WOOD BUFFALO ENVIRONMENTAL ASSOCIATION

WBEA

[*2001 annual report*]

We are not green activists.

Far from being front page news, we are in the background as

quiet watchdogs, gathering the information that is central to

the environmental health of our region.

AND US.

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[1.1 INTRODUCTION]

As much as the WBEA would like to be in the headlines as green activists, that is not what we do. Far from being front page news, we are in the background as quiet watchdogs, gathering the information that is central to the environmental health of our region. It is only in fiction that a brilliant detective determines the events by intuition. In reality, it is the beat cop, painstakingly knocking on doors who gets the answers. The answers we found are here, on our website and in the volumes of data we have collected, and continue to collect 24 hours a day, 365 days a year. The chief objective of the WBEA is to monitor the environment in a manner that is transparent and open to scrutiny by all interested stakeholders. This produces credible monitoring results to be used for effective environmental management of emissions in the Wood Buffalo region. It's not a job that makes headlines, but is vital, nonetheless.

[1.2 ORGANIZATION]

The Wood Buffalo Environmental Association is a not-for-profit society registered under the Societies Act of Alberta. The ambient air program of the WBEA was the second regional airshed management zone to be developed in the province.

The WBEA currently consists of a number of committees and a governing board. The committees are operational in function, helping to carry out the work of the Association. They are:

> Ambient Air Technical Committee (AATC)
> Terrestrial Environmental Effects Monitoring Committee (TEEM)
> Communications Committee

The Association's Board of Directors meets at least quarterly. It is supported by a Management Committee, which carries out the decisions of the Board and by a full-time Chairman and Executive Director. The Board makes decisions only by consensus thus ensuring that every member has an equal voice at the table.

Management Committee:

> Ann Dort-MacLean, *Fort McMurray Environmental Association*
  President
> Gordon Kemp, *Suncor Energy Inc.*
  Vice-President
> Ken Shipley, *Fort McKay First Nation & Metis Local 122*
  Director
> Ted Ostrowski, *Syncrude Canada Ltd.*
  Director
> Maged Said, *Albian Sands Energy Inc.*
  Secretary Treasurer
> Lisa Schaldemose, *Executive Director, WBEA*
  Chair

Based on a formula relative to emissions, industry members provide ongoing operating and capital funding. With an annual direct budget of approximately $2.5 million and a number of in-kind contributions, actual costs of operating the WBEA are substantially greater than this figure. The time contributed by community representatives to the Organization has been immeasurable. Membership in the Association has grown to twenty-two full status members and one associate member.

[1.3 PURPOSE]

The Wood Buffalo Environmental Association is a cooperative endeavour. As such it must reflect the concerns of the community at large and balance them with the needs of industry. The objectives of the WBEA are to:

1. promote and foster cooperative effort among government, community, aboriginal groups and industry directed at establishing and maintaining a program for environmental monitoring and research in the Wood Buffalo Region of Alberta,
2. generate research and development projects, including application of traditional knowledge and expertise, to ensure that environmental protection practices used by resource developers can be implemented effectively,
3. establish and maintain a program for environmental monitoring and research in the Wood Buffalo Region,
4. act as a liaison among industry, government, aboriginal groups, communities and the public in matters pertaining to the monitoring of environmental conditions, and
5. cooperate with government, aboriginal groups and the public in establishing needs and priorities pertaining to the monitoring of environmental conditions.

[2.1 PRESIDENT'S REPORT]

As technology improves in air monitoring and environmental studies, the WBEA is at the forefront in evaluating how these advancements might apply to our regional air monitoring network. As a result, the WBEA leads the way with our 'state of the art' monitoring programs.

We prefer to address regional air monitoring issues. One such issue is the need for continuous review of the parameters of what we are monitoring and the availability of equipment to detect smaller trace elements. A plan is currently in the works for the strategic placement of air monitoring equipment.

With the ever increasing expansion of the oil sands industry and the resulting membership, the WBEA will be focusing on some of the larger issues and questions that arise from our discussions with each member.

Equally important is building community trust through open and honest communication. The membership work together to ensure that we not only do an excellent job of data collection but that we work with the surrounding communities to communicate that data effectively. With the continued dedication of the staff and the membership, the Association will continue to lead the way in environmental monitoring.

Ann Dort-MacLean
President

[2.2 EXECUTIVE DIRECTOR'S REPORT]

In its fourth year of operation, the Wood Buffalo Environmental Association met 2001 head on, prepared to meet the challenges of both the increasing activity in the region and for the Association.

The WBEA welcomed five new members to the table this past year: Toxic Watch Society of Alberta, Williams Energy (Canada) Inc., Canadian Natural Resources Ltd., Petro-Canada and TrueNorth Energy L.P. It is important that as development of our region's natural resources intensifies, stakeholders collaboratively participate in monitoring the impacts on the environment. To be accepted as a member in the WBEA, an applicant must commit to the Association's philosophies and principles as well as demonstrably add value to discussions and decision-making. Thus, each new member represents a contribution that will build upon the strength of the planning and delivery of our programs.

The Ambient Air Monitoring Network (AAMN) added another continuous air monitoring station at Suncor Energy Inc.'s Millennium Station, bringing the network to twelve stations spanning from Fort McMurray, through the plant sites and Fort McKay and including a northern station in Fort Chipewyan. As oil sands projects south of Fort McMurray are progressing towards operation, the WBEA anticipates those operators will become involved with the Association to extend our monitoring programs south.

In 2001, the AAMN boasted a 98.6% operational uptime for the 60 analyzers housed in the WBEA air monitoring stations that run 24 hours a day, 365 days a year. To ensure the integrity of the network and maintain this high average, the WBEA Ambient Air Technical Committee put a 4-year environmental equipment replacement plan into effect. It is also important to the Association that the network itself be as effective as possible. For this reason we initiated a project to determine the environmental and social benefits of placing network stations in accordance with a strategic plan for the entire region, to enhance the existing system of a project-by-project approval fulfillment.

The report is just one component of the Association's Communication Program. Our aim is to communicate the results of our technical programs in plain language that is not only understandable but also provides information for good decision making by community members, industry managers and

government officials. 2001 was a very productive year as we redesigned the website to be more user-friendly and conducted a survey of 400 Wood Buffalo residents to determine the effectiveness of our communications efforts.

The Terrestrial Environmental Effects Monitoring (TEEM) Program had a pivotal year in 2001. In addition to its long-term monitoring projects, the TEEM Committee of the WBEA conducted a workshop to address direct effects of air emissions on terrestrial ecosystems, in particular to those of our region. Experts from Europe and the U.S. toured the Wood Buffalo area and examined TEEM monitoring sites, providing the group with valuable insights based on their expertise in studying the ecological effects of air pollutants. This information, as well as a list of recommendations from the workshop, will help enhance TEEM Program development in the coming year.

New TEEM projects for 2001 included: a statistical review of the analysis of TEEM forest data, the development of a computer program to estimate dry deposition of nitrogen (to complement our model for sulphur), the analysis of data collected in the annual Spring Acid Pulse project and the establishment of a new forest sampling plot northeast of the Syncrude plant site. The success of TEEM is in a large part due to building upon the strengths that exist by regularly evaluating its projects and their science and then filling in the gaps between community concerns and data collection.

The WBEA ambient air continuous data for 2001 show slight increases in average 1-hour concentrations for:

sulphur dioxide – from 2.2 ppb to 3.0 ppb
(Alberta Ambient Air Quality Guideline = 172 ppb)

nitrogen dioxide – from 9.4 ppb to 10.0 ppb
(Alberta Ambient Air Quality Guideline = 212 ppb)

ozone – from 27.5 ppb to 28.9 ppb
(Alberta Ambient Air Quality Guideline = 82 ppb)

particulate matter (2.5) – from 6.4 µg/m^3 to 7.3 µg/m^3 for a CWS 24 hr guideline of 30 µg/m^3

The data also indicate decreases in average 1-hour concentrations for:

hydrogen sulphide – from 1.05 ppb to 0.7 ppb

carbon monoxide – from 0.26 ppm to 0.20 ppm

The total number of occasions that the Alberta Ambient Air Quality Guidelines were exceeded decreased from the previous year. In 2000 and 2001, the 1-hour guideline for sulphur dioxide was exceeded 4 times. The 1-hour guideline for H_2S was exceeded 82 times in 2000 and 31 times in 2001. No other guidelines were exceeded in either year.

The Association does not expect activity in the region to slow in 2002. My hopes for the WBEA next year are to continue leading the way for environmental monitoring to keep pace with the growth in the Wood Buffalo area and to effectively balance economic activity with environmental responsibility.

Lisa Schaldemose
Executive Director

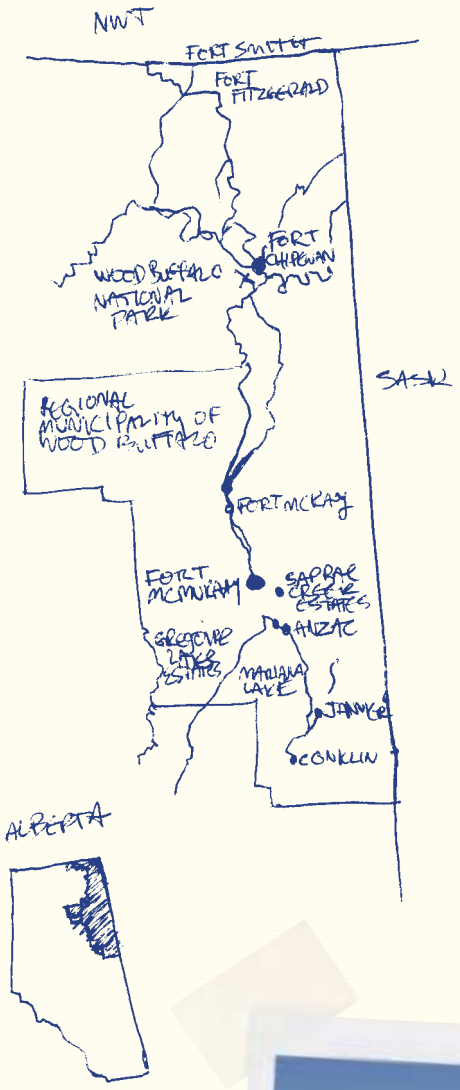
[3.1 AIR MONITORING PROGRAM]

The WBEA air quality monitoring program operates 365 days a year collecting scientifically credible data related to human and ecosystem health.

Spanning the Regional Municipality of Wood Buffalo, a network of twelve ambient air quality monitoring stations continuously monitor air emissions and parameters including: sulphur dioxide, oxides of nitrogen, hydrocarbons, total reduced sulphur compounds, ozone, carbon monoxide, particulates and meteorology (fig.4). They are located in the communities of Fort McKay and Fort Chipewyan, in the City of Fort McMurray and near the plant sites of Syncrude Canada Ltd., Suncor Energy Inc. and Albian Sands Energy Inc.

The WBEA also operates a network of ten passive monitoring stations to measure concentrations of sulphur dioxide, nitrogen dioxide and ozone at remote forest locations. These stations provide average concentrations of these pollutants over specific time intervals.

To ensure the highest quality data are collected by the Ambient Air Monitoring Program, the WBEA has rigorous quality control and assurance programs in place. These programs include daily calibration and monitoring of instrument performance with monthly multi-point calibrations and regular annual and biannual government audits. Data are reviewed for long term systematic errors and all raw and quality controlled data are archived for future reference. WBEA information contributes to the Clean Air Strategic Alliance (CASA), province-wide integrated data management system.



3.1.1 SULPHUR DIOXIDE (SO_2)

characteristics

Sulphur dioxide is formed during the processing and combustion of fossil fuels containing sulphur. A colourless gas with a pungent odour, it 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 irritate the upper respiratory tract and aggravate existing cardiac and respiratory disease. Long-term exposure may increase the risk of chronic respiratory disease.

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

sources

It is estimated that sulphur dioxide emissions within the Wood Buffalo Zone averaged 302 tonnes per day (tpd) in 2001. Suncor and Syncrude were the major sources in the region, emitting approximately 64.12 tpd and 237.8 tpd respectively in 2001.

alberta guidelines

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

> 1-hour average of 172 ppb
> 24-hour average of 57 ppb
> annual average of 11 ppb

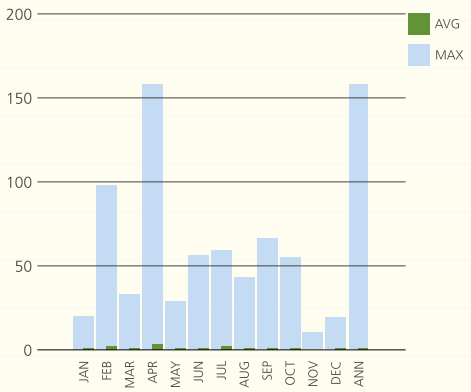
monitoring results

In 2001, the average sulphur dioxide concentration in the ambient atmosphere was highest at the Mildred Lake Station (AMS 2), 3 ppb, followed by the Mannix, Albian Mine and Lower Camp stations (AMS 5, 10 and 11, respectively), all with 2 ppb. The lowest average concentration was recorded at Fort Chipewyan (AMS 8), 0 ppb (Table 1). This range of concentrations is consistent with the location of the monitoring stations. The Mildred Lake Station is located within the boundary of the Syncrude Lease, while Fort Chipewyan is remote from major sources of pollutants. Concentrations at Fort Chipewyan averaged 0 ppb in 2001, 0.2 ppb in 2000 and 0.4 ppb in 1999. This station is also remote from major industrial sources of pollution. The 2001 yearly average concentration at the Athabasca Valley Station in Fort McMurray was 1 ppb, and 1 ppb at Fort McKay. These values are similar to the averages of 0.9 ppb and 1 ppb recorded at the two stations in 2000.

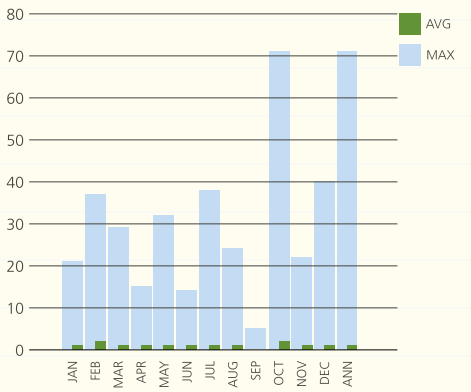
The Alberta guideline for 1-hour average SO_2 concentration of 172 ppb was not exceeded in the population centers of Fort McMurray, Fort McKay, or Fort Chipewyan. The 1-hour guideline was exceeded on four occasions at stations located close to the plants. The maximum 1-hour values reached in the town stations were 158 ppb at Fort McKay, 78 ppb at the Patricia McInnes Station in Fort McMurray, and 25 ppb at Fort Chipewyan (Table 1). Closer to the plants a maximum of 289 ppb was reached at the Lower Camp Station. This is similar to the maximum 1-hour concentration of 284 ppb recorded in 2000 but higher than the 168 ppb recorded in 1999.

figure 1 - maximum and average sulphur dioxide 1-hour concentrations for each month in 2001.

SO_2 concentrations at Fort McKay



SO_2 concentrations at Athabasca Valley



3.1.2 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 and is rapidly changed to nitrogen dioxide in the atmosphere.

A reddish-brown gas with a pungent, irritating odour, it has been linked to respiratory disease and 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 emerges shortly after exposure followed within a few days by bronzing.

sources

Major sources of nitrogen oxides within the Wood Buffalo are the oil sands extraction and processing plants followed by local vehicle use and light industry. In 2001, Syncrude and Suncor emitted 55.3 tpd and 60.7 tpd of NO_x respectively.

alberta guidelines

Alberta Environment guidelines are based on the prevention of human health effects. They are equal to Environment Canada's most rigorous 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 212 ppb
> 24-hour average of 106 ppb
> annual average of 32 ppb

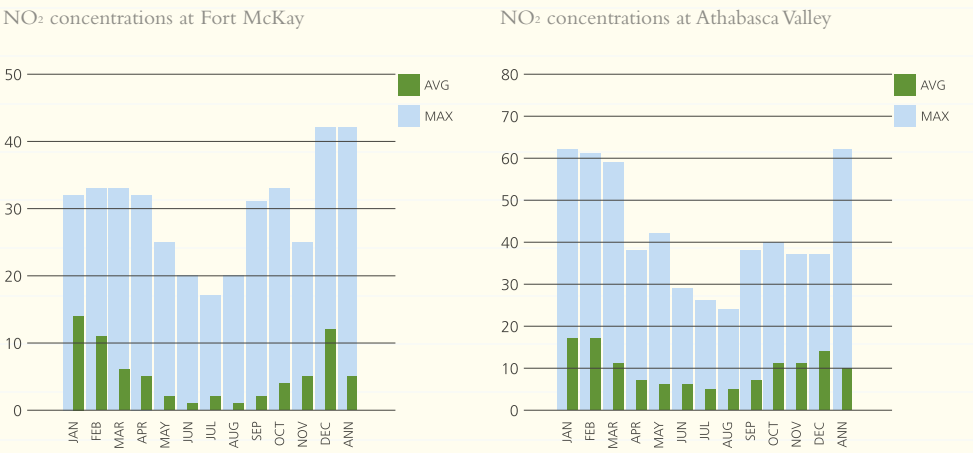
monitoring results

Ambient atmospheric concentrations of nitrogen dioxide (NO_2) are monitored at five locations in the Wood Buffalo zone. The average annual concentration of nitrogen dioxide in 2000 ranged from a low of 1 ppb at Fort Chipewyan to a high of 10 ppb at the downtown (Athabasca Valley, AMS 7) and Albian Mine air monitoring stations. The 2001 average at the downtown site was similar to that measured in 2000, 9 ppb, and to the 9 ppb in 1999. Nitrogen dioxide concentrations at this location reflect emissions from nearby motor vehicle traffic. At the residentially located Patricia McInnes monitoring station and at Fort McKay, the average concentrations were

10 and 5 ppb respectively. The 2001 average for the Albian Mine Station, 10 ppb was also similar to that recorded for the monitoring conducted during the last four months of the year, 11 ppb. The higher concentrations at the Albian Mine Station are the result of site preparation work. These values are well below the Alberta guideline of 30 ppb for an annual average NO_2 concentration in ambient air.

There were no exceedences of the Alberta Ambient Air Quality Guidelines for NO_2. The highest maximum 1-hour concentration was recorded at 161 ppb at the Millennium Station (AMS 12) during the four months that monitoring was conducted. Millennium is also undergoing site preparation. The maximum 1-hour value of 62 ppb at the Athabasca Valley Station was in the same range as the maximums of 52 ppb reported in 2000, 47 ppb in 1999, and 51 ppb in 1998. This value is about 25% of the Alberta guideline of 212 ppb for NO_2 as a 1-hour average. At Fort McKay, the maximum of 42 ppb was slightly higher than the 36 ppb measured 2000.

figure 2 - maximum and average nitrogen dioxide 1-hour concentrations for each month in 2001.



3.1.3 HYDROCARBONS (THC)

characteristics

Hydrocarbons are divided into two broad categories, "non-reactive" and "reactive" hydrocarbons. The major non-reactive hydrocarbon in the atmosphere is the colourless, odourless gas, methane, which is a major contributor to the greenhouse effect. The reactive hydrocarbons consist of many volatile organic compounds (VOCs). Some VOCs react with the oxides of nitrogen in the atmosphere to form ozone. These include ethylene, propane, butane, benzene, a-pinene and a host of other hydrocarbons. Among the reactive VOC's are the aromatic compounds benzene, toluene, ethylbenzenes, and xylenes (BTEX). When these are present in sufficient quantities, these compounds affect human health. Polycyclic aromatic hydrocarbons (PAH's) are of higher molecular weight and less volatile and some are known to be carcinogenic.

sources

Large amounts of methane are produced naturally through the decay of vegetation. Trees and plants are major natural emitters of reactive hydrocarbons with other major sources being motor vehicle exhaust, gasoline handling and the petroleum and chemical industries. Combustion processes, both natural such as forest fires, and human influenced such as industrial activities and the use of motor vehicles, result in the formation of PAH's.

The tailings ponds, extraction plant vents and fugitive emissions from the oil sands industries are the most significant anthropogenic sources of reactive hydrocarbons and methane in the region. Exact VOC emission numbers from the oil sands plants are unknown but estimated to be in the 40 to 80 tonne per day range (excluding methane).

alberta guidelines

There are no Alberta guidelines for ambient hydrocarbon concentrations.

monitoring results

Total hydrocarbons are monitored at all Wood Buffalo stations except Fort Chipewyan (AMS 8). Average annual concentrations ranged from 1.8 to 2.1 ppm. Mildred Lake Station (AMS 2) had the highest annual average ambient atmosphere concentration at 2.1 ppm. The highest 1-hour maximum concentration of 11.8 ppm was recorded at Buffalo Viewpoint Station (AMS 4). Buffalo Viewpoint had an annual average of 2 ppm, Lower Camp Station (AMS 11) had an average of 7.2, and the Athabasca Valley Station (AMS 7) in Fort McMurray, had an average of 1.9 ppm. The annual average for Fort McKay was 4.2 ppm. These values are similar to those measured in previous years and are comparable to other rural locations in the province. Maximum 1-hour values of 11.8 ppm at Buffalo Viewpoint were indicative of emissions from nearby industrial sources. Four months of monitoring at the Millennium Station gave an average of 2 ppm and a maximum 1-hour concentration of 3.9 ppm.

Samples were collected at the Athabasca Valley, Patricia McInnes, Fort McKay, Barge Landing and Millennium stations for detailed analysis of volatile organic compound (VOC's) and polynuclear aromatic compounds (PAH's). Millennium Station sample collection began in September 2001. Over the past year the most abundant VOC's were toluene and butane followed by pentane. Ambient atmospheric concentrations of benzene averaged 0.18 ppb at the Fort McKay Station, 0.22 ppb at the Patricia McInnes Station, 0.26 ppb at the Athabasca Valley Station, 0.21 ppb at the Barge Landing Station and 0.15 ppb at the Millennium Station. Average BTEX concentrations were 0.91 ppb at Fort McKay, 0.98 ppb at the Patricia McInnes Station 1.38 ppb at the Fort McMurray Valley Station, 1.59 ppb at the Barge Landing Station and 2.71 ppb at the Millennium Station.

Phenanthrene and pyrene were the PAH's most commonly detected in ambient air samples. Concentrations of phenanthrene averaged 0.007 micrograms per cubic meter (µg/m^3) at Fort McKay, 0.009 µg/m^3 at Patricia McInnes and 0.008 µg/m^3 at Athabasca Valley. Pyrene concentrations averaged 0.003 µg/m^3 at Fort McKay, 0.004 µg/m^3 at Patricia McInnes and 0.002 µg/m^3 at Athabasca Valley. Other PAHs were generally below detection limits.

3.1.4 TOTAL REDUCED SULPHUR COMPOUNDS (TRS)

characteristics

The term total reduced sulphur compounds (TRS) is used to collectively describe hydrogen sulphide and mercaptans. The major component is hydrogen sulphide (H_2S). It is a colourless gas with a characteristic rotten egg odour and is toxic at high concentrations. It should be noted that continuous analyzers may read many sulphur compounds as H_2S when they are in fact mercaptans.

sources

Hydrogen sulphide is produced both naturally and through industrial processes. It is found naturally in coal, natural gas, oil, sulphur hot springs, sloughs, swamps, and lakes. The decomposition of organic matter by bacteria with no oxygen present results in the release of H_2S. This produces the characteristic odour commonly associated with sewers, sewage lagoons, and swamps. Industrial sources are primarily petroleum refining, petrochemical complexes, and pulp and paper mills.

Sulphur is removed from bitumen by oil sand industries, first as H_2S and then converted into elemental sulphur or burned to produce SO_2. However, some H_2S does escape from fugitive sources within the plant areas. H_2S is released from the tailings ponds on an intermittent basis as well. The majority of the TRS is H_2S with light mercaptans making up most of the remaining.

alberta guidelines

The guidelines for maximum permissible concentrations of H_2S are based on the odour threshold, although many individuals can smell H_2S at levels below the ambient guidelines. Alberta has adopted Environment Canada's most rigorous ambient objectives for maximum permissible H_2S concentrations.

The Alberta guidelines are:
> 1-hour average of 10 ppb
> 24-hour average of 3 ppb

monitoring results

Hydrogen sulphide is monitored at four WBEA stations and TRS at five additional stations. The highest average H_2S concentration was recorded at the Mannix Station (AMS 5), with 7 ppb while Mildred Lake Station (AMS 2), Lower Camp Station (AMS 11) and Buffalo Viewpoint Station (AMS 4) had average annual concentrations of 6, 5 and 4 ppb, respectively. These values reflect emissions from the plant sites. TRS annual averages at the Athabasca Valley, Patricia McInnes, and Fort McKay stations were 2, 4 and 5 ppb, respectively.

The 1-hour Alberta Environment guideline for H_2S of 10 ppb was exceeded 12 times at the Mannix Station with the maximum 1-hour measurement being 28 ppb. At the Mildred Lake Station, the guideline value was exceeded on 6 occasions with the maximum being 22 ppb, and on 4 occasions at the Buffalo Viewpoint Station with a maximum 1-hour value of 12 ppb. At the Lower Camp Station, the guideline was exceeded 3 times with the maximum value recorded as 35 ppb. The number of exceedences and maximum concentrations have dropped from those recorded in 2000. There were 22 1-hour exceedences with a maximum concentration of 28 ppb recorded in 2001 as compared to 61 1-hour exceedences with a maximum concentration of 99 ppb in 2000. There were 4 exceedences of the 1-hour guideline at Fort McKay with a maximum of 18 ppb and 2 at the Patricia McInnes Station with a maximum value of 11 ppb. There were also 10 exceedences of the Alberta Environment guideline for a 24-hour average H_2S concentration with a maximum 24-hour average concentration of 5 ppb at Mildred Lake.

3.1.5 OZONE (O_3)

characteristics

Ozone is both a natural component of the atmosphere and a major constituent of photochemical smog. At normal atmospheric concentrations, it is an odourless, colourless gas but at high concentrations, such as found near photocopier machines, laser printers and near electrical discharges, it has a sharp, distinctive odour.

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 in the atmosphere through a series of complex chemical reactions. Concentrations are controlled largely by emissions of nitrogen oxides and reactive hydrocarbons. These reactions may lead to an increase in ozone concentrations or a decrease, as in the case of Alberta cities. Ozone is also 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:
> 1-hour average of 82 ppb
> 24-hour average of 25 ppb

Provincial and Federal guidelines are presently under review.

monitoring results

Ozone is monitored at four stations in the Wood Buffalo zone: Fort McKay, Patricia McInnes, Athabasca Valley, and Fort Chipewyan. There were no exceedences of the Alberta Ambient Air Quality Guidelines for ozone in 2001. The highest hourly concentration measured in 2001 was 48 ppb at the Athabasca Valley and Fort Chipewyan Stations (Table 5). This is well below the Alberta guideline value of 82 ppb. Annual average ozone concentrations ranged from 18 ppb at the Athabasca Valley Station to 29 ppb at the Fort Chipewyan Station.

3.1.6 CARBON MONOXIDE (CO)

characteristics

Carbon monoxide (CO) is a colourless, odourless, and tasteless gas produced by the incomplete combustion of carbon containing fuels. It has a strong affinity for haemoglobin and thus reduces the ability of blood to transport oxygen. Exposure to concentrations of 400 to 500 ppm for periods of one hour may not produce an appreciable effect, while concentrations in excess of 4,000 ppm may cause asphyxiation. Long-term exposure to low concentrations may cause adverse effects in people suffering from cardiovascular disease.

sources

Transportation is the major source of carbon monoxide with elevated concentrations during the morning and evening rush hours. Other sources include building heating systems, boilers, and industrial operations.

alberta guidelines

The Alberta Environment guidelines for the maximum permissible concentrations of carbon monoxide are based on the prevention of adverse human health effects. The maximum permissible concentrations are:

> 1-hour average of 13 ppm
> 8-hour average of 5 ppm

Alberta Ambient Air Quality Guidelines

> 1-hour average of 15 ppm
> 8-hour average of 3 ppm

monitoring results

Carbon monoxide is monitored at the WBEA's Athabasca Valley Station in Fort McMurray. There were no exceedences of the Alberta Clean Air Guidelines for CO in 2001. The maximum 1-hour average concentration measured in 2001 was 5.8 ppm and the yearly average was 0.2 ppm. Concentrations are well below the Alberta Environment guideline values. The 1-hour maximum of 5.8 ppm is higher than the yearly averages of 4.4 ppm in 2000 and 3.9 ppm measured in 1999. Downtown Edmonton had an average concentration of 0.6 ppm.

3.1.7 PARTICULATES (PM_{10} & $PM_{2.5}$)

characteristics

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

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, from motor vehicles, power plants, gas processing plants, compressor stations, household heating, and forest fires.

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 30 µg/m³, 24-hour averaging time, by the year 2010.

monitoring results

Concentrations of particulate matter are measured both by collection on a filter followed by weighing and by continuous monitoring. Particles collected on filters can then be analyzed for chemical composition. In the Wood Buffalo zone PM_{10} and $PM_{2.5}$ size particles are collected at the Athabasca Valley, Patricia McInnes, Fort McKay, Fort Chipewyan, Albian Mine and Millennium monitoring stations. Concentrations of $PM_{2.5}$ size particles are also continuously monitored at these stations.

Continuous monitoring of $PM_{2.5}$ showed annual average concentrations ranging from 4.4 µg/m³ at Fort Chipewyan to 7.3 µg/m³ at the Albian Mine Station. Maximum 1-hour average concentrations were higher, up to 301 µg/m³ at the Albian Mine Station and 267 at the Athabasca Valley Station.

3.1.8 METEOROLOGY AND AIR QUALITY

influence of meteorology

Air quality is dependent 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 Wood Buffalo Environmental Association air quality monitoring programs are:

> wind speed and direction
> temperature
> difference in temperature at two heights
> solar radiation
> amount of precipitation
> relative humidity
> surface wetness

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

monitoring results

Hourly average temperatures in Fort McMurray ranged from a low of -37.8˚C to a high of 30.5˚C in 2000. At Fort McKay the range was -40.9˚C to 30.1˚C and at Fort Chipewyan, -37.8˚C to 31.0˚C.

Winds at the Fort McMurray Athabasca Valley Station averaged 8.5 kilometers per hour. They were predominantly from the SE, 26% of the time, reflecting the orientation of the river valley. At the Patricia McInnes Station, the influence of the river valley was less pronounced. Winds had a more southerly and westerly component being

from the SW 18% of the time and from the W 15% of the time. Southeast winds were present 15% of the time. Winds were from the north 17% of the time in the valley and 10% of the time at the higher Patricia McInnes Station. At Fort McKay, winds were lighter averaging 7.8 kilometers per hour and were from the S or SE 36% of the time. At Fort Chipewyan, winds were from the east or northeast 34% of the time and from the west or northwest 30% of the time. They were from the south, the direction of the oil sands plants, 8% of the time. Wind speeds were much higher than at the other sites, particularly when blowing off the lake to the east. The annual average wind speed was 15.9 kilometers per hour.

Nineteen precipitation samples were collected in 2001 at the Fort McKay Station and their chemical composition and acidity measured. The precipitation in 2001 had a similar acidity to that of 2000 with the lowest pH recorded being 4.78 and the volume weighted pH for the 19 samples being 5.23. The major constituents of the precipitation were sulphate, nitrate and calcium.

Please refer to Appendix II for additional detail on meteorological observations at each WBEA station.

figure 3 - wind speed and direction.

Station	Annual Avg Wind Speed (Kph)	Primary Wind Direction	Total Annual Percentage	Secondary Wind Direction	Total Annual Percentage
1	7.9	south	25.03	north	18.35
2	9.0	north	21.09	southeast	18.64
3 (20M LVL)	8.4				
4	13.8	southeast	23.02	north	18.40
5 (20M LVL)	10.9	south	24.87	southeast	16.25
6	9.3	southwest	17.63	southeast	16.81
7	9.0	southeast	25.13	north	18.12
8	17.2	east	24.29	north	18.59
9	5.2	south	23.80	southwest	17.10
10	7.0	south	22.12	southwest	18.69
11	9.6	southeast	26.89	north	17.17
12 (SEPT-DEC)	15.6	south	30.34	southeast	25.26

3.1.9 PASSIVE MONITORING

characteristics

Passive monitoring systems are useful adjuncts to continuous air monitoring networks. They require no expensive shelters or power, and can be deployed in remote locations. They provide average concentrations of pollutants over a previously selected monitoring period, usually one to three months.

monitoring program

The WBEA uses a network of passive monitors to measure concentrations of sulphur dioxide, ozone, and nitrogen dioxide at remote forestry locations. The network consists of 10 stations. Passive samplers are affected by both meteorological conditions and their location in relation to the forest canopy. During 2000, the proximity of several samplers to the forest canopy was adjusted to provide results that are more representative of air quality at that location.

A program to validate the passive monitoring systems was carried out at the Fort McKay and Patricia McInnes continuous air monitoring stations by co-locating a passive monitor with a continuous analyzer.

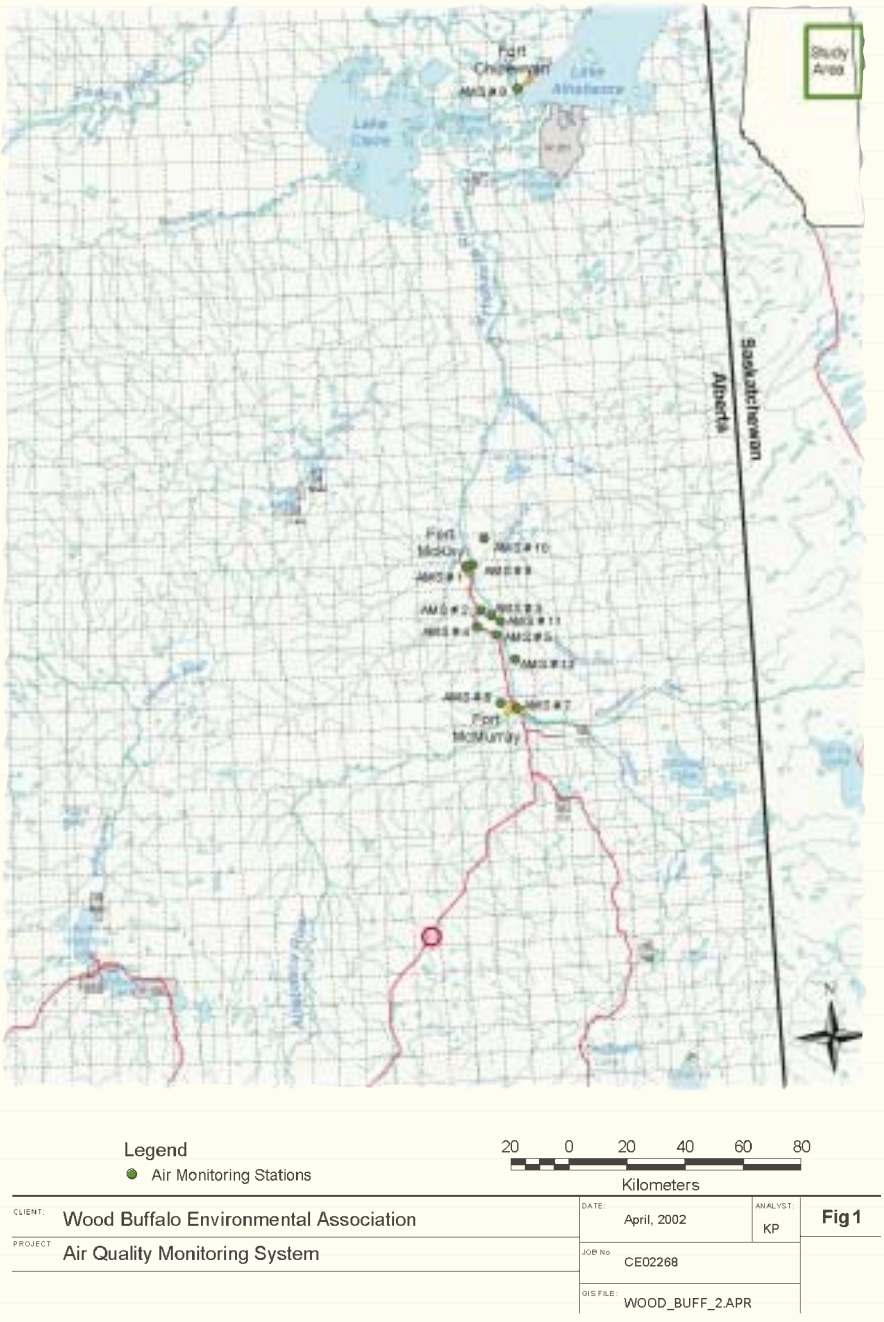
monitoring results

The validation program showed annual average concentrations of SO_2 measured by the passive monitors and continuous air quality monitors at the Patricia McInnes Station agreed within 20%, while individual measurements differed considerably. Passive SO_2 concentrations for the year averaged 0.21 ppb more than those measured with the co-located continuous SO_2 monitor with the greatest difference being 1.3 ppb. The two methods gave average nitrogen dioxide concentrations that differed by 1.4 ppb, or 28% and ozone concentrations differed by 0.8 ppb, or 4%. At Fort McKay, the differences were comparable with the SO_2 passive sampler giving average concentrations that were 0.27 ppb, or 22%, higher than the continuous monitor was. The precision of the continuous monitor is 0.4 ppb. Passive nitrogen dioxide measurements averaged 2.34 ppb, or 38% lower than the continuous measurements. Ozone concentrations differed by only 1.31 ppb or 6.4% at this station.

The average concentrations of sulphur dioxide, nitrogen dioxide, and ozone were measured monthly at each remote station over the year. Concentrations are shown in Table 8 of Appendix I.

The sulphur dioxide measurements are consistent with the continuous monitoring data from Fort McKay and Fort McMurray. Highest sulphur dioxide values were measured at sites closer to the oil sands plants to the east and southeast. The highest average concentration was 2.29 ppb at site JPH4 followed by 1.84 ppb at site AH7 that it located to the southwest but closer to the plants. Sites located at greater distances from the sources had the lowest concentrations. The average sulphur dioxide concentrations at a station east of Fort McMurray across the Saskatchewan border were 0.30 ppb. Nitrogen dioxide showed the same general trends with the highest average concentration of 1.99 ppb being found at the jack pine monitoring site designated JPH4. In comparison with continuous monitoring results from the Patricia McInnes, and Fort McKay Stations, the passive NO_2 results appear low. Ozone results from the passive samplers were similar to those from continuous monitors and varied little among the sites. The highest average ozone concentration was 29.68 ppb, measured at AH7 that is located southeast of the oil sands plants.

figure 4 - regional distribution of WBEA air monitoring stations in the wood buffalo region.



STUDIES CONDUCTED IN 2001

This report summarizes the monitoring programs conducted by the Terrestrial Environmental Effects Monitoring Committee (TEEM) of the WBEA.

Prior to the inception of the TEEM Program in 1997, terrestrial effects monitoring was carried out by the industries in the area. Selected projects from the industries have since been incorporated into the TEEM Program.

* *aerial infrared vegetation stress survey*

This survey documents changes over time of the extent of vegetation stressed by atmospheric emissions associated with oil sands mining, processing, and upgrading. Areas of stressed vegetation are identified on false colour infrared aerial photographs at a scale of 1:10,000. Field surveys are conducted to confirm the areas of vegetation stress and to characterize the cause and degree of stress. Syncrude conducted these surveys in 1978, 1984, 1990, and 1996. This study was adopted by the TEEM program and an expanded study area was surveyed in 2001. Prior to 2001 the study area was a 15 km by 32 km rectangle centered on the Syncrude and Suncor plants. In 1990 and 1996 it also included a 42.5 km by 2 km wide transect extending 42.5 km southeast from the confluence of the Steepbank and Athabasca Rivers. The 2001 survey area was a 30 km by 60 km rectangle that included the previous study areas as well as the Syncrude Aurora South, Albian Sands Muskeg River, and Suncor Millennium mine sites.

The percent of the study area with stressed vegetation was 11.1%, 22.0%, 26.4%, and 3.7%, respectively in 1978, 1984, 1990, and 1996. Results of the 2001 survey were not available at time of publication. Stressors were identified as air pollution, insects and disease, human disturbance (timber harvesting, well-sites, borrow pits, etc.). The percent of the study area with vegetation stressed by air pollution was 3.1%, 8.2%, 8.8%, and 0.4%, respectively in 1978, 1984, 1990, and 1996. Based on the percentage of vegetation with visual symptoms of stress, the degree of stress was classified as:

> low (10-25%)
> medium (26-50%)
> high (51-75%)
> extreme (76-100%)

The degree of stress was almost entirely low in 1978 and 1996, and equally divided between low and medium in 1984 and 1990. The stressed areas have largely, but not entirely, occurred within and near the Athabasca River Valley and its principal tributaries.

The dramatic reduction in areas of stressed vegetation due to air pollution from earlier surveys to 1996 is noteworthy, since there has been no substantial reduction in emissions during this time. The low area of stress in 1996 may be accounted for by increased health and vigour of vegetation as a result of favourable moisture conditions that year, as compared to less favourable conditions in 1990 resulting from drought.

The 2001 survey has been completed and the report is currently under review. Due to increased development in the region, the survey area has been expanded. It is important to note that this increase in area will result in a compromise in compatibility when comparing the percentage of stressed vegetation across survey years.

* *trace metals in deer mice*

This involved an analysis of the trace metal content of vegetation and small mammal tissues collected in 1987 and 1994 at sites ranging in distance from 6 km to 72 km south of the Syncrude and Suncor oil sands plants. The objective was to document, through periodic surveys, environmental accumulation and movement of trace metals up the food chain over time. This study was conducted by Syncrude prior to 1996 and was tentatively adopted in 1996 as part of the WBEA-TEEM program. The scheduled survey for 2000 was put on hold, however, until an overall TEEM program review has been completed.

In the 1987 survey, soil samples, vegetation (Lesko, 1990), and small mammal samples (Pauls and Arner, 1989) were collected at oil sands sites and at four urban park locations within Edmonton city limits. Soil samples were taken from the surface organic (litter and humus) layers. Vegetation samples consisted of the above-ground portion of fireweed. Small mammal samples consisted of whole bodies of deer mice and red-backed voles. Samples were analyzed for all trace metals emitted in significant quantities from oil sands operations. In soil samples, only nickel and vanadium showed accumulation above background levels and only in the humus layer. No trace metal accumulations were noted in the

fireweed samples or in the red-backed vole samples. There appeared to be some elevation of aluminium, copper, and titanium and a reduction of barium in deer mice nearer the oil sands plants, as evidenced by a weak but statistically significant correlation between distance from the emission source and metal concentration. Aluminium, copper and titanium were negatively correlated with distance from the emission source; barium was positively correlated with distance from the emission source. In all cases metal concentrations at oil sands locations were similar to, or less than, metal concentrations within Edmonton city parks. There were no instances of metal concentrations that would be considered damaging to the deer mice or that would pose a risk to predators of deer mice.

* *trace metals in traditional country foods*

This addressed concerns about the accumulation of substances released from oil sands operations in regional plants, fish, and wildlife used as foods by aboriginal residents. Members of the Fort McKay and Fort Chipewyan communities identified the species and parts of plants, animals, and fish to be sampled, based on frequency of consumption. Vegetation samples were collected in 1999 and 2000; fish and wildlife samples were collected in the winter of 1999/2000. Samples were collected from the Fort McKay and Fort Chipewyan traditional harvest areas. Vegetation samples included berries, berry leaves, Labrador tea leaves, mint leaves, cattail root, and ratroot root. Animal tissues included fish fillets, beaver and hare muscle and liver tissue, and moose and grouse muscle tissue. This report is currently in the final stages of review.

* *spring acid pulse studies*

This is an assessment of the role of acidic deposition in the spring pH depression in regional streams. This program was started in 1989 by Alberta Environment and continued with support from WBEA in 1990, 1996, 1998, 1999, and 2000.

The study conducted in 1990 had documented a reduction in pH during the spring snowmelt in the Steepbank River and the Firebag River. A pH drop was not observed in the Muskeg River. Stream flow and pH were monitored continuously during the spring run-off in the headwaters of the Steepbank and Firebag Rivers in 1996 and in the Muskeg River as well in 1998. Water samples were taken periodically for analysis at several sites along each stream.

The WBEA-TEEM program provided funding support to Alberta Environment to complete a report on this project in 2001. The report was not available at the time of writing. Preliminary results suggest that an acid pulse did not occur in 1996 and 1998. Further studies are likely to be needed to determine the frequency of occurrence and the factors underlying spring acid pulses.

* *soil acidification and forest health studies*

This work was designed to monitor potential effects of acid deposition on forest soils and vegetation. Permanent plots were established in 1998 to monitor changes in soil and forest health that may be related to acidic deposition. Initially plots were established in both jack pine and aspen forest communities, since both communities occur on the most acid-sensitive soils in the region. Studies were completed on the jack pine plots in 1998 to establish baseline conditions (AMEC, 2001). Planned studies on aspen plots in 1999 were put on hold pending further assessment of the value of monitoring in this colonial community species.

Ten jack pine plots were established: five near the oil sands plants and five at more distant sites. Plots were as ecologically similar as possible to facilitate comparison.

Visual examination of the plots has been conducted annually since 1998 (AMEC 2000a, 2000b, 2000c) to document disease, insect, mechanical damage, tree mortality, and general forest health. A photographic record of canopy closure/density was obtained. Armillaria root rot is present on the plots and is thought to have caused the death of seven trees between 1998 and 1999 and three trees from 1999 to 2000. Chlorosis of three year old needles was noted in all three years. A decrease in retention of four-year old needles was noted from 1998 to 1999 and a decrease in retention of three year old needles was noted from 1999 to 2000. Progressive needle loss was attributed to drought conditions in 1998 and 1999 and a five-day period of above-freezing temperatures in February, 2000, resulting in dehydration of needles. Tree health was considered normal for the region, with damage attributed to natural (i.e. insect, disease, etc.) causes.

Selected indicators of soil acidification were pH, exchangeable base saturation, soil solution calcium: aluminium ratio, and total sulphur. Exchangeable base saturation and calcium: aluminium ratio were considered to be the best indicators of acidification. Evidence of long term sulphur accumulation was

detected, consistent with 30 years of sulphur emissions and deposition. Total sulphur accumulation in soils was higher on plots closer to the plant sites. Differences were relatively small but were evident across several of the upper soil layers. There was, however, no evidence of accompanying changes in other aspects of soil chemistry with distance from the plant sites.

Vegetation monitoring parameters included height and radial growth of trees, annual shoot growth, percent needle retention in each of one to seven year old needles, and foliar chemistry. Average annual height growth over the lifetime of the trees did not differ significantly with distance from the plant sites. Annual shoot growth over each of the last seven years was greater on the near than the far deposition plots. Before 1968, when oil sands industry emissions began in the region, radial growth was greater on the near than on the far deposition plots. After 1968 radial growth did differ significantly between near and far deposition plots. The differences in reduction of growth rate from the pre- to the post-emission era on near versus far deposition plots were, however, statistically insignificant. There does not appear to be any acid-deposition related change in soil properties or tree growth at this time.

Six potential new monitoring sites were recently selected (AMEC, 2001). One of the far deposition sites (JPL8), located in Saskatchewan, had characteristics that were not comparable to the other nine sites. A replacement site in Saskatchewan has been selected.

Due to the number of new oil sands developments, activity is starting to encroach on the distant monitoring sites. Four potential new sites were identified at 100-150 km distance from current oil sands development. In addition to these sites, an effort was made to identify the highest deposition site in the region with the appropriate vegetation type. A monitoring site (JP212) was established at a location 10 km from the main emission sources and the same sampling and measurements that were taken in 1998 at the other sites was completed on this site in 2001. A report was in preparation at the time of writing.

* *effects of nitrogen deposition on peatland vegetation*

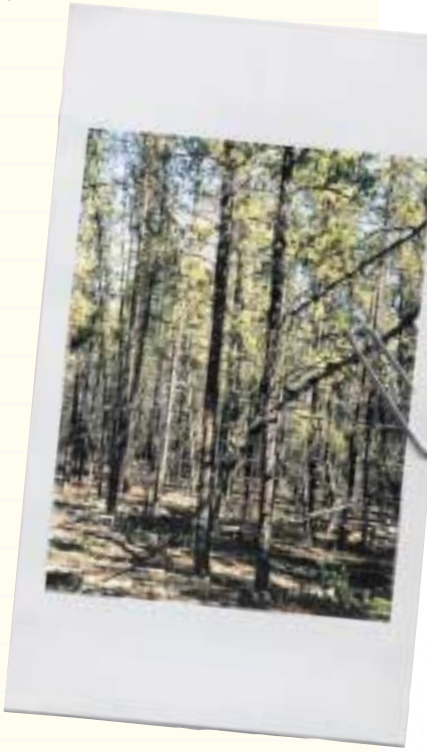
Growth rate of bryophyte species was measured during the growing season in a series of bogs along a gradient of high to low nitrogen deposition to determine whether vegetation has been altered by oil sands emissions. Vertical cores were taken at these sites to determine whether the onset of nitrogen emission caused changes in nitrogen content of plant tissues or changes in plant growth rates. Results and recommendations were not available at the time of writing.

* *monitoring plans for 2002*

Monitoring studies for terrestrial effects of air emissions from oil sands facilities have been ongoing since 1996 under the TEEM program. Some studies are continuations of previous work as noted in the preceding texts. During 2001 the multi-stakeholder TEEM committee agreed to significant enhancements to the program which will be brought in over the next several years. New components include nutrient enrichment (primarily nitrogen) and direct gaseous effects monitoring.

The following projects are planned for the 2002 field season.

> Soil Acidification and Forest Health Survey
> Vegetation Stress Survey
> Soil Microbiology Study
> Lichen Study
> Database Development



WBEA's Communications Program expanded its role this past year to deliver its message to the public face-to-face. In addition to providing information through a variety of media, including CJOK/KYX radio, the Fort McMurray Today paper, the WBEA quarterly newsletter, the WBEA information line and website, the Association gave presentations, visited a number of schools and hosted community barbeques. Our mission was not only to educate people of all ages on the nature of our organization, but also to put a face to a name. We participated in the Visitor's Bureau spring and fall trade shows and spoke about important environmental issues in the Fort McMurray Today paper, the CJOK radio morning line and on CFRN news.

The WBEA website (www.wbea.org) was redesigned to be more visually appealing and more user-friendly. 2001 was our first full year for the WBEA quarterly newsletter which was distributed through the paper as well as to the outlying communities. The newsletter has developed a format to provide readers with non-technical explanations of air pollutants, updates of environmental practices of our members as well as to provide information on local environmental initiatives and programs and to feature interesting articles relating to environmental effects.

As with all WBEA programs, evaluation of the work we do is a priority to our members. To ensure that we are making progress, the WBEA regularly has independent audits conducted on its activities. At the end of 2001, we had a communications survey conducted of 400 Wood Buffalo residents. Results indicate that 75% of the general public knows our name, although there is some confusion about the nature of our work. Along with other information gathered through the audit, the WBEA can confidently say that we have met our objective of gaining name recognition and in 2002, will put our efforts in informing the public of our specific role in the community.

Lisa Schaldemose
Chair

In 1996, the WBEA was endorsed as a regional airshed management zone by the Clean Air Strategic Alliance (CASA). The WBEA has adopted the CASA principles of consensus-based multi-party organizations as well as its Air Quality Management Guidelines.

Representing the Regional Municipality of Wood Buffalo, the WBEA actively participates in CASA activities and provides on-going progress updates of its own activities. The Association also shares its research information with other regional airshed management zones as they establish their management plans and continue to develop their programs (West Central Zone, Parkland Airshed Management Zone).

For more information about CASA and its programs, visit their website at www.casahome.org.

[WOOD BUFFALO ENVIRONMENTAL ASSOCIATION STATEMENT OF OPERATIONS FOR THE YEAR ENDED DECEMBER 31, 2001 - STATEMENT 3]

		2001	2000
contributions			
Suncor		$ 701,453	873,636
Syncrude		932,448	1,070,727
Albian Sands		491,959	389,605
Muskeg River Contractors		60,849	-
PanCanadian		-	-
Other contributions		65,000	37,478
Less: GST included in contributions		(124,658)	(144,328)
Contributions, net of GST		2,127,051	2,227,118
Interest & other income		12,033	10,751
Total contributions		**2,139,084**	**2,237,869**
AAM expenses			
Contracts: operation & maintenance	(Schedule A)	728,601	511,008
Contracts: analytical		297,403	303,513
Contracts: QAQC		9,500	6,629
Technical consulting		16,359	36,634
Station costs	(Schedule B)	23,435	14,694
Total AAM expenses		**1,075,298**	**872,478**
office & administration costs			
Administration costs	(Schedule C)	152,297	173,562
Communications	(Schedule D)	83,183	75,136
Data interpretation		-	3,602
Office expenses	(Schedule E)	39,331	29,742
Stakeholder involvement		9,920	479
Travel		10,991	15,920
Total office & administration		**295,722**	**298,441**
TEEM vegetation & soil monitoring	(Schedule F)	**383,846**	**362,900**
other projects			
Albian Sands project		8,087	344,924
SYN Vegetation & Soil Monitoring		-	13,493
Suncor Millennium Station		(3,635)	236,769
VOC Assessment project		-	30,000
Miscellaneous		20,739	8,270
Total other projects		**25,191**	**633,456**
capital expenditures			
Environmental equipment		80,849	32,066
Site relocation		-	35,026
Office furniture & equipment		10,247	3,502
Total capital expenditures		**91,096**	**70,594**
total expenditures		**1,871,153**	**2,237,869**
excess of contributions over expenditures, before transfer to reserve		**267,931**	**-**
transfer to reserve for future expenditures	(Note 5)	**(267,931)**	**-**
surplus for year		**NIL**	**NIL**

* for additional information contact the WBEA office

appendices >>

table 1 - sulfur dioxide (SO_2) concentrations at WBEA monitoring stations.

1-hour average concentrations for 2001, ppb.

Station	Average	Standard Deviation	Min	P1	P10	P25	P50	P75	P90	P99	MAX
Fort McKay	1.3	4.6	0.0	0.0	0.1	0.1	0.3	0.7	2.4	20.1	157.9
Mildred Lake	2.9	8.3	0.0	0.0	0.1	0.2	0.6	1.9	6.3	41.4	136.3
Lower Camp B	1.6	9.0	0.0	0.0	0.0	0.0	0.0	0.9	2.1	18.3	105.0
Buffalo Viewpoint	1.4	5.6	0.0	0.0	0.0	0.2	0.4	0.7	2.0	23.0	231.2
Mannix	2.0	5.6	0.0	0.0	0.2	0.4	0.8	1.5	3.6	23.9	211.3
Patricia McInnes	1.2	3.4	0.0	0.0	0.0	0.1	0.3	0.7	2.3	16.8	78.3
Athabasca Valley	1.0	2.9	0.0	0.0	0.1	0.2	0.4	0.7	1.7	13.5	70.7
Fort Chipewyan	0.4	1.0	0.0	0.0	0.0	0.1	0.1	0.2	0.8	4.8	24.5
Albian Mine	1.7	5.1	0.0	0.0	0.0	0.0	0.4	1.2	4.0	23.6	96.7
Lower Camp	2.2	7.5	0.0	0.0	0.0	0.1	0.5	1.4	4.4	29.9	289.0
Millennium	0.9	4.3	0.0	0.0	0.0	0.0	0.0	0.3	1.7	15.5	99.9

table 2 - nitrogen dioxide (NO_2) concentrations at WBEA monitoring stations.

1-hour average concentrations for 2001, ppb.

Station	Average	Standard Deviation	Min	P1	P10	P25	P50	P75	P90	P99	MAX
Fort McKay	5.5	6.7	0.0	0.0	0.0	0.3	2.6	8.4	16.2	26.6	41.7
Patricia McInnes	4.9	5.8	0.0	0.0	0.3	1.0	2.9	6.7	12.5	26.5	72.7
Athabasca Valley	9.7	8.2	0.0	0.3	1.7	3.5	7.4	13.9	21.0	36.7	62.3
Fort Chipewyan	0.9	1.7	0.0	0.0	0.0	0.0	0.2	0.9	2.6	8.4	23.5
Albian Mine	9.9	10.5	0.0	0.0	0.0	1.2	6.7	15.8	24.6	40.7	108.8
Millennium	3.6	7.2	0.0	0.0	0.0	0.0	0.6	3.3	12.7	28.7	161.3

table 3 - total hydrocarbon (THC) concentrations at WBEA monitoring stations.

1-hour average concentrations for 2001, ppb.

Station	Average	Standard Deviation	Min	P1	P10	P25	P50	P75	P90	P99	MAX
Fort McKay	1.9	0.2	1.6	1.6	1.7	1.7	1.8	1.9	2.2	2.7	4.2
Mildred Lake	2.1	0.5	1.2	1.5	1.6	1.8	2.0	2.3	2.6	4.1	6.9
Lower Camp B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Buffalo Viewpoint	2.0	0.5	1.5	1.6	1.7	1.8	1.9	2.0	2.4	3.9	11.8
Mannix	1.9	0.3	1.3	1.5	1.6	1.7	1.8	1.9	2.2	3.2	6.6
Patricia McInnes	1.9	0.2	1.5	1.6	1.7	1.7	1.8	1.9	2.1	2.5	6.3
Athabasca Valley	1.9	0.2	1.0	1.3	1.7	1.7	1.9	2.0	2.1	2.6	5.8
Barge Landing	1.8	0.3	1.4	1.5	1.6	1.6	1.7	1.9	2.2	2.8	4.2
Albian Mine	2.1	0.4	1.5	1.6	1.8	1.8	2.0	2.2	2.4	3.3	8.3
Lower Camp	2.1	0.4	1.6	1.7	1.7	1.8	2.0	2.2	2.5	3.3	7.2
Millennium	2.0	0.4	0.0	0.0	1.9	2.0	2.0	2.1	2.3	3.0	3.9

table 4 - total reduced sulphur compounds (TRS) and hydrogen sulphide (H_2S) concentrations at WBEA monitoring stations.

1-hour average concentrations for 2001, ppb.

Station		Avg	Std Dev	Min	P1	P10	P25	P50	P75	P90	P99	MAX
Fort McKay	TRS	0.5	0.6	0.0	0.1	0.2	0.3	0.4	0.5	1.1	2.8	17.6
Mildred Lake	H_2S	0.6	0.9	0.0	0.0	0.1	0.2	0.4	0.8	1.5	3.8	21.7
Lower Camp B	H_2S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Buffalo Viewpoint	H_2S	0.4	0.6	0.0	0.0	0.0	0.1	0.2	0.5	0.8	2.5	12.4
Mannix	H_2S	0.7	1.2	0.0	0.0	0.1	0.2	0.4	0.8	1.7	5.9	27.5
Patricia McInnes	TRS	0.4	0.3	0.0	0.1	0.2	0.3	0.3	0.4	0.6	1.6	11.1
Athabasca Valley	TRS	0.2	0.3	0.0	0.0	0.0	0.1	0.2	0.3	0.5	1.2	3.3
Barge Landing	TRS	0.3	0.4	0.0	0.0	0.1	0.1	0.2	0.3	0.7	1.9	5.7
Lower Camp	H_2S	0.5	0.8	0.0	0.0	0.0	0.1	0.2	0.7	1.2	2.9	34.6
Millennium	TRS	0.1	0.3	0.0	0.0	0.0	0.0	0.1	0.2	0.3	1.2	7.5

table 5 - ozone (O_3) concentrations at WBEA monitoring stations.

1-hour average concentrations for 2001, ppb.

Station	Average	Standard Deviation	Min	P1	P10	P25	P50	P75	P90	P99	MAX
Fort McKay	20.7	12.1	0.0	0.5	4.7	11.0	19.9	29.2	37.9	48.8	58.1
Patricia McInnes	21.7	12.2	0.0	0.2	5.9	12.1	21.1	30.1	38.5	50.5	74.1
Athabasca Valley	18.0	13.0	0.0	0.4	2.1	6.2	16.1	27.8	36.9	48.2	61.8
Fort Chipewyan	28.9	8.4	0.1	9.4	18.3	23.2	28.9	34.5	40.0	47.8	54.6

table 6 - particulate matter concentrations ($PM_{2.5}$) at WBEA monitoring stations.

1-hour average concentrations for 2001, $\mu g/m^3$.

Station	Average	Standard Deviation	Min	P1	P10	P25	P50	P75	P90	P99	MAX
Fort McKay	20.7	12.1	0.0	0.5	4.7	11.0	19.9	29.2	37.9	48.8	58.1
Patricia McInnes	21.7	12.2	0.0	0.2	5.9	12.1	21.1	30.1	38.5	50.5	74.1
Athabasca Valley	18.0	13.0	0.0	0.4	2.1	6.2	16.1	27.8	36.9	48.2	61.8
Fort Chipewyan	28.9	8.4	0.1	9.4	18.3	23.2	28.9	34.5	40.0	47.8	54.6
Albian Mine	7.3	7.6	0.0	0.0	2.3	3.6	5.5	8.9	13.6	34.3	301.3
Millennium	4.8	3.7	0.0	0.0	1.6	2.7	3.9	5.8	9.0	18.7	35.5

table 7 - carbon monoxide (CO) concentrations at WBEA monitoring stations.

1-hour average concentrations for 2001, ppm.

Station	Average	Standard Deviation	Min	P1	P10	P25	P50	P75	P90	P99	MAX
Athabasca Valley	0.3	0.3	0.0	0.0	0.0	0.1	0.2	0.3	0.5	1.3	5.8

table 8 - average concentrations of NO_2, SO_2 and O_3 - 2001.

Measured at forest monitoring stations by passive sampling, ppb.

Station	Nitrogen dioxide	Sulphur dioxide	Ozone
PL7	1.35	1.27	36.57
PH6	1.40	1.53	34.73
AL8	1.18	1.03	38.92
PH4	2.65	3.25	34.89
AH8	1.85	2.47	37.54
PH2	1.76	1.90	32.62
PL1	0.77	1.26	39.44
PL8	0.75	0.57	29.44
AH3	0.62	1.06	34.20
AH7	1.85	2.88	42.78

table 9 - temperature measurements at WBEA monitoring stations - 2001 (degrees celsius).

Station	Annual average	1-hour maximum	1-hour minimum
Fort McKay (AMS 1)	2.6	32.1	-37.4
Mildred Lake (AMS 2) (At 20m)	3.5	31.6	-33.2
Lower Camp B (AMS 3)	4.1	32.3	-35.3
Buffalo Viewpoint (AMS 4)	2.3	29.0	-36.3
Mannix (AMS 5)	2.8	30.6	-34.2
Patricia McInnes (AMS 6)	3.1	30.3	-36.6
Athabasca Valley (AMS 7)	3.1	32.3	-36.4
Fort Chipewyan (AMS 8)	1.3	31.3	-34.5
Barge Landing (AMS 9)	2.1	31.0	-38.0
Albian Mine (AMS 10)	1.9	31.0	-36.7
Lower Camp (AMS 11)	6.0	31.6	-35.4
Millennium (AMS 12)*	-1.3	29.5	-32.4

* began operation in September 2001

table 10 - wind speed measurements at WBEA monitoring stations - 2001 (kilometers per hour).

Station	Annual average	1-hour maximum	1-hour minimum
Fort McKay (AMS 1)	7.9	44.7	0.0
Mildred Lake (AMS 2)	9.0	34.2	0.0
Lower Camp B (AMS 3)	8.4	34.9	0.0
Buffalo Viewpoint (AMS 4)	13.8	60.4	0.0
Mannix (AMS 5)	10.9	46.0	0.1
Patricia McInnes (AMS 6)	9.3	36.4	0.0
Athabasca Valley (AMS 7)	9.0	52.8	0.0
Fort Chipewyan (AMS 8)	17.2	59.7	0.0
Barge Landing (AMS 9)	5.2	21.0	1.0
Albian Mine (AMS 10)	7.0	26.8	0.0
Lower Camp (AMS 11)	9.6	52.3	0.0
Millennium (AMS 12)	15.6	63.5	0.0

table 11 - relative humidity measurements at WBEA monitoring stations - 2001 (percent).

Station	Annual average	1-hour maximum	1-hour minimum
Fort McKay (AMS 1)	73.0	100.0	10.6
Fort Chipewyan (AMS 8)	76.5	100.0	17.6

table 12 - solar radiation measurements at WBEA monitoring stations - 2001 (watts per square meter).

Station	Annual average	1-hour maximum	1-hour minimum
Fort McKay (AMS 1)	114	875	0
Fort Chipewyan (AMS 8)	129	928	0

table 13 - wind direction at WBEA monitoring stations - 2001 (percent time from each direction).

Station	North	NE	East	SE	South	SW	West	NW
Fort McKay (AMS 1)	18.4	5.8	3.1	8.9	25.0	11.2	12.6	14.4
Mildred Lake (AMS 2)	21.1	8.6	4.8	18.6	18.0	11.5	10.1	7.3
Lower Camp B (AMS 3)	24.6	3.7	2.4	22.5	8.5	14.1	8.5	13.3
Buffalo Viewpoint (AMS 4)	18.4	6.0	2.9	23.0	16.5	9.7	13.5	9.9
Mannix (AMS 5)	12.7	10.2	4.3	16.3	24.9	7.7	14.4	9.2
Patricia McInnes (AMS 6)	11.0	9.9	5.7	16.8	10.6	17.6	16.1	12.3
Athabasca Valley (AMS 7)	18.1	4.4	5.4	25.1	10.5	14.8	11.1	9.5
Fort Chipewyan (AMS 8)	18.6	6.7	24.3	13.2	6.0	6.7	10.4	14.1
Barge Landing (AMS 9)	16.9	8.1	2.5	11.2	23.8	17.1	9.2	11.2
Albian Mine (AMS 10)	14.4	11.8	4.6	8.6	22.1	18.7	10.2	9.7
Lower Camp (AMS 11)	17.2	6.3	6.6	26.9	3.3	12.8	11.5	14.2
Millennium (AMS 12)	7.5	2.8	4.0	25.3	30.3	8.3	9.9	11.7

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> Larkspur Biological Consultants Ltd., *Evaluation of the Use of Trembling Aspen (Populus tremuloides Michx.) for biomonitoring in the Athabasca Oils Sands Region*, August 2001.

> Larkspur Biological Consultants Ltd., *Assessment of the Use of Lichens as Biomonitoring Tools in the Athabasca Oils Sands Region*, August 2001.

> WBEA, *2000 Annual Report*, June 2001.

> AMEC Earth and Environmental, *Jack Pine Acid Deposition Monitoring Network: Site Selection 2000*, March 2001.

ABBREVIATIONS

BTEX - Benzene, Toluene, Ethylbenzene and Xylene are aromatic volatile aromatic compounds. When found in sufficient quantities can affect human health.

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

chlorosis - Yellowing of leaf tissue due to a lack of chlorophyll.

CH_4 - methane is a colourless, 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.

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 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 212 ppb, a 24-hour average concentration of 106 ppb, and an annual average concentration of 32 ppb, are based on the prevention of human effects.

O_3 - ozone at ground level is generated from emissions of NO_x 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 30 ($\mu g/m^3$ 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.

TRS - Total reduced sulphur compounds are mainly of hydrogen sulphide with small amounts of mercaptans.

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.

UNITS OF MEASURE

μm - one one-millionth of a meter (10-6m)
ppb - parts per billion by volume
ppm - parts per million by volume
$\mu g/m^3$ - 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-hour, 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.

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

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.

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.

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