Inventory of Common Air Contaminants Emitted in the Williams Lake Airshed For the Year 2000

Prepared for:

Williams Lake Air Quality Roundtable

By

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Glossary of Terms

AP-42	U.S. EPA Compilation of Air Pollutant Emission Factors.
EPA	Environmental Protection Agency.
CO	Carbon monoxide.
NOx	Nitrogen oxides, including nitric oxide and nitrogen dioxide. Reported as nitrogen dioxide equivalent.
SOx	Sulphur oxides, including sulphur dioxide and sulphur trioxide. Reported as sulphur dioxide equivalent.
TRS	Total reduced sulphur, including dimethyl disulphide, dimethyl sulphide, methyl mercaptan, and hydrogen sulphide.
VOCs	Volatile organic compounds, including carbon, but excluding: carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, ammonium carbonate, methane, ethane, methlylene chloride, methyl chloroform, many chlorofluorocarbons, and certain classes of perfluorocarbons.
TP	Total particulate matter, including PM_{10} and $PM_{2.5}$.
PM_{10}	Particulate matter with aerodynamic diameters less than or equal to 10 micrometres. This group can be considered inhalable particulate.
$PM_{2.5}$	Particulate matter with aerodynamic diameters less than or equal to 2.5 micrometres. This group can be referred to as the fine fraction of $PM_{10,}$ or respirable particulate matter.
LDGV	Light duty gasoline powered vehicle (passenger vehicles)
LDGT1	Light trucks (gasoline powered), under 2722 kg (6000 lb.) GVW.
LDGT2	Light trucks (gasoline powered), 2722 kg (6000 lb.) to 3856 kg (8500 lb.) GVW.
HDGV	Trucks and Buses (gasoline powered), over 3856 kg GVW.
LDDV	Light duty diesel powered vehicle (passenger vehicles).
LDDT	Light trucks (diesel powered), under 3856 kg GVW.
HDDV	Heavy duty diesel powered vehicle (trucks and buses) over 3856 kg GVW.
MC	Motor cycles.

1.0 Introduction

This report has been prepared as part of the background information required to prepare an Airshed Management Plan for the City of Williams Lake. In order to develop airshed management strategies for common air pollutants emitted in the Williams Lake Airshed (Figure 1), the completion of a detailed emission inventory is a necessary first step. The emissions inventory values will be used in an airshed dispersion modelling exercise to determine ambient air impacts and to apportion contributions to poor air quality from major sources (Plain and Zirnhelt, 2000).

1.1 Scope of Work

The inventory contained in this report covers the emissions generated within the Williams Lake Airshed, some 19,936 hectares of land (Figure 1). Emission sources were grouped into the following major categories (sources investigated within each category are also summarized):

PERMITTED SOURCES
All point sources in the Williams Lake Airshed that are *Permitted* under the Ministry of Environment's Environmental Management Act to discharge air contaminants.
Permitted sources are 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 Industry, and the Electric Power Systems Industry.
COMMERCIAL SOURCES
Includes 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, Wood-waste Landfills, Bakeries, Asphalt Application, Dry Cleaning, Crematoriums, Metal Degreasing, Printing Inks, Glues Adhesives and Sealants, and Paint Applications.
MOBILE SOURCES
Includes emissions from the following source categories: Aircraft, Marine (boats), Rail (trains), Light Duty Vehicles, Heavy Duty Vehicles, Off-Road Vehicles, Tire and Break Wear, Road Dust from Unpaved Surfaces, and Road Dust from Paved Surfaces.
RESIDENTIAL SOURCES
Includes emissions from the following source categories: Wood Stoves, Backyard Burning, Camp Fires, Tobacco, Barbecues, Natural Gas Heating, Structural Fires, Fuel Oil Heating, LPG Heating, Lawn Equipment, Paint Application, and Consumer Products.
NATURAL SOURCES
Includes VOCs and NOx emissions from Wildfires and Vegetation. Does not include particulate estimates.

The air contaminants selected for this inventory are consistent with those reported in past provincial inventories but are also contaminants of concern in the Williams Lake Airshed. They include Carbon Monoxide (CO), Nitrogen Oxides (NOx), Sulphur Oxides (SOx), Volatile

Organic Compounds (VOCs), Total Particulate Matter (TP), Fine Particulate Matter less than 10 microns in diameter (PM_{10}) and, Fine Particulate Matter less than 2.5 microns in diameter ($PM_{2.5}$).

It should be noted that emissions inventory estimates for TP, PM_{10} and $PM_{2.5}$ are for primary particulates only. Secondary particulate matter, gaseous matter that may eventually convert to particulate matter through atmospheric chemical reactions (i.e. SO_2 to SO_4), is not included.

1.2 Methodology

This Airshed-specific emissions inventory was calculated using the information from the last B.C. provincial emissions inventory (2000) as a baseline. The title of the baseline document is "2000 British Columbia Emissions Inventory of Criteria Air Contaminants" (MOE, 2005). Efforts were then made to update the information in the database to reflect current emissions loading to the Williams Lake Airshed.

Initially, the provincial emissions inventory was scaled down to a Williams Lake Airshed-specific emissions inventory using the Air Contaminant Emissions (ACE) model (Glen, 2001). The ACE model is a Geographic Information Systems (GIS) based tool that can be used to create an area-specific inventory anywhere in B.C.. For the Williams Lake inventory, ACE used the 2000 provincial emissions inventory values as a baseline and then scaled these emissions by applying a Williams Lake Airshed factor (i.e. population or land use ratio) to regional emission estimates for each source category. An ACE data dictionary (Glen and Wakelin, 2001) is available that describes how each part of the baseline provincial emissions inventory is allocated across the province. The values produced by the model were then evaluated by Ministry of Environment (MOE) staff and changes were made where appropriate, based on Williams Lake specific values.

The following sections describe additional data sources, methods, and assumptions used to scale down the 2000 provincial inventory to Williams Lake Airshed values. Some of the limitations are also discussed.

1.2.1 Permitted Sources

The 1995 point source inventory for British Columbia (O'Neil, 1996) and the 2000 inventory (WLAP 2005) were used as the base case for the Permitted Sources section of this inventory. The base data for the permitted source inventory comes from the WASTE system – a large computer database residing on a VAX mainframe system in Victoria. In WASTE, emission totals for each air contaminant are calculated based on discharge permit limits. If the Environmental Management permit does not specify a limit for a specific contaminant, emissions are determined using emission factors for the sources located at each site (WASTE Permit Fees factors and/or USEPA AP-42 factors).

The use of WASTE system permit fees data for inventory purposes is conservative (higher) in most instances. Release estimates are based on permit limits (maximum concentrations and

flows) that are not to be exceeded, and generally do not reflect the average operating conditions of an industrial facility. However, there are instances where an under estimation could also occur for some sources that may operate above prescribed emission limits (i.e. older planer mill cyclones for instance).

Where provided, directly measured emissions data has been incorporated into this inventory. For instance, stack monitoring data was used directly to provide emissions values for particulate, NOx and CO emissions from the TransCanada Williams Lake power plant. Stack monitoring data and operating times were also used to adjust emissions from Gene's Paving. It is anticipated that this inventory will continue to be refined as industry undertakes more direct measurements of their point source discharges.

Other changes to the point source inventory include the removal of sources that are no longer operating (as of the year 2000) in the airshed and the addition of new sources since the original inventory was completed. These changes include the addition of three facilities - Williams Lake Cedar products, Riverside Slater Mountain and Jackpine Engineered Wood Products. In addition, the emissions presented for the veneer dryer source at Weldwood of Canada assume that a wet ESP is in place (installed in 2002). This results in a substantial reduction in particulate emissions from this source. A brief comparison between uncontrolled dryer emissions and controlled dryer emissions is described in the particulate section of this report (Section 2.5).

Table 1 summarizes the permitted sources used in this inventory, along with their respective emissions to the Williams Lake Airshed. Note that in the base case emissions inventory, emissions from some sources were calculated according to more than one source classification code (SCC). This is done to obtain better emission estimates for that source. If more than one SCC code is used for a source, the emission estimates are multiplied by a factor to form a composite value (i.e. if three SCC's are used, each estimate is multiplied by 0.3333 to form a composite sample for that source). One other emission factor change of note included using the AP-42 emission factor of 300 mg/m^3 for Carbon Monoxide instead of the Permit Fee system factor of 1515 mg/m3 for all power boiler sources. This reduction provides more realistic emission estimates when compared to stack monitoring data.

Also note that not all emission sources from permitted sites are included in this summary. There was no attempt to calculate fugitive dust emissions from chip piles as there are no emission factors available for this source type.

1.2.2 Commercial Sources

The report entitled "2000 British Columbia Emissions Inventory of Criteria Air Contaminants: Methods and Calculations" (MOE, 2004) contains the assumptions and emission factors used to calculate emissions from commercial sources. For most commercial source emissions calculated by ACE, a population ratio between Williams Lake and the Cariboo Region as a whole was used to scale down regional emissions to the Williams Lake Airshed level. The population for the City of Williams Lake and for the area encompassed by the Williams Lake Airshed was determined by the ACE model using gridded 1996 census data as provided by Statistics Canada

(1996). Dwelling counts used in the ACE model were obtained in the same manner. The 1996 population for the Williams Lake Airshed was calculated by ACE to be 13,814 people while the number of dwellings was calculated to be 5013. Both of these values appear to be reasonable estimates. An examination of the actual Statistics Canada (1996) census data shows that the population for the City of Williams Lake alone was 10, 472. This allows for population outside of city limits but within the airshed boundaries (Figure 1) of 3,342 people which seems reasonable. No adjustments were made to this population value to reflect the year 2000 as the population statistics from 1996 to 2001 indicate a slight decrease (0.7%). Table 2 summarizes the prorations used to scale down each commercial source category and also lists respective source emissions to the Williams Lake Airshed.

Another ratio used in scaling provincial commercial emissions in the Williams Lake Airshed is the land-use category of an area. The total area (in hectares) for each land-use category was calculated for the Williams Lake Airshed by the ACE model. These total areas were then used to calculate ratios (i.e. Williams Lake Airshed vs. Cariboo Region) for forested lands, agricultural lands, etc and applied to the baseline emissions.

In the baseline inventory, there are estimates for prescribed burning (major forestry/wildlife burns) but a proration method to estimate emissions for the Williams Lake Airshed was not deemed appropriate. Only a small five hectare wildfire was reported within the airshed boundaries in 2000 (Ranson, 2002). Emissions from this burn were calculated according to the methods outlined in Gibson, 1998.

The open-burning of land-clearing debris is prevalent within the airshed boundaries and can contribute significantly to particulate matter loading. As with prescribed burning, scaling of the baseline inventory to estimate emissions for Williams Lake from this source was not deemed appropriate. Instead, emissions from the burning of land clearing debris were calculated by assuming that at least 50 m^3 of material (five 10 m^3 piles) was burned for each reference number issued by the Ministry of Forests (MOF) in the Williams Lake Airshed (Ranson, 2002). The total number of burn reference numbers issued by the MOF within the Williams Lake Airshed in the year 2000 was 32. This yields a total volume of 1600 m^3 of fuel burned. A conversion from volume of material to weight of material was completed using the most conservative conversion factor available (Dobie and Wright, 1992). It was assumed that all the debris was Douglas Fir (highest weight per species) and that there was at least 50% moisture content in the green material. This yielded 1,441.60 tonnes of green material burned in 2000 within the airshed boundaries. The following emission factors provided by Gibson (1998) were then applied to the final weight of the material burned to derive emissions resulting from prescribed burning.

Emission factors for spot/landing (piles) burns - (g/kg)

CO	NOx	SOx	VOCs	CH_4	TP	PM_{10}*	$PM_{2.5}$*
101	1.5	5	4.27	5.7	6	5.94	5.4

*Tests conducted by USEPA indicate that 99% of TP is PM_{10} and 90% of TP is $PM_{2.5}$.

1.2.3 Residential Sources

Methods used to calculate emissions from residential sources are summarized in Gibson (1998) and in MOE (2004). The ACE model scaled down regional emissions from residential sources to Williams Lake Airshed values by using either a ratio based on population or on the number of dwellings. In addition to the ACE estimates, the results of a 2003 provincial woodstove survey (MOE 2004) were used to represent emissions from residential woodstoves.

Table 3 summarizes the proration parameters used by ACE to scale down each residential source category and also lists respective source emissions to the Williams Lake Airshed.

1.2.4 Natural Sources

Assumptions and methods used to calculate provincial emissions from natural sources are summarized in Gibson (1998) and in MOE (2004). These emissions were scaled down to airshed values by using the total area (hectares) of various land-use types (i.e. total forested land, rangeland, etc.) to calculate scaling ratios.

Table 4 summarizes the prorations used by ACE to scale down each natural source category and also lists respective source emissions to the Williams Lake Airshed.

1.2.5 Mobile Sources

Assumptions and methods used to calculate provincial emissions from mobile sources are summarized in Fam (1996) and in MOE (2004). Table 5 summarizes the prorations used by ACE to scale down each mobile source category and also lists respective source emissions to the Williams Lake Airshed. Most mobile emissions were scaled according to a population ratio. The exceptions are described below.

Road dust calculation assumptions were made according to the numbers of each vehicle type in B.C. (Fam, 1996) and the average kilometres travelled by each vehicle type. Vehicle kilometres travelled (VkmT) by each vehicle type for the airshed were calculated by subtracting the VkmT for the lower mainland from the B.C. total. These net values were scaled down to the Williams Lake Airshed by using a population ratio of Williams Lake to the rest of B.C. (less the lower mainland). As in the 1995 baseline inventory, it was then assumed that all vehicle types spent 96.74% of the time on paved roads and 3.26% of the time on unpaved surfaces. The total kilometres travelled by each vehicle type was then multiplied by a snow corrected emission factor (see Fam 1996) to calculate TP, PM_{10} and $PM_{2.5}$. This factor assumes that for 143 days of the year (average period of snowfall cover), dust is not released from paved and unpaved roads. Road dust due to traction material application (results in re-entrained dust following spring thaw) is included in the 3.26% of time representing travel on unpaved surfaces. It was assumed that all paved roads in the airshed behave as unpaved surfaces for 7 days out of the year (2% of the time) to account for spring road dust episodes attributable to traction material application. Table 7 (A, B & C) summarize the results of these road dust calculations by vehicle type.

Williams Lake itself is the only recreational lake within the Williams Lake Airshed boundaries. Therefore the only Marine emissions that were included in this emissions inventory were from recreational vessels, in/outboards, gasoline and diesel (see Table 5). This value is likely conservative as most recreational activity occurs on lakes outside of the airshed.

2.0 Emission Summary

An emission summary for all source categories is presented in Table 6. Emission summaries by parameter are also included graphically in the Appendix of this report. For instance, the major source contributions to Carbon Monoxide are presented in Appendix A. In addition, each major source category is further broken down to reveal the sources within that category that generate the highest atmospheric loading (tonnes/year) of each pollutant.

When interpreting the pie charts, one should also examine the accompanying tables at the top of the page that shows the total loading of the pollutant from those sources. For clarity, sources that have no emissions associated with them (note that this could also be because there were no factors available to calculate emissions when the baseline inventory was compiled) are not included in the pie charts.

2.1 Carbon Monoxide (CO)

Mobile and permitted sources emit the most CO into the Williams Lake Airshed (Appendix A) at 43% and 29% of the total CO loading respectively. Residential sources contribute 23% while commercial sources come in a distant fourth at roughly 5% of the total CO loading to the airshed.

Of the permitted sources, the electric power systems industry emits the greatest share of the carbon monoxide emissions (61%) followed by the softwood veneer and plywood industry (21%) and sawmill and planing mill sector (18%). The power boiler at the TransCanada Power Plant is the largest source of CO in the electric power systems industry while the hog fuelled energy systems emit the largest volume of CO from the other two sectors.

The largest mobile source of carbon monoxide is light duty vehicles (85% of the Mobile sources total). The main residential source of CO is wood stove emissions (93% of the total). Backyard burning contributes significantly less carbon monoxide emissions to the airshed because it is limited to outlying areas (prohibited within city limits) while wood stove use is prevalent throughout the entire airshed. The largest Commercial source of CO is from land clearing burning (94% of the total loading from this category), followed by emissions from space heating and agricultural burning.

2.2 Nitrogen Oxides (NOx)

Of all major source categories, permitted sources emit the most NOx into the Williams Lake Airshed at 934 tonnes per year (74% of the total). The electric power systems industry and the

sawmill and planing mill industry make up nearly 94% of the total NOx emissions from the permitted sector (Appendix B).

Mobile sources emit 17% of the total NOx emissions in the airshed. Rail, light duty vehicles, and heavy duty vehicles account for 91% of these Mobile NOx emissions. Residential sources account for 2% of the nitrogen oxides emissions in the airshed. Space heating (gas and wood) accounts for most of the residential NOx emissions at 93% of the total. Commercial space heating, land clearing burning emissions, and oil and gas distribution make up the bulk of the NOx emissions from the commercial sector.

It should be noted that NOx emissions are important precursors to ground-level ozone formation (smog). NOx can also be converted to secondary particulates such as particulate nitrate. Nitrate particles are very good at scattering visible light and can result in visibility degradation. In addition, NOx gases and secondary particles can enter clouds where they continue to react and eventually rain out as acid deposition.

2.3 Sulphur Oxides (SOx)

Permitted sources dominate as the main source of SOx in the Williams Lake Airshed at 63% (46.3 Tonnes/Year) of the total emissions (Appendix C). Of those emissions, the electric power systems industry is the dominant source at 65% of the permitted loading to the airshed.

Mobile sources contribute 19% (14 T/Y) of the total sulphur oxides emissions to the airshed. Rail, light duty vehicles, and heavy duty vehicles are responsible for over 93% of these mobile SOx emissions. Emissions from land clearing burning and space heating dominate as the main SOx source from the commercial sector, while space heating emissions are foremost in the residential division.

It should be noted that SOx emissions readily convert to secondary sulphate particles that can either deposit to the ground through dry deposition or be rained out of clouds as acid rain (wet deposition). Sulphate particles that remain in the atmosphere are also very good light scatterers and can be responsible for significant visibility impairment (Malm, 2000).

2.4 Volatile Organic Compounds (VOCs)

A large portion of the VOCs emissions come from the permitted sources sector (38%) followed by natural (biogenic emissions) at 28%, residential sources at 15%, mobile at 10%, and commercial sources at 10% of the total loading (Appendix D). The largest permitted sources include the electric power systems industry (TransCanada power boiler) at 58% of the total, the sawmill and planing industry (energy systems, and dry kilns) at 28% of the total, and the softwood veneer and plywood industry (power boilers, veneer dryers) at 14% of the total.

The main source of VOCs from the residential sector is wood stove emissions (73% of the total residential emissions) while light duty vehicle emissions dominate the mobile source category at

80% of the total VOCs emissions from this sector. Commercial sources of VOCs come mainly from the oil and gas industry (refuelling and spills at gas stations), landfills and from paint applications.

2.5 Total Particulate (TP)

Note that secondary particulates are not included in these loading estimates. Total particulate generally includes particles of all diameters (fine particles and coarse particles). From the mobile source category (Appendix E), road dust contributes the majority of TP. Therefore road dust has been broken out separately into paved and unpaved road dust to better understand and illustrate its contribution to overall TP loading to the airshed.

Note that the addition of a wet ESP to the previously uncontrolled dryer stacks at the Weldwood plywood facility has resulted in reductions in TP, PM_{10} and $PM_{2.5}$ of 121.92, 70.69 and 23.16 tonnes per year respectively from this one source.

The following text summary refers to those plots in Appendices E, F and G. These calculations assume that the wet ESP is on-line at Weldwood and is achieving a maximum emission rate of 50 mg/m^3 for particulate matter.

Paved road dust, which includes emissions from wintertime traction material, contributes 57% of the Total Particulate loading to the Williams Lake Airshed followed by permitted sources at 30% and unpaved road dust at 7%. Of the permitted sources, the sawmill and planing mill products industry and the softwood veneer and plywood industry combine to make up roughly 83% of the total emissions from this sector.

Commercial sources contribute 3% (144 T/Y) of the total TP loading to the airshed. Emissions from gravel pits make up the highest TP loading from this category at 62% of the total.

Paved road dust is generated by the grinding action of vehicles of all types travelling over material that has been deposited on the roads by either wind action or directly from vehicles (i.e. wood chips, mud, traction material, etc.). It should be noted that fugitive dust from activities around industrial areas (i.e. log yards) is not accounted for in these calculations. These emissions are likely significant near the Williams Lake outlet and in the Glendale industrial area.

2.6 PM_{10}

The emission factors used in calculating road dust contributions to PM_{10} reflect the fact that mechanical grinding (vehicles travelling over material on the road) primarily results in coarse fraction particles. Permitted sources emit the most PM_{10} (43% of the total loading) into the airshed with paved and unpaved road dust contributions at 38% and 8% respectively (Appendix F). It is evident that more of the permitted source particulate material remains in the fine fraction. The sawmill and planing industry (cyclones and power boilers) and the softwood veneer and plywood industry combined emissions account for over 86% of the permitted PM_{10}

emissions to the airshed. The electric power systems and value added millwork industries contribute roughly 14% to the permitted loading of PM_{10}.

Residential sources are beginning to come more into the picture at 7% of the total airshed PM_{10} loading. The dominant residential source of PM_{10} emissions is space heating with wood stoves at 94% of the total emissions from this sector. It should be noted that although the total residential emissions of PM_{10} are low relative to other sources in the airshed, they occur where people live. Fine particulate emissions from most residential sources stay nearby as they are released close to ground level where dispersion is less effective. In addition, emissions from sources such as wood stoves are released primarily at night, when dispersion is at its worst. As a result these types of emissions may have higher short-term impacts on the residents of local neighbourhoods versus the airshed as a whole.

Again, secondary particulates resulting from chemical conversion of SOx and NOx emissions are not included in PM_{10} loading estimates.

2.7 $PM_{2.5}$

As the particle size fraction that is being examined decreases (e.g. from TP to PM_{10} to $PM_{2.5}$), the industrial sector contributions to total loading increases. The permitted source sector emits the most $PM_{2.5}$ into the Williams Lake Airshed at 55% of the total loading while paved and unpaved road dust contributions drop to 21% and 5% of the total respectively (Appendix G). Combustion sources such as power boilers and kiln heating systems contribute the most $PM_{2.5}$ from the permitted sector.

Residential wood stoves contribute the most from the residential sector which now make up 16% of the total $PM_{2.5}$ loading, while agriculture and land clearing burning account for most of the $PM_{2.5}$ emissions from the commercial sector.

3.0 Conclusions

Permitted sources emit the most SOx, NOx, VOCs, and fine particulate matter (PM_{10} and $PM_{2.5}$) to the Williams Lake Airshed while mobile sources emit the most CO. Road dust contributes the most to total particulate (TP) loading to the airshed.

While there are uncertainties associated with road dust calculations, it is evident that effective control of this source will have a positive impact on ambient particulate matter values. The combined contribution of paved and unpaved road dust to TP, PM_{10} and $PM_{2.5}$ loading to the Williams Lake Airshed is 64%, 46% and 26% respectively.

As evidenced from the total loading of fine particulates to the airshed from permitted sources, management should also be focussed on this area. Secondary particulate formation from NOx also needs to be investigated through dispersion modelling.

4.0 Recommendations

During the next emissions inventory update, it is recommended that the following work be carried out to assist with the refinement of the emission values for the Williams Lake Airshed:

a) Confirm mobile source contributions by:
   - Contacting ICBC to obtain a list of the actual number of vehicles registered in Williams Lake by vehicle type.
   - Obtaining fuel supply and usage statistics from major fuel companies in the airshed.

b) Confirm commercial source contributions by:
   - Determining actual numbers of each commercial source type in the airshed (e.g. restaurants, bakeries, auto body shops, etc.).
   - Obtaining gravel pit production numbers and the crushing methods used at each location.
   - Obtaining updated information from the Ministry of Agriculture on crop types, rotation frequency, pesticide use, and livestock operations in the Williams Lake Airshed.

References

Dobie, J. and D.M. Wright. 1992. *Metric Conversion Factors for Forest Products in Western Canada*. Forintek Canada Corp. Western Forest Products Laboratory. Technical report No. 1 ISSN 0708-6172.

Fam, J. 1996. *1995 British Columbia Inventory of Common Air Contaminants Emitted from Mobile Sources Outside the Lower Fraser Valley*. Ministry of Environment, Lands and Parks. Air Resources Branch Victoria, BC. Revised February 1998.

Glen, A. 2001. *British Columbia GIS Accessible Emissions Inventory Development Air Contaminant Emissions (ACE) Project.* Glencomm Consulting. Prepared for Air & Toxics Control Section, Commercial Chemicals Division, Environmental Protection Branch, Environment Canada, and Air Resources Branch, British Columbia Ministry of Water, Land and Air Protection, Victoria, BC.

Glen, A and T. Wakelin. 2001. *British Columbia GIS Accessible Emissions Inventory Air Contaminant Emissions (ACE) Project. Data Dictionary.* Glencomm Consulting and Air Resources Branch, WLAP, Victoria, BC. Prepared for Air & Toxics Control Section, Commercial Chemicals Division, Environmental Protection Branch, Environment Canada, and Air Resources Branch, British Columbia Ministry of Water, Land and Air Protection, Victoria, BC.

Gibson, R.D. 1998. *British Columbia Inventory of Common Air Contaminants Emitted in 1995 from Miscellaneous Area Sources Outside of the Lower Fraser Valley*. Ministry of Environment, Lands and Parks. Air Resources Branch, Victoria BC.

Jennejohn, D., M. Newburger, K.C. Cheng and J.G. Wilkin. 1996. *1995 Emission Inventory of Agricultural Sources in British Columbia and the Lower Fraser Valley*. Prepared for Environment Canada, B.C. Ministry of Environment, Lands and Parks and the Greater Vancouver Regional District. Levelton Associates.

O'Neil, D. 1996. *British Columbia Inventory of Common Air Contaminants Emitted in 1995 from Point Sources Outside the Lower Fraser Valley.* Ministry of Environment, Lands and Parks. Air Resources Branch, Victoria BC. Revised November, 1996.

Malm, W.C. 2000. *Introduction to Visibility*. National Park Service. Air Resources Division. NPS Visibility Program. Colorado State University. Fort Collins, Colorado, U.S.A.

Plain, E. and N. Zirnhelt. 2000. *Air Monitoring Assessment Strategy for Quesnel BC, 2000-2005*. B.C. Ministry of Environment, Lands and Parks. Cariboo Region.

Ranson, P. 2002. *Personal communications*. Ministry of Forests, Protection Branch. Williams Lake/Horsefly Fire Zone. Williams Lake, BC.

Statistics Canada. *2001 Census Data. Population Statistics and Families and Dwellings statistics for Williams Lake BC*. Extracted on January 8, 2005. http://www.statcan.ca/english/census96/list.htm

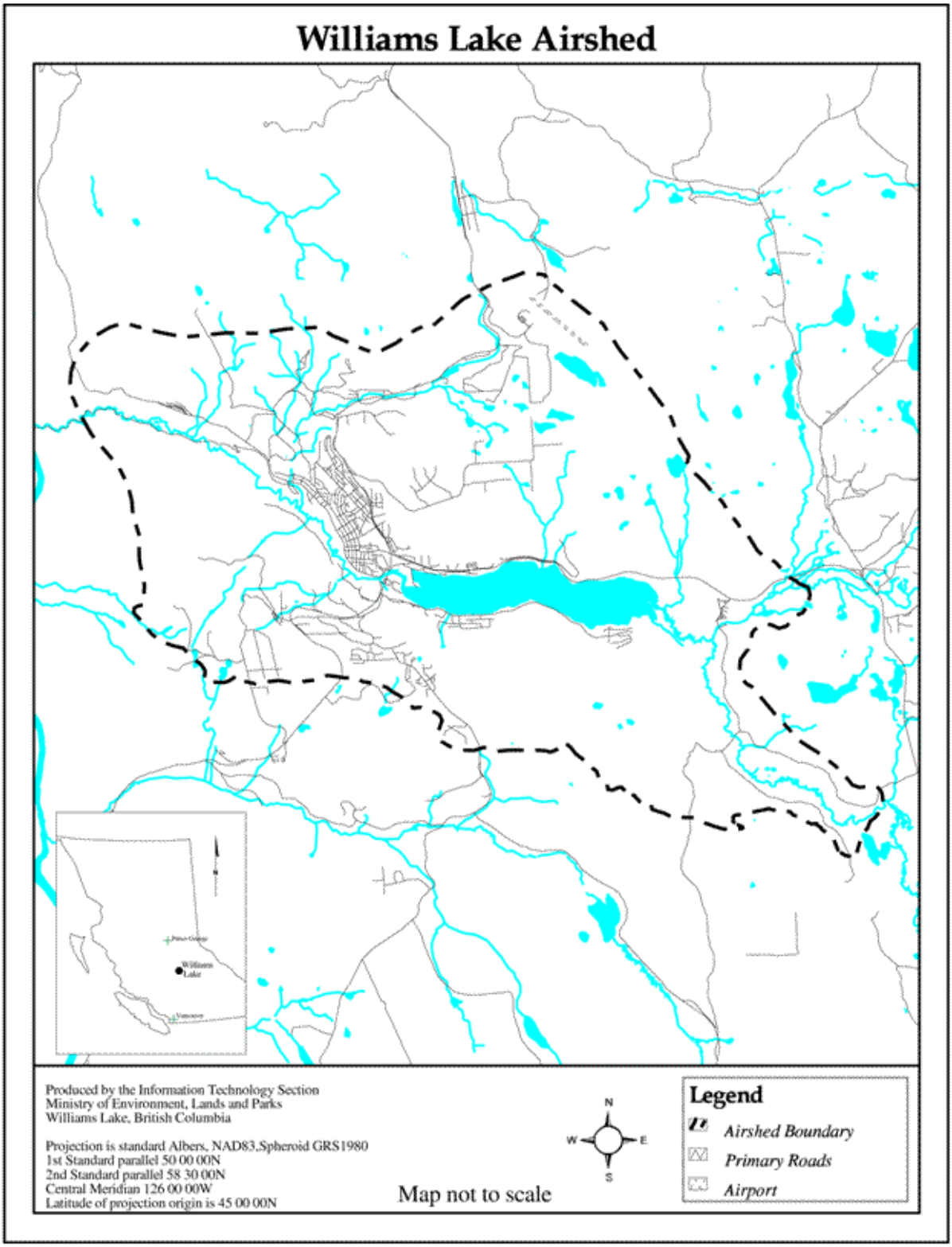
WLAP 2005. *2000 British Columbia Emissions Inventory of Criteria Air Contaminants: Result Highlights.* Ministry of Water, Land and Air Protection, Water, Air and Climate Change Branch, Victoria, BC. Revised June 2005. http://www.env.gov.bc.ca/air/airquality/pdfs/2000_em_inv_highlights.pdf

WLAP 2004. *2000 British Columbia Emissions Inventory of Criteria Air Contaminants: Methods and Calculations*. Ministry of Water, Land and Air Protection, Water, Air and Climate Change Branch Victoria, BC. Revised June 2005. http://www.env.gov.bc.ca/air/airquality/pdfs/2000_inven_rep.pdf

WLAP 2004. *Residential Wood Burning Emissions in British Columbia.* Ministry of Water, Land and Air Protection, Water, Air and Climate Change Branch Victoria, BC. Revised May 17, 2005. http://www.env.gov.bc.ca/air/airquality/pdfs/wood_emissions.pdf

FIGURES

Figure 1. Williams Lake Airshed Boundaries.



TABLES

Table 1. Permitted Source Summary and Respective Emissions to the Williams Lake Airshed (Tonnes/Year).

Permit Number	Client Name	SCC Description	Site Name	CO	NOx	SOx	VOCs	TP	PM_{10}	PM_{25}
1548	West Fraser Mills Ltd.	Sawmill & Planing Mill Industry	Planer Chip Cyclone					2.44	0.98	0.49
1548	West Fraser Mills Ltd.	Sawmill & Planing Mill Industry	9" Sawmill Dust Collection Cyclone					18.68	7.47	3.74
1548	West Fraser Mills Ltd.	Sawmill & Planing Mill Industry	Planer Shavings And Mill Dust Cyclone					75.45	30.18	15.09
1548	West Fraser Mills Ltd.	Sawmill & Planing Mill Industry	Chipper Cyclone					5.19	2.08	1.04
1548	West Fraser Mills Ltd.	Sawmill & Planing Mill Industry	14" Sawmill Dust Cyclone					42.01	16.80	8.40
1548	West Fraser Mills Ltd.	Sawmill & Planing Mill Industry	Sawdust And Shavings Load-out Cyclone					2.44	0.98	0.49
1548	West Fraser Mills Ltd.	Sawmill & Planing Mill Industry	Lumber Dry Kilns	2.131	10.66	0.06	0.56	0.32	0.32	0.32
1548	West Fraser Mills Ltd.	Sawmill & Planing Mill Industry	Lumber Dry Kilns				25.75	77.26	44.81	25.31
1548 Total				2.131	10.66	0.06	26.32	223.79	103.61	54.88
1764	Weldwood Of Canada Limited	Softwood Veneer and Plywood Industry	Plywood Plant Pneumatic Chip Conveyors					7.57	3.027	1.51
1764	Weldwood Of Canada Limited	Softwood Veneer and Plywood Industry	#1 Hog Boiler	100.28	12.90	2.85	32.10	69.01	62.11	52.45
1764	Weldwood Of Canada Limited	Softwood Veneer and Plywood Industry	#2 Hog Boiler	100.28	12.94	2.86	32.19	69.20	62.28	52.59
1764	Weldwood Of Canada Limited	Softwood Veneer and Plywood Industry	Three Steam Heated Veneer Dryers				19.62	31.54	18.29	5.99
1764	Weldwood Of Canada Limited	Softwood Veneer and Plywood Industry	Hog Cyclone					89.43	35.77	17.89
1764	Weldwood Of Canada Limited	Softwood Veneer and Plywood Industry	Co-lathe Sheet Diverter					14.36	5.74	2.87
1764	Weldwood Of Canada Limited	Softwood Veneer and Plywood Industry	Fuel Bin Baghouse					0.65	0.26	0.13
1764	Weldwood Of Canada Limited	Softwood Veneer and Plywood Industry	Pneumatic Chip Transfer System					0.19	0.08	0.04
1764	Weldwood Of Canada Limited	Softwood Veneer and Plywood Industry	99" Saw Cyclone					27.42	10.97	5.48
1764	Weldwood Of Canada Limited	Softwood Veneer and Plywood Industry	#3 Composer Stacker Cyclone					2.94	1.18	0.59
1764	Weldwood Of Canada Limited	Softwood Veneer and Plywood Industry	Chip Plant Cyclone					0.82	0.33	0.16

Permit Number	Client Name	SCC Description	Site Name	CO	NOx	SOx	VOCs	TP	PM_{10}	PM_{25}
1764	Weldwood Of Canada Limited	Softwood Veneer and Plywood Industry	#1 & #2 Composer Chipper Cyclone					13.06	5.22	2.61
1764	Weldwood Of Canada Limited	Softwood Veneer and Plywood Industry	#3 Composer Chipper Cyclone					13.06	5.22	2.61
1764	Weldwood Of Canada Limited	Softwood Veneer and Plywood Industry	Plywood Sander Baghouse					3.82	1.53	0.76
1764	Weldwood Of Canada Limited	Softwood Veneer and Plywood Industry	T & G Cyclone					14.42	5.77	2.88
1764 Total				200.57	25.84	5.71	83.91	357.47	212.02	145.70
2484	Riverside Forest Products (Williams Lake) Limited	Sawmill & Planing Mill Industry	Pneumatic Chip Transfer System					11.47	4.59	2.29
2484	Riverside Forest Products (Williams Lake) Limited	Sawmill & Planing Mill Industry	Three Cyclones					48.59	19.44	9.72
2484	Riverside Forest Products (Williams Lake) Limited	Sawmill & Planing Mill Industry	Planermill Dry Kiln, Item 5				6.45	19.34	11.22	6.34
2484	Riverside Forest Products (Williams Lake) Limited	Sawmill & Planing Mill Industry	Planermill Dry Kiln, Item 5	4.78	23.90	0.14	1.26	0.72	0.42	0.24
2484	Riverside Forest Products (Williams Lake) Limited	Sawmill & Planing Mill Industry	4 Lumber Dry Kilns, Items 6,7,8,& 9	14.75	73.81	0.45	3.90	2.23	1.29	0.42
2484	Riverside Forest Products (Williams Lake) Limited	Sawmill & Planing Mill Industry	4 Lumber Dry Kilns, Items 6,7,8,& 9				32.34	97.02	56.27	18.43
2484	Riverside Forest Products (Williams Lake) Limited	Sawmill & Planing Mill Industry	Two Cyclones, Items 3&4					1.05	0.42	0.21
2484 Total				19.53	97.71	0.59	43.95	180.43	93.65	37.65
3283	Lignum Limited	Sawmill & Planing Mill Industry	Nine Cyclones					42.88	17.15	8.58
3283	Lignum Limited	Sawmill & Planing Mill Industry	Pneumatic Chip Conveyor					10.85	4.34	2.17
3283	Lignum Limited	Sawmill & Planing Mill Industry	Pneumatic Sawdust Conveyor					2.07	0.83	0.41
3283	Lignum Limited	Sawmill & Planing Mill Industry	'Salton' Hot Oil Energy Recovery	113.5	14.65	3.24	36.44	78.34	70.50	59.53
3283	Lignum Limited	Sawmill & Planing Mill Industry	Two "Hot Oil" Lumber Dry Kilns				19.69	59.06	34.25	11.22
3283	Lignum Limited	Sawmill & Planing Mill Industry	Natural Gas Lumber Dry Kiln							
3283	Lignum Limited	Sawmill & Planing Mill Industry	Natural Gas Lumber Dry Kiln	1.96	9.79	0.06	0.52	0.30	0.17	0.056
3283	Lignum Limited	Sawmill & Planing Mill Industry	Natural Gas Lumber Dry Kiln							

Permit Number	Client Name	SCC Description	Site Name	CO	NOx	SOx	VOCs	TP	PM_{10}	PM_{25}
3283	Lignum Limited	Sawmill & Planing Mill Industry	Natural Gas Lumber Dry Kiln				0.25	0.76	0.44	0.14
3283 Total				115.46	24.43	3.2946	56.90	194.25	127.69	82.12
3679	Riverside Forest Products (Williams Lake) Limited	Sawmill & Planing Mill Industry	3 Natural Gas Fired Lumber Dry Kilns	31.56	157.90	0.95	8.34	4.76	2.76	0.91
3679	Riverside Forest Products (Williams Lake) Limited	Sawmill & Planing Mill Industry	3 Natural Gas Fired Lumber Dry Kilns				25.65	76.96	44.64	14.62
3679	Riverside Forest Products (Williams Lake) Limited	Sawmill & Planing Mill Industry	4 Sawmill/Planermill Cyclones					103.72	41.49	20.74
3679 Total				31.56	157.90	0.95	33.99	185.45	88.89	36.27
3849	Gene's Paving W.E. Ball	Other Petroleum & Coal Products industry	Batch Plant Stack	0.71	0.68	5.49	0.53			
3849	Gene's Paving W.E. Ball	Other Petroleum & Coal Products industry	Batch Plant Stack					0.08	0.02	0.00
3849 Total				1.71	0.68	5.49	0.53	0.08	0.02	0.00
7842	Ever-Redi Concrete Products Ltd.	Ready-Mix Concrete Industry	Concrete Batch Plant, Silos					0.01	0.01	0.00
7842 Total								0.01	0.01	0.00
8796	Parallel Wood Products Ltd.	Sawmill & Planing Mill Industry	Sawmill Cyclones					10.54	4.22	2.11
8796 Total								10.54	4.22	2.11
8808	TransCanada	Electric Power Systems Industry	Boiler Stack	589.04	565.98	29.86	338.44	44.94	27.86	23.37
8808 Total				589.04	565.98	29.86	338.44	44.94	27.86	23.37
10984	Jackpine Forest Products Ltd.	Other Millwork Industries	Shavings & Sawdust Collection System					84.63	33.85	16.93
10984	Jackpine Forest Products Ltd.	Other Millwork Industries	Natural Gas Fired Lumber Dry Kiln	6.00	30.03	0.18	1.59	0.91	0.53	0.17
10984	Jackpine Forest Products Ltd.	Other Millwork Industries	Natural Gas Fired Lumber Dry Kiln				2.63	7.88	4.57	1.50
10984 Total				6.00	30.03	0.18	4.21	93.42	38.95	18.60
11536	Cariboo Rewind Ltd.	Other Electrical Industrial Equipment Industries	Burnout Oven (PA11536)					0.37	0.21	0.15

Permit Number	Client Name	SCC Description	Site Name	CO	NOx	SOx	VOCs	TP	PM_{10}	PM_{25}
11536 Total								0.37	0.21	0.15
12255	Ball, Fred And Gery, Jerry	Other Concrete Products Industry	Fred & Jerry's Blocks Cement Blk Drying Kilns	0.03	0.16	0.0	0.01	0.00	0.00	0.00
12255	Ball, Fred And Gery, Jerry	Other Concrete Products Industry	Cement Silo Vent					0.01	0.01	0.01
12255 Total				0.03	0.16	0.00	0.01	0.00	0.00	0.00
12259	Pal Lumber Co. Ltd.	Sawmill & Planing Mill Products Industry	Remanufacturing Plant Cyclone, Mill's NW Cor.					7.83	3.13	1.57
12259 Total								7.83	3.13	1.57
12595	Hill & Sons Custom Planing Ltd.	Other Millwork Industries	Cyclone, PA12595 Hill&Sons					8.06	3.22	1.61
12595 Total								8.06	3.22	1.61
12992	Williams Lake Cedar Products	Sawmill & Planing Mill Products Industry	Three Cyclones					4.60	1.84	1.02
12992	Williams Lake Cedar Products	Sawmill & Planing Mill Products Industry	Two Natural Gas Dry Kilns	4.045	20.24	0.12	0.61	1.07	0.62	0.35
12992	Williams Lake Cedar Products		Two Natural Gas Dry Kilns				0.21	0.64	0.37	0.21
12992 Total				4.05	20.24	0.12	0.82	6.30	2.46	1.37
15512	Riverside Forest Products (Soda Creek)	Sawmill & Planing Mill Products Industry	Cyclones					5.15	2.06	1.03
15512 Total								5.15	2.06	1.03
16134	Jackpine Engineered Wood Products Inc.	Other Millwork Industries	Chipper Cyclone					7.67	3.07	1.53
16134	Jackpine Engineered Wood Products Inc.	Other Millwork Industries	Sawdust Cyclone					47.33	18.93	9.47
16134	Jackpine Engineered Wood Products Inc.	Other Millwork Industries	Planer Cyclone		Not operating in 2000 (planed material brought over from existing plant)					
16134	Jackpine Engineered Wood Products Inc.	Other Millwork Industries	Moulder Cyclone					30.79	12.32	6.16
16134 Total								85.79	34.32	17.16

Note: True zero values have been removed for clarity.
Values shown as 0.0 are between 0.0 and 0.01 T/Y.
Estimates for total emissions are subject to rounding errors, which may result in slight differences between totals.

Table 2. Commercial Source Summary and Emissions to the Williams Lake Airshed (Tonnes/Year).

N/A - Not applicable
NF - no factor provided in original inventory

Emissions Category	Emissions Process	Factor Used	CO (tonnes)	NOx (tonnes)	SOx (tonnes)	VOCs (tonnes)	Part (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)
Agriculture	Cattle	Bagriculture				9.67	11.06	7.03	1.10
	Fertilizer Applied	Bagriculture					0.17	0.08	0.02
	Fugitive Emission Agricultural	Bagriculture					12.38	2.59	0.55
	Horses	Bagriculture				0.30	1.12	0.71	0.11
	Pesticides	Bagriculture				0.36			
	Pesticides Applied	Bagriculture					0.47	0.23	0.07
	Pigs	Bagriculture				0.01	0.05	0.04	0.01
	Poultry	Bagriculture				0.01	0.00	0.00	0.00
	Sheep	Bagriculture				0.11	0.12	0.08	0.01
	Wind Erosion	Bagriculture					9.78	4.89	0.10
Miscellaneous Burning	Agricultural Burning	Bagriculture	3.94	0.14		0.61	0.75	0.75	0.75
Oil and Gas	Loading And Tankage Emissions At Bulk Plants	Bpopulation				12.53			
	Loading And Tankage Emissions At Bulk Terminals	Bpopulation				10.77			
	Natural Gas Ind - Combustion - Distribution	Bpopulation	0.91	1.84		0.02	0.21	0.21	0.21
	Natural Gas Ind - Leaks - Distribution	Bpopulation				5.06			
	Natural Gas Ind - Vents - Distribution	Bpopulation				5.38			
	Tanks, Refueling & Spills At Auto Serv Stations	Bpopulation				37.57			
Other	Bakeries	Bpopulation				0.34			
	Commerical-Light Industrial General Particulate	Bpopulation					2.50	1.44	1.02
	Cut Back Asphalt Application	Bpoprural95				5.61			
	Fugitive Emission Conc/Dem	Bcondem95					0.75	0.16	0.03
	Bio-Med/Cremat/Animal Incineration	Bpopulation	0.02	0.03	0.02	0.00	0.04	0.03	0.02
	Gravel Pits	Bpopulation					89.54	5.10	NF
	Landfills - Woodwaste	Blandfillc				20.06	1.75	0.63	0.17
	Landfills Municipal	Bpopulation				8.24	2.05	0.74	0.20
	Restaurants	Bpopulation					1.23	1.23	1.14
	Welding Shops	Bpopulation					0.97	0.97	0.97
Solvents	Application Of Coatings - Auto Refinishing	Bpopulation				4.57			
	Application Of Coatings - General Industrial	Bpopulation				8.33			

Emissions Category	Emissions Process	Factor Used	CO (tonnes)	NOx (tonnes)	SOx (tonnes)	VOCs (tonnes)	TP (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)
	Dry Cleaning	Bpopulation				1.72			
	Glues Addhesives Sealents	Bpopulation				1.85			
	Metal Degreasing	Bpopulation				6.12			
	Printing Inks	Bpopulation				8.26			
Space Heating	Fuel Oil Comm/Ind	Bheating	0.22	1.13	3.34	0.02	0.32	0.21	0.10
	Lpg Commercial	Bheating	0.18	1.30	0.00	0.03	0.04	0.04	0.04
	Natural Gas Comm/Ind	Bheating	4.29	5.11	0.10	0.28	0.39	0.39	0.39
Other	Land Clearing Burning	MOF Reference Numbers	145.60	2.16	7.21	6.16	8.65	8.56	7.79

Note: True zero values have been removed for clarity.
Values shown as 0.0 are between 0.0 and 0.01 T/Y.
Estimates for total emissions are subject to rounding errors, which may result in slight differences between totals.

Table 3. Residential Source Summary and Respective Emissions to the Williams Lake Airshed (Tonnes/Year).

N/A - Not applicable
NF - no factor provided in original inventory

Emissions Process	Factor Used	CO (tonnes)	NOx (tonnes)	SOx (tonnes)	VOCs (tonnes)	TP (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)
Back Yard Burning	Bpoprural95	19.00	1.36	0.23	6.78	3.62	3.62	3.62
Structural Fires	Bpopulation	0.13	0.00		0.02	0.02	0.02	0.02
Barbecues	Bdwelling95					1.07	1.07	1.07
Tobacco	Bpopulation	0.85	0.02	NF	NF	1.11	1.11	1.11
Application Of Architectural Coatings	Bpopulation				14.23			
Consumer Products	Bpopulation				36.27			
Fuel Wood Residential	Brheating	714.70	12.70	1.90	165.40	122.50	115.60	115.50
Lpg Residential	Bheating	0.07	0.53	0.00	0.01	0.02	0.02	0.02
Natural Gas Residential	Bheating	3.25	7.61	0.16	0.45	0.62	0.62	0.62
Oil Residential	Bheating	0.59	2.12	0.61	0.08	0.20	0.13	0.05
Lawn Equipment	Bdwelling95	18.63	0.19	0.01	2.50	0.06	0.06	0.05

Note: True zero values have been removed for clarity.
Values shown as 0.0 are between 0.0 and 0.01 T/Y.
Estimates for total emissions are subject to rounding errors, which may result in slight differences between totals.

Table 4. Natural Source Summary and Respective Emissions to the Williams Lake Airshed (Tonnes/Year).

Emissions Category	Emissions Process	Factor Used	CO (tonnes)	NOx (tonnes)	SOx (tonnes)	VOCs (tonnes)	TP (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)
Biogenics	Coniferous_Forest	Bforest		0.88		343.06			
	Cropland Region 2	Bagricult2				6.22			
	Deciduous_Forest	Bforest		0.03		11.64			
	Grassland	Brangeland		0.43		1.28			
	Mixed_Wood_Forest	Bforest		0.20		70.67			
	Transitional_Forest	Bforest				0.07			
	Urban Vegetation	Bpopurban95		0.02		0.28			
Wildlifes	Wildfires	Bwild	0.06	0.00	0.00	0.00	0.01	0.01	0.01
Wildlife	Wildlife	Bforest				0.22			

Note: True zero values have been removed for clarity.
Values shown as 0.0 are between 0.0 and 0.01 T/Y.
Estimates for total emissions are subject to rounding errors, which may result in slight differences between totals.

Table 5. Mobile Source Summary and Respective Emissions to the Williams Lake Airshed (Tonnes/Year).

Emissions Process	Factor Used	CO (tonnes)	NOx (tonnes)	SOx (tonnes)	VOCs (tonnes)	TP (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)
Commercial Jets	Bairports	3.21	1.21	0.09	0.91	0.07	0.04	0.03
Commercial Piston	Bairports	33.97	0.02	0.00	0.52	0.44	0.25	0.17
General Aviation Piston	Bairports	2.89	0.01	0.00	0.05	0.01	0.00	0.00
Government-Civil Jets	Bairports	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Helicopters	Bairports	0.21	0.25	0.04	0.25	0.27	0.15	0.11
Military Jets	Bairports	0.04	0.00	0.00	0.03	0.01	0.00	0.00
Private Jets	Bairports	0.21	0.00	0.00	0.02	0.03	0.01	0.01
Turboprop	Bairports	3.26	0.36	0.08	2.30	0.54	0.30	0.21
Hddv, City, Other Vehicle Emissions	Bnonhighway	23.75	28.78	0.45		2.11	2.11	1.88
Hddv, City, Vehicle Hydrocarbons	Bnonhighway				5.03			
Hddv, Highway, Other Vehicle Emissions	Bhighway	13.54	29.32	0.50		2.35	2.35	2.09
Hddv, Highway, Vehicle Hydrocarbons	Bhighway				3.13			
Hdgv, City, Other Vehicle Emissions	Bnonhighway	17.20	1.05	0.05		0.03	0.03	0.02
Hdgv, City, Vehicle Hydrocarbons	Bnonhighway				1.39			

Emissions Process	Factor Used	CO (tonnes)	NOx (tonnes)	SOx (tonnes)	VOCs (tonnes)	TP (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)
Hdgv, Highway, Other Vehicle Emissions	Bhighway	10.18	1.39	0.06		0.04	0.03	0.02
Hdgv, Highway, Vehicle Hydrocarbons	Bhighway				0.78			
Lddt, City, Other Vehicle Emissions	Bnonhighway	0.41	0.39	0.02		0.08	0.08	0.07
Lddt, City, Vehicle Hydrocarbons	Bnonhighway				0.23			
Lddt, Highway, Other Vehicle Emissions	Bhighway	0.12	0.20	0.01		0.04	0.04	0.04
Lddt, Highway, Vehicle Hydrocarbons	Bhighway				0.07			
Lddv, City, Other Vehicle Emissions	Bnonhighway	0.37	0.36	0.02		0.06	0.06	0.06
Lddv, City, Vehicle Hydrocarbons	Bnonhighway				0.16			
Lddv, Highway, Other Vehicle Emssions	Bhighway	0.09	0.15	0.01		0.03	0.03	0.03
Lddv, Highway, Vehicle Hydrocarbons	Bhighway				0.04			
Ldgt1, City, Other Vehicle Emissions	Bnonhighway	233.17	14.51	0.71		0.28	0.27	0.16
Ldgt1, City, Vehicle Hydrocarbons	Bnonhighway				20.92			
Ldgt1, Highway, Other Vehicle Emissions	Bhighway	61.12	7.27	0.33		0.14	0.13	0.08
Ldgt1, Highway, Vehicle Hydrocarbons	Bhighway				6.12			
Ldgt2, City, Other Vehicle Emissions	Bnonhighway	15.97	0.88	0.04		0.02	0.02	0.01
Ldgt2, City, Vehicle Hydrocarbons	Bnonhighway				1.68			
Ldgt2, Highway, Other Vehicle Emissions	Bhighway	7.26	0.74	0.03		0.02	0.01	0.01
Ldgt2, Highway, Vehicle Hydrocarbons	Bhighway				0.79			
Ldgv, City, Other Vehicle Emissions	Bnonhighway	697.43	40.86	1.47		0.81	0.77	0.44
Ldgv, City, Vehicle Hydrocarbons	Bnonhighway				70.54			
Ldgv, Highway, Other Vehicle Emissions	Bhighway	185.72	20.67	0.69		0.39	0.37	0.23
Ldgv, Highway, Vehicle Hydrocarbons	Bhighway				20.35			
Mc, City, Other Vehicle Emissions	Bnonhighway	4.09	0.16	0.01		0.01	0.01	0.00
Mc, City, Vehicle Hydrocarbons	Bnonhighway				0.57			
Mc, Highway, Other Vehicle Emissions	Bhighway	0.78	0.09	0.00		0.00	0.00	0.00
Mc, Highway, Vehicle Hydrocarbons	Bhighway				0.17			
Recreational Vessels, Outboards	Bpopulation	9.72	0.02	0.01	3.25			
Recreational Vessels, Inboards, Gasoline	Bpopulation	0.08	0.01	0.00	0.01			
Recreational Vessels, Inboards, Diesel	Bpopulation	0.01	0.02	0.00	0.01	0.00	0.00	0.00
Recreational Vessels, In/Outboards, Gasoline	Bpopulation	0.41	0.04	0.00	0.03			
Recreational Vessels, In/Outboards, Diesel	Bpopulation	0.03	0.08	0.01	0.04	0.00	0.00	0.00
Off-Road Diesel - Agriculture	Bagricult	3.51	8.76	0.14	1.32	0.95	0.95	0.87
Off-Road Diesel - Construction	Bpopulation	4.30	11.20	0.27	0.95	0.98	0.98	0.90
Off-Road Gasoline - Agriculture	Bagricult	20.79	0.70	0.02	0.79	0.04	0.04	0.04

Emissions Process	Factor Used	CO (tonnes)	NOx (tonnes)	SOx (tonnes)	VOCs (tonnes)	TP (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)
Diesel Line Travel	Brailway	16.98	88.31	6.39	4.42	2.10	2.10	1.93
Diesel Yard Travel	Brailway	6.57	38.50	2.50	2.28	0.93	0.93	0.85
Road Dust, Paved5	See Table 7 A-C					658.12	126.14	30.16
Road Dust, Unpaved5	See Table 7 A-C					119.52	37.71	5.62

Note: True zero values have been removed for clarity. Values shown as 0.0 are between 0.0 and 0.01 T/Y.
Estimates for total emissions are subject to rounding errors, which may result in slight differences between totals.

Table 6. Summary of Emissions from all Sources in the Williams Lake Airshed (Tonnes/Year).

Permitted Source Summary for Williams Lake by Category (T/Y)

	CO	NOx	SOx	VOCs	TP	PM_{10}	PM_{25}
Asphalt Industry	0.71	0.68	5.49	0.53	0.08	0.02	0.01
Electrical Power Systems Industry	589.04	565.98	29.86	338.44	44.94	27.86	23.37
Electrical Industrial Equipment Industries					0.37	0.21	0.15
Ready-Mix Concrete Industry	0.03	0.16	0.00	0.01	0.03	0.02	0.01
Sawmill & Planing Mill Products Industry	172.72	310.95	5.02	161.97	813.74	425.70	216.99
Softwood Veneer and Plywood	200.57	25.84	5.71	83.91	357.47	212.02	145.70
Value added Millwork Industries	6.00	30.03	0.18	4.21	187.27	76.49	37.37
Softwood Veneer and Plywood (actuals)	203.13	38.63	5.79	117.28	639.93	370.41	202.86

Commercial Source Summary for Williams Lake by Category (T/Y)

	CO	NOx	SOx	VOCs	TP	PM_{10}	PM_{25}
OIL and GAS Total	0.91	1.84	0.00	71.33	0.21	0.21	0.21
Restaurants Total					1.23	1.23	1.14
Gravel Pits Total					89.54	5.10	NF
Welding Shops Total					0.97	0.97	0.97
Landfills Total				28.313.79	1.37	0.38	0.07
Construction/Demolition Total					0.75	0.16	0.03
Bakeries Total				0.34			
Light Industrial General Particulate					2.50	1.44	1.02
Asphalt Application Total				5.61			
Dry Cleaning Total				1.72			
Metal Degreasing Total				6.12			

	CO	NOx	SOx	VOCs	TP	PM_{10}	PM_{25}
Printing Inks Total				8.26			
Glues Adhesives Sealants Total				1.85			
Paint Applications Total				12.89			
Space Heating Total	4.69	7.54	3.44	0.33	0.75	0.64	0.53
Land Clearing Burning Total	145.60	2.16	7.21	6.16	8.65	8.56	7.79
Bio-Med/Cremat/Animal Incineration	0.02	0.03	0.02	0.00	0.04	0.03	0.02
Agriculture Total	3.94	0.14	NF	11.07	35.89	16.47	5.25

Mobile Source Summary for Williams Lake by Category (T/Y)

	CO	NOx	SOx	VOCs	TP	PM_{10}	PM_{25}
Aircraft Total	89.32	3.63	0.38	6.73	2.11	2.07	2.03
Heavy Duty Vehicles Total	64.66	60.55	1.06	10.34	4.53	4.52	4.01
Light Duty Vehicles Total	1206.53	86.28	3.35	121.65	1.88	1.81	1.13
Marine Total	10.25	0.17	0.02	3.33	0.00	0.00	0.00
Off Road Total	28.59	20.66	0.43	3.06	1.97	1.97	1.81
Rail Total	23.56	126.81	8.89	6.70	3.03	3.03	2.79
Road Dust Paved Total					2710.96	650.12	161.45
Road Dust Unpaved Total					318.86	143.48	37.85

Residential Source Summary for Williams Lake by Category (T/Y)

	CO	NOx	SOx	VOCs	TP	PM_{10}	PM_{25}
Back Yard Burning	19.00	1.36	0.23	6.78	3.62	3.62	3.62
Structural Fires	1.93	0.05	0.00	0.16	0.12	0.12	0.11
Barbecues					1.07	1.07	1.07
Tobacco	0.85	0.02	NF	NF	1.11	1.11	1.11
Home Heating Nat Gas/LPG/Oil	3.91	10.26	0.77	0.54	0.83	0.76	0.68
Wood Stoves Residential	714.70	12.70	1.90	165.41	122.50	115.60	115.50
Lawn Equipment	18.63	0.19	0.01	2.50	0.06	0.06	0.05
Paint Applications				14.23			
Consumer Products				36.27			

Natural Source Summary for Williams Lake by Category (T/Y)

	CO	NOx	SOx	VOCs	TP	PM_{10}	PM_{25}
All Natural Sources	0.06	1.57	0.00	433.43	0.01	0.01	0.01

Note: True zero values have been removed for clarity.

Values shown as 0.0 are between 0.0 and 0.01 T/Y.
Estimates for total emissions are subject to rounding errors, which may result in slight differences between totals.

Table 7a. Williams Lake Airshed Mobile Source Vehicle Kilometer Traveled (VkmT) Calculations.

Vehicle type	No. of Vehicles BC	km/vehicle	VkmT X10^6	LFV Totals VkmT X10^6	Net Province VkmT X 10^6	VkmT X 10^6 Cariboo Region	VkmT Williams Lake Airshed
LDGV	1,390,111	16,948	23,560	10105	13455	578.565	109143677.4
LDGT1	461,505	17,422	8,040	3078	4962	213.366	40250533.42
LDGT2	66,902	17,422	1,166	871	295	12.685	2392968.029
HDGV	16,174	15,506	251	53	198	8.514	1606127.694
MC	60,458	3,223	195	83	112	4.816	908516.6753
LDDV	15,518	16,948	263	112	151	6.493	1224875.16
LDDT	12,159	23,588	287	124	163	7.009	1322216.233
HDDV	32,272	87,465	2,823	629	2194	94.342	17797192.73
Total	2,055,099	198,522	36,584	15,055	21,530	926	174,646,107

Table 7b. Williams Lake Airshed Road Dust Calculations (emissions in T/Y).

	Paved Surfaces (96.74 % of time)			Unpaved Surfaces (1.26% of time)			Winter sanding (paved surfaces assumed unpaved for 7 days or 2% of the time)		
	TSP	**PM_{10}**	**$PM_{2.5}$**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**TSP**	**PM_{10}**	**$PM_{2.5}$**
LDGV	1378	264	63	199	90	24	316	142	38
LDGT1	508	97	23	73	33	9	117	52	14
LDGT2	30	6	1	4	2	1	7	3	1
HDGV	20	4	1	3	1	0	5	2	1
MC	11	2	1	2	1	0	3	1	0
LDDV	15	3	1	2	1	0	4	2	0
LDDT	17	3	1	2	1	0	4	2	0
HDDV	225	43	10	32	15	4	52	23	6
Total Williams Lake Airshed	**2205**	**422**	**101**	**319**	**143**	**38**	**506**	**228**	**60**

Table 7c. Summary of Road Dust Emission Estimates for the Williams Lake Airshed (T/Y).

Totals with winter traction material included for Paved surfaces.	Paved Surfaces			Unpaved Surfaces		
	TSP	**PM_{10}**	**$PM_{2.5}$**	**TSP**	**PM_{10}**	**$PM_{2.5}$**
	2711	650	161	319	143	38