WCAS

annual report

2000

West Central Airshed Society

Contents

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Executive Summary

The year 2000 marks the sixth year of successful operation for the West Central Airshed Society (WCAS). Once again, the Society's goal of collecting high quality data through its various monitoring programs during this time has played a key role in improving the understanding of air quality of the zone. The year 2000 brought with it many new challenges that were met with innovative business restructuring. A business plan designed to lower costs while improving performance, communications, and operation controls was approved in November and will be implemented in early 2001.

WCAS started the new millennium by enhancing the continuous monitoring program. This was driven by an effort to keep costs in line with previous years. Soon into the New Year, Mr. Eric Peake announced his intentions to retire. The Board convinced Eric to stay on in a half time capacity as a technical manager until May 2001 and contracted Bob Scotten to take on the program management duties.

WCAS faced a major economic challenge as Canadian National Railway, an active member for five years, withdrew its membership and funding of forty seven thousand dollars per year. On the up side, the Parkland Airshed has indicated they will provide a contribution of twelve thousand dollars in 2001 for their use of data from the Hightower Ridge background air-monitoring station. Alberta Environment who also uses the Hightower Ridge station data has been approached to provide funding. Discussions with Alberta Environment are encouraging, with a possibility of some cost offsetting coming in 2001.

In July a new permanent office was established in Drayton Valley. Penn West Petroleum donated this facility through to the end of December 2000. The business plan approved in November included the leasing of office space and a shop in Drayton Valley. Again this is designed to lower mileage costs and improve control of operations.

The WCAS air-monitoring program is based on the collection of data continuously monitored at five locations strategically placed across the region. Data is collected and stored using one-minute averages, five-minute averages and one-hour averages. This program is based on the standards as set out by Alberta Environment.

Air quality monitoring in the West Central region was similar in 2000 to that recorded in 1999. Average SO_2 concentrations were within 0.2 parts per billion (ppb) of the 1999 values at the Carrot Creek, Tomahawk, and Violet Grove sites. The mean annual concentration of NO_2 was lower than averages recorded in 1999 for Carrot Creek, Tomahawk, and Violet Grove. Atmospheric concentrations of total hydrocarbons were monitored at the Violet Grove site for nine months in 2000. The average concentration was recorded at 2.3 parts per million (ppm), a slight increase over averages for the past four years. During 2000 continuous PM_{10} monitors were installed at the Tomahawk and Steeper monitoring sites. In addition, continuous $PM_{2.5}$ monitors were placed at the Tomahawk and Hightower Ridge sites. The monitored results in Tomahawk indicated an average of 10.3 ug/m^3 and 4.9 ug/m^3 for PM_{10} and $PM_{2.5}$ respectively. Average $PM_{2.5}$ concentrations at Hightower Ridge were 2.7 ug/m^3. PM_{10} concentrations averaged 5.4 ug/m^3 as compared to 8.6 ug/m^3 at the Steeper location.

The bio-monitoring program was challenged by extreme wet weather during the months of May, June and July. Our agricultural contractors worked diligently in mud and water for the entire season. Monitoring results were impacted causing delays in completion of the program. Efforts to complete the program without damaging its credibility are under discussion with the scientific team. A review of the data points available will determine whether or not the program can be completed in 2001 or 2002. This determination will be made in the spring of 2001.

Zone boundaries were an issue that arose during the business plan review. Emission deposition and participation of power companies located east of the existing boundaries provided a platform for boundary expansion discussions. Preliminary discussions with Alberta Environment and TransAlta encouraged the development of a WCAS subcommittee on boundary expansion. The committee is faced with evaluating the pros and cons of expanding the zone boundaries on the east and north. This study is to include a review of deposition data and modeling information, funding formula possibilities and the rationalization of monitoring in the region. Although early in the process, it is thought that monitoring improvements can be made in a cost effective manner. The subcommittee intends to continue its work in this area in 2001 with possible boundary expansion in early 2002.

1.0 Introduction

The West Central Airshed Society (WCAS) set up the first airshed management zone in Alberta. Since its establishment in February 1995, three more airshed monitoring zones have been created in the province and others are being planned. Each airshed zone is independent, but operates under the umbrella of the Clean Air Strategic Alliance.

The aim of regional airshed management is to monitor air quality and seek remedies for air quality problems within a region. In the West Central airshed zone, the potential impact of air quality on soil acidity, crops and forests was a major concern. The bio-monitoring research project has been collecting data for five years and should require only one more year before results can be fully analyzed.

The WCAS is a non-profit society established under the Societies Act of Alberta. The Society's volunteer Board of Directors has representatives from agriculture, electrical utilities, gas transmission, oil and gas producers, forestry, municipal and provincial governments and environmental non-government organizations. In 2000, the Board welcomed Mr. Bob Scotten as the new program manager. Mr. Scotten looks after the day-to-day operations of the society. The collection and evaluation of air quality data and the technical management of the bio-monitoring program was continued by Mr. Eric Peake.

The Society's work is funded by contributions from major industries operating in the region, with the amount paid being proportional to a company's contribution to air pollution. Other members including municipalities contribute in kind as well as monetary contributions. The budget for 2000 was $673,000 with air quality monitoring accounting for approximately 60% of the budget, the bio-monitoring program a further 20%, and 20% for administration.

Purpose

The purposes for which the West Central Airshed Society was formed are:

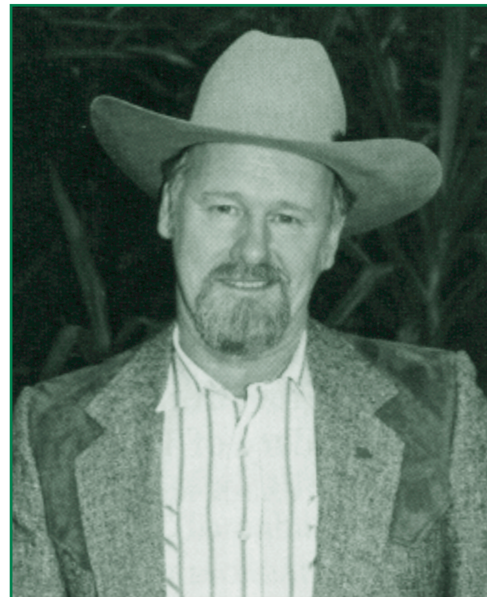
(a) to provide a forum for discussion and co-ordination of matters related to the management of an airshed monitoring and management program for the Zone. Monitoring programs will be designed to identify and quantify air quality concerns and the Board will develop and implement options to address concerns identified.

(b) to promote understanding between the Society, governments, stakeholders, the public, other airshed zones and other organizations about environmental impacts of activities inside and outside the airshed in regard to air quality within the airshed.

(c) to identify and quantify on a credible basis air quality concerns, and use the data to recommend and implement airshed management solutions for the zone.

(d) to coordinate and integrate airshed monitoring and management activities within the Zone with the provincial policies and guidelines as developed by Clean Air Strategic Alliance (CASA) and/or Provincial air quality stakeholders in their respective areas of authority.

2.0 Chairman's Report



In the 2000 year, the rains came and West Central Airshed Society was busy adjusting to the weather, dealing with administrative changes and meeting an ever increasing number of challenges, in ways that have contributed to our success.

Early in the year 2000, after successfully concluding our 5-year Business Plan, the WCAS Board of Directors took the bold step of tendering all WCAS contracts. After considerable consultation new contracts were awarded and the plans for the fiscal year were set in motion.

In April our Program Manager, Mr. Eric Peake, announced his intention to leave the Society after five years of impeccable service. Eric has agreed to remain as the technical manager on a half time basis to the end of May 2001.

Other changes included the hiring of Mr. Bob Scotten to act as the Society's new Program Manager on a half time basis until Eric concludes his term with the Society. Bob was formerly the Program Manager for the Wood Buffalo Environmental Association (WBEA) and brings many strengths and new ideas to the table. Bob faces many new challenges as he takes the reins of the WCAS.

In August, the WCAS established an office at Drayton Valley in the Penn West Building. At this time I would like to recognize Penn West for their cooperation in making this happen.

This year the WCAS made the decision to enter into a lease and maintenance agreement for our new monitoring/analytical equipment. This business decision was made with the intention of reducing capital costs and ensuring that the monitoring equipment meets with our reliability and performance criteria.

With these changes we were faced with a modest increase in our Annual Budget. We had managed to operate on a flat budget for the first five years, as was our mandate in the original five-year plan. The board was faced with reducing the program, which may have compromised the quality of the data gathered, or approve an increase. I am proud that the board has chosen to maintain the standards that have been established and to continue with a very creditable program.

Cecil Andersen
Chairman

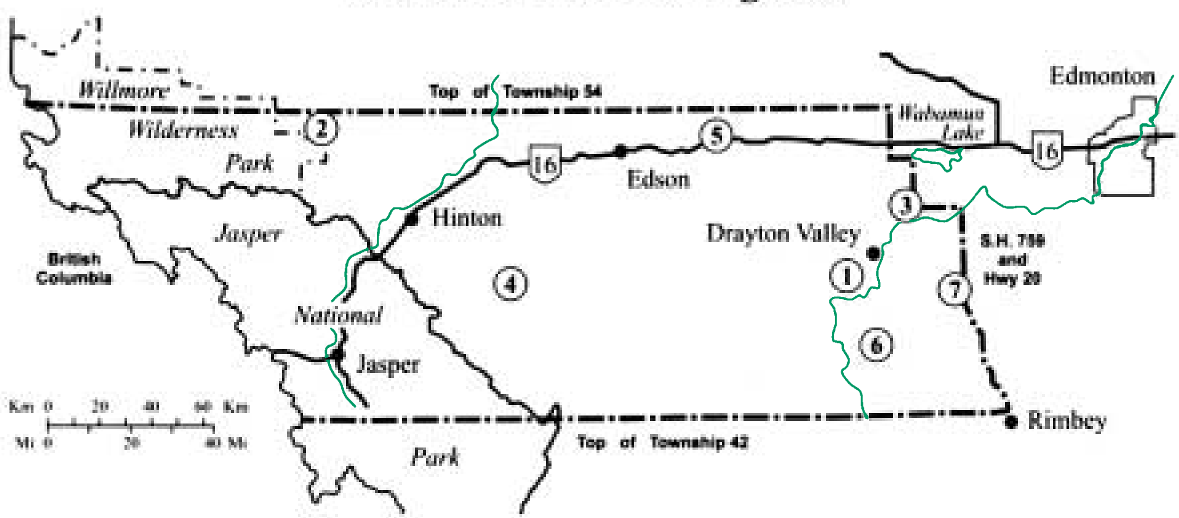
3.0 Activities and Progress

The West Central Airshed Society (WCAS) operates a network of five continuous on-line air quality monitoring stations, five agricultural bio-receptor monitoring sites, and two forestry bio-monitoring sites within the west central region of Alberta. Stations are strategically located throughout the zone to represent areas with industrial activity and areas remote from man-made emission sources.

Air quality monitoring and reporting methods used by the WCAS are compatible with those of Alberta Environment. Continuous monitoring is required to meet the Alberta Environment compliance standards for maximum hourly concentrations of pollutants. Continuous air monitoring is also needed to link any symptoms of stress observed on test crops to changes in air quality. Trace level monitors are used to measure the wide range of pollutant concentrations encountered within the zone and to accurately assess changes in air quality. WCAS uses passive monitoring systems at two bio-monitoring sites. These passive monitoring systems are capable of providing approximate average measurements of a pollutant concentration over extended periods of time.

The West Central Airshed Zone encompasses an area of about 35,000 square kilometres. It is delineated by the Alberta/British Columbia border on the west; the north boundary of Township 54 on the north, the north boundary of Township 42 on the south and Highways 20 and 759 on the east. (Please contact the Society for exact legal descriptions of boundaries.)

West Central Monitoring Sites



Site 1	Violet Grove	SE17 48-8-W5	Air monitoring/Agricultural bio-monitoring
Site 2	Hightower Ridge	SE11 54-2-W6	Air monitoring
		SW4 54-2-W6	Forestry bio-monitoring
Site 3	Tomahawk	SE2 51-6-W5	Air monitoring/Agricultural bio-monitoring
Site 4	Steeper	SW12 48-22-W5	Air monitoring
		SE1 48-22-W5	Forestry bio-monitoring
Site 5	Carrot Creek	SE31 53-13-W5	Air monitoring/Agricultural bio-monitoring
Site 6	Alder Flats	SE36 45-7-W5	Agricultural bio-monitoring
Site 7	Breton	NW25 47-4-W5	Agricultural bio-monitoring

3.1 Bio-Monitoring

When the West Central Airshed Zone was first established, stakeholders identified the effects of ambient air quality on vegetation as an important issue. Two of the main air quality issues identified by the public in the West Central zone were soil acidification and vegetative changes to agricultural crops and forests. To address the question of the vegetative effects of air quality a bio-monitoring program was developed to measure growth and yield, and to document visible symptoms of coincident air quality effects in representative indicator crops.

Alfalfa (*Medicago sativa L.)* and saskatoons (*Amelanchier alnifolia*) were selected as indicator species for growth and yield qualities. Both are sensitive to air quality and are grown commercially in the WCAS zone.

During 2000, the foliage of saskatoons and alfalfa planted at five locations was examined for visible stress. In previous years, mild symptoms of injury, that were typical of sulphur dioxide exposure, were observed on saskatoon foliage at Tomahawk. Vegetation surveys during the summer of 2000 revealed no symptoms of air quality stress.

Meteorological conditions affect the susceptibility of plants to air pollution stress. The 1998 growing season was warm and dry and evidence of chronic SO_2 injury was found in late July. During the cooler and wetter 1999 growing season symptoms occurred in the first week in September. Cool wet weather during the 2000 growing season was not conducive to the expression of chronic foliar SO_2 injury.

Continuous air monitoring showed atmospheric concentrations of sulphur dioxide to be well below Alberta Environment guidelines. Since sulphur accumulates in plants, the saskatoon foliage at Tomahawk was analysed for organic and inorganic sulphur content and compared to foliage from saskatoons at three other sites. The differing sulphur content of the soils results in a higher inorganic to organic sulphur ratio at Tomahawk. Ratios measured in injured plants in 1999 were considerably higher than those from uninjured plants in both 1999 and 2000.

The growth rates and harvested yield of alfalfa were determined in managed study plots at Tomahawk, Violet Grove, and Carrot Creek. These study plots are represented by successive annual seedings of alfalfa beginning in 1995 at Tomahawk and Violet Grove and in 1999 at Carrot Creek. This information, together with measurements of air quality and climatic variables, is being used to establish the relationships between air quality and crop response. With limited data at this time, a mathematical model indicates that ozone, sulphur dioxide, and oxides of nitrogen are important variables affecting alfalfa growth. It is anticipated that sufficient information to allow a more definitive determination of the effects of air quality on productivity will be available by the end of the 2002 growing season. The bio-monitoring committee performs a full review of the past year's program and develops a plan for the coming year each April.

The WCAS's biomonitoring program is a joint venture partnership with the Canadian Forest Service (CFS) and was established in 1997. Beginning in 2000 the program changed to a 5-year re-measurement period from a previous annual assessment. This was in keeping with the schedule for the entire Acid Rain National Early Warning System of plots. The Hightower and Steeper sites were visited in 1999 where the condition of trees had not changed since the plots were established. The vast majority of trees were in a healthy condition with no evidence of air pollution stress.

3.2 Air Quality Monitoring

The WCAS air quality monitoring program focuses on acid-forming gases, air quality parameters that may affect vegetation, and parameters that are of interest to health professionals. Emphasis is placed on obtaining credible and scientifically defensible data. The quality control and quality assurance program includes daily checks of calibration and instrument performance, together with regular multi-point calibrations and government audits. Data is examined for long-term systematic errors and all raw and quality controlled data is archived.

Data from the West Central zone is part of the new, province wide, integrated data management system developed through the Clean Air Strategic Alliance, and available through the Alliance's website at www.casahome.org. Specific requests for information may be directed to the Program Manager.

Pollutants Measured by Continuous Monitors

3.2.1 Sulphur Dioxide (SO_2)

Characteristics

Sulphur dioxide is formed during the processing and combustion of fossil fuels containing sulphur. It is a colourless gas with a pungent odour, and can be detected by taste and odour at concentrations as low as 300 parts per billion (ppb). Sulphur dioxide reacts in the atmosphere to form sulphuric acid and acidic aerosols, which contribute to acid rain. Sulphur dioxide combines with other atmospheric gases to produce fine particles, which may reduce visibility.

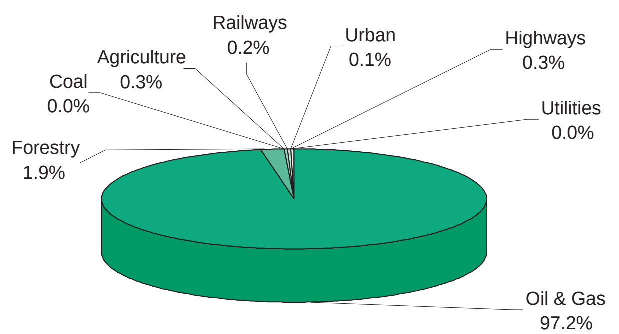
Brief exposure to high concentrations of sulphur dioxide and its products can produce human health effects, irritating the upper respiratory tract and aggravating existing cardiac and respiratory disease. Long-term exposure may increase the risk of developing chronic respiratory disease.

Sensitive vegetation may be injured by exposure to high sulphur dioxide concentrations. Symptoms include a chlorotic appearance of the leaf with silvering or bronzing of the underside.

Sources

The inventory of emissions within the West Central Regional Airshed Zone was updated based on 1999 data. The inventory includes measurements made by Alberta Environment and emissions calculated from the Alberta Energy Utilities Board records of fuel usage and flare volumes. Large emission sources that contribute pollutants to the airshed, but are located outside of its boundaries, are excluded. There was an estimated 8% increase in SO_2 emissions within the West Central Airshed Zone from 1998 to 1999. It is estimated that sulphur dioxide emissions within the Zone in 1999 totalled 26,880 tonnes. The oil and gas sector emitted 97% of the sulphur dioxide within the airshed with nine large sour gas processing plants contributing about 90% of the total emissions. Other sectors are relatively small emitters of SO_2 with forestry contributing about two percent of the total.

*West Central Airshed Zone Sulphur Dioxide Emissions by Sector**



*1999 Emissions data and fuel consumption records provided by Alberta Environment and the Alberta Energy Utilities Board. Emissions are from sour and sweet gas plants and compressor stations. Emissions from well testing are not included nor are the relatively small emissions from oil batteries.

Monitoring Results

The average sulphur dioxide concentrations in the ambient atmosphere in 2000 were lower at Violet Grove and Carrot Creek than recorded in 1999, and slightly increased at Tomahawk. The averages of 0.93 ppb at Violet Grove, 1.09 ppb at Tomahawk, and 1.31 ppb at

Carrot Creek were 9% to 13% of the Alberta guideline which is 10 ppb SO_2 for an annual average. There is no consistent trend toward lower or higher annual concentrations.

Average SO_2 concentrations in the West Central zone were considerably less than the 10-year average values of 2.6 ppb measured by Alberta Environment in east Calgary and 3.2 ppb in east Edmonton.

Sulphur dioxide concentrations reached a maximum of 20% of the Alberta one-hour guideline at Tomahawk, 16% at Violet Grove, and 14% at Carrot Creek.

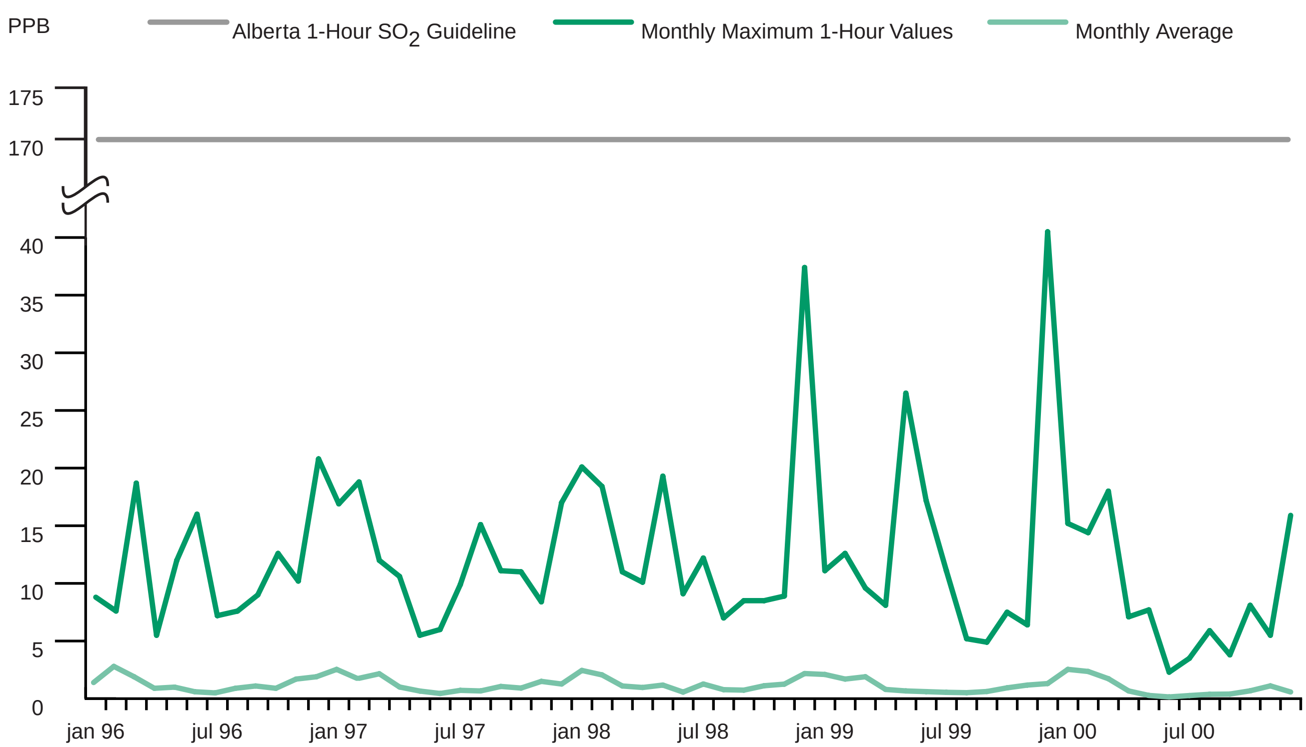
Periods of higher readings of sulphur dioxide were of short duration and often associated with increased levels of nitric oxide, indicative of emissions from local sources rather than regional air quality. Over the year, the highest average sulphur dioxide values at Violet Grove and Carrot Creek occurred when winds were from the northeast and southwest at both locations. At Tomahawk the highest average concentrations occurred with winds from the east-northeast, and at Steeper from the east-southeast. Highest concentrations at Hightower Ridge occurred with east-southeast winds.

Alberta Guidelines

Alberta Environment has adopted Environment Canada's most rigorous objectives for sulphur dioxide. The Alberta guidelines for ambient air are:

- 1-hour average of 170 ppb;
- 24-hour average of 60 ppb,and
- an annual average of 10 ppb

Maximum and Average Sulphur Dioxide Concentration by month 1996 – 2000 at Violet Grove.



3.2.2 Oxides of Nitrogen (NO_x)

Characteristics

Oxides of nitrogen, mostly in the form of nitrogen oxide (NO) and nitrogen dioxide (NO_2), are produced by the high temperature combustion of fossil fuels. Nitrogen oxide is the predominant species emitted by combustion sources but it is rapidly changed to nitrogen dioxide in the atmosphere.

Nitrogen dioxide is a reddish-brown gas with a pungent irritating odor. It has been linked to respiratory disease and contributes to acid rain. It plays a major role in atmospheric photochemical reactions and ground level ozone formation and destruction.

Exposure of vegetation to high concentrations of nitrogen oxides results in silvering of the lower leaf surface. A waxy appearance appears shortly after exposure followed by bronzing after two or three days.

Sources

Emissions of nitrogen oxides within the West Central Regional Airshed Zone, excluding transport from outside the zone, were estimated to be 29,800 tonnes in 1999. Major sources were the oil and gas sector, followed by railways and highways. Together, these three sectors contributed to about 87% of the total NO_x emissions. Of the oil and gas sector emissions, 60% of the NO_x was emitted by gas processing plants and 40% by compressor stations. These estimates do not include nearby major sources of NO_x located outside the zone.

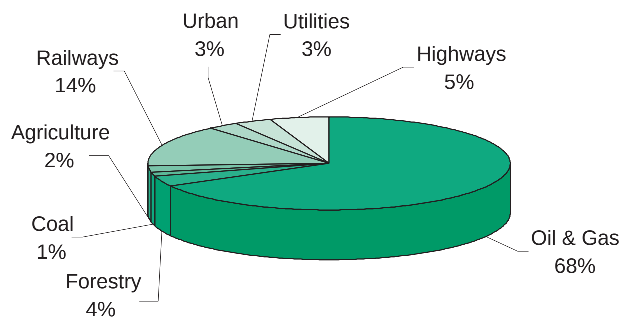
Computer modeling studies, conducted for the WCAS prior to establishment of the zone, indicated that 60% of the nitrogen deposited within the zone originates from outside of the zone boundaries.

Alberta Guidelines

Alberta Environment guidelines are based on the prevention of human health effects. They are equal to the most rigorous of Environment Canada's ambient air quality objectives. The Alberta guidelines for nitrogen dioxide, the major component of nitrogen oxides in the ambient atmosphere are:

- 1-hour average of 210 ppb,
- 24-hour average of 110 ppb, and
- an annual average of 30 ppb.

West Central Airshed Zone Oxides of Nitrogen Emissions by Sector*



*1999 Emissions data and fuel consumption records provided by Alberta Environment and the Alberta Energy Utilities Board. Emissions are from sour and sweet gas plants and compressor stations. Emissions from well testing are not included nor are the relatively small emissions from oil batteries.

Monitoring Results

The mean annual concentration of nitrogen dioxide at Violet Grove in 2000 was lower than in the previous two years. The average was 3.7 ppb as compared to 4.4 ppb in 1999 and 4.0 ppb in 1998. At Tomahawk the average of 5.0 ppb in 2000 was also lower than the average of 5.2 ppb recorded in 1999 but higher than the 1998 concentration of 4.2 ppb. The 2000 average at Carrot Creek was 6.9 ppb, somewhat lower than in 1999 but greater than 1998 values. These values are less than 25% of the Alberta Guideline of 30 ppb for an annual average NO_2 concentration in ambient air.

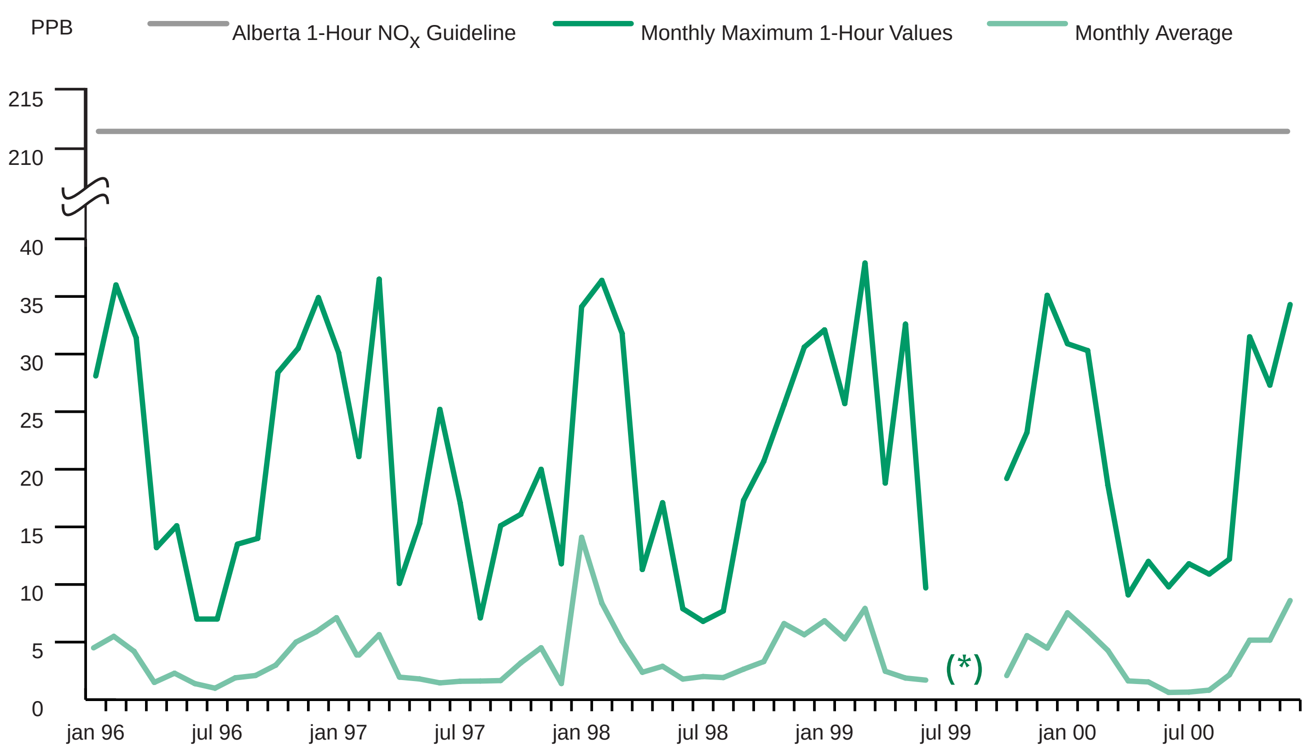
The maximum 1-hour value recorded in 2000 was 46 ppb measured at Carrot Creek. This is about 22% of the Alberta guideline of 210 ppb for a 1-hour NO_2 average.

These values are small compared to the annual averages of 25 ppb and 17 ppb measured by Alberta Environment in downtown Edmonton and Calgary. Motor vehicle emissions are the major source of high ambient NO_x concentrations in the cities and contribute 6% of the NO_x emissions within the West Central Zone.

Maximum 1-hour values were the result of local emissions, likely from flaring activities. Longer periods of above average NO_x concentrations had low NO to NO_2 ratios and were indicative of regional air quality.

At Carrot Creek highest NO_x concentrations occurred with winds from the south and were not associated with SO_2 emissions.

Maximum and Average Nitrogen Dioxide Concentration by Month, 1996 – 2000 at Violet Grove.



* Data unavailable due to equipment failure

3.2.3 Hydrocarbons

Characteristics

Hydrocarbons are divided into two broad categories, "non-reactive" and "reactive" hydrocarbons. The major non-reactive hydrocarbon in the atmosphere is methane, which is a naturally occurring colorless, odorless gas recognized as a major contributor the greenhouse effect. The reactive hydrocarbons consist of many volatile organic compounds, some of which react with oxides of nitrogen in the atmosphere to form ozone. They generally occur at much lower concentrations than methane. Total hydrocarbons (THC) include both reactive and non-reactive hydrocarbons.

Sources

Large amounts of methane are produced naturally through the decay of vegetation but human activity is contributing to a worldwide increase in methane concentrations of about 1% per year. Trees and plants are major natural emitters of reactive hydrocarbons with other significant sources being motor vehicle exhaust, gasoline handling and the petroleum and chemical industries.

Alberta Guidelines

There are no Alberta guidelines for ambient hydrocarbon concentrations.

Monitoring Results

Atmospheric concentrations of total hydrocarbons (THC) were measure at Violet Grove for 9 months in 2000, and reactive hydrocarbons and methane for 3 months. The average THC concentration was 2.3 parts per million (ppm). This is slightly more than the 2.2 ppm methane recorded in 1998, 2.2 ppm in 1997, and 2.0 ppm in 1996. The maximum 1-hour average value was 19.4 ppm indicative of a short-term nearby source.

Ninety percent of the measurements of reactive hydrocarbons were less than 0.5 ppm. The maximum 1-hour average concentration was 4.9 ppm compared to 5.7 ppm in 1999, 4.1 in 1998, 3.4 ppm in 1997, and 4.6 ppm in 1996.

The highest hydrocarbon readings were associated with local oil field activity and were not representative of regional air quality. The total hydrocarbon concentrations were generally highest with winds from the south-southeast.

3.2.4 Ground Level Ozone

Characteristics

Ozone is both a natural component of the atmosphere and a major constituent of photochemical smog. At normal atmospheric concentrations it is an odorless, colorless gas. However, at concentrations higher than one ppm, such as found near photocopier machines and near electrical discharges, it has a sharp odor.

Ozone is a strong oxidizer and can irritate eyes, nose and throat and decrease athletic performance. High concentrations can increase susceptibility to respiratory disease and reduce crop yields.

Sources

Unlike other pollutants, ozone is not emitted directly into the atmosphere but is produced through a series of chemical reactions in the atmosphere. Concentrations are controlled mainly by emissions of nitrogen oxides and reactive hydrocarbons. These reactions may lead to an increase in ozone concentrations or, as in the case of Alberta cities, a decrease. Ozone is a natural component of the upper atmosphere and may be transported to ground level by meteorological processes.

Alberta Guidelines

Alberta Environment guidelines for ozone are:

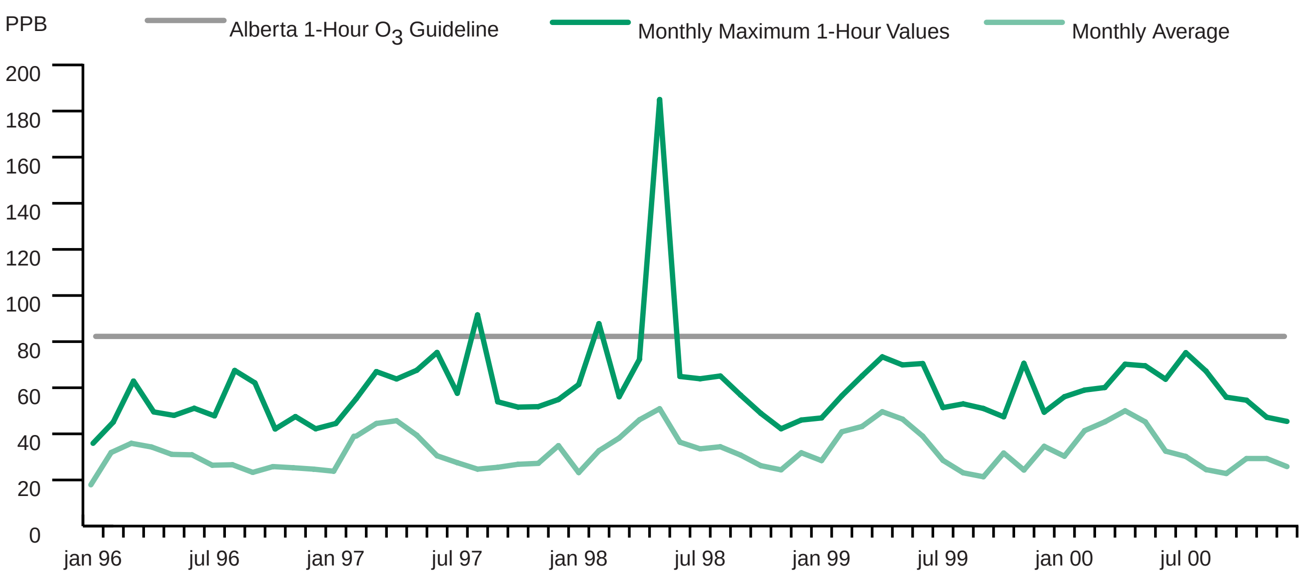
- a 1-hour average of 82 ppb, and
- a 24-hour average of 25 ppb

Provincial and federal guidelines are presently under review.

Monitoring Results

The maximum 1-hour ozone concentration recorded at Violet Grove in 2000 was 75 ppb which was within the Alberta Environment guideline of 82 ppb. Similarly the maximums of 75 ppb at Tomahawk, 78 ppb at Carrot Creek, 81 ppb at Hightower, and 80 ppb at Steeper were all within the guideline value. The mean annual concentrations of ozone in the eastern part of the zone during 2000 were 33.8 ppb at Violet Grove, 28.7 ppb at Tomahawk, and 27.0 ppb at Carrot Creek. In areas more remote from industrial activity the average concentrations were 44.9 ppb at Hightower Ridge and 38.8 at Steeper. These values are typical of rural and remote areas in Alberta but are higher than in downtown Edmonton and Calgary where ozone concentrations are depressed by motor vehicle emissions of the oxides of nitrogen.

Maximum and Average Ozone Concentration For Each Month from 1996 to 2000 at Violet Grove.



3.2.5 Particulate Matter (PM_{10} and $PM_{2.5}$)

Characteristics

Ambient particulate matter consists of a mixture of particles of varying size and chemical composition. Particles that are less than 10 micrometers in diameter (PM_{10}) can be inhaled. The fraction of particles, which are less than 2.5 micrometers in diameter ($PM_{2.5}$) can be trapped in the airways and lungs and is believed to cause adverse health effects. Fine particles ($PM_{2.5}$) also reduce visibility and can contribute to acidification of soils.

Sources

Sources of PM_{10} size particles include windblown soil, road dust, and industrial activities. $PM_{2.5}$ size particles are formed from gases released to the atmosphere by combustion processes such as from motor vehicles, power plants, gas processing plants, compressor stations, household heating, and forest fires.

Monitoring Results

During 2000, continuous PM_{10} monitors were installed at the Tomahawk and Steeper monitoring sites to compliment the PM_{10} monitor previously in operation at Hightower Ridge. Continuous $PM_{2.5}$ monitors were also installed at the Tomahawk and Hightower Ridge sites. These monitors replaced the method of particle collection and weighing previously used to determine atmospheric particle concentrations at these sites.

Concentrations of PM_{10} particles at Tomahawk, during the 7 months in 2000 during which the monitor was operational, averaged 10.3 ug/m^3 with a maximum 1-hour concentration of 197 ug/m3. During the same period the $PM_{2.5}$ concentration averaged 4.9 ug/m^3. Previous analyses showed PM_{10} particles to be composed mainly of windblown dust, as indicated by the high calcium content. Sulphate and nitrate derived from industrial emissions of SO_2 and NO_x were the major constituents of the $PM_{2.5}$ size particles.

PM_{10} concentrations at the Hightower Ridge background monitoring site averaged 5.4 ug/m^3 compared to 8.6 ug/m^3 at Steeper. The Steeper monitoring site may be influenced by dust from a nearby gravel road. The $PM_{2.5}$ concentration at the Hightower ridge background site was 2.7 ug/m^3.

Alberta Guidelines

Guidelines for ambient atmospheric concentrations of PM_{10} and $PM_{2.5}$ size particles are under consideration by the Alberta and the federal governments. A provisional Canada-Wide Standard has been adopted for $PM_{2.5}$ of 20 ug/m^3, 24-hour averaging time, by the year 2010.

3.2.6 Ammonia

Low concentrations of pollutants that cannot be monitored by continuous monitors can be measured using an integrated sampling method. Samples are collected over a two-week period to obtain suitable concentrations, and then analyzed in a laboratory. Ammonia is one such gas. It is a colorless gas with a pungent odor which is produced by natural anaerobic decay processes.

Major agricultural sources are animal wastes from the cattle industry and the fertilizers widely applied by the grain industry.

Ammonia concentrations are highest in the agricultural areas of the West Central zone averaging 0.29 ppb at Violet Grove in 2000 as compared to 0.13 ppb at the background Hightower Ridge monitoring station.

3.2.7 Meteorology and Air Quality

Influence of Meteorology

Air quality depends on the rate that pollutants are emitted to the atmosphere and the rate at which these pollutants are dispersed away from the sources. Air pollution transport and dispersion are influenced by wind speed and direction, the temperature structure of the atmosphere, the solar cycle, turbulence, precipitation and changes in these elements induced by local topography.

Precipitation may remove pollutants from the atmosphere, depositing them on soils and vegetation. Rates of deposition of pollutant gases are highest when vegetation and soils are wet. Vegetation is more susceptible to damage during periods of highest growth.

Monitoring Program

Meteorological parameters measured in support of the West Central Airshed Society air quality monitoring program are:

- wind speed and direction
- temperature
- difference in temperature at two heights
- solar radiation
- photosynthetically active radiation (PAR)
- amount of precipitation
- relative humidity
- surface wetness

Precipitation samples are also collected and chemically analyzed for acidity and major constituents.

Monitoring Results

The average temperature at Violet Grove during 2000 was 1.3°C with a maximum of 25.2°C and a minimum of –33.2°C. These values are close to the long-term climatological values measured at Edson. Similar temperatures were recorded at Tomahawk, 2.6°C, Carrot Creek, 2.0°C, and at Steeper, 1.9°C. At the higher elevation Hightower Ridge site the average temperature was 0.9°C.

Winds at Violet Grove were predominantly westerly. At Tomahawk, winds were mostly from the southwest but northwest winds were also common. Winds at Hightower Ridge were predominantly from the west and at Steeper from the southwest reflecting the influence of the adjacent mountain valleys.

The amount of precipitation measured at the Violet Grove monitoring location during 2000 was 353 mm with 408 mm of precipitation at the Hightower Ridge background monitoring site.

The acidity of precipitation at Violet Grove in 2000 was similar to that recorded in 1999. The volume-weighted average pH was 4.99, compared to 5.09 in 1999, 4.77 in 1998, and 4.69 in 1997. Alberta Environment made volume-weighted pH measurements at a nearby site of 5.12 in 1993, 5.10 in 1994, and 5.21 in 1995. These values are lower than the long-term average pH of 5.5 for precipitation in Alberta. The lowest pH recorded during the year was 4.32. This compares to 4.36 in 1999.

The volume-weighted pH at Hightower Ridge during 2000 was 4.91.

3.2.8 Pollutant Deposition

Characteristics

The amount of a pollutant flushed from the atmosphere by precipitation (wet deposition) or deposited to the landscape in the form of gases and particles (dry deposition) determines the eventual effect on the environment.

Precipitation removes some pollutants from the atmosphere, depositing them on soils and vegetation. Prolonged high rates of deposition of acidifying species may result in long-term acidification of susceptible soils and lakes. The SO_2 Management Project Team of CASA recommended that Alberta adopt critical and target loads for deposition of acidifying pollutants in order to protect aquatic and terrestrial ecosystems. The recommended method of determining the total acid input is based on the difference between the total wet and dry deposition of acidifying and neutralizing substances. A critical load of 0.25 kiloequivalents of total acidity per hectare per year (keq $ha^{-1}y^{-1}$) was recommended to protect sensitive areas of the province from long-term harmful effects.

There are natural variations of acidity in soils (pH) within the growing season and from year to year. In order to determine any changes in soil acidity caused by atmospheric input, measurements must be made over an extended period of time. Soils data is being collected by the WCAS as a continuation of the soil monitoring work previously performed under the Brazeau-Pembina Sulphur Deposition and Agriculture Study 1989 - 1994.

Monitoring Results

The potential acidity of wet deposition at Violet Grove during 2000 was 0.12 keq H^+ $ha^{-1}h^{-1}$ and at Hightower Ridge was 0.08 keq H^+ $ha^{-1}h^{-1}$. These values are approximately equivalent to the dry acidic deposition at each of these sites.

The amount of dry deposition of a pollutant is a function of its atmospheric concentration and its deposition velocity. The deposition velocity is controlled by meteorological conditions and the type (forest, grassland, agricultural land) and condition (wet, dry, snow covered) of the landscape. Dry acidic deposition in the eastern part of the West Central Zone was estimated to be 0.19 keq H^+ $ha^{-1}h^{-1}$. This estimate was based on measurements of pollutant concentrations made at Violet Grove, with the effects of surface wetness and the influence of each vegetation type in the zone being taken into consideration. About two-thirds of the acidic deposition was due to sulphur dioxide with nitric acid and ammonia being equally responsible for the other one-third. Estimates of acidic deposition in the western part of the zone are less precise but the rate of acidic deposition was much lower, about 0.04 keq H^+ $ha^{-1}h^{-1}$.

The acidity of soils at the West Central agricultural plots in 2000 differed from when the program began in 1995. The pH in the year 2000 was higher (less acidic) in most cases.

Table 1. Soil pH at WCAS plots 1995 and 2000.

	1995		2000	
Location	**Depth**	**pH**	**Depth**	**pH**
Violet Grove	0-15 cm	6.6	0-12 cm	7.2
Tomahawk	0-15 cm	5.5	0-12 cm	5.5
Alder Flats	0-12 cm	5.8	0-12 cm	6.3
Breton	0-19 cm	5.5	0-12 cm	6.1
Carrot Creek*	0-15 cm	5.1	**0-12 cm	5.5

*Carrot Creek plot moved in 1997.
** pH value for 1997

4.0 Links to the Clean Air Strategic Alliance

The Clean Air Strategic Alliance (CASA) provides the framework within which the West Central Airshed Society (WCAS) and other airshed zones operate. CASA is a provincial alliance formed to provide the strategic management of air quality in Alberta, with senior representatives from government, industry, and non-government organizations. It operates by consensus but is directly accountable to the Ministers of Environment, Resource Development, and Health and Wellness. CASA stakeholders work together to develop practical and innovative responses to air quality issues. Air Quality Management within airsheds is one such approach.

The regional, airshed approach works well for problems that are regional in nature and allows those within a region to work together to resolve air quality issues. The CASA document, "Zone Air Quality Management Guidelines" sets out the vision and principles of the Alliance under which airshed zones operate. Airshed zones follow the CASA model of consensus decision-making, in which stakeholders try to resolve their concerns in a collaborative manner. CASA also invites representative from the WCAS and other airshed zones to join in CASA projects and working groups, where appropriate.

The WCAS submits its air quality monitoring data to CASA and it can be viewed on the WCAS page of the CASA website at http://www.casadata.org/wcas/indexj.htm

The WCAS also shares experience with other regional airshed management zones, as they establish their management plans and develop their programs. In 2000, we were pleased to welcome the Fort Air Partnership as the fourth air quality management zone in Alberta.

This zone, that is centred on Ft. Saskatchewan, joins the Wood Buffalo Environmental Association and the Parkland Airshed Management Zone that have been set up in the last few years. We have encouraged those who are planning a new air management zone in Peace River/Grande Prairie region.

5.0 Financial Report

The WCAS Board designed and implemented a systematic process to evaluate and measure the success of the WCAS program and operations. In an effort to meet the changing needs of our stakeholders, we continue to modify and improve the air monitoring program and the equipment associated with it.

Our goal is to continue providing a credible and affordable program respected by industry, regulatory agencies and the general public.

The following is the audited Statement of Revenue and Expense for the West Central Airshed Society for the year ended December 31,2000. A complete set of audited financial statements is available upon request.

WEST CENTRAL AIRSHED SOCIETY

STATEMENT OF REVENUE AND EXPENSES

FOR THE YEAR ENDED DECEMBER 31, 2000

Revenue:	
Membership fees	$ 738,713
Interest	281
Uncollectible membership fees	(123,828)
	615,166
Expenses:	
Contractors	389,289
Project manager	82,294
Equipment rental	65,078
Office, secretarial and telephone	11,146
Site maintenance	7,496
Accounting fees	6,956
Annual report	6,559
Utilities	5,777
Land honorariums	2,500
Insurance	2,242
Bank charges	102
	579,439
Excess of revenue over expenses, before amortization	35,727
Amortization	173,719
Deficiency of revenues over expenses	$(137,992)

Appendix I: Ambient Air Monitoring Data - 2000

Alberta Environment air quality guidelines

Parameter (units)	1-hour average	24-hour average
Sulphur Dioxide (ppb)	170	60
Nitrogen Dioxide (ppb)	210	110
Ozone (ppb)	82	25

1-Hour average concentrations of gases at Violet Grove

Parameter (units)	Year	Average	Minimum	Maximum
Sulphur Dioxide (ppb)	2000	0.93	0.0	18
	1999	1.1	0.0	26.5
	1998	1.3	0.0	37.4
	1997	1.2	0.0	18.8
	1996	1.2	0.0	20.8
Nitrogen Dioxide (ppb)	2000	3.7	0.0	34.3
	1999	4.4	0.0	37.9
	1998	4.0	0.0	36.4
	1997	2.5	0.0	36.5
	1996	2.7	0.0	35.1
Nitric Oxide (ppb)	2000	0.62	0.0	32.7
	1999	0.55	0.0	30
	1998	0.74	0.0	32.4
	1997	0.47	0.0	30.5
	1996	0.45	0.0	24.1
Oxides of Nitrogen (ppb)	2000	4.4	0.0	50.5
	1998	4.7	0.0	51
	1997	3.0	0.0	43.4
	1996	3.2	0.0	36.0
Ozone (ppb)	2000	33.8	0.7	75.2
	1999	34.3	0.0	73.4
	1998	34.1	3.4	185.4
	1997	32.4	0.0	91.6
	1996	28.0	0.2	67.5
Total Hydrocarbons (ppm)	2000	2.3	1.3	19.4
Methane (ppm)	2000	2.1	1.8	2.9
	1999	2.1	2.0	3.3
	1998	2.2	1.8	5.0
	1997	2.2	1.9	4.2
	1996	2.0	1.4	4.5
Non-methane	2000*	0.3	0.0	4.9
hydrocarbons (ppm)	1999*	0.2	0.0	5.7
	1998	0.2	0.0	4.1
	1997	0.1	0.0	3.4
	1996	0.0	0.0	4.6

*Instrument operational only 3 months in each of 1999 and 2000

Average pollutant concentrations at select Alberta locations

Parameter	East Edmonton	East Calgary	Fort McMurray	Fort Sask.
Sulphur Dioxide (ppb)	3.2	2.6	0.9	2.2
Nitrogen Dioxide (ppb)	25	17	9	13
"Ozone, O3 (ppb)"	17	24	21	24
Total Hydrocarb. (ppm)	2.3	2.4	2.0	2.0

1-Hour average concentrations of gases at Tomahawk

Parameter (units)	Year	Average	Minimum	Maximum
Sulphur Dioxide (ppb)	2000	1.1	0.0	33.9
	1999	1.1	0.0	22.6
	1998	1.1	0.0	23.2
	1997	1.2	0.0	56.4
	1996	2.1	0.0	11.0
Nitrogen Dioxide (ppb)	2000	5.0	0.0	36.7
	1999	5.2	0.1	35.2
	1998	4.2	0.0	39.2
Nitric Oxide (ppb)	2000	1.0	0.0	30.6
	1999	0.8	0.0	58.7
	1998	0.7	0.0	18.8
Oxides of Nitrogen (ppb)	2000	6.0	0.0	58.0
	1999	6.0	0.1	91.5
	1998	4.9	0.0	44.2
Ozone (ppb)	2000	28.7	0.0	75.2
	1999	34.3	0.0	73.4
	1998	34.1	3.4	185.4
	1997	32.4	0.0	91.6
	1996	28.1	0.2	67.5

1-Hour average concentrations of gases at Hightower Ridge

Parameter (units)	Year	Average	Minimum	Maximum
Sulphur Dioxide (ppb)	2000	0.20	0.0	9.0
Nitrogen Dioxide (ppb)	2000	0.54	0.0	14.5
Nitric Oxide (ppb)	2000	0.10	0.0	9.4
Oxides of Nitrogen (ppb)	2000	0.64	0.0	20.4
Ozone (ppb)	2000	44.9	6.1	80.6
	1999	44.7	1.2	86.3
	1998	40.1	1.7	73.4
	1997	43.2	3.0	88.3
	1996	38.0	5.4	67.6

1-Hour average concentrations of gases at Carrot Creek

Parameter (units)	Year	Average	Minimum	Maximum
Sulphur Dioxide (ppb)	2000	1.3	0.0	23.1
	1999	1.5	0.0	47.7
	1998	1.1	0.0	18.5
Nitrogen Dioxide (ppb)	2000	6.9	0.0	45.9
	1999	7.2	0.0	47.7
	1998	3.9	0.0	33.9
Nitric Oxide (ppb)	2000	3.3	0.0	127.5
	1999	2.6	0.0	113.4
	1998	1.0	0.0	38.1
Oxides of Nitrogen (ppb)	2000	10.2	0.0	158.1
	1999	9.8	0.1	136.7
	1998	4.9	0.0	49.8
Ozone (ppb)	2000	27.0	0.0	77.5
	1999	28.0	0.0	74.8
	1998	24.9	0.0	77.4

1-Hour average concentration of gases at Steeper

Parameter (units)	Year	Average	Minimum	Maximum
Sulphur Dioxide (ppb)	2000	0.1	0.0	6.4
Nitrogen Dioxide (ppb)	2000	1.2	0.0	23.2
Nitric Oxide (ppb)	2000	0.3	0.0	41.4
Oxides of Nitrogen (ppb)	2000	1.6	0.0	54.0
Ozone (ppb)	2000	38.8	0.8	79.7
	1999	38.2	0.0	70.6
	1998	34.4	0.0	77.0

Percent of time instruments operational in 2000

	Violet Grove	Tomahawk	Hightower Ridge	Carrot Creek	Steeper
Sulphur Dioxide	98	98	92	99	99
Ozone	99	99	96	99	99
Oxides of Nitrogen	98	98	94	99	99
Wind Speed	98	99	97	98	98

1-Hour average concentration of particles, ug/m^3

Parameter	Year	Average	Maximum
Hightower Ridge PM10	2000	5.4	41
	1999	6.1	46
Hightower Ridge PM2.5	2000	2.7	19
Tomahawk PM10	2000	10.3	197
Tomahawk PM2.5	2000	4.9	37
Steeper PM10	2000	8.6	198

Percentile distribution of 1-Hour average concentrations of gases at Violet Grove, year 2000 (ppb)

Parameter (units)	P10	P25	P50	P75	P90
Sulphur Dioxide (ppb)	0.0	0.0	0.4	1.2	2.5
Nitrogen Dioxide (ppb)	0.0	1.0	2.3	5.1	9.2
Nitric Oxide (ppb)	0.0	0.0	0.1	0.4	1.6
Oxides of Nitrogen (ppb)	0.1	1.0	2.6	5.8	10.5
Ozone (ppb)	15	24	34	44	53
Methane (ppm)	1.9	2.0	2.1	2.2	2.3
Total Hydrocarbons (ppm)	1.8	2.0	2.2	2.4	2.8

Percentile distribution of 1-Hour average concentrations of gases at Tomahawk, year 2000 (ppb)

Parameter (units)	P10	P25	P50	P75	P90
Sulphur Dioxide (ppb)	0.0	0.0	0.5	1.3	2.7
Nitrogen Dioxide (ppb)	0.3	1.3	3.4	7.1	11.8
Nitric Oxide (ppb)	0.0	0.0	0.0	0.7	3.2
Nitrogen Oxides (ppb)	0.4	1.5	3.9	8.4	14.2
Ozone (ppb)	11	19	29	38	47

Percentile distribution of 1-Hour average concentrations of gases at Hightower Ridge, year 2000 (ppb)

Parameter (units)	P10	P25	P50	P75	P90
Sulphur Dioxide (ppb)	0.0	0.0	0.0	0.1	0.3
Nitrogen Dioxide (ppb)	0.0	0.1	0.2	0.5	1.2
Nitric Oxide (ppb)	0.0	0.0	0.0	0.1	0.2
Nitrogen Oxides (ppb)	0.0	0.1	0.3	0.6	1.4
Ozone (ppb)	25	32	38	45	50

Ammonia concentrations measured over 2-week periods (ug/m^3)

	Voilet Grove		Hightower Ridge	
Year	Average	Maximum	Average	Maximum
2000	0.29	0.71	0.13	1.03
1999	0.21	0.91	0.13	0.45
1998	0.70	1.50	0.13	0.45
1997	0.53	1.27	0.13	0.44
1996	0.61	1.97	0.12	0.61

Percentile distribution of 1-Hour average concentrations of gases at Carrot Creek, year 2000 (ppb)

Parameter (units)	P10	P25	P50	P75	P90
Sulphur Dioxide (ppb)	0.1	0.4	0.9	1.6	2.9
Nitrogen Dioxide (ppb)	1.0	1.9	4.1	9.1	17.1
Nitric Oxide (ppb)	0.0	0.0	0.2	1.7	7.7
Oxides of Nitrogen (ppb)	1.1	2.1	4.8	11.4	24.2
Ozone (ppb)	5	14	27	39	49

Percentile distribution of 1-Hour average concentrations of gases at Steeper, year 2000 (ppb)

Parameter (units)	P10	P25	P50	P75	P90
Sulphur Dioxide (ppb)	0.0	0.0	0.0	0.1	0.3
Nitrogen Dioxide (ppb)	0.1	0.3	0.6	1.5	3.1
Nitric Oxide (ppb)	0.0	0.0	0.0	0.1	0.6
Nitrogen Oxides (ppb)	0.1	0.3	0.7	1.7	3.8
Ozone (ppb)	20	30	40	48	57

Appendix II: Meteorological Observations - 2000

1-Hour average readings, Violet Grove

Parameter (units)	Average	Minimum	Maximum
Temperature (degrees Celcius)	1.3	-33.2	25.2
Wind speed (kilometers/hour)	10.3	0.0	52.7
Solar radiation (watts/square meter)	152	0.0	1061
Relative humidity (percent)	71.3	19.0	100.0

Total precipitation at Violet Grove in 2000 was 354 mm.

1-Hour average readings, Hightower Ridge

Parameter (units)	Average	Minimum	Maximum
Temperature (degrees Celcius)	0.9	-31.5	25.2
Wind speed (kilometers/hour)	12.3	0.0	61.0
Solar radiation (watts/square meter)	133	0.0	1064
Relative humidity (percent)	62.8	13.6	100.0

Total precipitation at Hightower ridge in 2000 was 409 mm.

1-Hour average readings, Tomahawk

Parameter (units)	Average	Minimum	Maximum
Temperature (degrees Celcius)	2.6	-31.6	27.7
Wind speed (kilometers/hour)	10.1	0.0	48.1
Photosynthetic radiation (PAR)	70.4	0.0	569.5
Relative humidity (percent)	73.0	20.3	100.0

1-Hour average readings, Steeper

Parameter (units)	Average	Minimum	Maximum
Temperature (degrees Celcius)	1.9	-19.8	25.2
Wind speed (kilometers/hour)	7.5	0.0	47.8
Solar radiation (watts/square meter)	115.3	0.0	992.4
Relative humidity (percent)	63.3	9.5	100.0

1-Hour average readings, Carrot Creek

Parameter (units)	Average	Minimum	Maximum
Temperature (degrees Celcius)	2	-32.6	28.4
Wind speed (kilometers/hour)	8.4	0.0	44.7
Photosynthetic radiation (PAR)	78.2	0.0	632.3
Relative humidity (percent)	70.2	13.1	100.0

Appendix III: WCAS Board of Directors

Sector	***Director & Alternate***
Agriculture	**Cecil Andersen**, Pembina Agricultural Protection Association **Cliff Whitelock**, Pembina Agricultural Protection Association
Electric Utilities	**Jim Bolton**, TransAlta Utilities[1] **Mike Leaist**, TransAlta Utilities[1]
Environmental Non-Gov't Organizations	**Mary Griffiths**, Pembina Institute for Appropriate Development[1] **Chris Severson-Baker**, Pembina Institute for Appropriate Development[1]
Forestry	**JoAnne Volk**, Weldwood of Canada **Mike Woods**, Weyerhaeuser Ltd
Gas Transmission	**Srikanth Venugopal**, Trans Canada Transmission **Sandra Barnett**, Trans Canada Transmission
Oil and Gas Producers	**Greg Gabert**, Penn West Petroleum Ltd. **Kim Jespersen**, Petro-Canada
Provincial Government	**Bill Mcdonald**, Alberta Environment Protection **David Onuczko**, Alberta Environment Protection[1] **Larry Paslawski**, Alberta Energy & Utilities Board[1]
Public at Large/Municipalities	**Hank Archibald**, County of Yellowhead **Maureen Schwab**, MD Brazeau No.77
Foothills Coal	**Al Watson**, Cardinal River Coals Ltd.
Program Manager	**Bob Scotten**, 724108 Alberta Ltd.
Technical Manager	**Eric Peake**, EPCM Associates Ltd.

[1] Changes made to the West Central Board for 2000; subject to ratification.

Appendix IV: Contractors and Cooperating Landowners

The West Central Airshed want to express their appreciation to everyone who has contributed in making the program a success. In particular, we would like to note the invaluable assistance of the landowners and co-operators who have contributed both time and resources to this program.

Contractors:

Maxxam Analytics Inc.
Jacques Whitford Environment Limited
Dr. Allan Legge, Biosphere Solutions
Dr. Sagar Krupa, University of Minnesota
Dr. Allan Reid, Brooks Diagnostics
Larry Turchenek, Landcare Research
Elaine Ryl, Agricultural Crop Operations
Eric Peake, EPCM Associates Ltd.
Bob Scotten, 724108 Alberta Ltd.

Co-operators:

Bill and Sylvia Flesher
Garth and Rosemary Parker
Dave and Gloria Jouan
Deeluw Farms
Ian and Pauline Dunn
Cliff and Audrey Whitelock
Weldwood of Canada

Appendix V: Supporters

Following is a list of agencies and organizations that have supported the work of the West Central Airshed Society, by contributing cash and/or in-kind donations of goods and services. We apologize for any omissions and would appreciate being notified of these.

Alberta Agriculture, Food and Rural Development
Alberta Energy and Utilities Board
Alberta Energy Company Ltd.
Alberta Environment
Alberta Research Council
Alta Gas Services Inc.
Amoco Canada Petroleum Co Ltd.
Anderson Oil & Gas Inc.
Apache Canada Ltd.
ATCO Electric
Beau Canada Exploration Ltd.
Bonterra Energy Corp
BP Amoco
Bumper Development Corp Ltd.
Burlington Resources Ltd.
Canada Forest Oil Ltd.
Canadian Association of Petroleum Producers
Canadian Natural Resources Ltd
Cardinal River Coals Ltd.
Chevron Canada Resources
Clean Air Strategic Alliance
Compton Petroleum Corporation
Conoco Canada Ltd.
Crestar Energy
Drayton Valley Power
Edge Energy Inc.
Elk Point Resources Inc.
EOG Resources Canada Inc.
Encal Energy Ltd.
Environment Canada
Fletcher Challenge Energy Canada Inc.
Glencoe Resources Ltd.
Gulf Canada Resources Limited
Husky Oil Operations Ltd.
Imperial Oil Resources Limited
Ionic Energy Inc.
Keyspan Energy Canada
Luscar Ltd.
Lario Oil & Gas Company
Marathon Canada Limited
M.D. of Brazeau No. 77
M.D. of Yellowhead No. 94
Mobil Oil Canada
Mountain Energy Inc.
N C E Resources Group Inc.
Norcen Energy Resources
Numac Energy Inc.
Obed Mountain Coal Ltd.
PanCanadian Petroleum Limited
Pembina Agricultural Protection Association
Pembina Institute for Appropriate Development
Penn West Petroleum Ltd.
PetroCanada Oil and Gas
Place Resources Corporation
Renaissance Energy Ltd.
Rider Resources Inc.
Rio Alto Exploration Ltd.
Shiningbank Energy Mgmt Inc.
Signalta Resources Ltd.
Stellarton Energy Corporation
Suncor Energy Inc.
Sundance Forest Industries Ltd.
Talisman Energy Inc.
Tethys Energy Inc.
Texaco Canada Petroleum Inc.
Town of Drayton Valley
Town of Edson
Town of Hinton
TransAlta Utilities Corporation
Trans Canada Transmissions
Vermillion Resources Ltd.
Weldwood of Canada
Weyerhaeuser Ltd.
Wolcott Gas Processing Ltd.

Glossary of Terms

Abbreviations

CASA - Clean Air Strategic Alliance is a multi-stakeholder society sponsored by the Departments of Health, Energy, and Environment which provides a forum to discuss and address issues related to air quality in the province.

CH_4 - methane is a colorless, odourless gas, which is the most common hydrocarbon in the earth's atmosphere. It is of significance as a greenhouse gas responsible for global warming. About 20% of the total greenhouse effect is attributable to methane.

Critical Load - the highest deposition load that will not cause chemical changes leading to long-term harmful effects on the most sensitive ecological systems.

NO_x - oxides of nitrogen are formed when nitrogen combines with oxygen during the combustion of fossil fuels. Other sources are the natural degradation of vegetation and the use of chemical fertilizers. Oxides of nitrogen affect visibility and lead to ozone formation. For monitoring purposes nitrogen oxides are considered to be the sum of nitric oxide and nitrogen dioxide.

NO - nitric oxide is the major oxide of nitrogen produced by combustion. It is rapidly oxidized to nitrogen dioxide in the atmosphere.

NO_2 - nitrogen dioxide is the most abundant of the oxides of nitrogen in the atmosphere. It is a reddish-brown gas. The Alberta guidelines of a 1-hour average concentration of 210 ppb, a 24-hour average concentration of 110 ppb, and an annual average concentration of 30 ppb, are based on the prevention of human effects.

O_3 - ozone at ground level is generated from emissions of NOx and hydrocarbons. At high concentrations it may contribute to crop damage and cause respiratory problems. The Alberta guideline for ozone is 82 ppb for a 1-hour average. In the stratosphere it protects the earth from excessive ultraviolet radiation.

pH - the measurement of the degree of acidity on a scale of 1 to 14. One is very acidic, 7 is neutral and 14 is very alkaline. The natural pH of precipitation in the absence of pollution is thought to be 5.6.

PM_{10} - particles less than 10 micrometer in diameter, small enough to be inhaled but do not reach the lungs.

$PM_{2.5}$ - particles less than 2.5 micrometer in diameter, small enough to be inhaled and may reach the lungs. Concentrations greater than 20 ug/m^3 are thought to adversely affect pulmonary function.

SO_2 - sulphur dioxide is formed during the processing and combustion of fossil fuels containing sulphur. It is a colourless gas with a pungent odour, and can be detected by taste and odour at concentrations as low as 300 ppb. Historically SO_2 is the main component of acid rain.

Target Load - the maximum level of acidic atmospheric deposition, that affords long-term protection from adverse ecological consequences, and that is practically and politically achievable.

VOCs - volatile organic compounds can be emitted naturally or as by-products of industrial processes. Examples are terpenes produced by forests, ethylene from industrial and natural sources, and chloroform from industry.

Volume-weighted pH - the average pH of precipitation throughout the year when the volume of rainfall and the H^+ concentration of each precipitation sample is considered.

Units of Measure

μm - one one-millionth of a meter (10^{-6}m)
ppb - parts per billion by volume
ppm - parts per million by volume
mg/m^3 - micrograms per cubic meter
keq $ha^{-1} yr^{-1}$ - kiloequivalents per hectare per year
kg $ha^{-1} yr^{-1}$ - kilograms per hectare per year

Definition of Terms

Alberta guideline - concentration value adopted by the Province of Alberta with the intention of preventing deterioration of air quality. Guidelines for SO_2, NO_2, O_3 and several other pollutants are based on the prevention of adverse human health and vegetation effects. Guidelines may be for 1 hour, 24 hours, or 1-year average concentrations.

Ambient air quality - the concentration of pollutants in the ambient air. Generally the concentrations of gases or particles to which the general population would be exposed, as opposed to the concentration of pollutants emitted by a specific source.

Average annual concentration - the sum of the 1-hour average concentration measurements for the year divided by the number of hours that measurements were made within that year. It can be compared against the recommended guideline for the same period to assess absolute air quality or against other year's data to assess improvement or degradation of air quality in the same air.