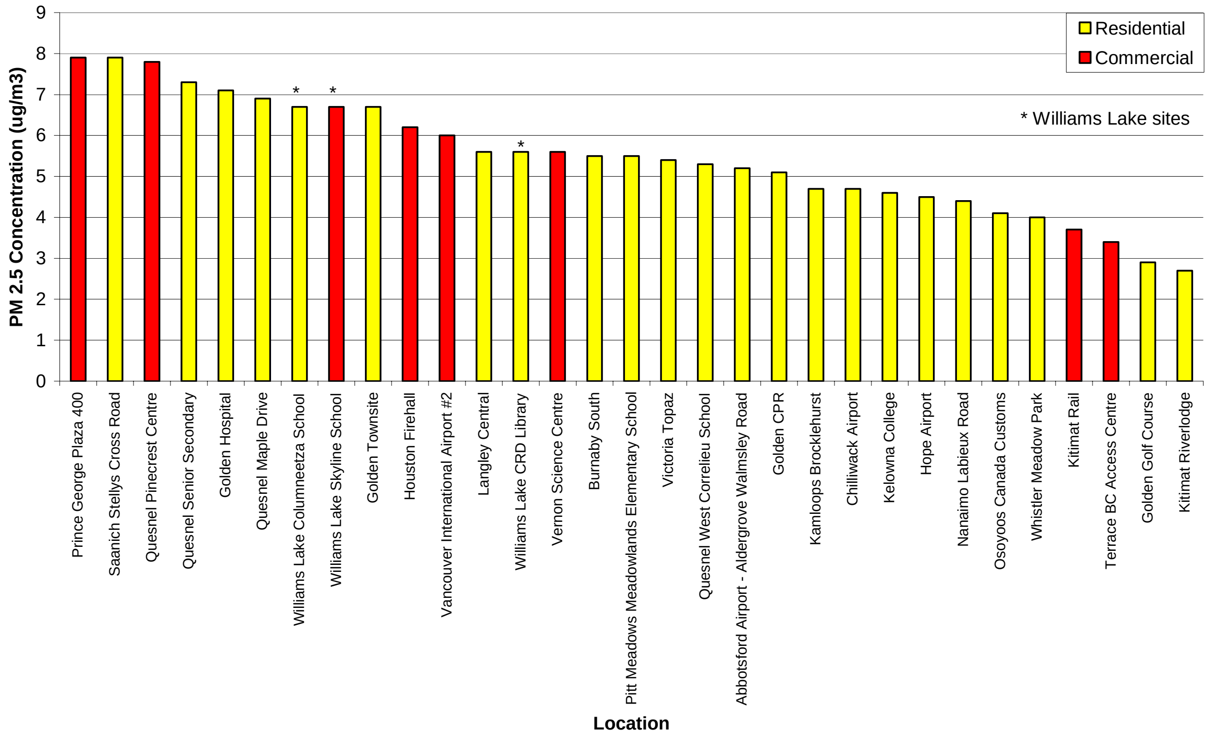
Percent of Time Above the Provincial Level B Objective for PM_{10} at the Williams Lake Columneetza Site



The continuous $PM_{2.5}$ record is too short to report on any patterns in trends - continuous monitoring began in 2001. However, $PM_{2.5}$ levels in Williams Lake have ranked in the top ten since that time, when compared to all other monitoring sites within the province (see 2005 chart on following page). Concentrations of $PM_{2.5}$ exceed the federal health reference level up to 11% of the time, depending on location, but are in compliance with the Canada-Wide Standard (see section 3.7 for further details).

The following chart shows how $PM_{2.5}$ levels in Williams Lake compare with the rest of the province.

Continuous $PM_{2.5}$ Annual Average Values Across British Columbia - 2005



3.6 Other Air Quality Parameters

3.6.1 Ground Level Ozone (O3) & Nitrogen Oxides (NOx)

Ozone is a colourless, reactive oxidant gas that is formed at ground-level from photochemical reactions involving principally NO_x, VOCs and, to a lesser degree, CO. Ozone is one of the main concerns in urban smog because of the adverse effects on human health that can arise from both short-term and long-term exposure to elevated concentrations. Elevated concentrations of ozone can cause respiratory and eye irritation to humans and can damage vegetation and building materials.

Photochemical ground-level ozone occurs in the lower portion of our atmosphere, known as the troposphere.

Ozone is formed by the reaction of volatile organic compounds (VOCs) and nitrogen oxides (NOx) in the presence of sunlight and warm temperatures. A stagnant air mass – the result of high atmospheric pressure and light winds – keeps the pollution from being dispersed and ozone buildup can occur. The ideal conditions for ozone buildup occur from late spring to early fall in most Canadian cities.

It should be noted that VOCs, NOx and ozone occur naturally in the lower atmosphere, too. However, human activities – fossil fuel use, in particular – have greatly increased the amounts.

VOCs (also called hydrocarbons) are the most important constituents of oil and natural gas. The major man-made source of VOC emissions is motor vehicles. Evaporation of gasoline, solvents, oil-based paints, and hydrocarbons from the petrochemical industry are also significant sources.

Like VOCs, NOx are mainly produced by oil and gas, but in this case it's burning the fuel that does it. The exhaust from fossil fuel combustion in our motor vehicles is the primary source, followed by fuel burning in homes, businesses, factories and power plants.

Low concentrations of ground-level ozone can irritate the eyes, nose and throat. As levels increase, more serious health problems can be triggered, including:

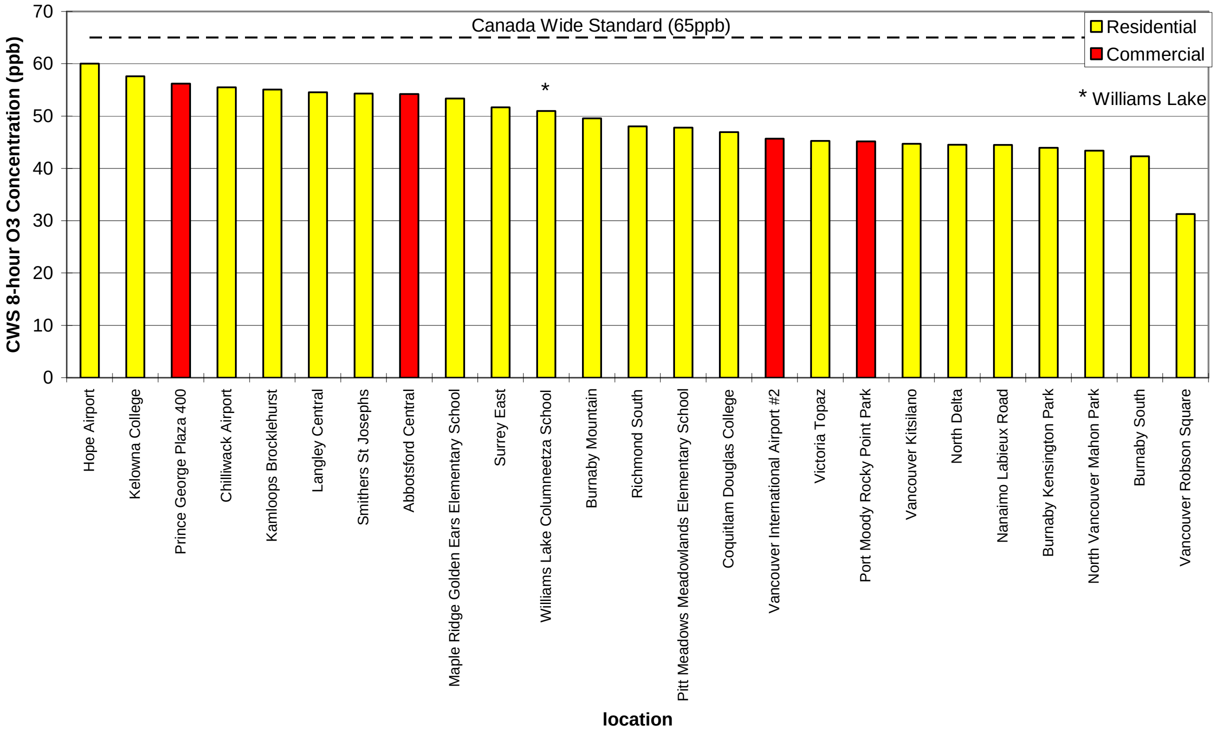
- Asthma, bronchitis, coughing and chest pain;
- Increased susceptibility to respiratory infections; and
- Decreased lung function and physical performance.

Prolonged exposure can eventually damage lung tissue, cause premature aging of the lungs and contribute to chronic lung disease. Children, the elderly and people with impaired lung function are considered to be most at risk (*No Room to Breathe: Photochemical smog and Ground-Level Ozone* (BC Environment, 1992)).

Ozone levels in Williams Lake have been relatively low when compared to levels found in larger urban centers. From 1995-2002 ozone measurements in Williams Lake were below the Canada Wide Standard of 65ppb (based on the 4^{th} highest 8-hour annual value, averaged over three consecutive years). Hourly values between 1995 and 2002 have been above the federal Level A objective between 0.5% and 1.8% of the time. The hourly Level B objective was not exceeded during that period.

The following chart shows the 8-hour Canada Wide Standard calculations for ozone across BC.

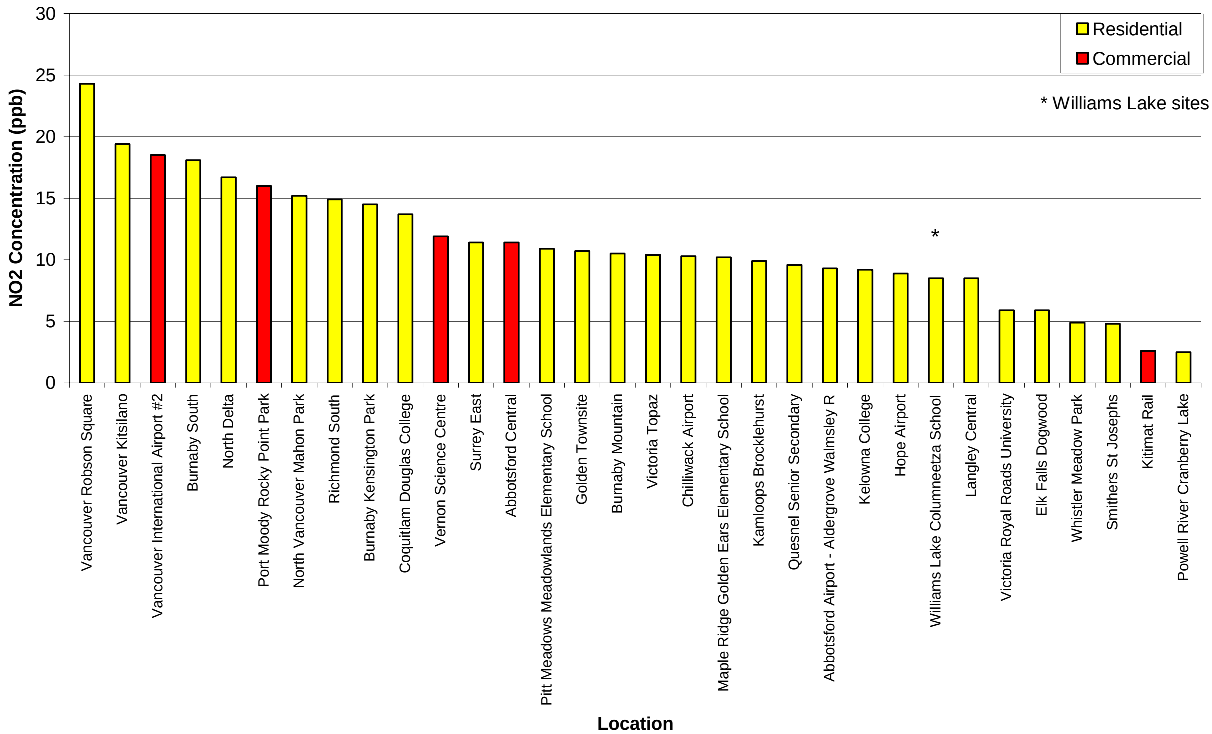
2002 Canada Wide Standard Ozone Values for All Locations Across British Columbia



Nitrogen dioxide levels measured in Williams Lake are well below the federal Level A objectives. Elevated concentrations of nitrogen dioxide produce a brownish gas that causes irritation of mucous membranes in the respiratory tract and increased risk of respiratory irritation and infection. NO_2 is an important precursor to ground-level ozone formation through photochemical reactions involving volatile organic compounds (VOCs). NO_2 causes a brown colour in the atmosphere at elevated concentrations and reacts in the atmosphere with ammonia to form fine particulate salts, which reduce visibility and increase $PM_{2.5}$ concentrations.

The following chart shows NO_2 levels measured across the province.

2005 NO_2 Mean Values For All Monitoring Sites Across British Columbia



3.7 Air Quality Assessment Summary – Key Findings

This section provides a summary of the key findings of the three-year air quality assessment taken from the reports listed in Section 7.1.

- The air pollution potential in the Williams Lake area is high due to topography and local weather conditions. This leads to periods when air quality is poor and 24-hour fine particulate levels can be elevated. For example, the following table is from Williams Lake Columneetza School - 2005:

	Maximum 24-Hour Value	**24-Hour Provincial Level B Objective**	**24-Hour Federal Health Reference Level**
PM_{10}	86.29 µg/m^3	50 µg/m^3	25 µg/m^3
Exceedances (number of days)	N/A	9 days	67 days
$PM_{2.5}$	31.08 µg/m^3	N/A	15 µg/m^3
Exceedances (number of days)	N/A	N/A	20 days

- Ground-level ozone values measured in Williams Lake are in compliance with the federal Canada Wide Standard.
- Nitrogen Dioxide values measured in Williams Lake are well below ambient federal objectives.
- Pollutants considered to be a priority at this time from a public health perspective include PM_{10} and $PM_{2.5}$.

Air Quality Monitoring (fine particulates)

- The largest single change in emission sources prior to 1996 was the phase-out of all beehive burners in the Williams Lake airshed between December 1992 and December 1995 and the subsequent start-up of the TransCanada energy plant. This combined with other changes such as the backyard burning bylaws has had a positive effect on air quality in Williams Lake.
- Air quality as measured by fine particulates, has improved since the 1990's and there are statistically significant downward trends evident at continuous and non-continuous fine particulate monitoring sites. However, in 2005 Williams Lake still ranks as the 4th poorest community for PM_{10} levels in BC out of 35 communities that have continuous monitoring stations.
- Human activities have a large influence on fine particulate levels in Williams Lake. This is shown in the hebdomadal (day of the week) analysis, as the lowest levels are recorded on the weekend while the highest levels are recorded during weekdays. Industrial, commercial, and transportation activity is lowest during the weekends.
- Several indicators point to fugitive dust from industrial operations (particularly in the Glendale and Williams Lake outlet industrial areas), and road dust (from both paved and unpaved surfaces) as being major contributors to PM_{10} and to some extent $PM_{2.5}$ across the airshed:

    - The highest frequencies of elevated hourly PM_{10} values at the Skyline monitoring site occur when winds are out of the west. This sector includes emissions from the Tolko Mills and Parallel Wood Products, and mobile emissions from Highway 97. Higher values also occur when winds are out of the east indicating that mobile emissions from South Lakeside Drive and emissions from commercial activity in the area also have an impact at this site.
    - PM_{10} levels are especially elevated during the early spring months at all monitoring sites. Analysis indicates that there is a large coarse component driving these numbers. The elevated coarse component of PM_{10} in the early spring is largely attributable to road dust being re-entrained by passing vehicles. Over the winter months, the material that is deposited on roadways (i.e. road sand, bark/chips, etc.) is ground up into a fine dust. Once the ice and snow melts, this material is exposed to vehicle traffic which "kicks up" the fine dust into the air.
    - The coarse component of PM_{10} is elevated throughout most of the non-winter months at all monitoring sites indicating that road dust has a large impact throughout the airshed. It is evident from the monitoring results that effective control of road dust alone could result in dramatic reductions in PM_{10} concentrations across the community.

- The highest frequency of elevated hourly PM_{10} levels are recorded at the residential monitoring location of Columneetza Secondary School (CSS) when winds are out of the northwest, where the Glendale industrial area is located. Other high values are experienced when winds are from the east-southeast. A large residential area is located in this sector as are main arterial roads.
- At the downtown CRD/Library monitoring location high PM_{10} values are experienced from all wind directions. This indicates that various sources contribute to the levels recorded at this site (i.e. industrial, commercial, residential, mobile, and area sources in all directions from the site).
- Between 2000 and 2005, PM_{10} concentrations were above the federal health reference level of 25 $\mu g/m^3$ an average of 45% of the time at Skyline, 31% of the time at CRD/Library, and 19% of the time at CSS. Over the same time period, PM_{10} levels were above the provincial Level B objective of 50 $\mu g/m^3$ an average of 13% of the time at Skyline, 5% of the time at CRD/Library, and 1% of the time at CSS. Higher PM_{10} levels occur at Skyline and the downtown area than in the residential area around Columneetza.
- A significant portion of PM_{10} objective exceedances occur during air quality episodes in the late winter/early spring. Management efforts targeted at sources that contribute most significantly to episodes should reduce the overall number of exceedances, reduce the annual average PM_{10} value and result in improved air quality.
- Diurnal (hour of the day) patterns of fine particulate concentrations at two of the three monitoring locations show that highs and lows generally correspond well with traffic patterns (road dust and exhaust emissions) as well as the formation and break-up of night-time inversions. Patterns at the Skyline monitoring site indicate that industrial emissions have a larger influence in this area.
- On average between 2001 and 2005, $PM_{2.5}$ concentrations were above the federal health reference level of 15 $\mu g/m^3$ an average of 6% of the time at Skyline, 5% of the time at CRD/Library, and 8% of the time at CSS. The bulk of these exceedances occur during the winter months.
- The $PM_{2.5}$ federal health reference level of 15 $\mu g/m^3$ is exceeded more frequently at Columneetza during the winter months than at the other monitoring locations. This suggests that localized sources such as woodstoves or open burning in areas outside of city limits are contributing in addition to impacts from industrial emissions.
- The highest frequencies of elevated hourly $PM_{2.5}$ levels are recorded at CSS when winds are out of the northwest, where the Glendale industrial area is located. However, high values (lower frequency) are experienced when winds are from all directions indicating that localized sources of $PM_{2.5}$ such as woodstove emissions and automobile exhaust have an impact at this site.
- $PM_{2.5}$ seasonal pollution rose indicates that fall and wintertime burning (i.e. woodstoves and backyard burning) in the Dog Creek Road area may be having an affect on values recorded at the Skyline site.

Emissions Inventory

- Permitted sources emit the most sulphur oxides, nitrogen oxides, volatile organic compounds, and fine particulate matter (PM_{10} and $PM_{2.5}$) to the Williams Lake airshed.
- Road dust contributes the most total particulate (TPT) to the airshed. Road dust also contributes significantly to PM_{10}, and to a lesser degree contributes to $PM_{2.5}$.
- Mobile sources emit the most carbon monoxide to the Williams Lake airshed.

Fine Particulate Source Apportionment/Computer Dispersion Modelling

- Computer modelling confirms that road dust contributions to PM_{10} are significant throughout the airshed. Road dust was predicted to contribute between 16-80% of the PM_{10} mass depending on location in the airshed.
- Computer modelling shows that permitted source emissions from facilities such as West Fraser Plywood, West Fraser Mills, Tolko Industries, Epcor (Williams Lake Power Plant), and Jackpine Forest Products, can have effects as far out as Sugar Cane and Pine Valley. However each of these sources contributes relatively small amounts to the total mass at these locations.
- Computer modelling confirms that emissions from all sectors contribute to fine particulate concentrations in the downtown core. However, permitted sources and residential sources tend to dominate the picture. When road dust is excluded at the CRD/Library monitoring site, approximately 52% of the $PM_{2.5}$ mass is from permitted sources, 27% from residential wood heating, 12% from secondary particles (e.g. nitrates and sulphates), 5% from commercial sources, 3% from automobiles/trucks/rail, and 1% from open burning (outside city limits), agriculture and other residential sources.
- Computer modelling indicates that emissions from the permitted and residential sectors contribute the most to fine particulate concentrations in the Columneetza area. When road dust is excluded at the Columneetza monitoring site, residential emissions (including wood heating emissions in the winter) and permitted emissions combine to account for more than 84% of the $PM_{2.5}$ mass.
- Computer modelling shows that fine particulate concentrations in the Skyline area are primarily from permitted source emissions and road dust.
- Computer modelling indicates that in some locations, permitted sources contribute a significant portion of the PM_{10} and $PM_{2.5}$, whether or not road dust was included in the model. It was also confirmed that residential emissions can have a large impact in some areas, such as Pine Valley, Dog Creek Road, and Fox Mountain.
- Computer modelling indicates that the transportation sector (automobile exhaust, diesel emissions) contributes up to 21% of the $PM_{2.5}$ mass in the Pine Valley area when road dust is excluded from the model. However, in most areas examined, mobile sources only contributed between 2-12% of the $PM_{2.5}$ mass.

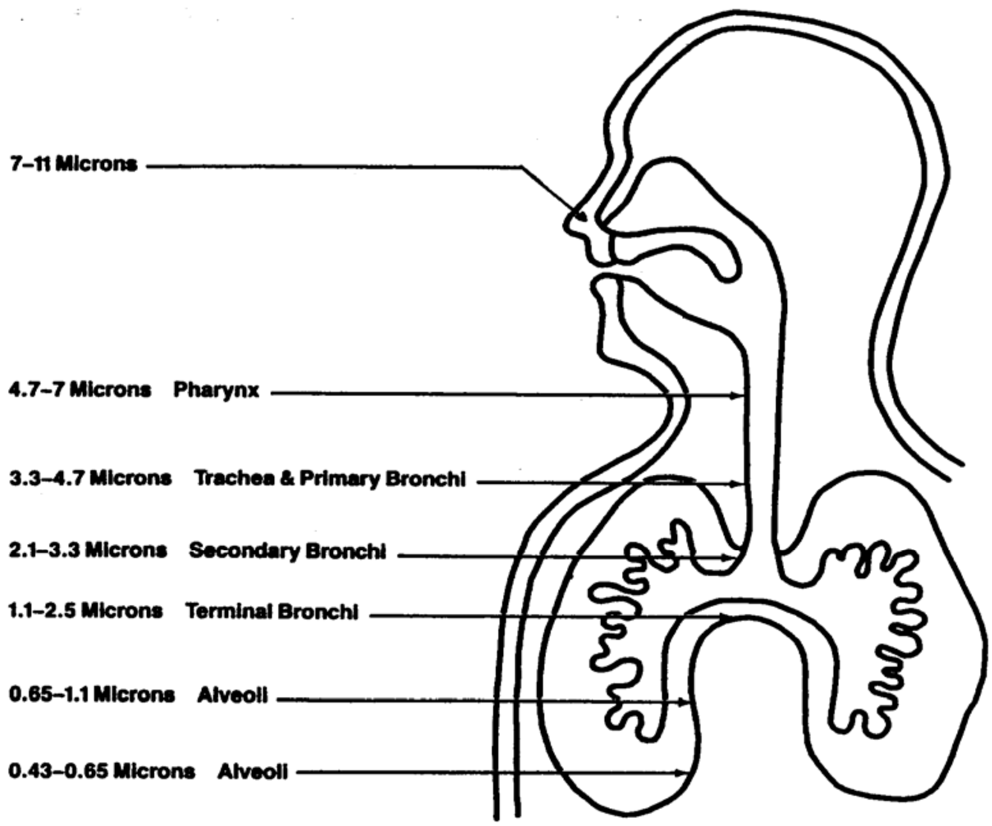
Main Conclusion of the Air Quality Assessment

In terms of fine particulate, the Williams Lake air quality problem is the result of the combined impact of a number of sources. Analysis indicates that PM_{10} levels are largely attributable to road dust, fugitive dust, and industrial emissions. $PM_{2.5}$ levels are primarily related to industrial emissions and residential/commercial activities. However, there is no **one** source that can be targeted to completely solve the air quality problem.

To improve fine particulate levels in the community, reductions are required from all sectors with particular focus on permitted sources, fugitive and road dust sources (including track-out), and commercial/residential sources.

4. HEALTH EFFECTS OF PM_{10} AND $PM_{2.5}$

The following figure illustrates how various sized particles deposit in the human respiratory system. As discussed in section 3.5.1, large suspended particulates may cause a nuisance or irritation problem, however, fine particulates (PM_{10}, and in particular, $PM_{2.5}$) have the greatest effect on human health as they are inhaled deep into the lung cavity.



Settling Pattern of Various Particles in the Human Respiratory System

Recent research has shown that fine particulates (either by themselves or in combination with other air pollutants) may have serious human health impacts (Vedal, 1995; CEPA/FPAC, 1999;

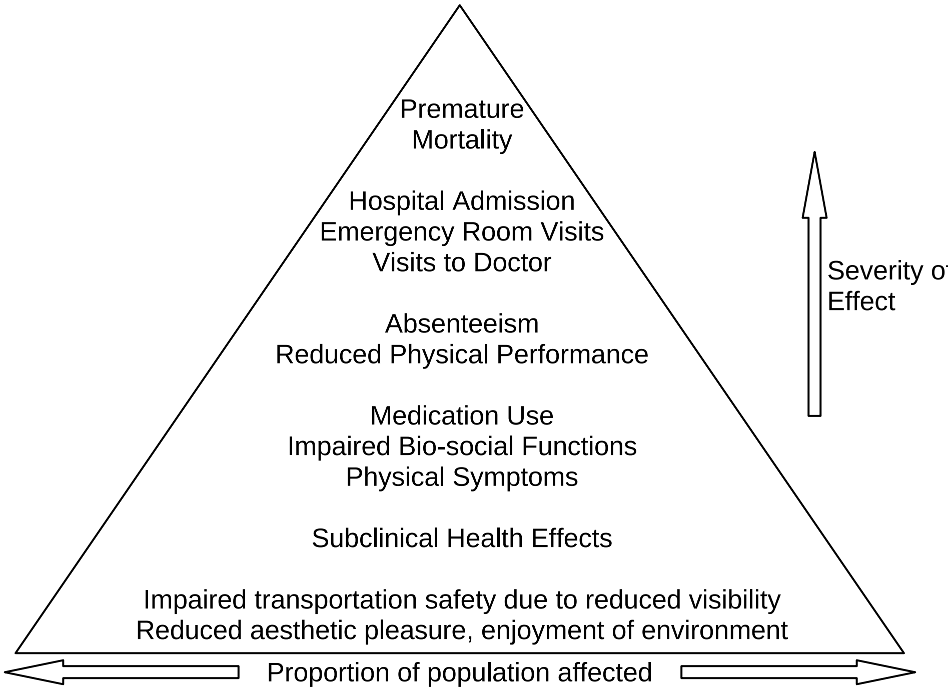
Bates et al, 2003). These health effects include such things as premature death, increased hospital visits, worsening respiratory symptoms and disease, and decreased lung function. Individuals with chronic obstructive pulmonary or cardiovascular disease, asthmatics, the elderly and children are most at risk.

A University of BC professor and BC Lung Association researcher, Dr. Sverre Vedal, conducted a study entitled *Health Effects of Inhalable Particles: Implications for British Columbia* (Vedal, 1995). Vedal's study points out that "while air pollution is composed of different types of pollutants, fine particulates (or inhalable particles) are considered a greater health hazard than some higher profile pollutants such as ground level ozone, sulphur dioxide and carbon monoxide."

The undesirable health outcomes attributable to particulates are also proportionately higher in the smaller population centers. Further, it has been argued that the health effects of particulate matter air pollution reported in studies represent only the 'tip of the iceberg'. These more obvious effects could be only the most visible outcomes of a much greater burden of illness in the general population that, although less critical, may be impairing or have the potential for future impairment of quality of life (from *Ambient Particulate Matter: An Overview* (Environment Canada, 1998)).

The types of health effects summarized above are commonly referred to in an ever-growing body of literature within the health community. It should be noted that several studies have found that soil-related particulate matter is less potent than combustion-related particulate in association with the most severe health effects. In other words, sources of PM_{10} such as road dust may be less harmful than sources of $PM_{2.5}$ such as vehicle exhaust, diesel emissions, smoke, industrial emissions, etc. Furthermore, current thinking is that soil particles (i.e. the coarse fraction of PM_{10}) that come from natural sources such as wind blown dust off an exposed river bank are inert, while those soil particles that come in contact with other contaminants such as diesel exhaust (i.e. road dust) may be associated with health effects. In contrast, *all* combustion derived particulates have health effects.

Pyramid of Health Effects



Air pollution affects both the respiratory and cardiac systems. The health effects of air pollution can be seen as a pyramid, with the mildest but most common effects at the bottom of the pyramid, and the least common but more severe at the top of the pyramid. The pyramid demonstrates that as severity decreases, the number of people affected increases (adapted from Health Canada - http://www.hc-sc.gc.ca/ewh-semt/air/out-ext/effe/health_effects-effets_sante_e.html).

As a society, we pay for the health effects of air pollution in many ways. Additional health care costs for the treatment of these effects may come from any of the following: hospital admissions, visits to the emergency room or doctor's office, homecare service, medication such as inhalers for asthma. Other considerations include lost productivity in the workplace, lost wages due to sick time, out of pocket expenses incurred while ill (e.g. additional child care costs), and finally, lost quality of life or the premature loss of life itself.

As discussed in section 3.2, the federal health reference levels for both PM_{10} and $PM_{2.5}$ are exceeded up to 33% and 11% of the time, respectively, depending on location. It is important to remember that a health reference level is simply "an estimate of the lowest ambient PM level at which statistically significant increases in health responses can be detected and not a level where impacts will not occur" (CEPA/FPAC, 1999). In other words, there is no risk-free level of exposure for particulate matter.

Health impacts of specific sources have been described in some of the background information found in section 7.2, and references on the health effects of air pollution can be found in Appendix B.

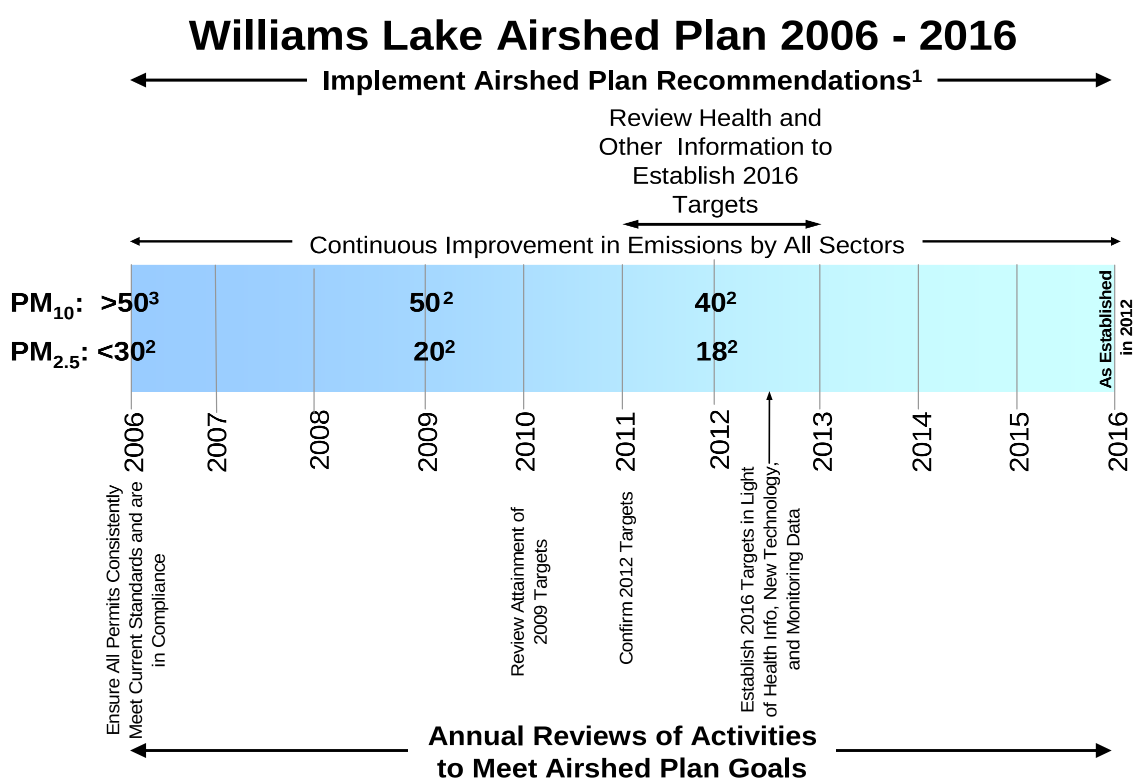
5. WHAT THE PLAN WILL ACHIEVE

5.1 Chart of Clean Air Goals 2006-2016

After the completion of the three-year air quality assessment, recommendations were developed by the Williams Lake Air Quality Roundtable for improving air quality.

As discussed in the previous sections, fine particulates were identified by the Roundtable as the primary pollutants of concern. PM_{10} and $PM_{2.5}$ are generally reported in units of micrograms of pollutant per cubic meter of air (µg/m^3). At times, daily pollutant levels in Williams Lake are greater than 50 µg/m^3 for PM_{10} (this exceeds the provincial Level B air quality objective), and greater than 20 µg/m^3 for $PM_{2.5}$. However, the $PM_{2.5}$ levels measured in the community are in compliance with the Canada-Wide Standard of 30 µg/m^3.

The Williams Lake Air Quality Roundtable has developed a ten-year plan to improve air quality which is represented by the following chart. Background information leading to the development of this plan can be found in previous sections of this document. Specific recommendations to improve air quality are outlined in section 5.2, and the detailed rationale behind these recommendations can be found in section 7.2.



1: Incorporate into community and industry planning as opportunities arise.
2: µg/m^3; based on a 24-hour average, and achievement is based on the 98^{th} percentile ambient measurement annually, averaged over 3 consecutive years (allows for 7 days of exceedance per year).
3: µg/m^3; 24-hour average not to be exceeded.

5.2 Airshed Management Plan Recommendations

5.2.1 General

1. The Williams Lake Air Quality Roundtable will request that all stakeholders submit an annual written update on their activities and plans with regard to their contributions towards the community meeting the air quality goals as laid out in the Williams Lake Airshed Management Plan, commencing in 2006.

2. The Williams Lake Chamber of Commerce should be encouraged to work with the Williams Lake Air Quality Roundtable to further promote improvements in community air quality through an annual recognition award program.

5.2.2 Permitted Operations

3. Regulatory authorities should ensure all permits and regulated activities consistently meet current standards and are in compliance.

5.2.3 Mitigation of Dust from Paved and Unpaved Sources

4. Mitigation of dust from paved and unpaved sources should be carried out during the spring, summer, and fall as follows:
    a. the City, the Ministry of Transportation (MOT), and other applicable parties should reduce road dust on high traffic unpaved routes, through the use of dust suppressants or hard surfacing. Priority areas should be considered to be within the city limits and urban fringe areas;
    b. the City, the Ministry of Transportation, and other applicable parties should investigate solutions for reducing track-out and carry-out from unpaved roads and lots;
    c. the City should consider requiring effective, consistent dust control of all traffic areas permitted for new industrial and commercial developments through the use of dust suppressants and/or hard-surfacing;
    d. between 2006 and 2016 the City should suppress dust in all unpaved alleys and lanes by applying dust suppressants as required in conjunction with surface blading. As a long term goal, the City should work towards hard surfacing problematic unpaved alleys within city limits to reduce track-out onto main paved traffic corridors. Unpaved alleys should be prioritized based on areas where track-out is a known issue; and
    e. the City and the Ministry of Transportation should review and increase sweeping frequency from the first major melt period through to the first snowfall. This may require the MOT to re-open existing maintenance contracts to allow contractors more flexibility.

5. The City and the Ministry of Transportation should reduce the impact of winter traction material by:
    a. continuing to reduce the amount of traction material used in winter road/parking lot maintenance by switching to a better quality, coarser traction material and/or de-icing compound, and expanding the application of that improved traction material and/or de-icing compound on main roadways throughout the city;
    b. investigating the feasibility and continued use of an anti-icing program;
    c. continuing to harmonize efforts to improve winter road maintenance practices and reduce spring time dust episodes; and
    d. implementing the timely, aggressive cleanup of roadways and parking lots in the early spring; and
    e. examining and adjusting MOT road maintenance contracts as required to allow more flexibility for contractors to utilize better techniques.

6. The Ministry of Transportation should investigate the use of liquid de-icers with a wet sweeper to allow for earlier clean up of winter traction material from roads and parking lots. This should be a requirement in new road maintenance contracts that cover the Williams Lake airshed. The City should expand on the use of this practice.

7. The City should consider adopting a bylaw that requires local businesses, whether industrial or commercial, to clean and maintain their parking lots and roadways, by:
    a. introducing minimum specifications for winter traction material used on such parking lots/roadways;
    b. requiring timely, aggressive spring cleanup as well as seasonal maintenance, through the use of wet sweeping or a vacuum sweeper;
    c. requiring effective dust control throughout the spring, summer, and fall, whether the lot/road is paved or not; and
    d. requiring that local businesses hard-surface their lots before a certain date or that they hard surface the last 30 m of lane linking unpaved parking areas to the main paved traffic arterial.

8. The City should consider adopting a bylaw that requires building contractors who track materials onto roadways to routinely clean up the track-out.

5.2.4 Backyard/Open Burning

9. The Ministry of Environment should consider issuing Stage I and Stage II burning advisories for the Williams Lake airshed according to the following table.

Stage I and Stage II Burning Advisory Definitions

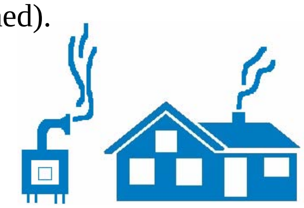
	Stage I:	Stage II:
$PM_{2.5}$ level (based on a 24-hour rolling average**)**	20 to 25 µg/m^3	> 25 µg/m^3

10. Following the implementation of the public educational program as described in section 5.2.8 the CRD should consider adopting a bylaw whereby backyard/open burning (regardless of pile size) shall be permitted outside of the city boundaries (but within the Williams Lake airshed), provided that:
    a. all burning, including agricultural and grass or stubble burning, is done in accordance with the Venting Index requirements of the Open Burning Smoke Control Regulation. Venting Index requirements currently do not apply to these types of burns;
    b. no person shall start any outdoor fire at any time within the airshed when an air quality advisory, or a Stage I or II burning advisory (according to the table below) has been issued by the Ministry of Environment and remains in effect;
    c. those persons responsible for fires that are already burning when an air quality advisory, or a Stage I or II burning advisory is issued, shall either extinguish or withhold fuel from their burn piles; and
    d. these provisions (a, b, and c) do not apply to backyard campfires, or the cooking of food in barbecues or grills.

Summary of Open/Backyard Burning Restrictions during Stage I and II Burning Advisories

	Stage I: Voluntary	Stage II: Mandatory
$PM_{2.5}$ level (based on a 24-hour rolling average)	20 to 25 µg/m^3	> 25 µg/m^3
Backyard/Open Burning	NO	NO
Note: "NO" indicates that backyard/open burning shall not be permitted. Voluntary curtailment is requested under Stage I.		

11. Following the implementation of the public educational program as described in section 5.2.8, the Ministry of Forests and the Ministry of Environment should consider developing unique burning restrictions for burns within the Williams Lake airshed (i.e. revise the current Williams Lake Forest District Burn Plan for Smoke Management to include a new sensitivity rating for the local airshed).



5.2.5 Wood Burning Appliances

12. The City of Williams Lake should consider adopting a bylaw that includes domestic wood fired boilers and wood furnaces, whether inside or outside of the premises. Consideration within such a bylaw could include things such as set-back distance regulations (to address lot size issues), and CSA/EPA **emissions** certification requirements. Consideration should be given to expanding this bylaw to the Cariboo Regional District within the

Williams Lake airshed boundaries.

13. Following the implementation of the public educational program as described in section 5.2.8 the City and the CRD should consider adopting a bylaw whereby no person shall use a wood burning appliance at any time within the airshed when an air quality advisory, or a Stage I or II burning advisory (according to the table below) has been issued by the Ministry of Environment and remains in effect, unless that wood burning appliance is their sole source of heat.

Summary of Wood Burning Appliance Restrictions during Stage I and II Burning Advisories

	Stage I: Voluntary	Stage II: Mandatory
$PM_{2.5}$ level (based on a 24-hour rolling average)	20 to 25 $\mu g/m^3$	> 25 $\mu g/m^3$
CSA/EPA emissions certified wood burning appliance (includes pellet stoves)	YES	NO
All other appliances	NO	NO
Note: "YES" indicates that the appliance may be operated, and "NO" indicates that the appliance may not be operated, except during Stage I where curtailment is voluntary.		

14. Following the implementation of the public educational program as described in section 5.2.8 the City and the CRD should consider adopting a bylaw which outlines a list of prohibited burning materials for wood burning appliances and other heating devices, including, but not limited to: plastics and plastic products, treated lumber, drywall, animal carcasses, rubber and rubber products, paints and chemicals, tar paper, household waste, biomedical waste, fuel and lubricant containers, asphalt and asphalt products, used oil and diesel products, and other noxious materials in general.

15. In areas within the airshed where complaints are received regarding smoke from wood burning appliances, neighbourhood education programs should be conducted. For example: provide a "User's Guide to Residential Wood Burning" booklet and/or a "Burn It Smart" video along with brochures regarding the local airshed, the health effects of wood smoke, and tips for better burning to citizens who are the subject of a complaint.

    If the above is found to be ineffective, the City and the CRD should consider adopting a wood burning appliance nuisance bylaw which includes the following provisions:

    a. no person shall cause or allow emission of a smoke plume from any wood burning appliance to exceed an average of 20% opacity for six minutes in any one-hour period. This shall not apply to smoke emitted during:
        i. the starting of a new fire for a period not exceeding 20 minutes in any four-hour period, or
        ii. a six-minute period after a fire is re-stoked with fuel (as per bylaws in Saanich, BC; GVRD, BC; Washington State; Spokane, WA; Jackson County, OR).

16. The Cariboo woodstove exchange program should continue to be held biennially.

5.2.6 Transportation

17. All new road development should have bike lanes. Include planning to enhance existing trail networks to facilitate non-motorized transport.

18. Public transit should be optimized. Forms of land use and development strategies should be encouraged that make public transit more viable. The CRD should expand existing transit routes into the City of Williams Lake urban fringe areas to provide area residents with a viable transportation alternative.

19. Depending on availability through Environment Canada, the vehicle emissions clinics should continue to be held biennially, on alternate years of the woodstove exchange program. A diesel emissions testing component should be added to the clinic.

5.2.7 Community and Regional Planning

20. The Ministry of Environment should provide a comprehensive review and update of emission estimates for all point, area, and mobile sources every five years, with the next major update based on 2005 emissions. Input files for the CALMET/CALPUFF dispersion modelling platform should be updated for the same year that there is an emissions inventory update.

21. Industrial expansion should be encouraged within the airshed provided that
    a. companies use emission control technology that facilitates community progress towards the ambient goals of the airshed plan and,
    b. new industrial proposals for the Williams Lake airshed are assessed using the most recent CALMET/CALPUFF modelling platform available. Proposals to increase production that would result in a substantial increase in emissions above an existing facility's current operating permit limit should be assessed in the same manner, and
    c. the co-management of air quality and greenhouse gases have been examined.

22. The City and the CRD should incorporate Williams Lake Airshed Management Plan recommendations into all levels of planning.

23. The air quality assessment and dispersion modelling conducted in the development of the Williams Lake Airshed Management Plan should be used as tools for industrial zoning within the airshed. The City and the CRD should work with the Ministry of Environment Air Quality Meteorologist on this planning.

24. The City of Williams Lake should consider developing a Community Energy Plan to address energy consumption, green house gas emissions, and the promotion of alternative renewable fuels.

5.2.8 Public Education

25. Public education programs should be implemented concerning lifestyle impacts on air quality, through the use of:
    a. the media. For example: continue to provide the Air Quality Index on a daily basis, and Air Quality Advisories during periods of degraded air quality; use channel 10 to show the “Burn It Smart” video;
    b. informational brochures, posters, and billboards;
    c. public invitations to attend Wood Energy Technology of BC Workshops during woodstove exchange programs;
    d. public open houses with participation from credible professionals such as: real estate agents, insurance agents, local retailers, chimney sweeps, building inspectors, fire fighters, health professionals, etc.;
    e. interactive computer education programs or air quality computer kiosks to be offered/set up in schools, libraries, and other public places;
    f. the City and CRD websites with links to other air quality resources;
    g. in-school presentations and the inclusion of air quality in the local science curriculum for elementary- and high school students;
    h. citizen-friendly approaches regarding wood burning appliances and open burning, such as “wood burning: we already do it well, but here is how to do it better”;
    i. annual airshed statistical summaries or air quality status reports to be released to the public; and
    j. anti-idling materials such as brochures, signage at schools, etc.
    k. workshops and correspondence with retailers to promote zero or low emission gardening implements over standard 2-stroke engines.

26. An information bulletin should be developed by the Roundtable and distributed to the public clearly explaining the facts regarding residential wood boilers and wood furnaces.

27. An educational program should be developed by the Roundtable and communicated to the public which:
    a. clearly explains the rules and guidelines for open burning;
    b. outlines a list of prohibited burning materials according to the Open Burning Smoke Control Regulation;

c. advises residents within the Williams Lake airshed of the hazards associated with open burning; and
d. encourages alternatives to burning such as onsite chipping and re-use and/or chipping and composting of vegetative materials at the City of Williams Lake Landfill site.

5.2.9 Air Quality Monitoring and Future Research

28. The current air monitoring program should be reviewed as to its adequacy for the implementation phase of the airshed plan.

6. IMPLEMENTATION OF THE WILLIAMS LAKE AIRSHED MANAGEMENT PLAN

As per recommendation 1, the Williams Lake Air Quality Roundtable will request an annual written update from all stakeholders on their activities and plans with regard to their contribution toward the goals of the airshed plan (see section 5.1). The criteria for these submissions will revolve around three questions:

1. What have you done in the past 12 months?
2. What are you planning to do in the next 12 months?
3. What are your long term plans for meeting the 2016 goals?

It is anticipated that the Williams Lake Air Quality Roundtable will issue an annual progress report to the community, and the Ministry of Environment will update the community annually on air quality. The Williams Lake Airshed Management Plan will be reviewed and updated on an ongoing basis.

It is expected that long term monitoring of air quality over the implementation period of 2006 to 2016 will demonstrate improvements to the ambient air. This timeframe is necessary because, based on the air quality assessment, it will take the combined effect of all of the recommendations being implemented to result in an improvement. It is necessary to maintain an adequate air monitoring network for effective trend assessment.

7. BACKGROUND INFORMATION

7.1 Supporting Documents

The airshed plan is based on the following documents which were written as a part of the air quality assessment and airshed management planning process. Many of these can be found in the local library or on the Ministry of Environment website.

Levelton Consultants Ltd., Koscher, C. and A. Schutte. 2005. *Fine Particulate Source Apportionment Update for the Williams Lake Airshed Based on Calpuff Modelling*. Prepared for the Ministry of Environment Cariboo Region, Williams Lake, B.C.

Levelton Consultants Ltd., Schutte, B., Jain, R. and C. Walsch. 2005. *CALPUFF Modelling for the Williams Lake Airshed*. Prepared for the Ministry of Water, Land and Air Protection Cariboo Region, Williams Lake, B.C.

Levelton Consultants Ltd., Ostermann, K. and A. Schutte. 2004. *CALMET Modelling for the Williams Lake Airshed*. Prepared for the Ministry of Water, Land and Air Protection Cariboo Region, Williams Lake, B.C.

Levelton Engineering Ltd., Schutte, A., Newton, T. and E. Plain. 2003. *Williams Lake Airshed Management Planning Background Air Quality Report*. Prepared for the Ministry of Water, Land and Air Protection, Cariboo Region, Williams Lake, B.C.

Plain, E. 2002 (revised 2003). *Inventory of Common Air Contaminants Emitted in the Williams Lake Airshed for the Year 2000.* Ministry of Water, Land, and Air Protection. Cariboo Region, Williams Lake B.C.

Plain, E. and N. Zirnhelt. 2001. *Air Monitoring and Assessment Strategy for Williams Lake BC, 2001 – 2006.* Pollution Prevention, Ministry of Environment, Lands and Parks. Williams Lake, B.C. http://wlapwww.gov.bc.ca/car/epd/air/aq_reports/pdf/wml/wlmonitoring_plan.pdf

Williams Lake Air Quality Roundtable (WLAQR). 2001. *Airshed Management Planning in Williams Lake: A community initiative to improve air quality*. An information brochure. Eight pages. http://wlapwww.gov.bc.ca/car/epd/air/aq_reports/pdf/wml/wlbrochure.pdf

Zirnhelt, N. and E. Plain. 1999. *Framework Outline for Airshed Management Planning in Quesnel and Williams Lake.* Document prepared for the Quesnel Air Quality Roundtable. Pollution Prevention, Ministry of Environment, Lands and Parks. Williams Lake, B.C.

7.2 Rationale for Recommendations

It was felt that the reasoning behind recommendations 1, 2, 20-23, and 27-28 (see section 5), was self evident. As such, only those recommendations in need of a more thorough explanation were outlined in this section.

Recommendation 3

Permits and regulated activities should generally be in compliance; however MOE staff believes there is room for improvement. Increased inspections, compliance audits, updating of permits as needed, and stack audits will be undertaken beginning in 2006.

There are currently 17 operations in the Williams Lake airshed that have particulate air discharge permits in place with the Ministry of Environment. These operations vary in size and complexity ranging from a single discharge (e.g. a chipper cyclone) to multiple discharges such as those found at the area plywood plant.

Of all the source groups in the Williams Lake airshed that emit air contaminants, the permitted operations emit the most fine particulate matter (PM_{10} and $PM_{2.5}$), sulphur oxides (SOx), nitrogen oxides (NOx), volatile organic compounds (VOCs), and carbon monoxide (CO) (see *Inventory of Common Air Contaminants Emitted in the Williams Lake Airshed for the Year 2000* (Plain, 2002)). However, this does not mean that the largest emitters will necessarily have the largest impact on air quality. Meteorology, geography, facility location, and discharge characteristics (temperature, exit velocity, concentration, etc.), all play a key role in how well an emission disperses in the atmosphere.

Ambient monitoring for fine particulate indicates that permitted sources have a defined role in the Williams Lake outlet area (see *Williams Lake Airshed Management Planning Background Air Quality Report* (Schutte, Newton, Plain, 2003)) and in the Columneetza area. The highest frequency of elevated PM_{10} and $PM_{2.5}$ concentrations at Skyline are recorded when winds are out of the west and northwest sector – the Tolko industrial area. The highest frequency of elevated PM_{10} and $PM_{2.5}$ concentrations at Columneetza are recorded when winds are out of the west and northwest sector – the Glendale industrial area. Monitoring data in the downtown area indicates that permitted sources contribute to PM concentrations but that other sources play a large role as well.

The results of the ambient monitoring network were confirmed through computer dispersion modelling (see *Fine Particulate Source Apportionment Update for the Williams Lake Airshed Based on Calpuff Modelling Exercise* (Koscher, Schutte, 2005). Dispersion modelling predictions for the period June 2003 – May 2004 indicated that when all source groups are considered together, permitted sources contribute significantly to the PM_{10} levels predicted at many of the 15 locations (receptors) examined. Contributions ranged from 2% to 81% of the total $PM_{10,}$ and 4% to 74% of the total $PM_{2.5}$ depending on the proximity of the location to major sources and on the magnitude of other source group contributions. The following areas were strongly influenced by permitted emissions, particularly for $PM_{2.5}$: Commodore Crescent, Comer Hill Trailer Park, Edwards Drive in Glendale, 11th Avenue, Skyline School, Williams Lake Golf and Country Club, and the CRD/Library site. The Columneetza ambient monitoring site had a relatively strong but not overwhelming permitted source component.

The dispersion model was also used as a tool to examine various source reduction scenarios. For instance, to confirm that the ambient targets set out in the airshed plan could be achieved, a scenario was run where certain plywood, and wood manufacturing sector sources were operating with best available control technology in place. Reductions in other sectors (e.g. road dust reduction, burning reductions, etc.) combined with these pollution control upgrades resulted in achievement of the ambient targets that were adopted in this plan. With a commitment from all sectors to reduce fine particulate loading from their respective operations, the ambient targets adopted in the airshed plan can be achieved.

Permitted sources also contribute to the road dust and fugitive dust issue in Williams Lake. Heavy machinery working in large unpaved lots such as log yards, re-entrain dust which deposits throughout the community. Mud and dirt from unpaved surfaces is tracked onto highways under moist conditions and is ground up further by traffic and re-entrained upon drying. Material falling from logging trucks onto paved roadways (from brake drums, the truck bed, or the logs themselves) is ground up and re-entrained in the same fashion. In addition, materials handling and transport loss also adds to the equation.

Short term (e.g. house keeping issues, paving, etc.) and long term reduction measures (upgrades to process controls, etc.) in the permitted sector are recognized as being key to the success of the Williams Lake Airshed Management Plan.

Recommendations 4 – 8

Suspended dust particles from paved and unpaved roads range in size up to 100 micrometers (μm) in diameter. Particles larger than 10 μm in diameter settle out of the air quite quickly and close to the source. These larger particles can be a nuisance issue for many residents (i.e. soiling vehicles, covering plants, decks, etc.) and they can also induce allergic reactions. Fine particles less than 10 μm (PM_{10} and $PM_{2.5}$) can remain suspended for long periods of time and can travel great distances from the emission source depending on the meteorology. These fine particles have the largest effect on human health as they are inhaled deeply into the lung cavity. Recent health studies have shown that fine particulates, either by themselves or in combination with other air pollutants, have serious human health impacts. From a dust perspective, consultants and researchers (Bates, Koenig, and Brauer, 2003) have indicated that pure crustal material (e.g. wind blown dust from exposed bluffs, agricultural tilling, etc.) is inert. However, fine material from roadways can become contaminated with metals and hydrocarbons emitted from vehicle exhaust. These particles are more of a health concern as any contaminants adhering to the particles are transferred directly to our lungs.

Several lines of evidence from the air quality assessment for Williams Lake point to paved and unpaved road dust emissions, and to fugitive dust emissions from industrial operations (particularly near the Lake outlet industrial area) as being major contributors to PM_{10} and to some extent, $PM_{2.5}$.

The year 2000 emissions inventory for the Williams Lake airshed indicates that the largest contributors to PM_{10} loading (see *Inventory of Common Air Contaminants Emitted in the Williams Lake Airshed for the Year 2000* (Plain, 2002)) are *Permitted Sources* at 46% of the total, and *Road Dust* (paved and unpaved surfaces) at 47% of the total. Road dust also accounts for 26% of the total $PM_{2.5}$ loading in the airshed.

While there are uncertainties associated with the calculation of road dust emissions in this inventory, it is evident that effective control of this source will have a positive impact on ambient fine particulate matter values, and in particular PM_{10}.

Two pollutants are monitored in the Williams Lake airshed that gives us a measure of dust impacts in an area: PM_{10}, and $PM_{2.5}$ (see *Williams Lake Airshed Management Planning Background Air Quality Report*). PM_{10} is a measure of particles in the air that are less than 10 micrometers in diameter, and $PM_{2.5}$ is a subset of PM_{10} that measures the mass of particles less than 2.5 micrometers in diameter. Studies show that road dust particle contributions to PM_{10} tend to be concentrated in the "coarse fraction" of PM_{10} (i.e. dominant particle sizes of between 2.5 and 10 microns in diameter). Particle speciation studies across Canada and the United States indicate that soil and road dust particles can contribute up to a **maximum of 5-10% of the $PM_{2.5}$ mass** under conditions when dust is the primary source of particles in an area (Brook et al 2001).

Seasonal trends are apparent at all PM_{10} monitoring locations in the Williams Lake airshed. The highest monthly concentrations (and the highest number of provincial objective exceedances when $PM_{10} > 50\ \mu g/m^3$) typically occur in the late winter/early spring while the lowest concentrations are measured in December or January. The low winter values recorded at all monitoring sites occur when a large portion of the coarse fraction of PM_{10} (e.g. road dust) is bound up in ice and snow and photochemical activity and vegetative emissions are at an annual low. It is the coarse component of PM_{10} that is responsible for the large values experienced in the early spring. These particles are largely attributable to road dust being re-entrained by passing vehicles. Material that has been placed on the roads during the winter months (e.g. traction material, debris falling from logging trucks, etc.), is ground up under the weight of passing vehicles and the fine material becomes available for re-entrainment by passing motorists once the ice and snow melts in the early spring. Note that PM_{10} values begin to decrease once the roads have been cleaned.

Further evidence of road dust impacts during non-winter months comes from the analysis of continuous PM_{10} and $PM_{2.5}$ data at three locations in Williams Lake (collocated monitors at each site). This analysis indicates that there is a larger coarse PM_{10} component during the late winter/early spring months than in other months. The coarse component of PM_{10}, largely attributable to road dust, is also relatively high during the other non-winter months. Again, it is the coarse component of PM_{10} that is responsible for the elevated PM_{10} values experienced in the early spring. Reductions in the coarse fraction of $PM_{10,}$ namely dust control, will play a large role in reducing PM_{10} levels in the airshed.

Springtime wind blown dust from the Glendale industrial area contributes to elevated PM_{10} levels throughout the community.

The results from the Williams Lake airshed dispersion modelling exercise confirmed that fine particle concentrations in the downtown core result from emissions from all sectors. However, road dust has a large impact on PM_{10} concentrations in this area. Dispersion modelling predictions indicate that road dust can account for as much as 44% of the PM_{10} mass recorded at the downtown monitoring site. Modelling also confirms that road dust has a large affect on PM_{10} concentrations throughout the airshed (see *CALPUFF Modelling for the Williams Lake Airshed; and Fine Particulate Source Apportionment Update for the Williams Lake Airshed Based on CALPUFF Modelling*).

The air quality assessment indicated that focusing on the late winter/early spring PM_{10} peaks will reduce annual average values and exceedances of the provincial air quality objective. Indications are that targeting winter traction material application and the timely clean up of the material in the late winter/early spring months will be effective in reducing these peaks. From a health perspective, this material has the largest potential to become contaminated with metals and hydrocarbons as it remains on the road for the entire winter period.

Initial experiments with cleaner, coarser traction material in the downtown area of Quesnel from 2001 to 2003 appear to have helped reduce spring time dust levels in that community. Similar success stories have been reported from Prince George, BC where washed, crushed aggregate has been used for the past five years in the downtown area instead of the traditional road sand. Note that material selection is only one part of the solution in any part of the city. Innovative solutions to further reduce the amount of material placed on roadways/parking lots combined with timelier cleanup of the material in the early spring are also required. Types of things that have been successfully applied in other jurisdictions include de-icing and anti-icing programs, cleaner/coarser traction materials (including washed crushed aggregate), and different street sweeping strategies and technologies. For instance, in Prince George, street sweeping begins earlier in the season as magnesium chloride is used as the wetting agent instead of water thus eliminating the freezing hazard. Magnesium chloride has the added benefit of suppressing dust in any material that remains on the road until the next road cleaning occurs. Many of these techniques are outlined in a Ministry of Environment "Best Management Practices" document that was developed to help local governments, planners and road-maintenance crews (Ministry of Water, Land, and Air Protection, 2005).

Tracking of mud from unpaved areas onto main paved roads is another issue that needs to be addressed in Williams Lake. This is particularly important in the lake outlet industrial area where material is tracked from log yards and other unpaved areas onto Highway 20 and South Lakeside Drive. However, there are also unpaved commercial lots and alleyways in the downtown area that add to the tracking problem. Once this tracked out material dries, it becomes available for re-entrainment by passing motorists.

Soil material being tracked from an unpaved roadway to a paved surface contributes to elevated PM_{10} values in Williams Lake.

Local businesses need to examine options to manage the tracking of material onto paved arterials, and fugitive dust emissions from log yards and haul roads. Some options include hard-surfacing (e.g. paving, seal coating, etc.) entire problem yards, hard-surfacing (and maintaining) the last 30-50 meters of unpaved haul roads and access roads adjacent to a paved connector road, dust suppressants, road fabrics, and tire washes or rumble strips. Many unpaved roads in the area are primarily composed of native material (dirt). Resurfacing these roads using road bed materials that contain fewer fines is something else that could be examined to reduce track-out and to minimize dust generation. In addition, the incorporation of solid dust suppressants and/or road fabrics right into the surface material has also been found to be effective. In addition, the City should consider a bylaw that requires building contractors to clean up any material that is tracked from an unpaved job site onto a paved surface.

Unpaved road dust from a local mill haul road.

Very few unpaved roads remain in the valley bottom area. However, significant amounts of dust can be generated if the remaining roads are not maintained properly. It is suggested that dust suppressants and/or hard surfacing be examined as a way to minimize dust from sources such as these. However, many of these roadways are privately owned and therefore dust control and road maintenance are not under the control of the City, CRD, or Ministry of Transportation. In an effort to encourage such landowners to control dust, it is recommended that the Williams Lake Air Quality Roundtable provide information on choosing and applying dust control techniques that are both appropriate and cost effective. In addition, the City should consider adopting a bylaw that requires maintenance of private unpaved roadways and parking lots in such a manner as to reduce or eliminate dust generation from such a roadway or parking lot. This bylaw could consider such things as specifying minimum standards for winter traction material size and cleanliness, and requiring dust suppression or hard-surfacing in problem areas.

Another source of spring time dust is paved parking lot cleaning. This source can be managed through the application of cleaner, coarser winter traction material, combined with an early clean up of the material in the spring. Any sweeping that is done must incorporate pre-wetting of the surface to minimize dust. The pre-wetting agent could be an anti-icing compound such as magnesium chloride, to allow for earlier clean-up. Alternatively, a vacuum truck could be used instead of a standard brush sweeper. Educating private lot owners and private sweeping companies would be a good first step. The City could also consider a bylaw that specifies minimum standards for winter traction material size and cleanliness, requires aggressive timely cleanup of the material in the spring, and requires dust control throughout non-winter months (keeping lots clean, etc.).

Winter traction material accumulated on a parking lot in Williams Lake.

Recommendation 9

Based on current research, health officials have stated that fine particulates from combustion-type sources pose a greater risk to human health than those particles formed from non-combustion type sources (i.e. natural dust). Combustion sources generally produce fine particles less than

2.5 micrometers in diameter ($PM_{2.5}$). When inhaled, these fine particles are capable of penetrating to the deepest parts of our lungs, and can have far reaching effects on health.

The current BC air quality objective for fine particulates is based on 24-hour measurements of particles less than 10 micrometers in diameter (PM_{10}). The provincial Level B objective for PM_{10} is 50 $\mu g/m^3$. Note that PM_{10} includes the $PM_{2.5}$ subset but that it is generally the coarse fraction (particles between 2.5 and 10 micrometers in diameter) that drives the PM_{10} values above the objective level. This is because coarser particles are heavier than finer ones. However, it is the $PM_{2.5}$ particles that are most responsible for health effects and for visibility degradation (urban smog).

It has been determined that 24-hour $PM_{2.5}$ levels greater than 20 $\mu g/m^3$ creates a situation where vistas are visibly degraded in the Williams Lake airshed. Under these conditions, the public perceives the air quality as POOR even though the total PM_{10} levels may be well below 50 $\mu g/m^3$ and an air quality advisory would not be issued. This has occurred in the past during the winter months when dust (the coarse component of PM_{10}) is bound up in ice and snow and $PM_{2.5}$ emissions (e.g. smoke) are dominant but not sufficient by themselves to push the total PM_{10} level over the 50 $\mu g/m^3$ plateau. When $PM_{2.5}$ levels reach 20 $\mu g/m^3$ it is recommended than a burning advisory be issued to inform the public of the degraded conditions and to voluntarily curtail emissions from open burning and wood burning appliances. When $PM_{2.5}$ levels reach 25 $\mu g/m^3$, it is recommended that mandatory actions be required. By requiring mandatory actions at this level we may be able to avoid a situation where air quality deteriorates further and an air quality advisory needs to be issued. By managing episodes in this manner, long term exposure to $PM_{2.5}$ should be reduced.

Recommendations 10-11

Open burning of material, whether it is smaller scale backyard burning of leaves and grass or open burning of larger land-clearing debris piles or agricultural areas, covers a wide range of potential ambient and health impacts. These impacts depend on such things as the proximity of the burn to populated areas, the volume and moisture content of the material being burned, the type of material being burned, and meteorological conditions.

Smoke from open burning contains a wide variety of pollutants that can have an adverse impact on public health. Of particular concern are fine particulates less than 2.5 microns in diameter ($PM_{2.5}$) as these particles are thought to have the largest effect on human health (see *Williams Lake Airshed Management Planning Background Air Quality Report*). Many of the other compounds found in wood smoke can be classified as carcinogens or mutagens (or both, in some cases). Infants, children, pregnant women, senior citizens, and all those suffering from impaired lungs or heart or lung disease are at a greater risk of being affected by wood smoke. Also, from an aesthetic point of view, the $PM_{2.5}$ emitted from vegetative burning can reduce visibility, especially in the fall and winter months during temperature inversions when emissions become trapped in the valley.

Open burning during winter months and its effects on visibility.

The 2000 emissions inventory for Williams Lake indicates that emissions from open burning, agricultural burning, and backyard burning, makes up a relatively small portion (roughly 2%) of the total $PM_{2.5}$ emissions discharged into the Williams Lake airshed from all sources. However, the location of the smaller burns and the nature of the emissions can create poor air quality in the vicinity of people's homes (neighbourhood scale vs. airshed scale) and as such, these sources need to be managed in such a fashion as to minimize impacts on human health. For more information, refer to the *Inventory of Common Air Contaminants Emitted in the Williams Lake Airshed for the Year 2000* (Plain, 2002).

Open burns larger than two meters wide by three meters high and those classified as land clearing and forest harvesting type burns tend to be longer in duration and load more pollutants to the atmosphere than smaller burns. These larger burns are regulated by the Open Burning Smoke Control Regulation (MWLAP B.C. Reg. 145/93) which prescribes where, when, and how these fires are to be initiated and controlled. In contrast, smaller backyard fires that are lit in residential areas outside of Williams Lake city limits are not regulated. These smaller fires, whether lit in a burn barrel or right on the ground, may not produce as much smoke as a large slash burn but they take place right where people live - and breathe. As a result, residents are often caught in the smoke plume before it's been diluted and they're exposed to high concentrations of pollutants.

Backyard burning can expose nearby residents to high levels of pollutants.

The nature of backyard burning itself also contributes to the smoke problem. Often, people burn wet materials (e.g. grass or leaves) or starve the fire of oxygen, producing a very smoky fire. Even worse, residents may add materials like painted wood, plastics and rubber that should never be burned because they release additional toxic substances. These types of activities may be addressed through public information programs. Another type of backyard burning includes the burning of household garbage. This is something that is unnecessary and dangerous to the health of local residents, as these types of fires also release additional toxic substances such as dioxins and furans. There is no reason for these types of burns to be occurring in the Williams Lake area. Garbage pickup is available in most areas of the airshed or residents can take their garbage to the local transfer station or landfill free of charge. This type of activity should be banned.

As backyard burning is unregulated outside of the Williams Lake city limits, it can occur at any time of the day. Typically, these types of burns occur under unfavourable meteorological conditions for smoke dispersion (e.g. under calm conditions in the evening hours for instance). As discussed above, the neighbourhood scale air pollution resulting from the smoke these fires can generate is significant. In addition, it has been suggested that down slope drainage winds in the evening hours may transport fine particulates from sources on the hillsides (e.g. such as smoke from residential woodstoves and backyard burning) into the valley bottom area where they build-up in the morning inversion layer and contribute to degraded air quality in the downtown area (see *Williams Lake Airshed Management Planning Background Air Quality Report*). Local air quality and public health would benefit by restricting or banning these types of activities in and around populated areas. Computer dispersion modelling indicates that up to 5% of the $PM_{2.5}$ mass recorded at ambient monitoring sites can be attributable to open burning impacts. These impacts include smoke from agricultural field burning which is also unregulated and which can also occur under variable weather conditions. Based on the above, it is evident that control of smoke from open burning, agricultural burning, and backyard burning activities in the Williams Lake airshed needs to be addressed in this plan.

One way to reduce impacts from backyard and open burning is to reduce the amount of material that is burned in the airshed. This can be accomplished by chipping/composting yard and garden residues onsite, or by delivering the compostable materials to the Central Cariboo Transfer Station and Landfill site. Woody debris from land-clearing operations can be chipped or hogged and the material used as mulch. Alternatively, this material can also be taken to the landfill for proper disposal.

Another way to reduce impacts is to ensure that materials that are burned are only burned under favourable atmospheric venting conditions. Under the conditions of the Open Burning Smoke Control Regulation (OBSCR), burning of piles greater than two meters wide by three meters high can only occur under Good venting conditions near populated areas. It is proposed that all types of burning within the airshed boundaries be restricted to periods of good atmospheric venting as defined by the OBSCR **– as a minimum**. This will ensure that the smoke from smaller fires that may only last for one to four hours is adequately dispersed. A defined burning window may also be appropriate to discourage individuals from burning small piles during the evening hours. It is also proposed that the prohibited materials list from the OBSCR (see *B.C. Reg. 145/93 Schedule A)* be adopted in any bylaw that is drafted. This would eliminate the burning of domestic refuse, and other materials that produce toxics when burned. If it is desirable to further restrict open burning of material piles larger than two meters wide by three meters high, the smoke management plan for the Central Cariboo Forest District can be revised to include a new sensitivity class for the Williams Lake airshed and more stringent conditions developed for that classification (e.g. pile size limits, number of piles ignited, venting conditions, special event days etc.).

It is also proposed that all open burning activities be banned (mandatory) during air quality advisories, or during periods when $PM_{2.5}$ levels have accumulated to the point where 24-hour levels exceed 25 $\mu g/m^3$ (a Stage II Burning Advisory). During a Stage I Burning Advisory, a voluntary burn ban will be in place where residents and commercial\industrial operators will be asked not to open burn as a proactive measure.

Recommendation 12

Domestic wood fired boilers are outdoor heating units that consist of a large firebox surrounded by a water jacket and contained within a weather resistant enclosure. The heated water is pumped into the house and other buildings and then transferred into heat. Outdoor boilers can be the right heating solution when there are multiple buildings to heat, and when there are no neighbours living nearby. However, these heating units can be a serious problem in urban areas since their technology does not allow for efficient combustion on a consistent basis. This typically results in a large amount of smoke being discharged, compromising the health of neighbouring residents and further degrading air quality.

There are several reasons why most outdoor boilers are noted for their excessive smoke. For complete combustion of wood to take place, the firebox must reach temperatures of nearly 1000°F (or 540°C). In outdoor boilers, the water jacket surrounding the firebox prevents temperatures from reaching that level, thereby making complete combustion nearly impossible.

Another reason is the cyclical operating pattern that is used, which causes the firebox to heat up and cool down according to the heating demands. During the off cycles the fire smoulders, which causes creosote to form on the cold internal surfaces. When the thermostat again calls for heat and the fire is rekindled, the creosote clinging to the boiler walls is ignited and a large emission of smoke issues from the stack for about ten minutes before the system settles back into its normal operation. This is often seen when the unit selected is too large for the heat load, and when the unit is used to heat water for domestic use but not to heat buildings during the summer time.

Finally, because the stack height is usually only eight to 10 feet tall (as opposed to regular woodstove chimneys which typically reach 20 or 30 feet), the impact of a wood boiler's emissions is much more localized, creating an unpleasant, smoky environment for neighbours.

Several manufacturers quote "combustion efficiencies" of over 90% for these units which can be misleading to the general public. John Gulland, head of the Wood Heat Organization and author of *A Guide to Residential Wood Heating* states that "the only useful efficiency number for potential buyers is net delivered efficiency, and even then the conditions under which the tests were conducted and the agency that conducted the tests must be known. For example, the results from a universally recognized and government sanctioned test method show that advanced EPA emissions certified stoves have net delivered efficiencies between 60 and 80 percent and that conventional wood stove efficiency is between about 40 and 65 percent."

The smoke caused by the misapplication of outdoor boilers can become a health hazard in residential areas.

In 1998, the EPA sponsored a series of tests of two outdoor boilers that were representative of typical units, which showed efficiencies of approximately 50% when the units were under load. Regarding these tests, John Gulland and the Wood Heat Organization stated that "we don't think the tests were representative of real world conditions because the firewood was dry and the heat losses from the unit itself and its underground piping (estimated to be eight percent by one manufacturer) was not considered. We know of no real tests of units under real conditions, but one can expect the actual delivered efficiency would be considerably lower... than these test results."

Currently, the provincial Solid Fuel Burning Domestic Appliance Regulation (B.C. Reg. 302/94) prohibits the retail sale of non-emissions certified woodstoves in BC. For the past 10 years, the regulation has required that all woodstoves sold in BC be CSA/EPA emissions certified. Unfortunately, this regulation does not apply to central heating systems such as domestic wood fired boilers. However, this does not mean that they should be overlooked. The Solid Fuel Burning Domestic Appliance Regulation sets emission limits at 7.5 grams of combustion particulate per hour (based on the CSA and EPA emission certification levels for non-catalytic wood burning appliances). Based on test results from a recent report released by the North-east States for Coordinated Air Use Management (NESCAUM), the average fine particulate emissions from one outdoor wood-fired boiler are equivalent to the emissions from 22 EPA certified wood stoves, 205 oil furnaces, or as many as 8,000 natural gas furnaces (NESCAUM, 2006).

Although these heating units are relatively new to the Williams Lake area, they are a serious emerging problem because they pose an additional risk to an already compromised state of air quality. In terms of human exposure to wood smoke, the NESCAUM study documented 15-second $PM_{2.5}$ values greater than 1,000 µg/m^3 with spikes greater than 8,000 µg/m^3 throughout the course of normal daily operating modes.

There are many municipalities across Canada that have established bylaws to either ban from city limits or at least regulate the use and installation of outdoor wood boilers. Within BC there are communities that are looking to take similar measures against the proliferation of residential/commercial domestic outdoor wood boilers in their airsheds. The smoke that these boilers produce carries negative health impacts (which have been outlined in previous sections), and is cause for complaint among neighbours, especially in urban areas where lot sizes are small.

John Gulland offers a few comments on outdoor boilers, which have also been taken from the Wood Heat Organization's website (http://www.woodheat.org):

> *"[The] suggestion that outdoor boilers should not be located in populated areas is a good one. We have corresponded with people whose enjoyment of their houses and property has been virtually destroyed by a close neighbor's smoky outdoor boiler. This problem is minimized if the units are located only in rural areas with lots of space between houses."*

> *"In certain situations, mainly when the heating load is big and spread out in two or more buildings, and where there are no close neighbors, the outdoor boiler can be just the right technology. Unfortunately, the technology is all too often crudely executed by the manufacturer and miss-applied by the retailer."*

Wood furnaces are another example of wood burning appliances that are not CSA/EPA emissions certified, and are exempt from provincial regulation. Natural Resources Canada states on their Burn It Smart website (http://www.burnitsmart.org) that "uncertified stoves and fireplaces release 40 to 80 grams of smoke per hour [while] the new EPA-certified stoves produce only 2 to 5 grams of smoke per hour. Increased efficiency also means that they burn up to a third less wood, which means savings in labour and costs." They also mention that "when used properly, new [CSA/EPA emissions] certified wood burning appliances burn so efficiently that they produce virtually no smoke. This means almost no creosote (up to a 90 percent reduction), making them much safer than conventional models." There are moves afoot by the industry to develop a wood furnace that will comply with CSA/EPA emissions certification.

Wood burning appliances that are not CSA/EPA emissions certified are based on old technology. In a comparative study done by Environment Canada and the Hearth Products Association of Canada, EPA emissions certified stoves were found, on average, to release 94% less PM than conventional wood burning appliances (see *Characterization of Organic Compounds from Selected Residential Wood Stoves and Fuels*, p. ii). This clearly demonstrates that the installation of non-CSA/EPA emissions certified wood burning appliances is counterproductive to improving air quality.

Recommendations 13 – 16

The Ministry of Environment conducted a province-wide survey regarding emissions from wood burning appliances in 2003. Of the 451 Williams Lake airshed residents that were surveyed, 119 stated that they used a wood burning appliance within the past year. This means that 26% (+/- 10%, see *Residential Wood Burning Emissions in British Columbia*, pp. 2, 4) of the households in the Williams Lake airshed employ wood burning appliances for heat. According to the emissions inventory for the Williams Lake airshed, residential wood burning appliances contribute 82.5 tonnes of PM_{10} to the airshed each year, which includes 78.4 tonnes per year of $PM_{2.5}$ (see *Inventory of Common Air Contaminants Emitted in the Williams Lake Airshed for the Year 2000* (Plain, 2002)). In terms of total loading, this makes residential wood burning appliances the third largest contributor of $PM_{2.5}$, after permitted sources, and paved road dust.

Ambient monitoring in Williams Lake has shown that $PM_{2.5}$ concentrations are higher in late fall and winter than in spring and summer (see *Williams Lake Airshed Management Planning Background Air Quality Report*), which may be indicative of the influence wood burning appliances have on the airshed, since they are not typically used in the warmer months. Some of the factors which can compound the problem of poor air quality related to wood smoke include poor burning practices, lack of maintenance, improper fuel use, improper installation, and the use of non-EPA emissions certified equipment.

Wood smoke can be a serious nuisance for those people who live beside a residence where improper burning techniques or non-EPA emissions certified equipment is employed. Such nuisances can result in adverse health effects (as described in the background information for open/backyard burning) for the entire neighbourhood if they are not dealt with.

Wood smoke from residential wood stoves can have detrimental effects on community air quality.

Public education plays a vital role in making any nuisance bylaw work. As such, first time offenders should be offered materials that outline the effects of wood smoke on human health and the airshed, and provide tips on how to burn cleaner and more efficiently. This, combined with effective bylaw enforcement, has been shown to minimize the number of second offences done by the same party in other communities such as Kelowna, thus reducing the impacts of wood burning appliances on the airshed and neighbourhood health and comfort (B. Ralph, personal communication, 2004).

Proper burning techniques should result in little or no visible smoke being emitted from the top of a building's chimney. Excess smoke may occur if the operator is: using improper burning techniques, burning wet wood, or burning garbage and noxious materials. It is important to realize that those people who use improper burning techniques may be the cause of complaint whether their wood burning appliance is CSA/EPA emissions certified or not.

A good cord of wood that has been properly seasoned and sheltered from rain and snow will have a moisture content between 18 and 22% (see *A Guide to Residential Wood Heating*). Wet wood will produce more smoke and less heat than dry wood. Also, because of the excess moisture, wet wood may prevent proper combustion from taking place. Moisture content can be measured with a moisture meter which can be obtained at most hardware stores. This type of measurement can be used very effectively as an educational tool by enforcement personnel attending the site of a complaint.

The burning of household garbage, plastics, and other noxious materials is recommended to be banned. Burning these materials is unnecessary and dangerous to the health of local residents, as these types of burning materials also release additional toxic substances such as dioxins and furans. There is no reason for these types of materials to be burned within the Williams Lake area. Garbage pickup is available in most areas of the airshed or residents can take their garbage to the local transfer station or landfill.

Recommendations 17 – 19

Highway 97 and Hwy 20 bring as many as 10,000 vehicles per day (MOT traffic count data August 1997) through the commercial districts of Williams Lake. This number has probably risen over the past few years with the increased truck traffic carrying beetle wood to the local sawmills. This results in congestion and much *stop and go* traffic at stop lights that in turn release a toxic mixture of air contaminants in the valley bottom area.

Emissions from the transportation sector, also known as *mobile sources*, include direct emissions of carbon monoxide (CO), nitrogen oxides (NOx), sulphur oxides (SOx), volatile organic compounds (VOCs), particulate matter ($PM_{2.5}$), and even small amounts of total reduced sulphur compounds related to the catalytic converter process. The *Inventory of Common Air Contaminants Emitted in the Williams Lake Airshed for the Year 2000* (Plain, 2002) indicates that the mobile source sector accounts for 37% of the CO emissions, 24% of the NOx emissions, 17% of the SOx emissions, 9% of the VOC emissions, and 1.5% of the $PM_{2.5}$ emissions. Even though total emissions are small relative to other source types in the airshed, mobile sources can have an effect on air quality as these emissions are released at ground level and they generally disperse poorly. The NOx and VOC emissions are of particular importance as these compounds can contribute to secondary particle and ground-level ozone formation.

Mobile sources of air pollution contribute to $PM_{2.5}$ concentrations in Williams Lake.

The source apportionment exercise (see *Fine Particulate Source Apportionment Update for the Williams Lake Airshed Based on Calpuff Modelling* (Koscher, Schutte, 2005) indicated that mobile sources contribute to air quality degradation in areas adjacent to major traffic corridors. For instance, dispersion modelling indicated that in the Pine Valley area, mobile sources and secondary particles account for roughly 26% of the total predicted ambient $PM_{2.5}$ mass (road dust not included for $PM_{2.5}$). In the downtown area, mobile and secondary particles account for approximately 13% of the $PM_{2.5}$ concentration measured at the CRD/Library monitoring location (road dust not included for $PM_{2.5}$).

Given the focus on health impacts from particles less than 2.5 microns in diameter, it is evident that measures directed at reducing the number of vehicles in the downtown area would result in improvement of air quality. In addition, the California Air Resources Board (CARB) has reviewed all of the epidemiological studies involving exposure to diesel particulate matter (see *Diesel Particulate Matter and Associated Environmental Concerns, Health Risks and Tradeoffs*) and has concluded that diesel particulate is carcinogenic. Diesel emissions from rail and from truck traffic routed through the downtown area contribute to degraded air quality in the area. Some measures to reduce the number of vehicles in the downtown area include re-routing all west bound truck traffic around the city by utilizing the Mackenzie Connector (from Hwy 97) as opposed to using Mackenzie Avenue. Other options include reducing the public's reliance on the personal vehicle by providing alternatives such as bike lanes on all new road ways, and by optimizing public transit.

Road dust contributions from the mobile sector drive the PM_{10} values in Williams Lake – particularly in the spring, but also through most of the non-winter months (see *Williams Lake Airshed Management Planning Background Air Quality Report*). Road dust emissions are less important from a $PM_{2.5}$ perspective. However, recent particle speciation work across Canada indicates that we can generally expect contributions to $PM_{2.5}$ in the neighbourhood of 10% of the mass from paved road dust sources. Again, reductions in traffic volume in the downtown area will have a positive effect on air quality.

The general public should also be encouraged to properly maintain their vehicles and reduce emissions. It is recommended that depending on continued availability of the program, vehicle emissions clinics be held biennially in cooperation with Environment Canada's Let's Drive Green program. At these clinics a free tailpipe emissions test is provided for motorists, along with checks on tire pressure and gas cap seals. The public is also provided with helpful tips on how to keep emission levels low for the life of the vehicle thereby reducing impacts on health and on the environment.

Recommendation 24

The City of Williams Lake should consider joining the Partners for Climate Protection (PCP) initiative of the Federation of Canadian Municipalities. Membership in this voluntary program includes a commitment to undertake five milestones centered about developing and implementing a "Local Action Plan". Other communities such as Quesnel have fully participated in the program leading to the eventual development of a Community Energy Plan (Heap, N. 2003) and the hiring of an energy planner. Energy consumption in the city not only contributes to green house gas production and climate change, but it also links to community air quality through ground level ozone production and fine particulates.

If the City of Williams Lake wishes to pursue this line of action, it is recommended that they contact the City of Quesnel for further information.

Recommendation 25

Public education plays a vital role in the airshed management process, because when it comes down to improving our air quality we are all part of the solution. The public needs to be informed on an ongoing basis of practical ways in which they can help to realize our clean air goals. It is therefore recommended that a wide range of tools be used to educate the public and to help ensure that people of all demographics across the airshed are aware of their role in improving Williams Lake's air quality. It is also recommended that annual status reports be released to the public to raise awareness regarding progress made and any air quality concerns that may persist. Awareness about issues that may require new bylaws down the road, for example, will help residents to understand and comply with the new regulations once they are enacted before enforcement becomes an issue.

Recommendation 26

An information bulletin would help consumers understand why the current technology used in domestic wood fired boilers and wood furnaces do not allow wood to burn efficiently, and why CSA/EPA emissions certified wood burning appliances are a better investment, and release significantly less combustion particulate into the airshed. In such a bulletin, it would be important to distinguish between CSA safety certification and CSA emissions certification. It would also be important to point out what might be an appropriate use of current outdoor domestic wood-fired boiler technology and which applications cause the most problems (e.g. urban areas where lot sizes are small and the demand for heat is small relative to a ranch/greenhouse application in a rural area).

8. APPENDICES

A. Glossary

$\mu g/m^3$ - Micrograms (0.000001 grams) of contaminant per cubic meter of air.

µm – See **Micrometer**.

Air quality episodes - where the ambient air quality objective is exceeded for an extended period of time. These are important from an air quality management perspective. For many air contaminants, including PM_{10} and $PM_{2.5}$, the risk to human health increases with the length of exposure to unacceptable ambient levels.

Airshed – see Williams Lake airshed.

Ambient air – The portion of the atmosphere, external to buildings, to which the general public has access; open air.

Canada-Wide Standard – A) standard for $PM_{2.5}$ of 30 $\mu g/m^3$, based on a 24-hour average, 98^{th} percentile ambient measurement annually, averaged over three consecutive years. **B)** A standard for ground level ozone of 65 ppb, based on the 4^{th} highest annual 8-hour value, averaged over 3 consecutive years.

Carcinogen - a substance that can cause cancer.

CO - Carbon monoxide. Sources include: industrial emissions, automobiles, open burning, and home heating.

CSA – Canadian Standards Association

CSA/EPA emissions certified woodstove – A woodstove that meets the current CSA Standard B415.1-00 or the standard set by the EPA in “40 CFR 60 Subpart AAA – Standards of Performance for Residential Wood Heaters” as amended from time to time.

Dioxins and furans - toxic chemicals that are released when household garbage, plastics, treated wood and other noxious materials are burned.

Dispersion - being scattered or diffused over a large area.

Dustfall - Generally a measure of larger suspended particles that settle out of the atmosphere quickly due to their size (>20 micrometers in diameter).

Emissions inventory - an accounting of air contaminants released into the air for a specific geographic area in order to determine the nature and quantity of substances being released into the atmosphere.

EPA – United States Environmental Protection Agency.

Federal health reference level – 25 µg/m^3 for PM_{10}, and 15 µg/m^3 for $PM_{2.5}$, based on a 24-hour average.

Fine particulate matter - particulate matter that is 10 µm in diameter or smaller. Includes PM_{10} and $PM_{2.5}$.

Ground-level ozone - Ozone that forms in the lower part of the atmosphere. Nitrogen oxides (NOx) and volatile organic compounds (VOCs) react with sunlight and heat to form ozone. Topography and meteorological conditions can promote ozone build-up, which results in smog. For example, cities that lay in the base of a valley may experience visibility degradation due to ground-level ozone, especially on warmer days when the air is stagnant. Ground-level ozone can cause adverse health effects in those who suffer from respiratory diseases.

H_2S – Hydrogen Sulphide. A colourless gas having a characteristic odour of rotten eggs.

Inversion – A meteorological condition in which a layer of warm air resides over a layer of cold air. Pollution is trapped below this warm air resulting in poor air quality over an area.

Micrometer - (µm) 1 µm = 0.001 millimeters (one millionth of a meter).

Micron – see **Micrometer**.

mg/dm^2/day - milligram per decimetre squared per day. The unit used for measuring dustfall.

Mutagen - a substance that can cause a genetic mutation or increases the rate of mutation.

NAAQ – National Ambient Air Quality Objectivies.

NAPS - National Air Pollution Surveillance. A federal schedule in which pollutants are monitored for a 24-hour period (midnight to midnight) once every six days.

NOx - Nitrogen oxides, including nitric oxide and nitrogen dioxide. Sources include: automobiles, industrial emissions, commercial space heating, and land clearing burning emissions. NOx emissions are a precursor to ground-level ozone, and contribute to visibility degradation.

Noxious materials - materials that when burned produce emissions that are harmful to health.

OBSCR - Open Burning Smoke Control Regulation.

Particle speciation - the chemical analysis of a specific air pollutant (e.g. PM_{10}) used to identify the make-up of that pollutant and potential sources.

PM – Particulate matter.

PM_{10} - Fine particulate matter 10 micrometers (µm) or less in diameter. One micrometer is a millionth of a meter. Includes particles that are inhalable into the lungs.

$PM_{2.5}$ - Fine particulate matter 2.5 micrometers (µm) or less in diameter. $PM_{2.5}$ is considered the fine fraction of PM_{10} and is generally made up of combustion source emissions (e.g. wood smoke, vehicle emissions) and secondary particles. This type of particulate matter causes adverse health effects, as it is small enough to enter the deepest parts of the lungs.

ppb - Parts (of contaminant) per billion (parts of air).

ppm - Parts (of contaminant) per million (parts of air).

Provincial Levels A and B Ambient Air Quality Objectives –

Level A objectives are established to provide the basis for an anti-degradation policy for undeveloped areas with an adequate safety margin. For some contaminants, the provincial Level A objectives are equal to the national *Maximum Desirable Level* which is the long term goal for air quality and provides the basis for an anti-degradation policy for unpolluted parts of the country, and for the continuing development of control technology.

Level B objectives are established to provide adequate protection against adverse effects on human health, animals, vegetation, soil, water, materials and visibility. Comparable to the national *Maximum Acceptable Level*.

Re-entrain - to stir up into the air again, as with road dust.

Secondary particles - Particles that are formed from physical and chemical reactions involving gases such as NOx, SOx, ammonia, and VOCs that are emitted into the air (e.g. end products such as sulphates and nitrates). These particles are very fine (smaller than $PM_{2.5}$) and are responsible for visibility degradation.

SOx - Sulphur oxides, including sulphur dioxide and sulphur trioxide.

Stakeholders - Any organization, governmental entity, or individual that has a stake in, contributes to, or may be impacted by the air quality in Williams Lake (e.g. industrial sector, commercial sector, local and provincial government, residents, etc.).

Topography – The physical features of an area, or the shape of the land surface.

TPT – Total particulate. Refers to airborne particles that range in size from 0.001 micrometers (µm) to 100 µm, including PM_{10} and $PM_{2.5}$.

Venting condition - an indicator of the atmosphere's ability to disperse pollutants.

Venting index - a calculated index ranging from "poor" to "good" indicating the atmosphere's ability to disperse pollutants.

VOC – Volatile organic compound. VOCs are gases that are released to the atmosphere from such things as trees & grasses, decomposition of vegetative matter, combustion, industrial processes, and evaporation from liquid petroleum fuel. Natural biological sources are responsible for the majority of VOC releases. However, man-made sources may dominate in urban airsheds. Some VOCs have direct health and environmental effects while others react with other gases in the atmosphere to promote ground-level ozone formation.

Williams Lake airshed - The mass of air contained in Williams Lake and the immediate surrounding communities of the Cariboo Regional District, and particularly that air mass contained and affected by the natural topographical features of the Williams Lake valley. For a map of the airshed see section 3.2.

B. References on the Health Effects of Air Pollution

The references found here pertain to the health effects of air pollution. The documents that were written directly in support of the development of this airshed plan can be found in section 7.1, and references regarding air quality in general can be found in Appendix C.

Bates, D., J. Koenig, and M. Brauer. 2003. *Health and Air Quality 2002 – Phase 1 Methods for Estimating and Applying Relationships Between Air Pollution and Health Effects*. Prepared for the British Columbia Lung Association.

British Columbia. Provincial Health Officer. 2004. *Every Breath You Take…Provincial Health Officer's Annual Report 2003. Air Quality in British Columbia, a Public Health Perspective*. Victoria, BC Ministry of Health Services. http://www.healthservices.gov.bc.ca/pho/pdf/phoannual2003.pdf

Environment Canada. 2001. *Precursor Contributions to Ambient Fine Particulate Matter in Canada*. Meteorological Service of Canada.

Health Canada. 2004. It's *Your Health - Dioxins and Furans*. http://www.hc-sc.gc.ca/english/iyh/environment/dioxins.html

Health Canada. 2004. *It's Your Health - Wood Smoke*. http://www.hc-sc.gc.ca/iyh-vsv/environ/wood-bois_e.html

Health Canada. 2003. *Air Quality and Health Effects of Air Pollution.* http://www.hc-sc.gc.ca/ewh-semt/air/out-ext/effe/health_effects-effets_sante_e.html

Pope, C.A., R.T. Burnett, M.J. Thun, E.E. Calle, D. Krewski, K. Ito, and G.D. Thurston. 2002. *Lung Cancer, Cardiopulmonary Mortality, and Long Term Exposure to Fine Particulate Air Pollution*. JAMA. 287:1132-1141.

SENES Consultants Ltd, Hrebenyk, B., McEwen, B. and D.V. Bates. 2005. Development of Options for a New Provincial $PM_{2.5}$ Air Quality Objective; Summary Report. Prepared for the British Columbia Lung Association. Vancouver, BC. http://www.bc.lung.ca/PM2.5SummaryReport24Mar06.pdf

Vedal, S. 1995. *Health Effects of Inhalable Particles: Implications for British Columbia.* Prepared for the Air Resources Branch, BC Ministry of Environment, Lands and Parks.

C. General References on Air Quality

The references listed here concern air quality in general. The documents that were written directly in support of the development of this airshed plan can be found in section 7.1, and references regarding the health effects of air pollution can be found in Appendix B.

BC Environment. 1992. *No Room to Breathe: Photochemical Smog and Ground-Level Ozone*. A brochure. 8 pages. http://env.gov.bc.ca/air/vehicle/nrtbpsag.html

BC Environment. 2004. *Environmental Management Act: Open Burning Smoke Control Regulation*. B.C. Reg. 145/93. O.C. 481/93. http://www.qp.gov.bc.ca/statreg/reg/E/EnvMgmt/145_93.htm

CEPA/FPAC. 1999. *National Ambient Air Quality Objectives for Particulate Matter. Part 1: Science Assessment Document.* A report by the CEPA/FPAC Working Group on Air Quality Objectives and Guidelines. Health Canada.

Environment Canada. 2002. *Characterization of Organic Compounds from Selected Residential Wood Stoves and Fuels*. Environment Technology Centre. Report ERMD 2000-01.

Environment Canada. 1998. *Ambient Particulate Matter: An Overview*. An information brochure. 16 pages.

Gulland, J. 2002. *A Guide to Residential Wood Heating*. Natural Resources Canada. Cat. No. M92-23/2002E.

Heap, N. 2003. *City of Quesnel Community Energy Planning Options Report*. Prepared for the Community Energy Association by the Pembina Institute and presented to the City of Quesnel by the Community Energy Association.

Levelton Engineering Ltd., Alchemy Consulting Inc., and Dr. D. V. Bates. 2000. *Diesel Particulate Matter and Associated Environmental Concerns, Health Risks and Tradeoffs.* Project: 499-0998.

NESCAUM. 2006. *Assessment of Outdoor Wood-Fired Boilers*. http://www.nescaum.org/documents/assessment-of-outdoor-wood-fired-boilers

Ministry of Environment, Lands, and Parks. 1994. *Fine Particulates... What they are and how they affect us.* A brochure. 12 pages. QP #18701.

Ministry of Water, Land, and Air Protection. 2005. *Best Management Practices to Mitigate Road Dust from Winter Traction Materials.* http://www.env.gov.bc.ca/air/airquality/pdfs/roaddustbmp_june05.pdf

Ministry of Water, Land, and Air Protection. 2004. *Residential Wood Burning Emissions in British Columbia*. http://www.env.gov.bc.ca/air/airquality/pdfs/wood_emissions.pdf

Ralph, B. 2004. Bylaw Enforcement Officer. Regional District of the Central Okanagan. Personal Communication. April 2.

D. Contact Information and Websites

Williams Lake Environmental Society
Bert Groenenberg: Chair - Williams Lake Air Quality Roundtable
(250) 398-7033

City of Williams Lake
(250) 392-1772
http://www.williamslake.ca/

Cariboo Regional District
(250) 392-3351 or 1-800-665-1636
http://www.cariboord.bc.ca

Ministry of Environment
(250) 398-4530
http://wlapwww.gov.bc.ca/car/env_protection/index.html#airshed

Interior Health
http://www.interiorhealth.ca

"We are ALL part of the air quality solution."