WOOD BUFFALO
ENVIRONMENTAL ASSOCIATION

W B E A

2022 WBEA Annual Report

Contents

Cliff Dimm

Message from the President

In many ways, this past year served to represent the kind of organization the WBEA is at its core—one predicated by sincere collaboration, careful planning, and confident execution.

We continue to be recognized as an extremely relevant partner within the OSM Program. This can be evidenced by key WBEA inputs—the result of the previous strategic planning process and commitment to multi-stakeholder decision making—being taken seriously by key OSM stakeholders. This is excellent news, though certainly not unexpected given our track record for engagement.

Like many organizations, the WBEA was glad to return to "business as usual" in 2022 with all staff coming back to the office following two years of COVID-19 related disruptions. As we have settled into the "new normal", I encourage everyone to engage with coworkers and fellow stakeholders face-to-face when appropriate. Your physical presence at meetings is almost always preferred!

The two years leading up to 2022 brought significant changes to our world, both at home and at work. Those same impacts were felt at the WBEA. I'd like to thank Sanjay and staff for successfully navigating the dynamic environment of restrictions—from both government and communities—as well as staff changes, to continue to deliver on the organization's objectives. Being adaptable and responsive is an important trait in a business, and the WBEA has demonstrated that.

To those staff, stakeholders, rightsholders, and partners who continue to put the work in to ensure the WBEA's growth and acceptance as a leader in environmental monitoring, thank you for all you do. We should all continue to be educated advocates for the work we do, and how we do it.

On a personal level, the past seven years as WBEA President have been some of the most educational and enjoyable I have had in my career, and this is work, and a team, that I will very much miss being part of. I would like to thank Sanjay, all the WBEA staff, WBEA General Members and fellow Governance Committee members, for your conversation, insight, and ideas over that time. I'm proud to be a part of this organization, and to engage in the spirit of sincere collaboration, careful planning, and confident execution the WBEA demonstrates every day.

WBEA President

Sanjay Prasad

Message from the

Executive Director

I want to begin by recognizing a foundational component of the WBEA's continued success: our Members.

In 2022, the WBEA welcomed Chard Métis Nation and Keyera Energy Ltd. into membership, bringing the total number of Indigenous community, Industry, Government, and Non-Government partners to 43. Our model of governance is effective due to the active participation of all WBEA Members, and I am pleased to report we reached a ninety-percent attendance rate at our General Members meetings last year.

Funding received from the Oil Sands Monitoring (OSM) Program and Alberta Environment and Protected Areas is critical to the ongoing success of the WBEA's core long-term Air, Deposition, and Odour Monitoring Programs. It supports our work with regional multi-stakeholder groups such as the Fort McKay Air Quality and Odour Advisory Committee and the community-based operation of the Fort Chipewyan Air Monitoring Station, as well as our work with community initiatives such as the CAREERS Indigenous Youth Internship Program and Wood Buffalo Regional Science Fair.

If membership serves as our foundation, then our staff is the heart of the WBEA's operations. Our team grew to thirty-eight dedicated individuals, who were joined by three summer students and an Indigenous Youth Intern last year. An operational goal for all WBEA leadership continued to be the transition of knowledge to new leads, managers, and staff, as well as the development of our Operations Leadership Team (OLT).

Community Relations and Communications positions were added to ensure the WBEA achieves its overall objectives and goals. The WBEA anticipates re-initiating our Traditional Knowledge Committee (TKC) which was originally established to develop and oversee long-term Indigenous Knowledge and community-based monitoring programs. Through leveraging media marketing strategies—including radio, digital, and print media—and in-person engagement opportunities, the WBEA continues to empower all stakeholders, rightsholders, and community members with environmental data to make informed decisions.

The highlights of the work performed by both our members and our staff throughout 2022 include the approval of the 2022-2026 Strategic Plan, which will provide direction to our operations for the next five years.

Our commitment to scientific independence remains a core value. The WBEA's Analytical Services Group launched sample analyses for ion exchange resins (IER), particulate matter, and dry deposition denuder tubes. This benefits the WBEA by ensuring consistent reference standards, procedures, and quality control. Additionally, Deposition Program rationalization efforts continued with regional site selection and sampling optimization focusing on the IER, ozone, and denuder programs.

Throughout 2022, a sub-group of our Ambient Air Technical Committee (AATC), the Network Assessment Working Group (NAWG) has been evaluating the WBEA's ambient air monitoring network. Monitoring objectives and purposes have been developed for statistical analysis of historical data and stakeholder requirements for the network and were considered to develop technical recommendations for the future network. The NAWG will continue to meet in 2023, and the final recommendations will inform future WBEA work plans.

The Community Odour Monitoring Program (COMP) app turned five years old in 2022. This past year saw 117 total odour observations. From September 2017 to December 2022, 1446 odour observations have been reported through the COMP. The WBEA's Air Quality Events (AQE) app—which reports exceedances of Alberta Ambient Air Quality Objectives and Guidelines to users in near-real time—also received a refresh in 2022.

The WBEA continues to be committed to fiduciary duties as a not-for-profit agency. New financial policies and procedures were established in 2022 which will ensure accountability of program costs. We are now in the second phase of the deployment of a new inventory management system, which will streamline our inventory controls, purchasing, and management.

Another core commitment is to the safety and welfare of our staff and partners. The WBEA continued to prioritize compliance with our safety program, focusing on injury and loss reduction through hazard identification and management. The WBEA continued to maintain its Certificate of Recognition (COR) through the Alberta Association for Safety Partnerships.

The data in this report represents innumerable hours of field and lab analysis, program development and reporting, and stakeholder and partner engagement. I encourage you to visit our newly refreshed website, wbea.org, and our Annual Trends website, annualtrends.wbea.org, to learn more about the work we continue to do.

On behalf of the WBEA staff, I thank all Members and partners for your ongoing commitment to independent air quality and deposition monitoring in the Regional Municipality of Wood Buffalo.

Sanjay Prasad,
WBEA Executive Director

We are the Wood Buffalo Environmental Association, the WBEA.

For more than twenty-five years, we've served as our region's independent air quality reporter. We're founded on a vision of scientifically independent, consensus-based environmental monitoring. The WBEA serves all stakeholders, rightsholders, and individuals in the Regional Municipality of Wood Buffalo (RMWB) by providing the data they need 24/7 to make informed environmental decisions.

The WBEA Today

The past year invited an opportunity for the WBEA to reflect on its guiding principals, and plan for a successful, sustainable future.

With the release of our 2022 – 2026 Strategic Plan, the WBEA outlined seven organizational milestones, which are summarized in the following four strategies:

- Focusing on organizational strengths to provide world-class environmental monitoring programs.
- Understanding our members' needs, including expanding relationships with Indigenous partners, and committing resources to deliver enhanced collaboration and focused purpose.
- Clarifying and strategically promoting the WBEA's value proposition, as well as raising the WBEA's profile to demonstrate credibility and social acceptance.
- Developing a practical, appropriate strategy to ensure financial stability and program security.

The WBEA's vision for the future also necessitated our growth. We were pleased to establish the Indigenous Relations and Community Liaison role as a permanent addition to our team. With this position, the WBEA will focus on demonstrating respect for Indigenous Ways of Knowing through engaging with our community partners and centering Traditional Knowledge (TK) in our programs.

To better understand the needs and expectations of our stakeholders, the WBEA initiated the Network Assessment project in 2022. Through collaboration and purposeful engagement, the WBEA aims to establish a new strategic direction for our Ambient Air Monitoring (AAM) network in the very near future.

It is our intention that the information found in the 2022 Annual Report will empower our stakeholders and rightsholders to effect positive change, make informed decisions, and ensure a safe and healthy environment today, and in the years to come.

Who We Are

The WBEA has had a long-standing presence in the region, officially since 1997. The WBEA's website, **wbea.org**, has more information to learn more about the organization, including our governance structure, partnerships, and our past, present, and vision for the future.

Vision

To empower all stakeholders and rights holders with environmental data to make informed decisions.

Mission

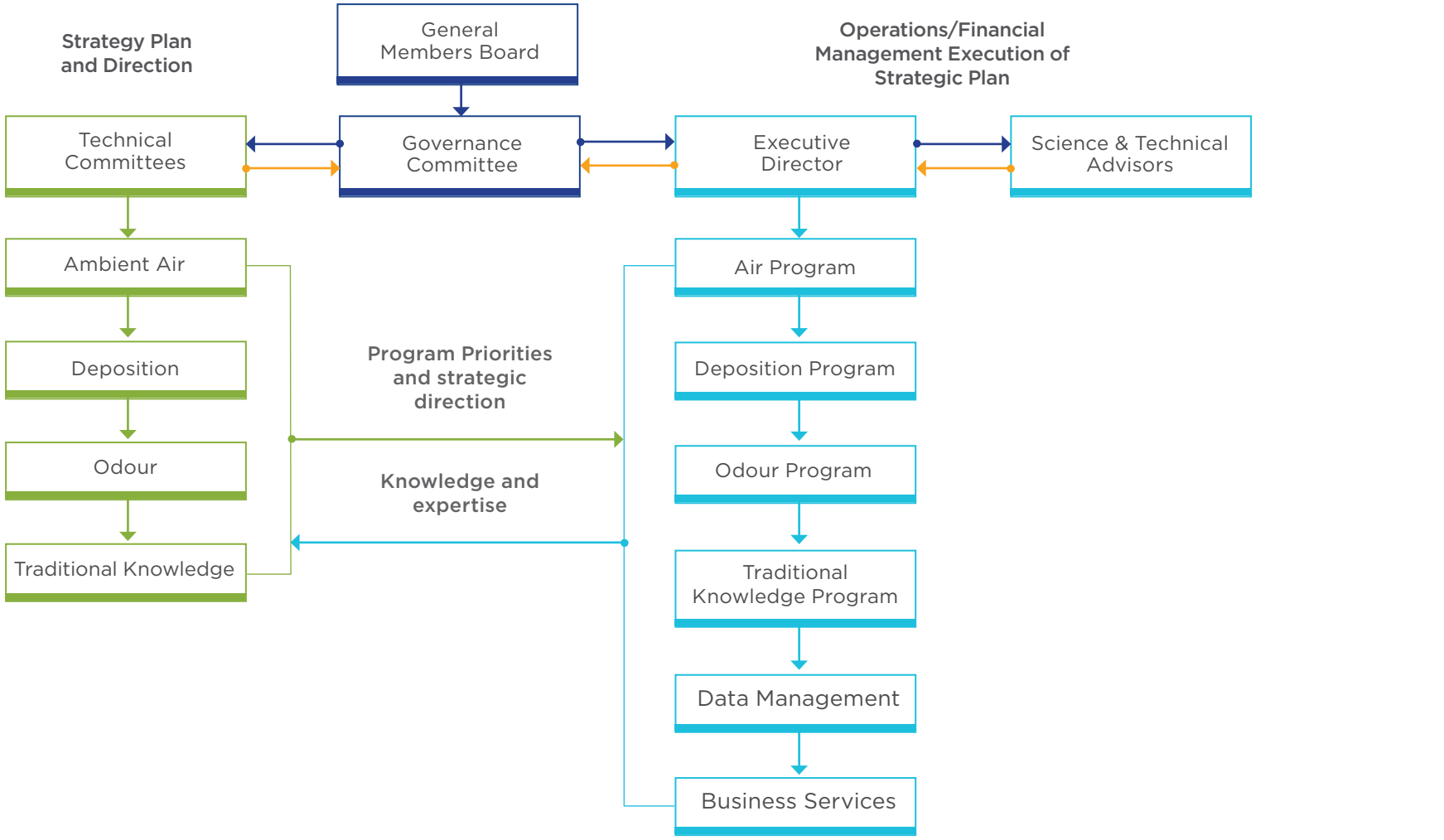
The Wood Buffalo Environmental Association is a multi-stakeholder, consensus-based organization providing world-class environmental monitoring and reporting.

Our Values

- ☑ Scientifically independent
- ☑ Recognize and respect Indigenous Knowledge
- ☑ Transparent and timely in communicating accurate and accessible data
- ☑ Dedicated to using best practices and technology
- ☑ Support diverse stakeholder participation and consensus-based decisions

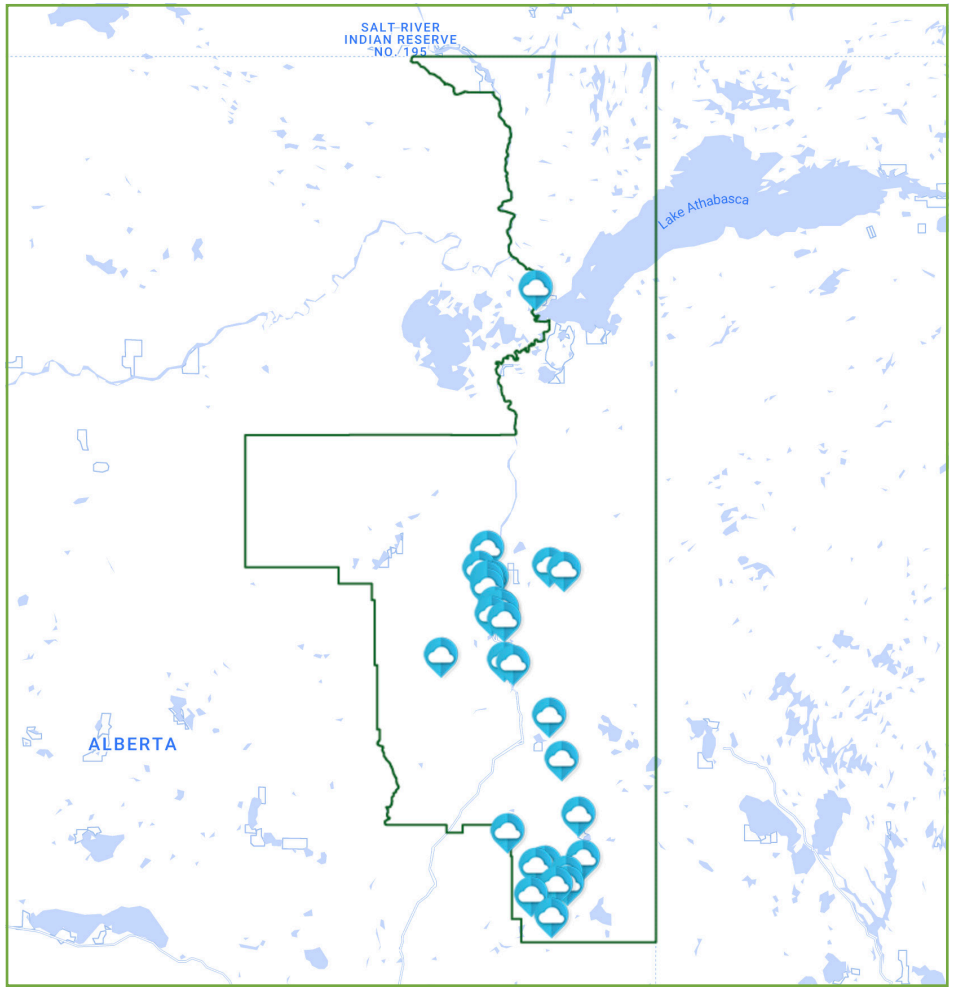
Organizational Structure

The General Members Board and Governance Committee provide strategic direction and oversight for the organization. The Technical Committees determine the strategic plans and direction for each of the WBEA's monitoring programs. The Executive Director provides operational direction for the WBEA staff, engaging science and technical advisors as required, to ensure stewardship to the overarching direction set by the General Members Board and Governance Committee.

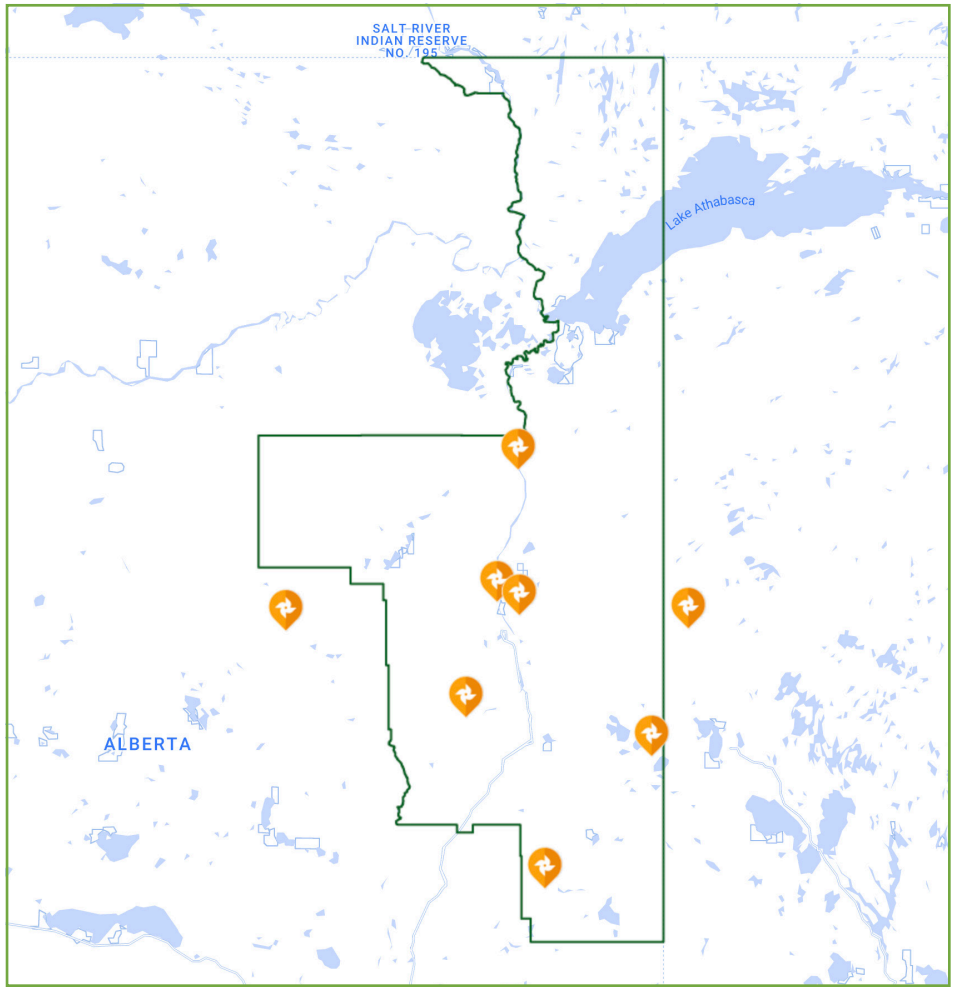


WBEA Monitoring Network

Ambient Air Monitoring sites

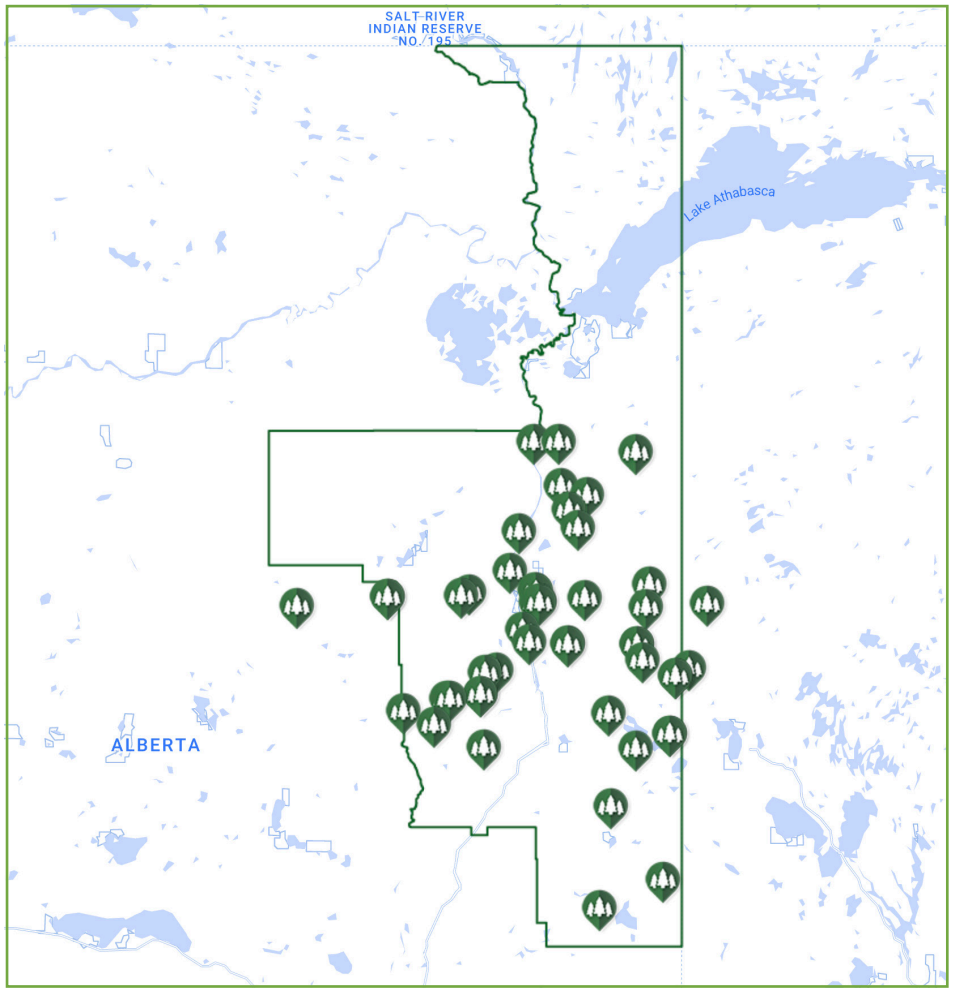


Deposition – Denuder/IER sites

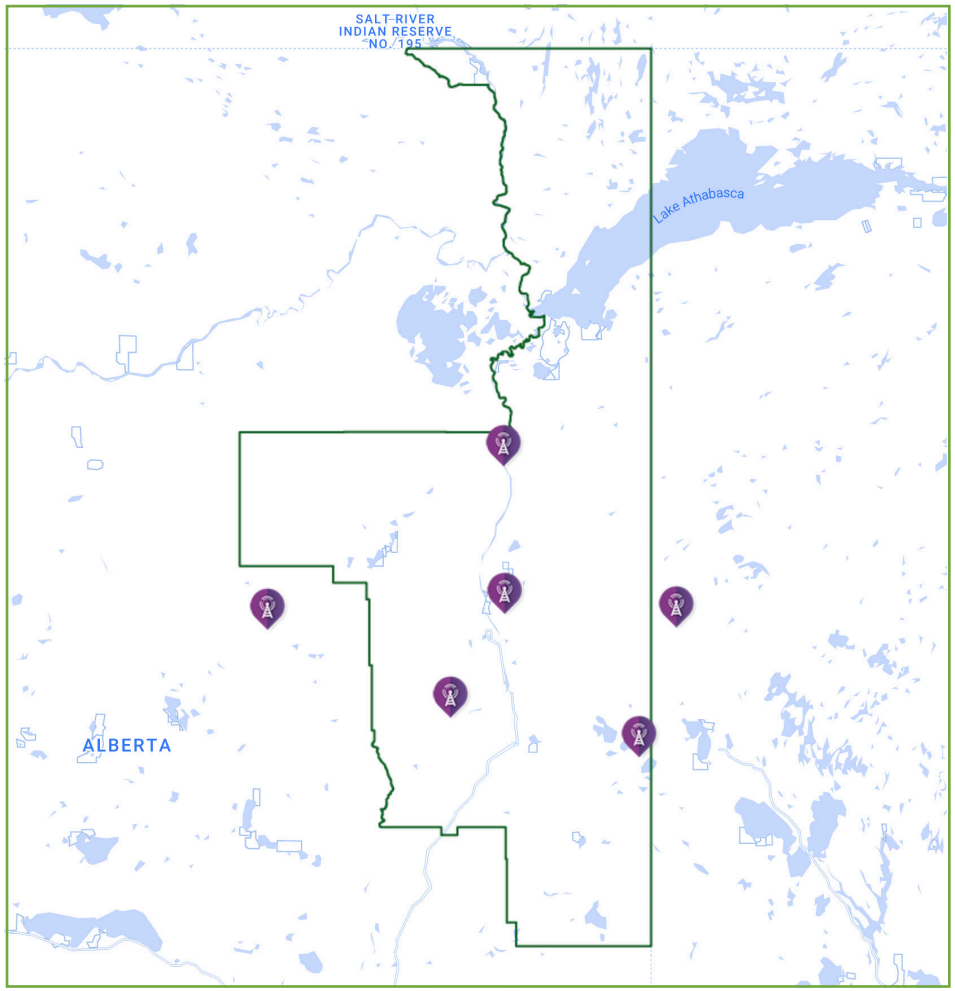


Note: No portable Ozone monitors were deployed in 2022.

Deposition – Forest Health Monitoring sites



Regional Meteorologocal sites



Note: No portable Ozone monitors were deployed in 2022.

WBEA Partnerships

The WBEA is fortunate to work with partners across the province, including Alberta Environment and Protected Areas, the Oil Sands Monitoring Program, and Alberta Airsheds Council. The WBEA acknowledges the financial support of the Oil Sands Monitoring Program. Learn more about the WBEA's involvement with these partnerships by visiting the "About" section on our website, wbea.org.

OIL SANDS MONITORING PROGRAM

AAC ALBERTA AIRSHEDS COUNCIL

Ambient Air Monitoring

The WBEA operated about 30 ambient air monitoring stations (AMS) throughout the RMWB in 2022. These included industrial, attribution, community, background, and meteorological stations.

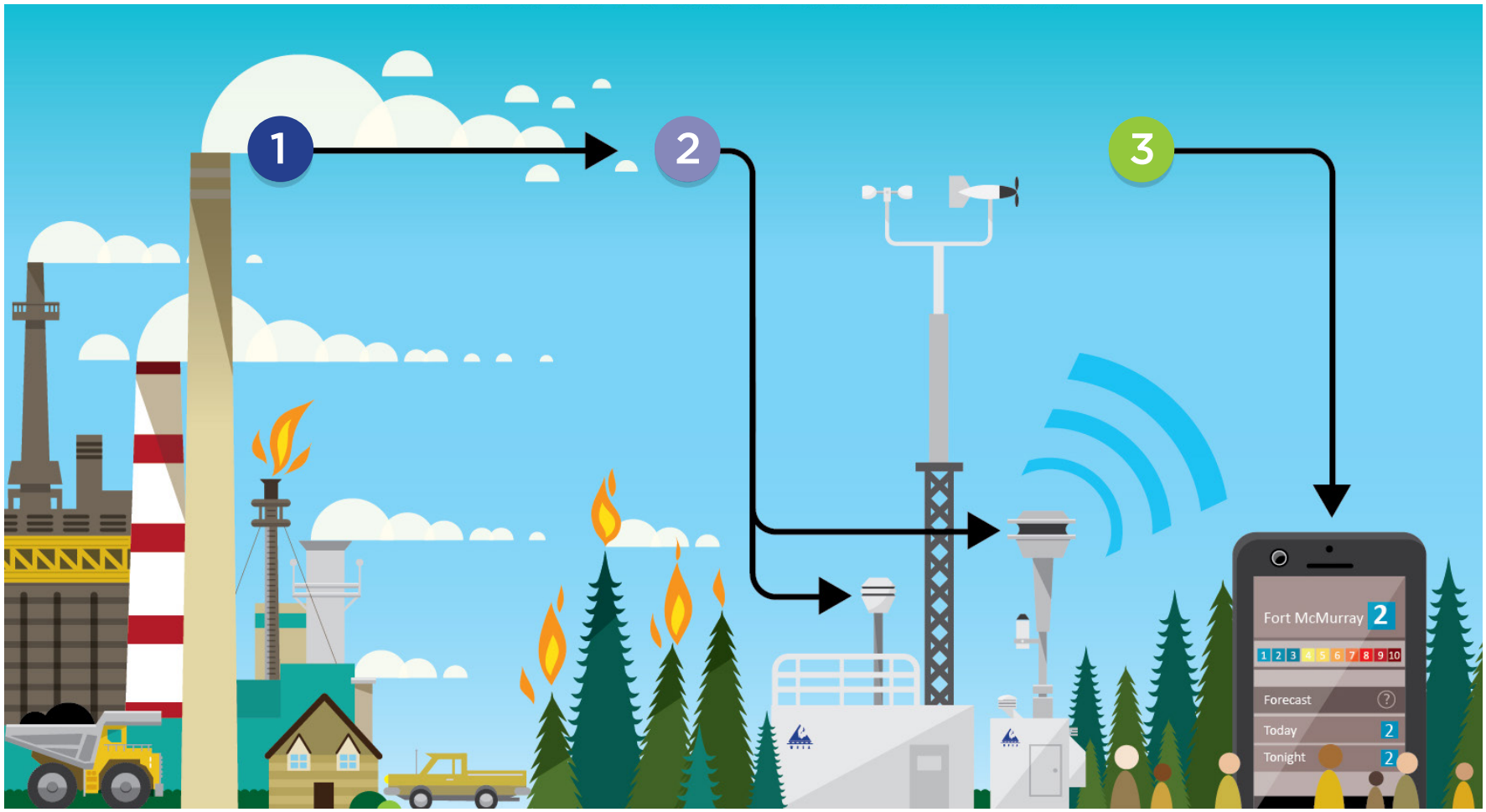
The WBEA's Ambient Air Monitoring (AAM) Program activities function to address multiple objectives, scientific questions, and requirements set by global, national, provincial, and regional jurisdictions. The WBEA's website highlights each of these specifically and how they relate to the WBEA's monitoring network activities.

When ambient concentrations of any air pollutant the WBEA measures exceed the Alberta Ambient Air Quality Objectives and Guidelines (AAAQOs & AAAQGs), which are set provincially, the WBEA has an Immediate Reporting Protocol that is put into action.

Details about the WBEA's monitoring network, monitoring objectives and requirements, and the WBEA's Immediate Reporting Protocol can be found at **wbea.org**.

View parameters monitored at each AAM station by visiting the "Monitoring Programs" section on **wbea.org**.

The following image demonstrates how the WBEA collects ambient air data through continuous analyzers and time-integrated samplers to ensure residents and stakeholders have the information they need to make informed environmental decisions.



1 Source

Pollution is emitted into the air from a variety of sources.

2 Measure

The WBEA ambient air monitoring stations measure the concentrations of pollutants in the air.

3 Share

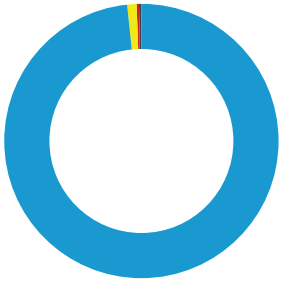
The information the WBEA collects is available to view on wbea.org and is used to calculate the Air Quality Health Index (AQHI).

Air Quality Health Index

Alberta's Air Quality Health Index—AQHI—is a scale created to help individuals better understand the impact of air quality on their health by providing important ambient air data at a glance. The following graphs show the percentage of time each community station reported each risk level during 2022. Visit **wbea.org** to access near real-time values for and to learn more about **AQHI** and **Fort McKay Air Quality Index** (FMAQI).

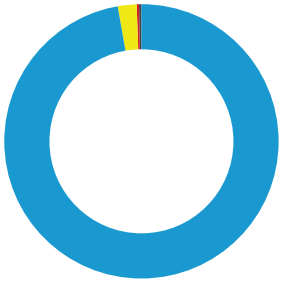
2022 Hourly AQHI by Station

LOW RISK 1 2 3 | MODERATE RISK 4 5 6 | HIGH RISK 7 8 9 10 | VERY HIGH RISK 10+



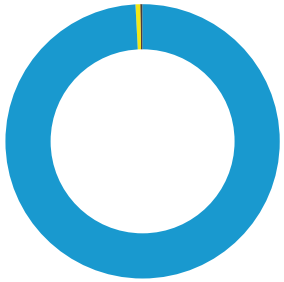
Anzac

98.61% Low Risk
1.02% Moderate Risk
0.35% High Risk
0.02% Very High Risk



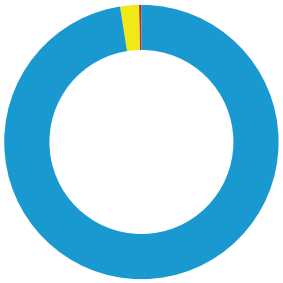
Conklin

97.26% Low Risk
2.44% Moderate Risk
0.28% High Risk
0.02% Very High Risk



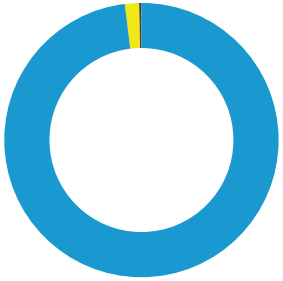
Fort Chipewyan

99.28% Low Risk
0.47% Moderate Risk
0.20% High Risk
0.05% Very High Risk



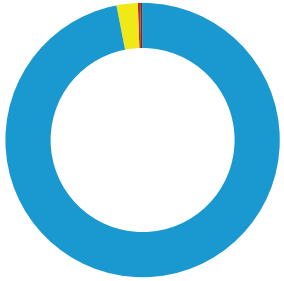
Athabasca Valley (Fort McMurray)

97.66% Low Risk
2.13% Moderate Risk
0.21% High Risk
0.00% Very High Risk



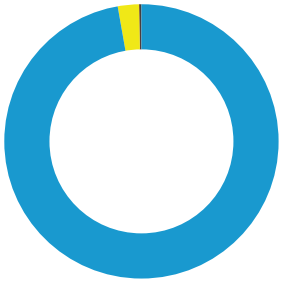
Patricia McInnes (Fort McMurray)

98.25% Low Risk
1.56% Moderate Risk
0.15% High Risk
0.04% Very High Risk



Janvier

97.10% Low Risk
2.42% Moderate Risk
0.26% High Risk
0.22% Very High Risk

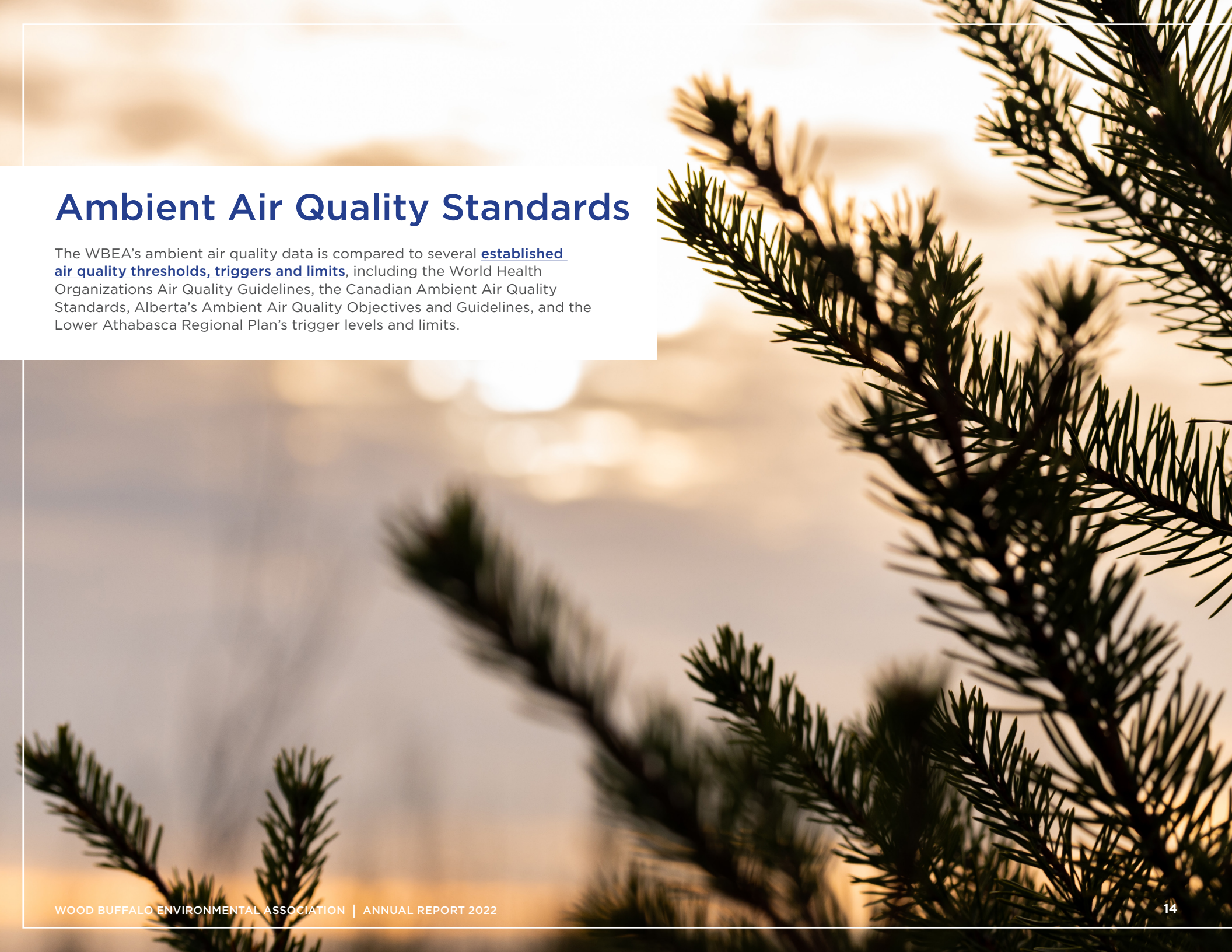


Fort McKay

97.31% Low Risk
2.56% Moderate Risk
0.11% High Risk
0.02% Very High Risk

Ambient Air Quality Standards

The WBEA's ambient air quality data is compared to several **established air quality thresholds, triggers and limits**, including the World Health Organizations Air Quality Guidelines, the Canadian Ambient Air Quality Standards, Alberta's Ambient Air Quality Objectives and Guidelines, and the Lower Athabasca Regional Plan's trigger levels and limits.



Alberta Ambient Air Quality Objectives & Guidelines

Alberta's Ambient Air Quality Objectives (AAAQOs) and Ambient Air Quality Guidelines (AAAQGs) were developed under the Alberta Environmental Protection and Enhancement Act (EPEA) to protect Alberta's air quality. AAAQOs help assess industry compliance and evaluate facility performance, and AAAQGs are a general performance indicator used to help with airshed planning and management. Both are established for a variety of averaging periods depending on the characteristics of the pollutant.

The graph on page 16 presents a total count of air quality event exceedances at all WBEA ambient air monitoring stations over a five-year period for AAAQOs from 2018-2022. Since the $PM_{2.5}$ 1-hour AAAQG was established in 2019, exceedance data available from 2019 and 2021 are included in the graph. The second graph, on page 17, shows the exceedances for 2022 based on station locations.

Parameter	1-hour Average	8-hour Average	24-hour Average	30-day Average	Annual Average
AAAQOs					
Sulphur Dioxide (SO_2)	172 ppb	-	48 ppb	11 ppb	8 ppb
Nitrogen Dioxide (NO_2)	159 ppb	-	-	-	24 ppb
Ozone (O_3)	76 ppb	-	-	-	-
Total Reduced Sulphurs (TRS)/ Hydrogen Sulphide (H_2S)*	10 ppb	-	3 ppb	-	-
Particulate Matter 2.5 ($PM_{2.5}$)	-	-	29 µg/m^3	-	-
Carbon Monoxide (CO)	13 ppm	5 ppm	-	-	-
Ammonia (NH_3)	2 ppm	-	-	-	-
AAAQG					
$PM_{2.5}$	80 µg/m^3	-	-	-	-

**In the WBEA network TRS concentrations are reported using the H_2S AAAQOs.*

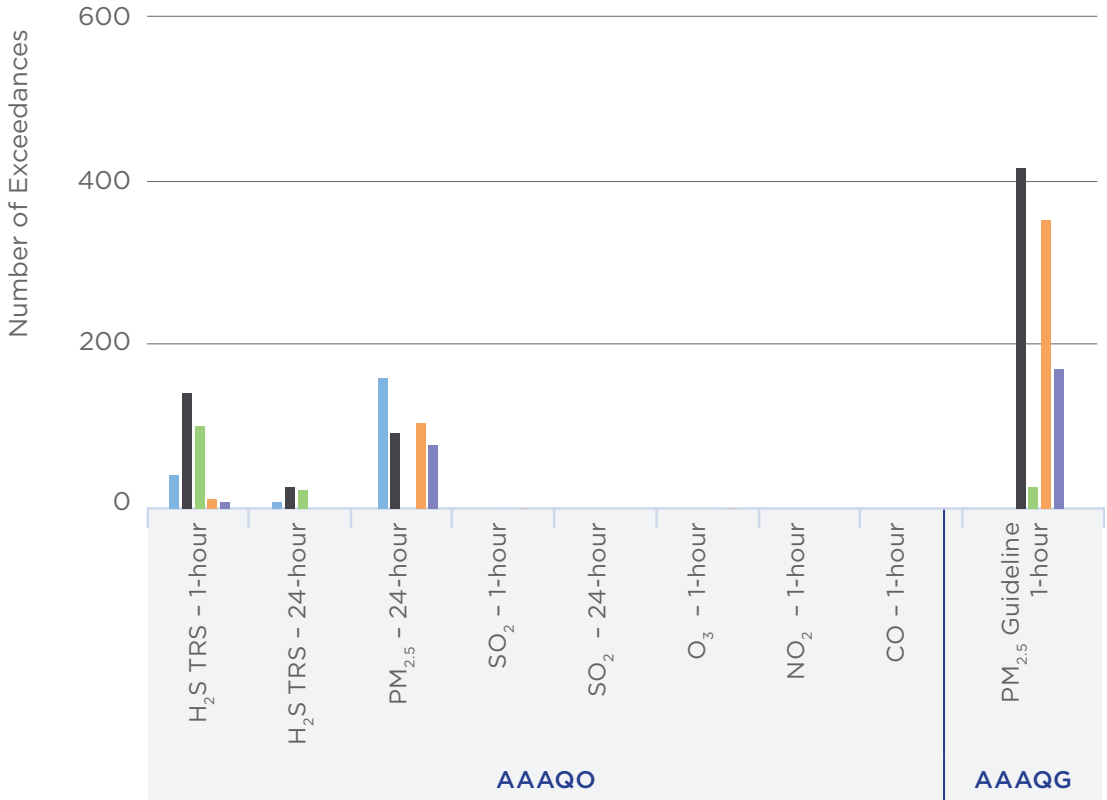
Air Quality Events

The WBEA's ambient air quality data is compared to several established air quality thresholds, triggers, and limits. Air quality events occur when the concentration of ambient air detected by the WBEA exceeds the standards set by the Alberta Ambient Air Quality Objectives (AAAQO), and indicators identified by the Alberta Ambient Air Quality Guidelines (AAAQG). When an exceedance occurs the WBEA follows the guidance of the Air Monitoring Directive and reports each occurrence to the appropriate governing bodies.

The WBEA has developed an Air Quality Events (AQE) app as another way to notify interested stakeholders and partners of air quality events related to AAAQOs and AAAQGs. The AQE app provides near-real time notifications when an exceedance occurs in the network and allows users to subscribe to the air monitoring stations of interest. The app is available for download to all iOS platforms. In addition, the WBEA stores all the historical and near real-time air quality events information on the Air Quality Events page of the WBEA website: **https://wbea.org/data/air-quality-events/**.

Note: Values may be too small to be visible on some graphs.

Air Quality Events in Excess of AAAQOs and AAAQGs (2018-2022)

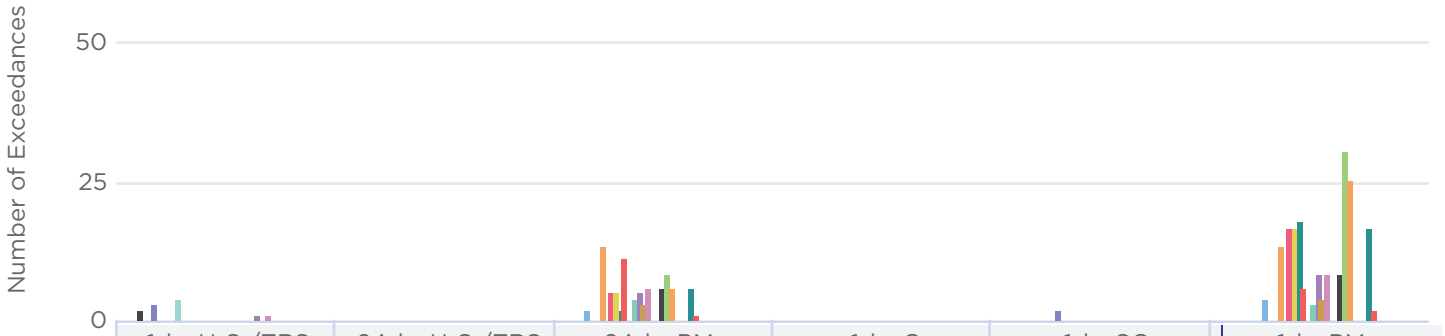


	H_2S TRS – 1-hour	H_2S TRS – 24-hour	$PM_{2.5}$ – 24-hour	SO_2 – 1-hour	SO_2 – 24-hour	O_3 – 1-hour	NO_2 – 1-hour	CO – 1-hour	$PM_{2.5}$ Guideline 1-hour
	AAAQO								AAAQG
2018	44	10	163	1	0	0	0	0	-
2019	146	31	95	0	0	0	0	0	420
2020	103	27	0	1	0	1	0	0	30
2021	15	0	109	2	0	3	0	0	354
2022	11	1	83	1	1	0	0	0	174

Note: Forest fire season was considered to be from March 1 – October 31, 2022.

Note: The WBEA began reporting $PM_{2.5}$ AAAQG exceedances in 2019 as per the Alberta Air Monitoring Directive (AMD) requirements; the graph shows exceedance data for only 2019 to 2022.

2022 Exceedances by Station



	1-hr H_2S /TRS	24-hr H_2S /TRS	24-hr $PM_{2.5}$	1-hr O_3	1-hr SO_2	1-hr $PM_{2.5}$
	AAAQO					AAAQG
Bertha Ganter - Fort			2			4
Mildred Lake	2					
Lower Camp Met Tower						
Buffalo Viewpoint			13			13
Mannix	3				2	
Patricia McInnes			5			16
Athabasca Valley			5			16
Fort Chipewyan			2			17
Barge Landing			11			6
Lower Camp	4					
Fort McKay South			4			3
Anzac			5			8
Wapasu			3			4
Stony Mountain			6			8
Firebag						
Mackay River						
Conklin			6			8
Janvier			8			29
Fort Hills			6			24
Waskow Ohci Pimatisiwin						
Christina Lake						
Jackfish 2/3						
Surmont 2			6			16
Ells River			1			2
Leismer						
Sawbones Bay						
Jackfish 1	1					
Kirby South						
Kirby North	1					

Note: Forest fire season was considered to be from March 1 – October 31, 2022.

Reporting Air Quality Events

When ambient concentrations of any air pollutant the WBEA measures exceed the AAAQOs and AAAQGs, the WBEA has an Immediate Reporting Protocol that is put into action. WBEA analyzers continuously monitor ambient air, and in the event of an exceedance, the following steps are taken:

1. The data collection system automatically sends out alarm notifications to WBEA personnel and an independent third-party alarm monitoring company.

2. If an AAAQO is exceeded, the alarm company acknowledges the incoming alarm and reports the data and supporting information such as wind conditions, locations, time, etc. to Alberta Environment and Protected Areas (EPA) in real time. EPA uses the data and information from the WBEA to follow up appropriately.

3. If an AAAQG is exceeded, the WBEA reports the data and supporting information such as wind conditions, locations, time, etc. to EPA during business hours. EPA uses the data and information from the WBEA to follow up appropriately.

4. If the exceedance occurs at an industry station, the owner is informed that they have exceeded an AAAQO or AAAQG, and they are provided with the same information that was given to EPA. They follow up with EPA and/or the Alberta Energy Regulator (AER), as required. Exceedances at community stations are followed up by the WBEA.

LARP Triggers & Limits

The Lower Athabasca Regional Plan (LARP) has existed as an extension of the Alberta Land-Use Framework since September 2012.

The LARP air quality objective is to manage releases from multiple sources, so they do not collectively result in unacceptable air quality. LARP sets out trigger levels and limits for NO_2 and SO_2 as described in the table on the right. The WBEA provides EPA with the air quality data that is used to calculate the annual LARP triggers and limits. When a trigger is exceeded, EPA is required to create a regional management response.

The following graphs show the annual average and hourly 99th percentile concentrations of NO_2 and SO_2 at each station location compared to the respective triggers and limit for each parameter. The use of the hourly 99th percentile data is a statistical measure to indicate upper limits of the data. Increases in the 99th percentile beyond the LARP triggers can be an early warning to help inform appropriate management actions to prevent future exceedances.

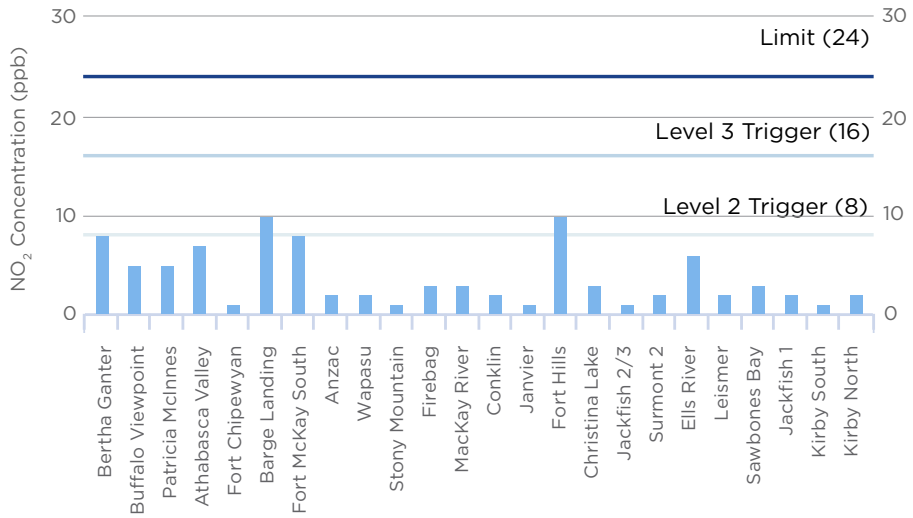
Larp Trigger Levels & Limits for Air Quality

Description	Management Intent
Level 4	
Ambient air quality exceeding air quality limits	Improve ambient air quality to below limits
Limit	
Level 3	
Ambient air quality below but approaching air quality limits	Proactively maintain air quality below limits
Trigger	
Level 2	
Ambient air quality below air quality limits	Improve knowledge and understanding, and plan
Trigger	
Level 1	
Ambient air quality well below air quality limits	Apply standard regulatory and non-regulatory approaches

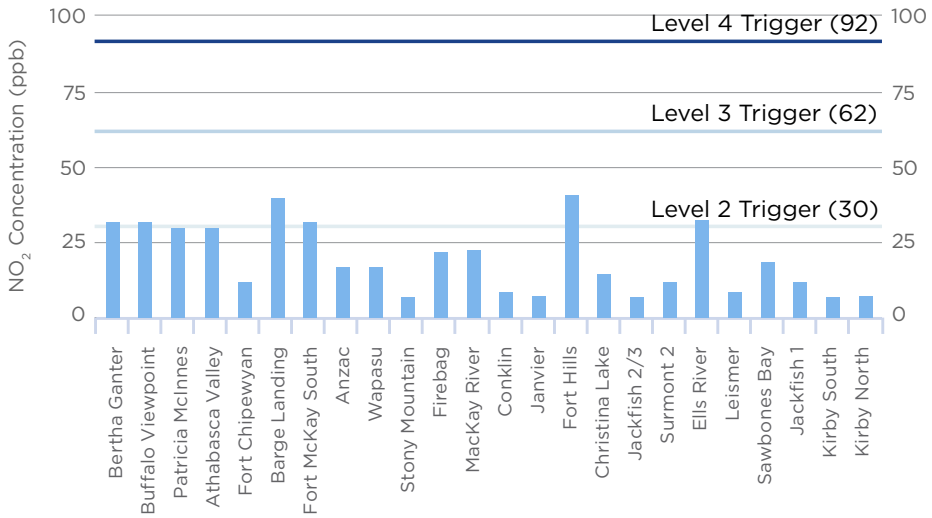
Note: The ambient air quality values based on the 99th percentile of hourly data are all established as triggers in the management framework

Stations

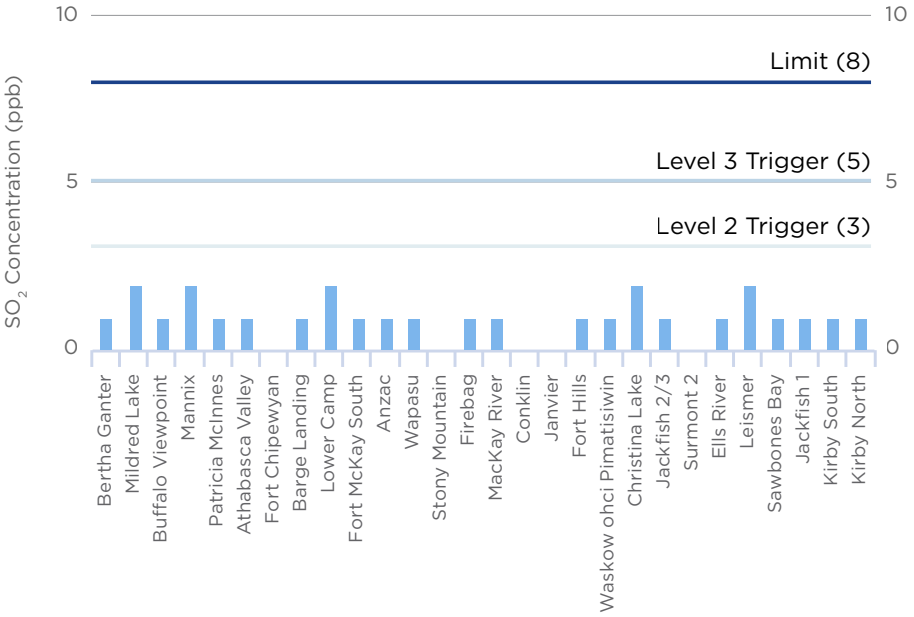
LARP NO_2 Annual Average



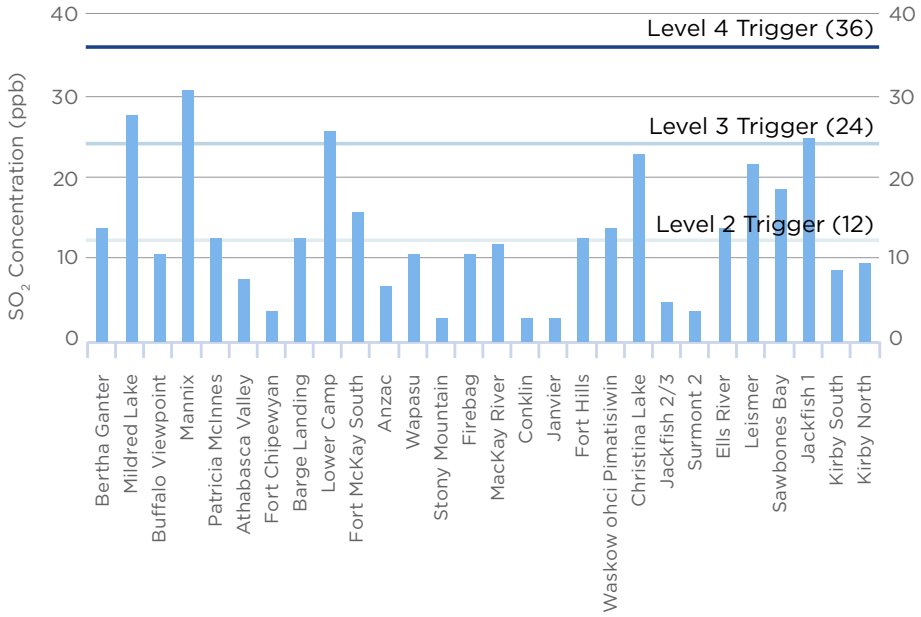
LARP NO_2 Hourly 99th Percentile



LARP SO_2 Annual Average



LARP SO_2 Hourly 99th Percentile



Regional Wind Profiles

Meteorological parameters, including wind speed and direction, humidity, precipitation, atmospheric pressure, solar radiation, and the vertical temperature structure of the atmosphere, all impact the dispersion, deposition, and transformation of common air pollutants.

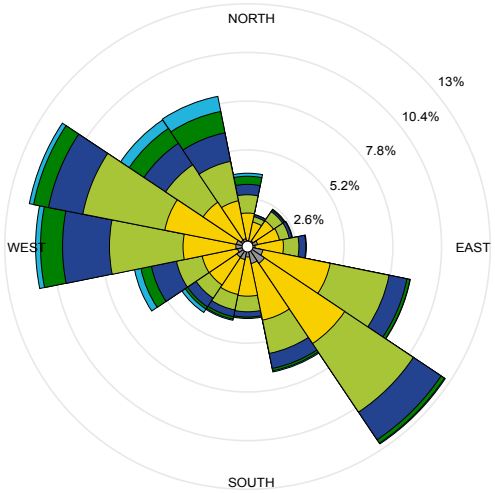
Wind rose plots are a visual representation of the wind profile for a specific location, showing wind speed and wind direction for communities within the WBEA network. The position relative to the centre of the wind rose represents the direction which wind is blowing from. The magnitude of the slice represents the frequency which the wind blows from that direction. The colours within each wind rose triangle represent the wind speeds when blowing from that direction (shown in the legend above the wind roses).

For example, the largest triangle in the Fort Chipewyan wind rose shows the wind comes from the East approximately 17% of the time in 2022.

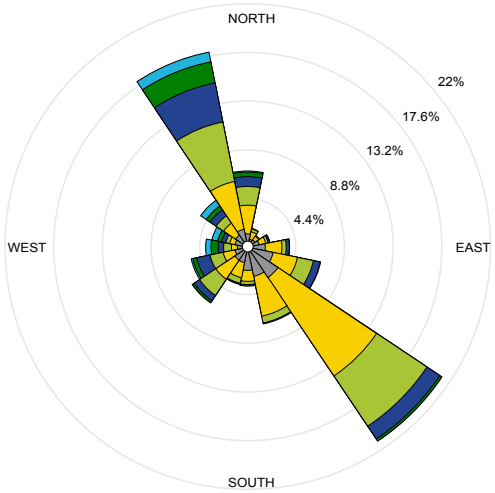
WIND SPEED (km/h)

0.5 - 5 | 5 - 10 | 10 - 15 | 15 - 20 | 20 - 25 | > = 25

Anzac
Calms: 0.02% | Tower Height: 20m



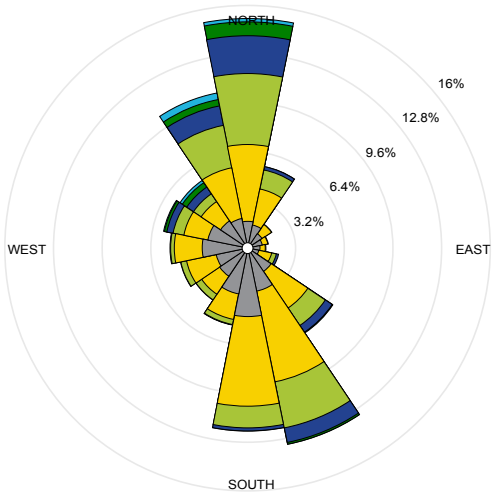
Athabasca Valley (Fort McMurray)
Calms: 0.36% | Tower Height: 10m



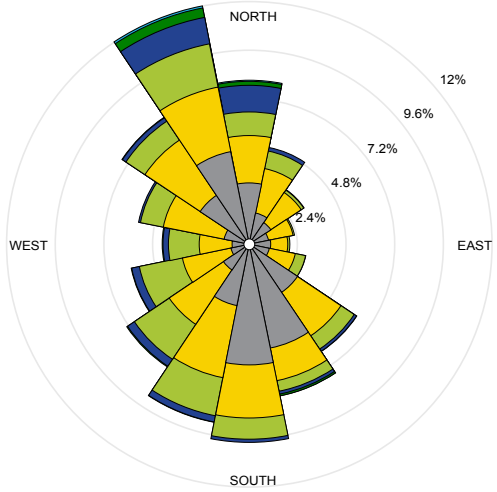
WIND SPEED (km/h)

0.5 - 5 | 5 - 10 | 10 - 15 | 15 - 20 | 20 - 25 | > = 25

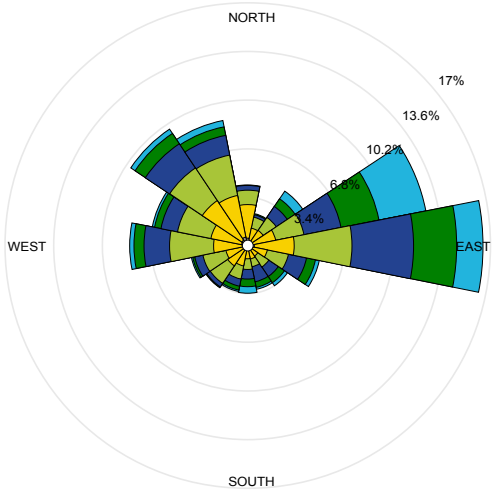
Bertha Ganter - Fort McKay
Calms: 0.35% | Tower Height: 10m



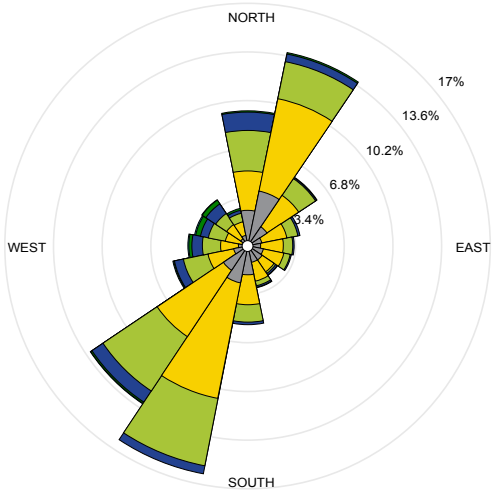
Conklin
Calms: 1.21% | Tower Height: 10m



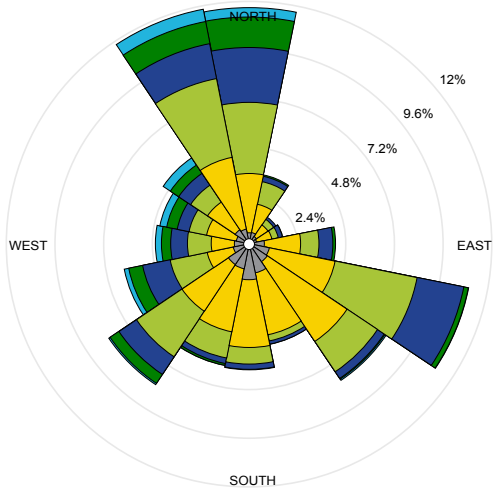
Fort Chipewyan
Calms: 0.00% | Tower Height: 10m



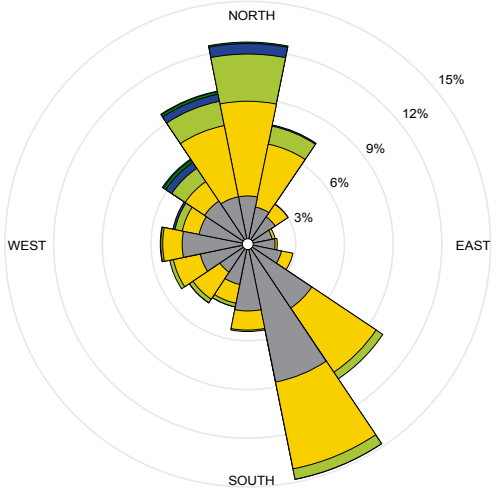
Janvier
Calms: 0.26% | Tower Height: 10m



Patricia McInnes (Fort McMurray)
Calms: 0.05% | Tower Height: 10m



Waskōw ohci Pimâtisiwin
Calms: 1.00% | Tower Height: 10m



Air Quality Parameters Monitored within the WBEA Network

Two key sampling methods are used by the WBEA for conducting high quality ambient air monitoring within its network: continuous, which generates raw air quality data in near real-time, and time-integrated or “non-continuous”. The following pages provide a summary of stations and parameters measured at WBEA sites.

Summary of stations and parameters measured continuously at WBEA sites

WBEA ID	Type	Station Name	SO_2	NO_2	O_3	$PM_{2.5}$	TRS	H_2S	THC	NMHC	CO	CO_2	NH_3
1	Community	Bertha Ganter-Fort McKay	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Compliance	Mildred Lake	✓					✓	✓	✓			
3	Meteorological	Lower Camp Met Tower											
4	Compliance	Buffalo Viewpoint	✓	✓	✓	✓		✓	✓	✓			
5	Compliance/Meteorological	Mannix	✓					✓	✓	✓			
6	Community	Patricia Mcinnes	✓	✓	✓	✓	✓		✓	✓			✓
7	Community	Athabasca Valley	✓	✓	✓	✓	✓		✓	✓	✓		
8	Community/Compliance	Fort Chipewyan	✓	✓	✓	✓	✓				✓	✓	
9	Attribution	Barge Landing	✓	✓		✓	✓		✓	✓			
11	Compliance	Lower Camp	✓					✓	✓	✓			
13	Compliance/Attribution	Fort McKay South	✓	✓	✓	✓	✓		✓	✓			
14	Compliance/Community	Anzac	✓	✓	✓	✓	✓		✓	✓			
17	Compliance	Wapasu	✓	✓	✓	✓		✓	✓				
18	Background	Stony Mountain	✓	✓	✓	✓	✓		✓	✓	✓	✓	
19	Compliance	Firebag	✓	✓				✓	✓				
20	Compliance	Mackay River	✓	✓				✓	✓				
21	Community	Conklin	✓	✓	✓	✓	✓		✓	✓			
22	Community	Janvier	✓	✓	✓	✓	✓		✓	✓			
23	Compliance	Fort Hills	✓	✓		✓	✓		✓	✓			
25	Emergency Response	Waskōw ohci Pimâtisiwin	✓					✓					
26	Compliance	Christina Lake	✓	✓				✓					
27	Compliance	Jackfish 2/3	✓	✓				✓					
29	Compliance	Surmont 2	✓	✓		✓		✓	✓				
30	Compliance	Ells River	✓	✓		✓	✓		✓	✓			
501	Compliance	Leismer	✓	✓				✓					
505	Compliance	Sawbones Bay	✓	✓				✓					
506	Compliance	Jackfish 1	✓	✓				✓					
507	Compliance	Kirby South	✓	✓				✓	✓				
508	Compliance	Kirby North	✓	✓				✓	✓				
509	Test	Horizon 2	✓	✓		✓	✓		✓	✓			
510	Test	Kirby Central	✓	✓				✓	✓				

Summary of stations and meteorological parameters measured continuously at WBEA sites

WBEA ID	Type	Station Name	Temperature	RH	BP	Wind Speed	Wind Direction	Vertical Wind Speed	Solar Radiation	Precip	Leaf Wetness
1	Community	Bertha Ganter-Fort Mckay	✓	✓		✓	✓		✓	✓	✓
2	Compliance	Mildred Lake	✓	✓		✓	✓				
3	Meteorological	Lower Camp Met Tower	✓	✓		✓	✓	✓			
4	Compliance	Buffalo Viewpoint	✓	✓		✓	✓				
5	Compliance/Meteorological	Mannix	✓	✓		✓	✓	✓			
6	Community	Patricia Mcinnes	✓	✓		✓	✓				
7	Community	Athabasca Valley	✓	✓	✓	✓	✓				
8	Community/Compliance	Fort Chipewyan	✓	✓		✓	✓		✓		✓
9	Attribution	Barge Landing	✓	✓	✓	✓	✓				
11	Compliance	Lower Camp	✓	✓	✓	✓	✓				
13	Compliance/Attribution	Fort Mckay South	✓	✓		✓	✓				
14	Compliance/Community	Anzac	✓	✓		✓	✓				✓
17	Compliance	Wapasu	✓	✓		✓	✓			✓	
18	Background	Stony Mountain	✓	✓		✓	✓		✓	✓	✓
19	Compliance	Firebag	✓	✓		✓	✓				
20	Compliance	Mackay River	✓	✓		✓	✓			✓	
21	Community	Conklin	✓	✓		✓	✓				
22	Community	Janvier	✓	✓		✓	✓				
23	Compliance	Fort Hills	✓	✓		✓	✓				
25	Emergency Response	Waskōw ohci Pimâtisiwin	✓	✓		✓	✓				
26	Compliance	Christina Lake	✓	✓		✓	✓				
27	Compliance	Jackfish 2/3	✓	✓		✓	✓				
29	Compliance	Surmont 2	✓	✓		✓	✓				
30	Compliance	Ells River	✓	✓		✓	✓		✓		
501	Compliance	Leismer	✓	✓		✓	✓				
505	Compliance	Sawbones Bay	✓	✓		✓	✓				
506	Compliance	Jackfish 1	✓	✓		✓	✓				
505	Compliance	Kirby South	✓	✓		✓	✓				
508	Compliance	Kirby North	✓	✓		✓	✓				
509	Test	Horizon 2	✓	✓		✓	✓				
510	Test	Kirby Central	✓	✓		✓	✓				

Summary of parameters measured using integrated methods at WBEA sites

WBEA ID	Type	Station Name	VOC	$PM_{2.5}$	$PM_{2.5}$ ECOC	PM_{10}	PAH	Precip	Dustfall
1	Community	Bertha Ganter-Fort McKay	✓	✓	✓	✓	✓	✓	✓
6	Community	Patricia Mcinnes	✓	✓		✓	✓		✓
7	Community	Athabasca Valley	✓	✓		✓	✓		✓
8	Compliance/Community	Fort Chipewyan	✓	✓		✓	✓		
9	Attribution	Barge Landing	✓						
13	Compliance/Attribution	Fort McKay South	✓			✓			
14	Compliance/Community	Anzac	✓	✓		✓	✓		✓
17	Compliance	Wapasu			✓			✓	
18	Enhanced Deposition/Background	Stony Mountain			✓			✓	
21	Community	Conklin	✓	✓		✓	✓		✓
22	Community	Janvier	✓	✓		✓	✓		✓
23	Compliance	Fort Hills	✓			✓			
30	Compliance	Ells River	✓			✓			

Continuous Monitoring

As its title suggests, the WBEA's continuous ambient air monitoring uses analyzers that continually measure concentrations of pollutants in the air. This data is readily available to anyone in near real-time on our website, **wbea.org**

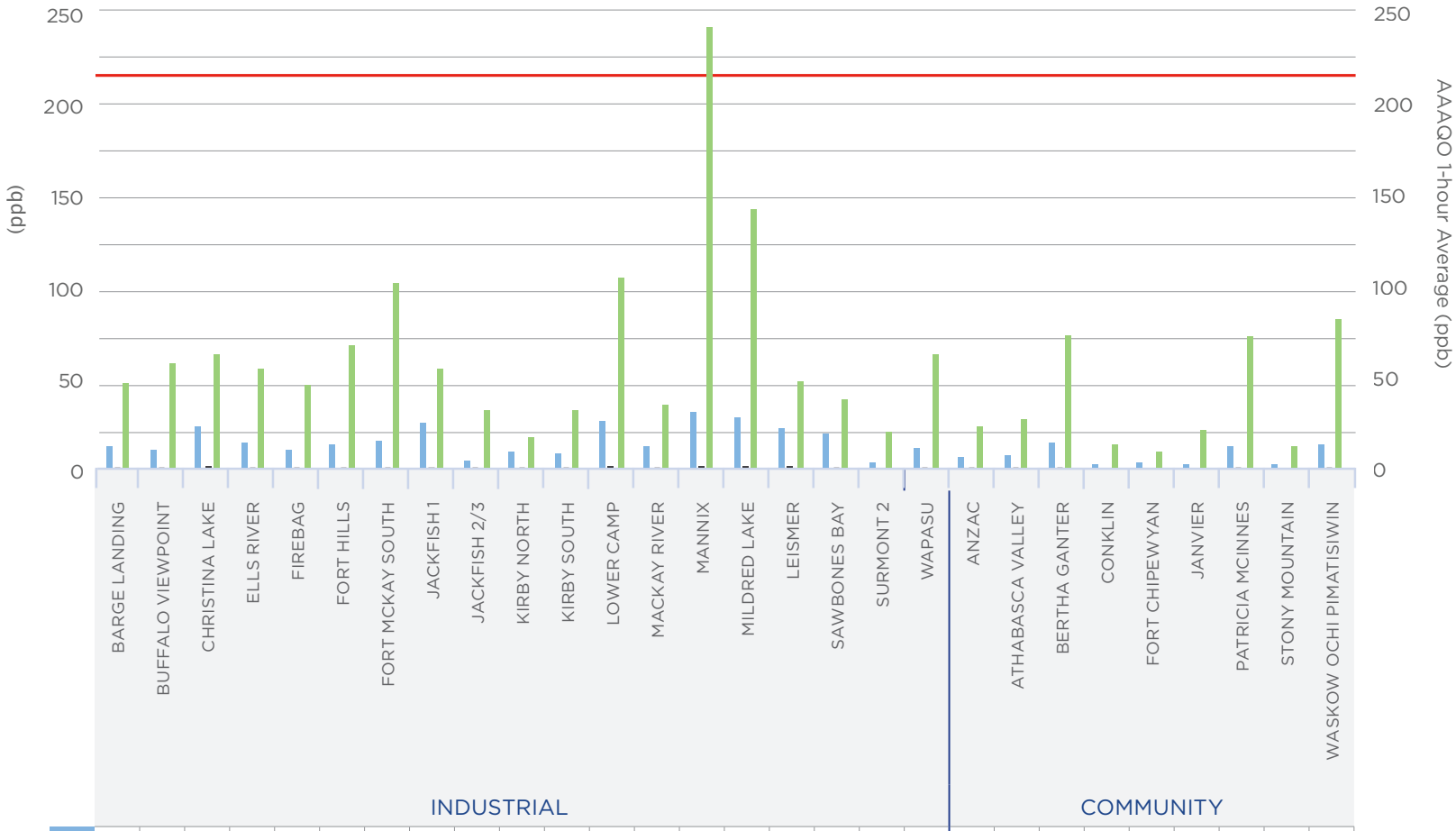
In addition to specific compounds, all stations continuously measure temperature, relative humidity, and wind speed and direction.

The data for continuous monitoring is presented in the following graphs as the annual hourly average (mean) concentrations of each parameter, along with the annual hourly 99th percentile and maximum concentrations. Please note, the averages may be too small to be visible on some graphs. The annual hourly 99th percentile is used to show the high end of concentrations measured at the WBEA air monitoring stations, after removing the highest 1% of events which may be outliers.

Note: Averages may be too small to be visible on some graphs.

Sulphur Dioxide (SO_2)

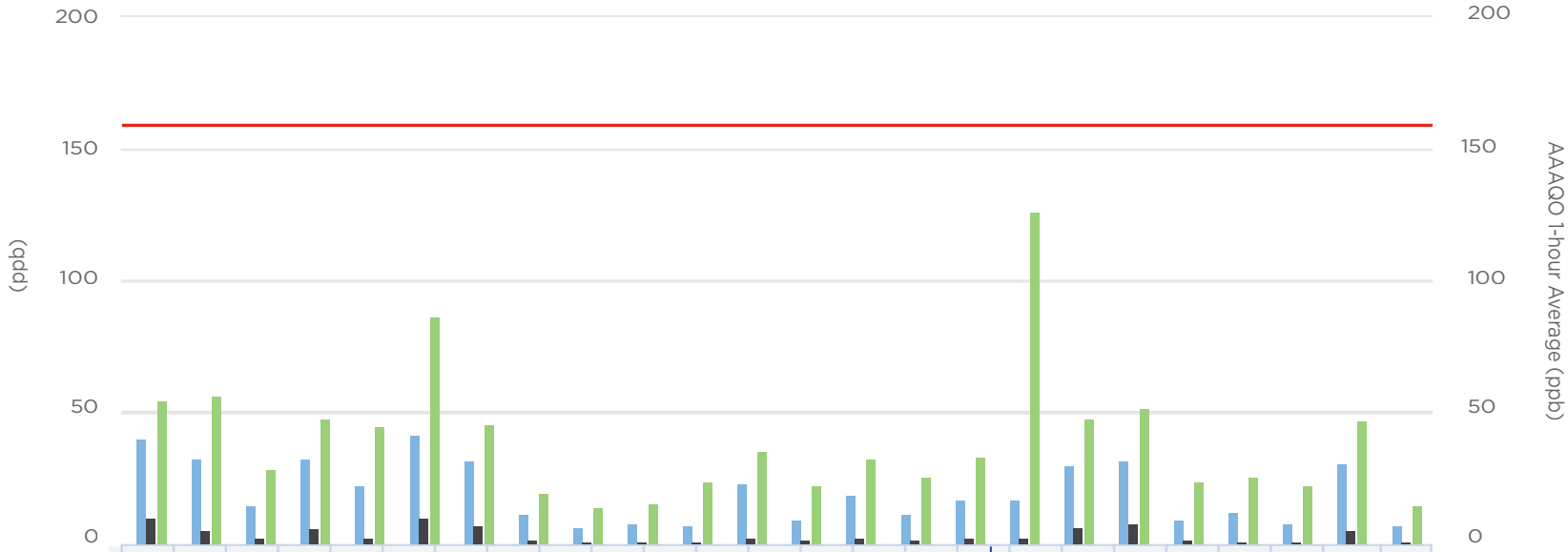
SO_2 is produced from the combustion of sulphur-containing fossil fuels. Sulphur dioxide in the air at high concentrations can make breathing difficult, particularly for children, the elderly, and people with asthma. SO_2 reacts in the atmosphere to form sulphuric acid and acidic aerosols, which contribute to acid deposition and acid rain.



	BARGE LANDING	BUFFALO VIEWPOINT	CHRISTINA LAKE	ELLS RIVER	FIREBAG	FORT HILLS	FORT MCKAY SOUTH	JACKFISH 1	JACKFISH 2/3	KIRBY NORTH	KIRBY SOUTH	LOWER CAMP	MACKAY RIVER	MANNIX	MILDRED LAKE	LEISMER	SAWBONES BAY	SURMONT 2	WAPASU	ANZAC	ATHABASCA VALLEY	BERTHA GANTER	CONKLIN	FORT CHIPEWYAN	JANVIER	PATRICIA MCINNES	STONY MOUNTAIN	WASKOW OCHI PIMATISIWIN
99th Percentile	12.9	10.9	23.4	14.0	10.8	13.3	15.8	25.2	4.7	9.6	9.0	25.5	12.2	30.5	27.6	21.8	19.3	4.3	11.1	6.7	7.8	14.3	3.3	4.1	2.6	12.6	3.3	13.9
Average	0.8	0.7	1.8	0.8	0.9	0.8	1.1	1.4	0.6	0.7	0.7	1.8	0.9	2.1	1.8	1.7	1.2	0.4	0.8	0.6	0.6	1.0	0.4	0.2	0.3	1.0	0.4	0.9
Max	46.6	56.6	61.4	54.0	44.8	66.3	99.6	54.1	32.2	17.7	31.5	103.1	34.8	237.4	139.2	47.1	37.1	20.4	61.2	23.3	27.1	72.2	13.1	9.7	20.7	70.8	12.4	80.3
AAAQO 1-hour avg.	172																											

Nitrogen Dioxide (NO_2)

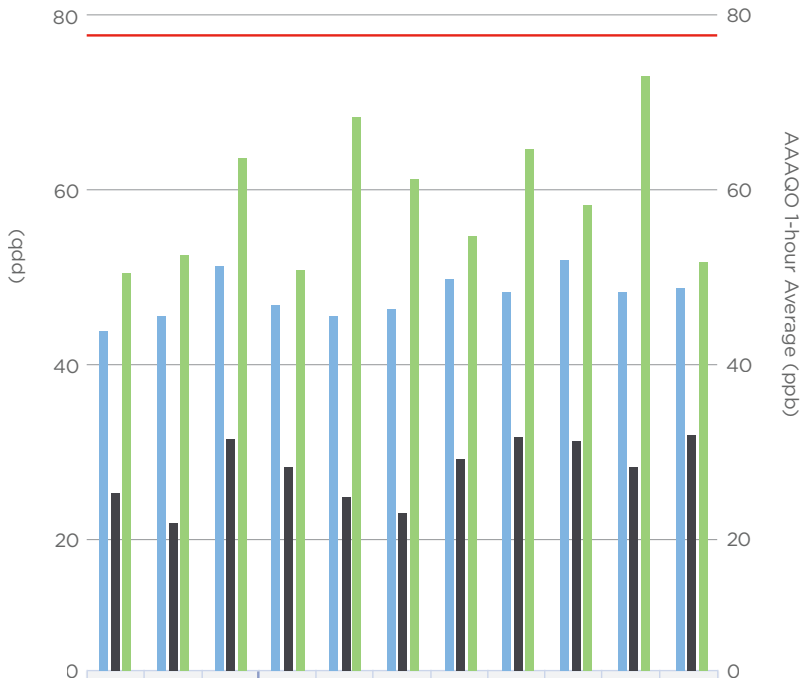
NO_2 is a reddish-brown gas with a pungent, irritating odour that is produced by combustion of fossil fuels. It plays a major role in atmospheric photo-chemical reactions, ground level ozone formation and destruction, and can also interact with water to form acid rain.



	BARGE LANDING	BUFFALO VIEWPOINT	CHRISTINA LAKE	ELLS RIVER	FIREBAG	FORT HILLS	FORT MCKAY SOUTH	JACKFISH 1	JACKFISH 2/3	KIRBY NORTH	KIRBY SOUTH	MACKAY RIVER	LEISMER	SAWBONES BAY	SURMONT 2	WAPASU	ANZAC	ATHABASCA VALLEY	BERTHA GANTER	CONKLIN	FORT CHIPEWYAN	JANVIER	PATRICIA MCINNES	STONY MOUNTAIN
99th Percentile	39.5	32.2	15.0	32.6	22.1	41.4	31.5	11.6	7.0	8.4	7.3	23.2	9.1	18.6	11.7	17.0	16.7	29.9	31.8	9.2	11.8	8.3	30.2	7.1
Average	9.9	5.1	2.9	6.0	3.0	10.0	7.7	2.2	1.3	1.6	1.1	2.7	1.8	2.8	1.7	2.5	2.4	6.9	7.9	1.7	1.2	1.4	5.3	1.1
Max	54.1	56.2	28.1	47.1	44.7	85.3	45.0	19.7	13.9	15.3	23.7	35.0	22.1	32.6	25.5	32.9	124.8	47.3	51.3	23.4	25.9	22.5	46.7	14.8
AAAQO 1-hour avg.	159																							

Ozone (O_3)

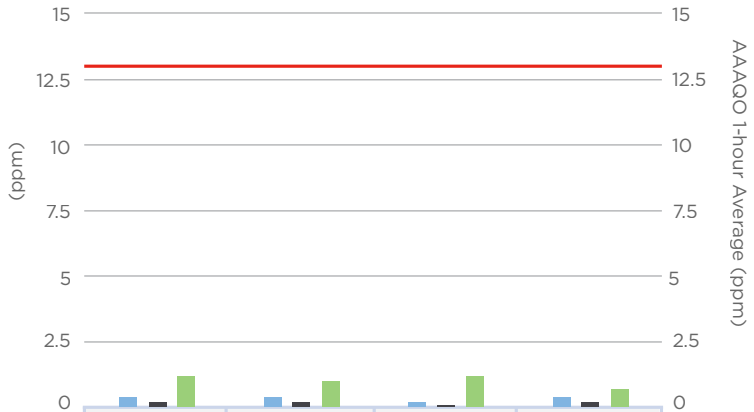
O_3 at ground-level is not emitted directly into the air but formed by chemical reactions of NO_x and volatile organic compounds (VOCs), from vehicular and industrial emissions. At high concentrations, breathing ozone can affect respiratory function, and cause coughing, throat irritation, and airway inflammation. Children, the elderly, and people with asthma are the most susceptible. Ozone can affect sensitive vegetation, by slowing plant growth and making them more susceptible to disease.



	BUFFALO VIEWPOINT	FORT MCKAY SOUTH	WAPASU	ANZAC	ATHABASCA VALLEY	BERTHA GANTER	CONKLIN	FORT CHIPEWYAN	JANVIER	PATRICIA MCINNES	STONY MOUNTAIN
	INDUSTRIAL			COMMUNITY							
99th Percentile	42.5	44.4	50.6	45.9	44.5	45.2	48.9	47.4	51.4	47.3	48.0
Average	22.4	18.5	29.1	25.7	21.7	19.9	26.6	29.3	28.7	25.5	29.6
Max	49.8	52.0	64.0	50.1	69.1	61.3	54.3	65.1	58.3	74.3	51.3
AAAQO 1-hour avg.	76										

Carbon Monoxide (CO)

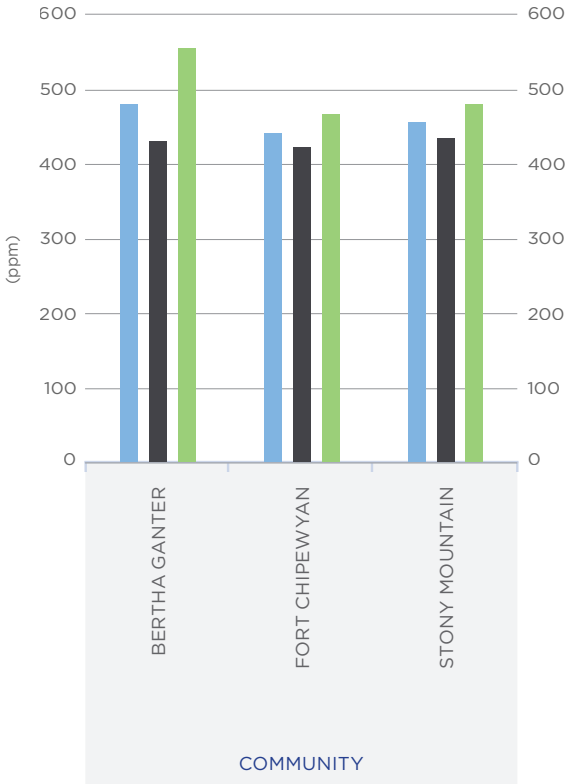
CO is formed from the incomplete combustion of carbon in fossil fuels. Transportation and vehicle emissions are the major source of carbon monoxide with elevated concentrations during the morning and evening rush hours. Breathing carbon monoxide decreases the amount of oxygen carried by the blood stream.



	ATHABASCA VALLEY	BERTHA GANTER	FORT CHIPEWYAN	STONY MOUNTAIN
99th Percentile	0.4	0.4	0.2	0.4
Average	0.2	0.2	0.1	0.2
Max	1.2	1.0	1.2	0.7
AAAQO 1-hour avg.	13			

Carbon Dioxide (CO_2)

CO_2 is a natural component of the air we breath. It is a colorless, odourless gas produced by respiration of plants and animals, and through combustion of fossil fuels. Ambient carbon dioxide is generally not a human health concern and is monitored in the network to help differentiate between origins of emissions such as forest fires and anthropogenic sources.

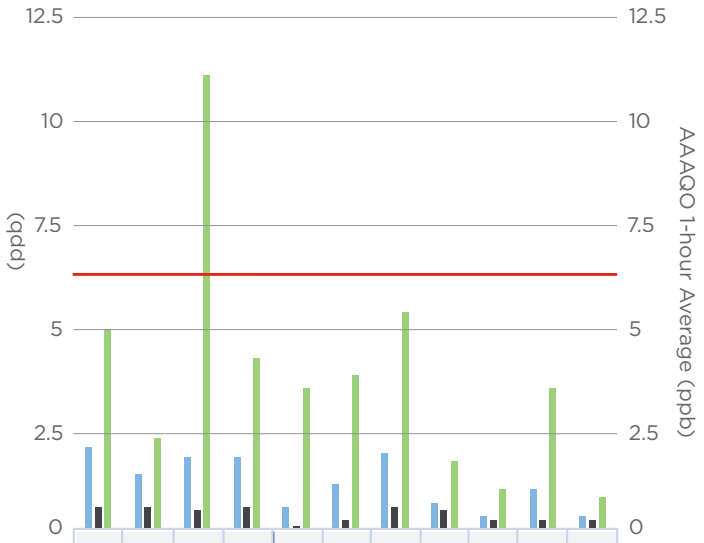


	BERTHA GANTER	FORT CHIPEWYAN	STONY MOUNTAIN
99th Percentile	481	442	457
Average	431	424	436
Max	555	468	481

Note: CO_2 does not currently have an AAAQO

Total Reduced Sulphur (TRS)

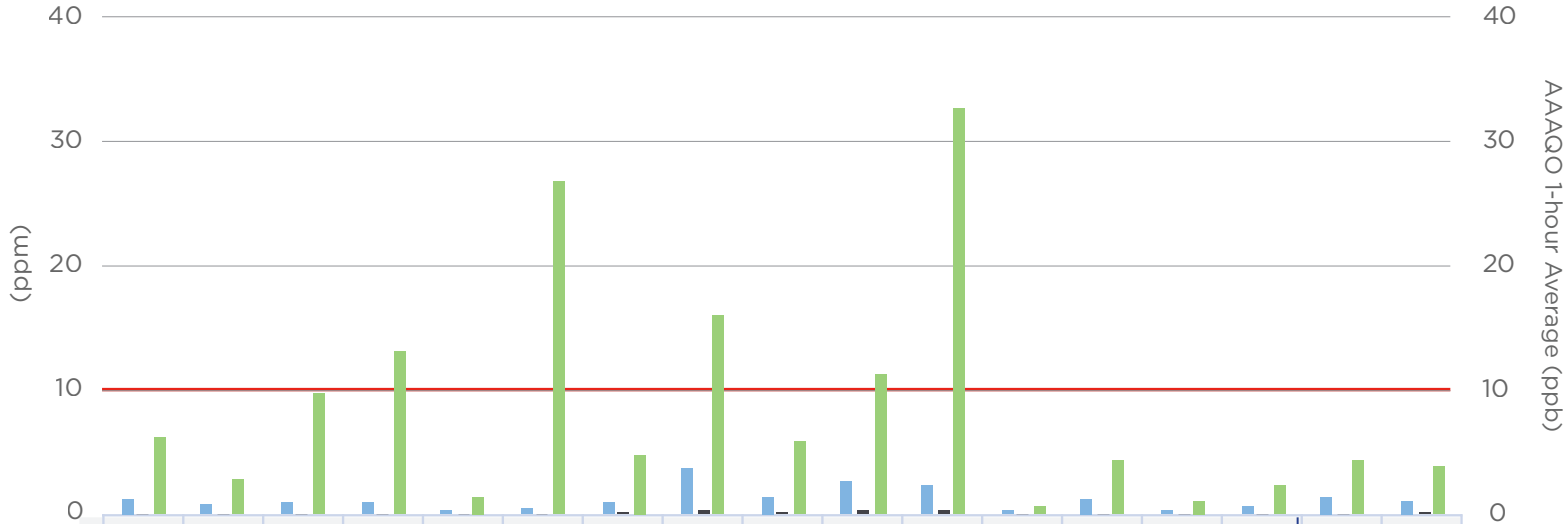
H_2S is a colourless gas with a rotten egg odour. It is produced through industrial processes. The term "Total Reduced Sulphurs" covers a larger group of sulphur-containing compounds, including H_2S, carbonyl sulphide, mercaptans, etc. These substances have the potential to cause odours in the region. In the WBEA airshed most industrial TRS and H_2S emissions are from upgraders and tailings ponds, though there is a natural background ambient air concentration of the reduced sulphur compound carbonyl sulphide of approximately 0.5 ppb.



	BARGE LANDING	ELLS RIVER	FORT HILLS	FORT MCKAY SOUTH	ANZAC	ATHABASCA VALLEY	BERTHA GANTER	CONKLIN	JANVIER	PATRICIA MCINNES	STONY MOUNTAIN
99th Percentile	1.8	1.2	1.6	1.6	0.5	1.0	1.7	0.6	0.3	0.9	0.3
Average	0.5	0.5	0.4	0.5	0.1	0.2	0.5	0.4	0.2	0.2	0.2
Max	4.4	2.0	10.0	3.8	3.1	3.4	4.8	1.5	0.9	3.1	0.7
AAAQO 1-hour avg.	10										

Hydrogen Sulphide (H_2S)

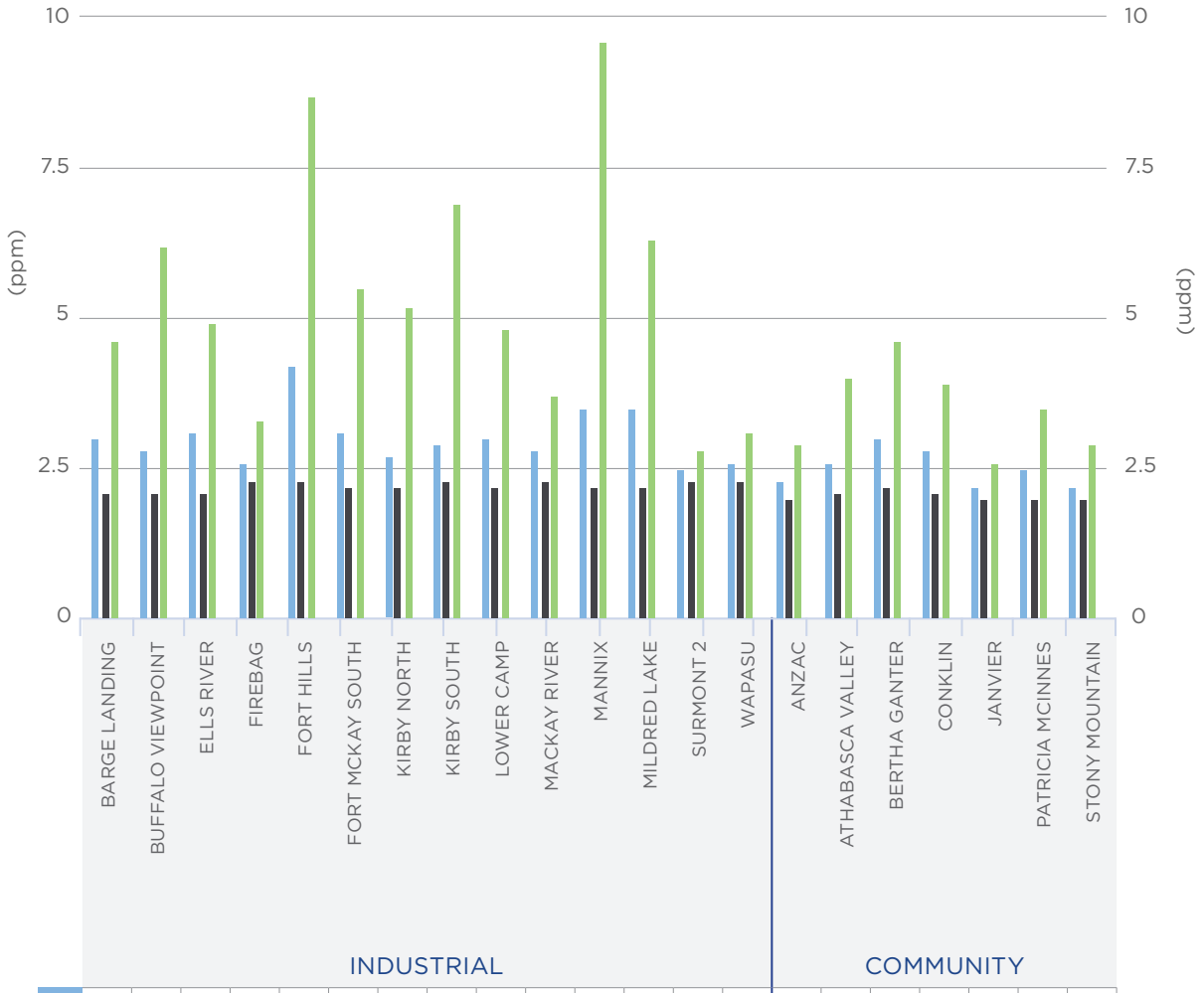
H_2S is a colourless gas with a rotten egg odour. It is produced through industrial processes. The term "Total Reduced Sulphurs" covers a larger group of sulphur-containing compounds, including H_2S, carbonyl sulphide, mercaptans, etc. These substances have the potential to cause odours in the region. In the WBEA airshed most industrial TRS and H2S emissions are from upgraders and tailings ponds, though there is a natural background ambient air concentration of the reduced sulphur compound carbonyl sulphide of approximately 0.5 ppb.



	BUFFALO VIEWPOINT	CHRISTINA LAKE	FIREBAG	JACKFISH 1	JACKFISH 2/3	KIRBY NORTH	KIRBY SOUTH	LOWER CAMP	MACKAY RIVER	MANNIX	MILDRED LAKE	LEISMER	SAWBONES BAY	SURMONT 2	WAPASU	BERTHA GANTER	WASKŌW OHCI PIMÂTISIWIN
99th Percentile	1.4	1.0	1.1	1.1	0.5	0.6	1.1	3.8	1.5	2.8	2.5	0.5	1.4	0.5	0.7	1.5	1.3
Average	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.5	0.3	0.4	0.4	0.1	0.2	0.1	0.1	0.2	0.3
Max	6.3	3.0	9.8	13.3	1.6	27.0	5.0	16.1	6.0	11.4	32.7	0.8	4.4	1.2	2.5	4.4	4.0
AAAQO 1-hour avg.																	

Total Hydrocarbons (THC)

Total hydrocarbons (THC) are the combined concentrations on both methane and non-methane hydrocarbons. Some stations in the WBEA network only measure THCs, while certain stations measure CH_4, NMHC, and THC. Many hydrocarbons are emitted from natural sources, while others can come from industrial and vehicular emissions. The natural background level of THC, composed mainly of CH_4, is generally around 1.8 ppm.

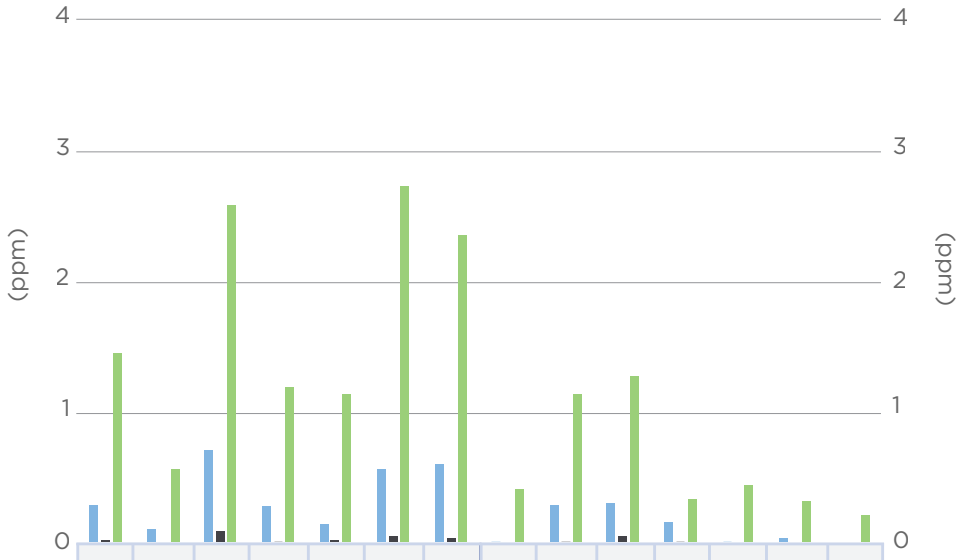


	BARGE LANDING	BUFFALO VIEWPOINT	ELLS RIVER	FIREBAG	FORT HILLS	FORT MCKAY SOUTH	KIRBY NORTH	KIRBY SOUTH	LOWER CAMP	MACKAY RIVER	MANNIX	MILDRED LAKE	SURMONT 2	WAPASU	ANZAC	ATHABASCA VALLEY	BERTHA GANTER	CONKLIN	JANVIER	PATRICIA MCINNES	STONY MOUNTAIN
99th Percentile	3.0	2.8	3.1	2.6	4.2	3.1	2.7	2.9	3.0	2.8	3.5	3.5	2.5	2.6	2.3	2.6	3.0	2.8	2.2	2.5	2.2
Average	2.1	2.1	2.1	2.3	2.3	2.2	2.2	2.3	2.2	2.3	2.2	2.2	2.3	2.3	2.0	2.1	2.2	2.1	2.0	2.0	2.0
Max	4.6	6.2	4.9	3.3	8.7	5.5	5.2	6.9	4.8	3.7	9.6	6.3	2.8	3.1	2.9	4.0	4.6	3.9	2.6	3.5	2.9

Note: THC does not currently have an AAAQO

Non-Methane Hydrocarbons (NMHC)

Methane (CH_4) is the most abundant hydrocarbon on earth, while reactive non-methane hydrocarbons (NMHCs) can react with other compounds in atmosphere to form ozone. Total hydrocarbons (THC) are the combined concentrations on both methane and non-methane hydrocarbons. Some stations in the WBEA network only measure THCs, while certain stations measure CH_4, NMHC, and THC. Many hydrocarbons are emitted from natural sources, while others can come from industrial and vehicular emissions. The natural background level of THC, composed mainly of CH_4, is generally around 1.8 ppm.

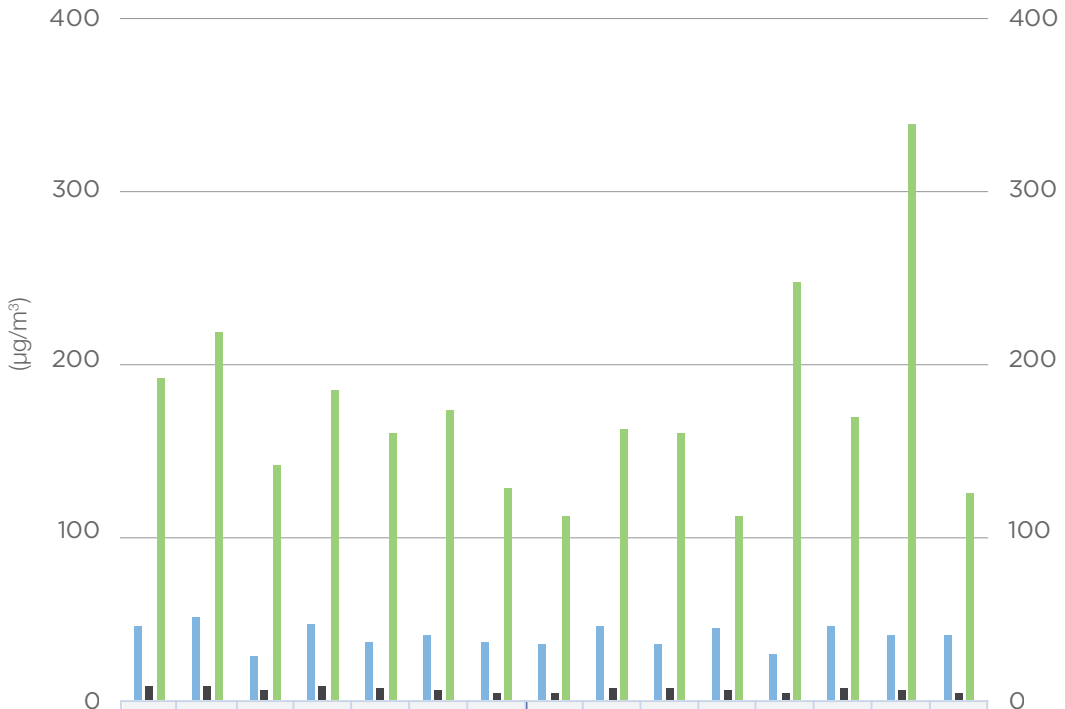


	BARGE LANDING	BUFFALO VIEWPOINT	FORT HILLS	FORT MCKAY SOUTH	LOWER CAMP	MANNIX	MILDRED LAKE	ANZAC	ATHABASCA VALLEY	BERTHA GANTER	CONKLIN	JANVIER	PATRICIA MCINNES	STONY MOUNTAIN
99th Percentile	0.3	0.1	0.7	0.3	0.2	0.6	0.6	0.0	0.3	0.3	0.2	0.0	0.0	0.0
Average	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Max	1.5	0.6	2.6	1.2	1.2	2.7	2.4	0.4	1.2	1.3	0.3	0.5	0.3	0.2

Note: NMHC does not currently have an AAAQO

Particulate matter less than 2.5 µm

Particulate matter consists of a mixture of solid particles and aerosols found in the air. $PM_{2.5}$ is the fraction of total particulate that are 2.5 µm (microns) in diameter or less, and is produced mainly by combustion processes, including forest fires.

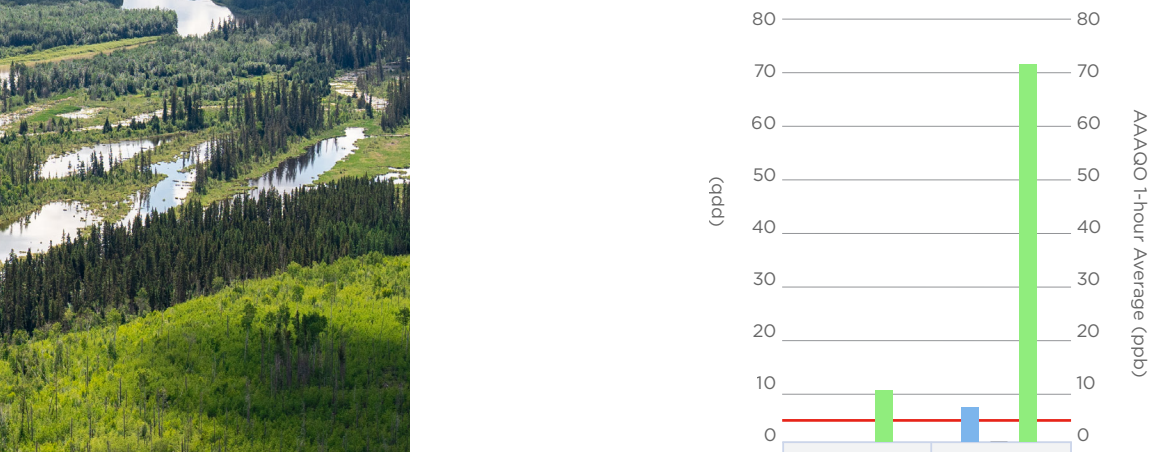


	BARGE LANDING	BUFFALO VIEWPOINT	ELLS RIVER	FORT HILLS	FORT MCKAY SOUTH	SURMONT 2	WAPASU	ANZAC	ATHABASCA VALLEY	BERTHA GANTER	CONKLIN	FORT CHIPEWYAN	JANVIER	PATRICIA MCINNES	STONY MOUNTAIN
99th Percentile	44.2	50.2	27.1	46.3	35.1	38.4	35.0	34.0	44.9	33.0	42.6	28.2	44.5	39.4	39.5
Average	9.1	9.1	6.3	8.8	7.9	6.2	5.7	5.7	7.8	7.9	6.9	5.2	7.7	7.3	5.7
Max	190.3	216.6	138.5	182.6	157.2	171.4	125.2	108.5	160.2	158.1	108.8	247.0	166.7	339.3	122.2

Note: The data in the graph is presented using 1-hour concentration averages.
Note: $PM_{2.5}$ does not currently have a 1-hour average AAAQO.
Note: Forest fire season was considered to be from March 1 - October 31, 2022.

Ammonia (NH_3)

NH_3 is a natural compound found in the environment as part of the nitrogen cycle and can also come from human activity. NH_3 is monitored by the WBEA because it is used by one industry member to help reduce SO_2 emissions. Exposure to elevated concentrations of ammonia can cause irritation of the nose, throat, and respiratory tract. NH_3 is currently monitored at the Bertha Ganter-Fort McKay and Patricia McInnes air monitoring stations.



	BERTHA GANTER	PATRICIA MCINNES
99th Percentile	0.0	6.6
Average	0.0	0.2
Max	9.9	71.6
AAAQO 1-hour avg.	2	

Note: Averages may be too small to be visible on some graphs.

Time-Integrated Monitoring

Time-integrated sampling provides more detailed analysis of species present in ambient air, and supplements continuous monitoring which reports a total concentration in real-time. Time-integrated monitoring methods consist of exposing sample media to the atmosphere for a period of time, and then the media is sent to a laboratory for analysis.

The WBEA's time-integrated sampling data is available to everyone at **wbea.org/network-and-data/integrated-data**. The data for time-integrated monitoring methods is presented in the following graphs as the annual average (mean) of 24-hour sample concentrations, along with the 95th percentile to show readings on the high-end of the data collected, after removing the highest 5% which may be outliers. There are numerous species collected, however, the graphs show the nine (9) or ten (10) parameters with the highest concentrations in 2022.

Note: Averages may be too small to be visible on some graphs.

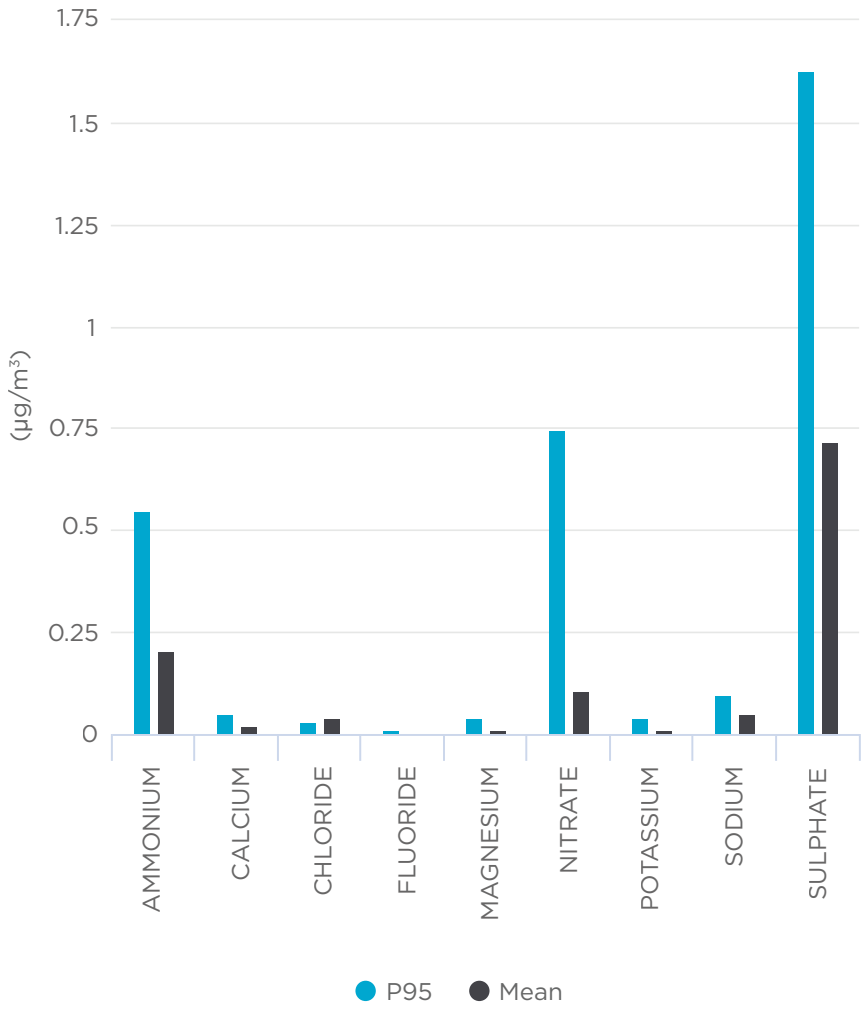
Particulate matter less than 2.5 µm Ions

Particulate matter consists of a mixture of solid particles and aerosols found in the air. $PM_{2.5}$ is the fraction of total particulate that are 2.5 µm (microns) in diameter or less, and is produced mainly by combustion processes, including forest fires.

Typically, exceedances of the $PM_{2.5}$ AAAQO in the WBEA network are a result of forest fires. Fine particles are composed primarily of sulphate, nitrate, ammonium, inorganic and organic carbon compounds, and heavy metals. $PM_{2.5}$ poses a health risk as the particles can be inhaled deep into the lungs.

The continuous analyzer measures the concentration of particulate matter in the air at any given time. A time-integrated $PM_{2.5}$ sample is a measure of dry deposition and is analyzed for major ions similar to the wet deposition samples, and metals that make up the particulate matter in the air.

Anzac



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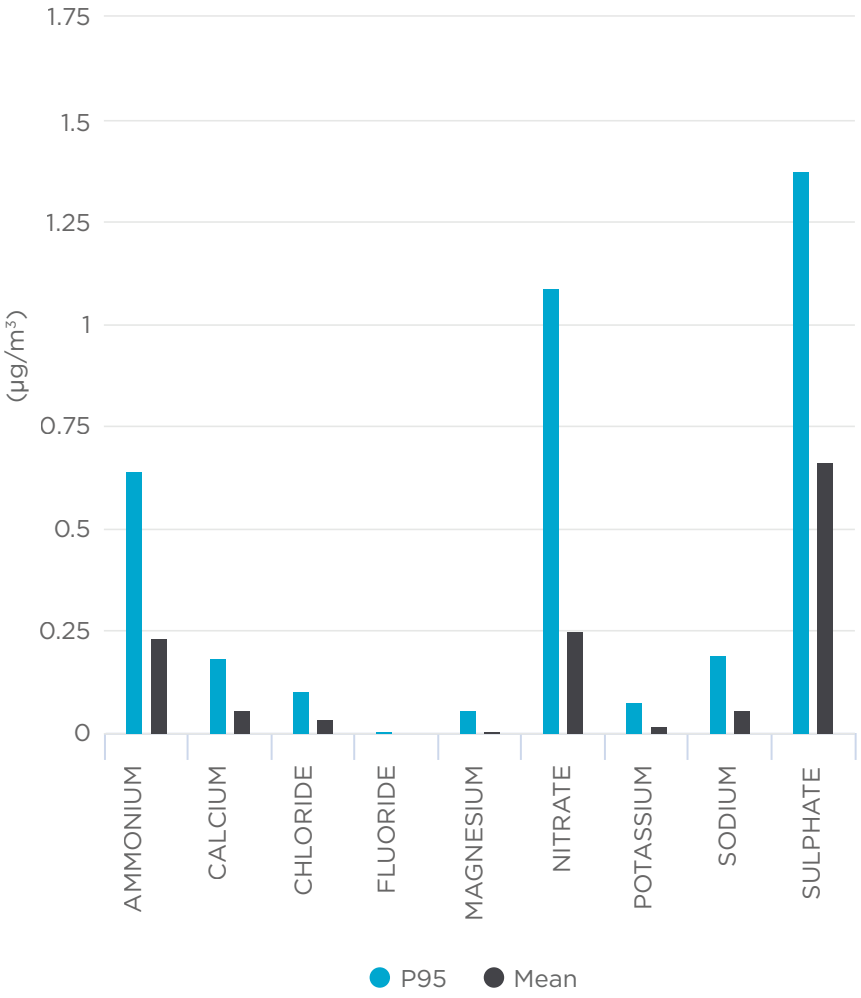
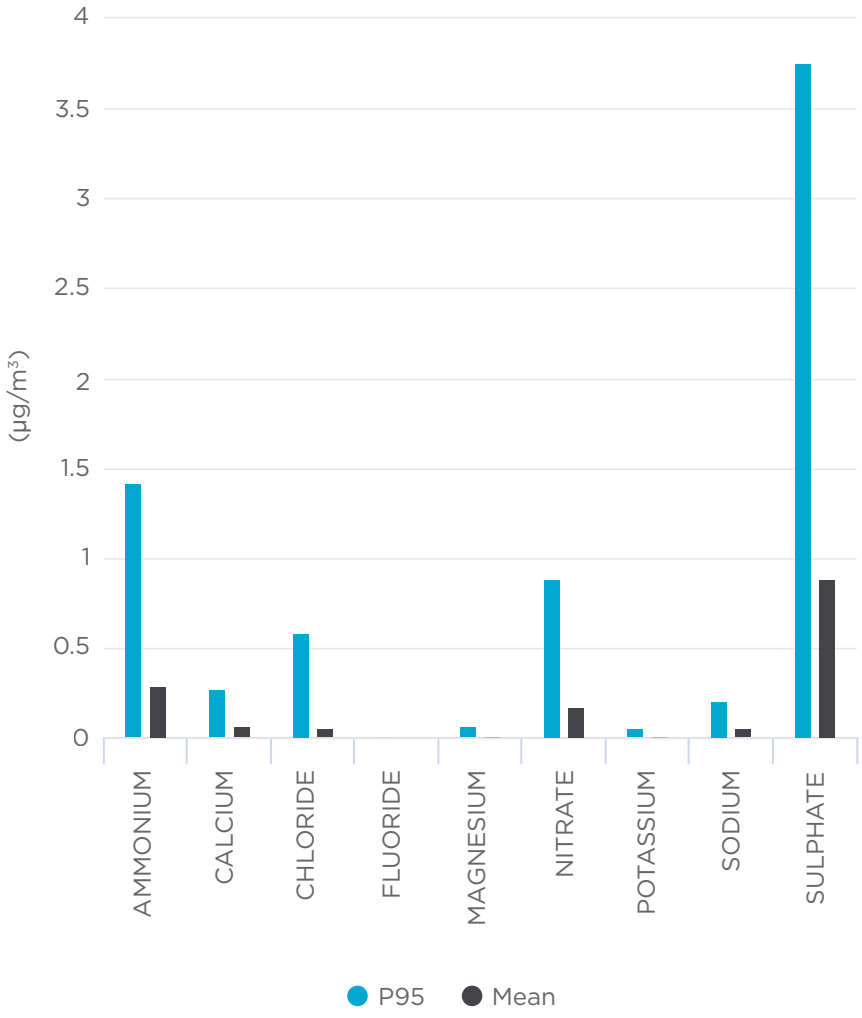
Athabasca Valley



Bertha Ganter - Fort McKay



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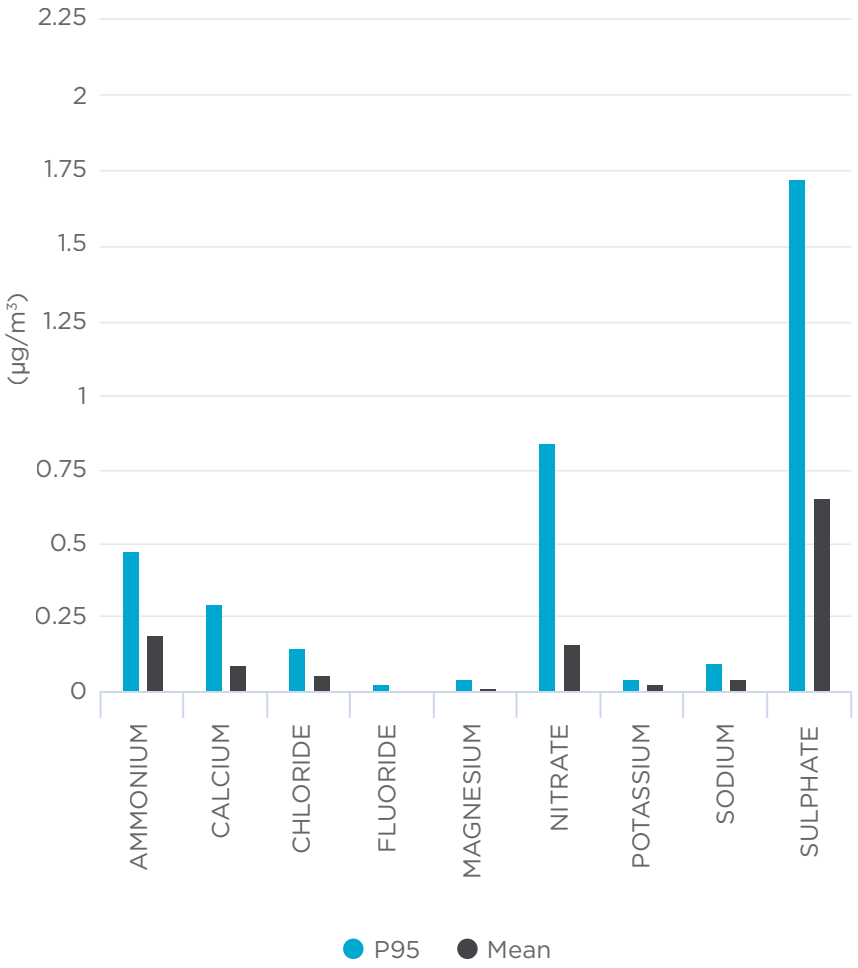
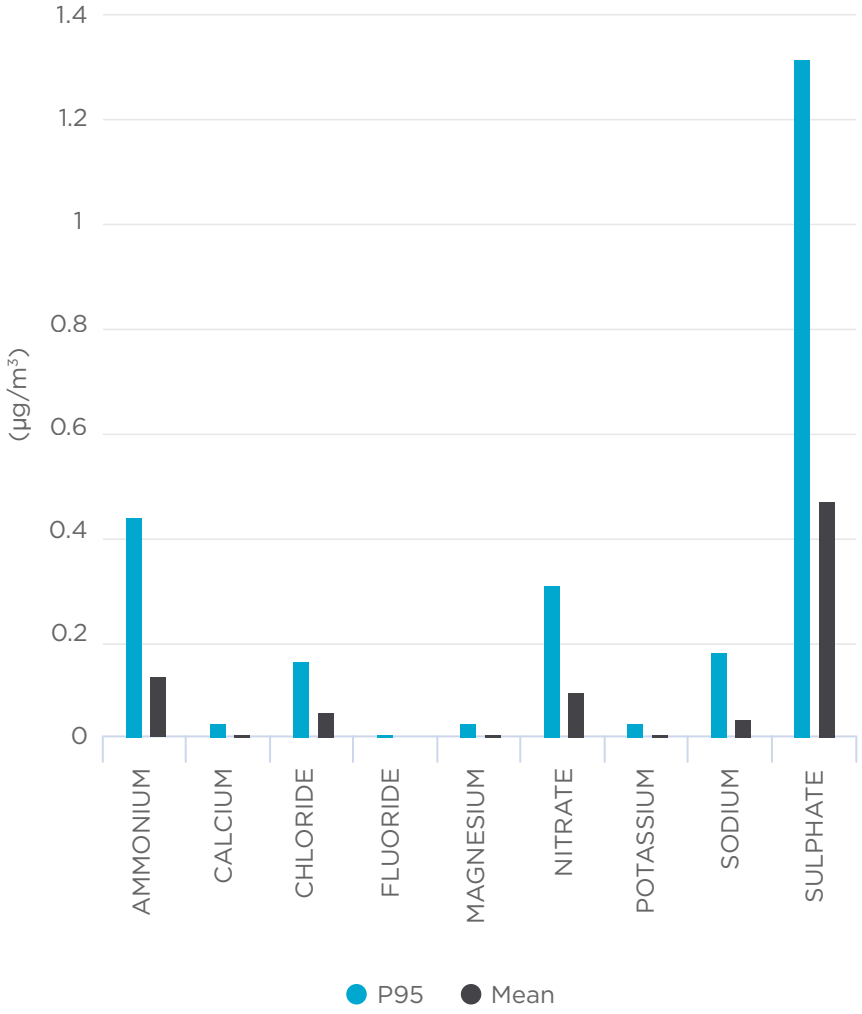
Conklin



Fort Chipewyan



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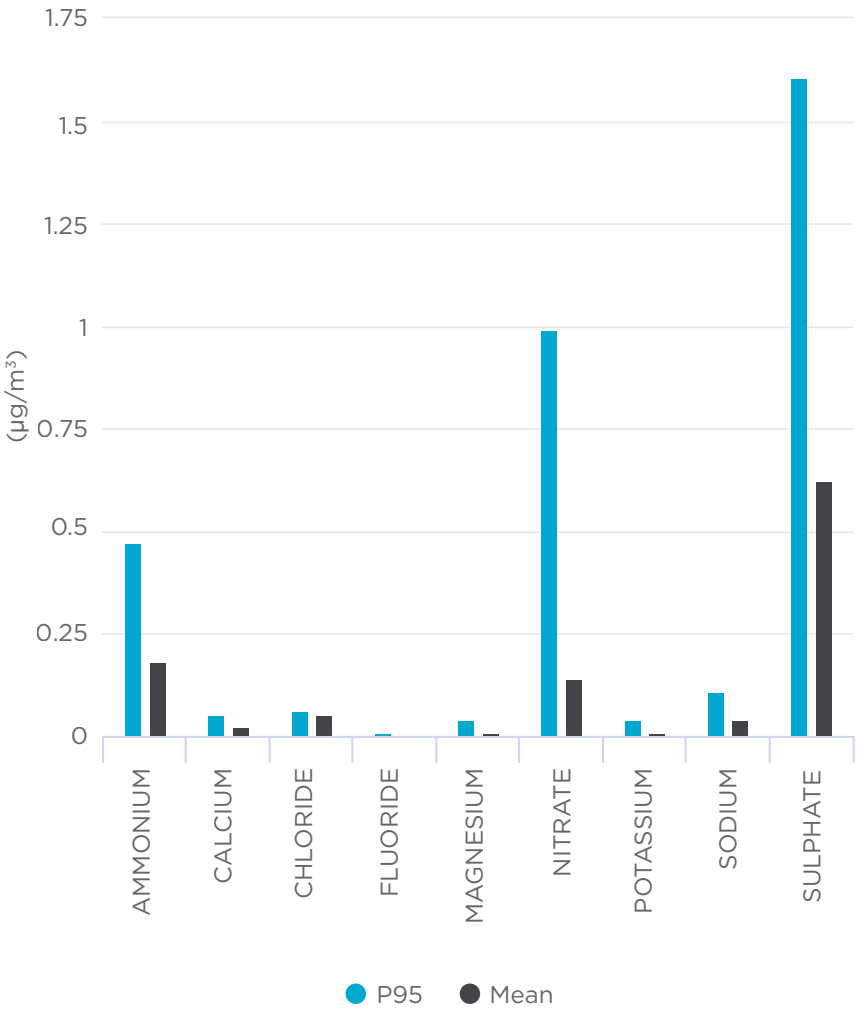
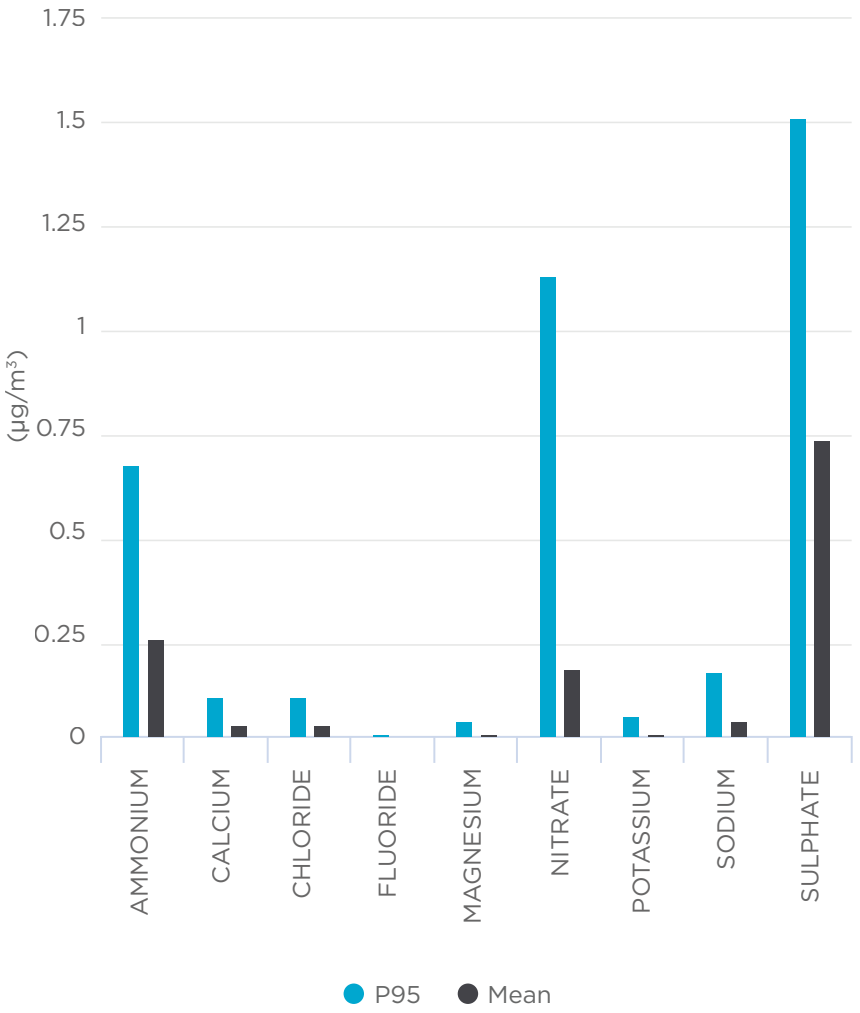
Janvier



Patricia McInnes



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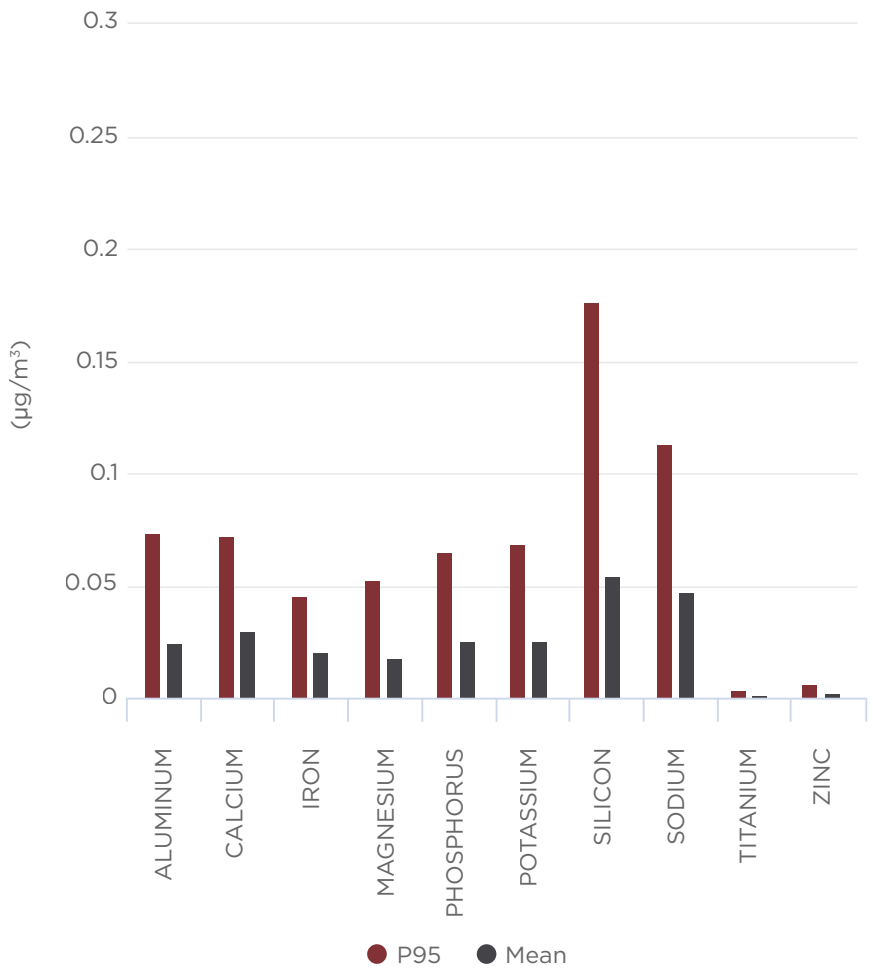
The continuous analyzer measures the concentration of particulate matter in the air at any given time. A time-integrated $PM_{2.5}$ sample is a measure of dry deposition and is analyzed for major ions similar to the wet deposition samples, and metals that make up the particulate matter in the air.

Anzac



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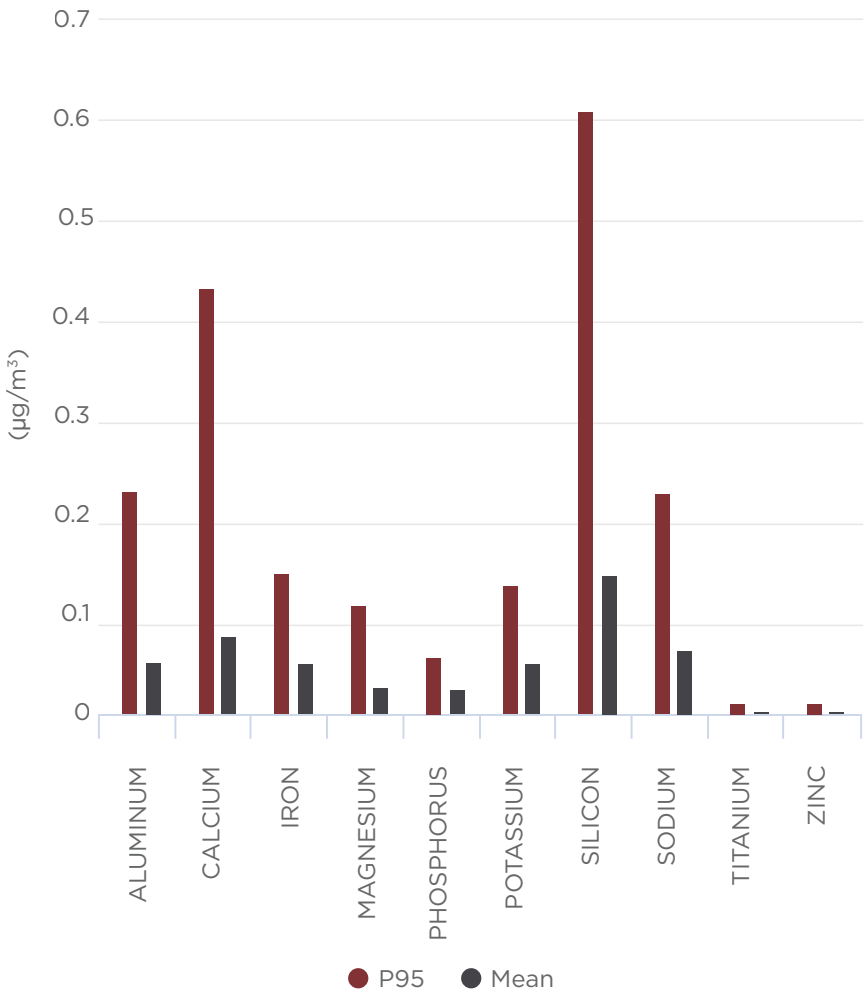
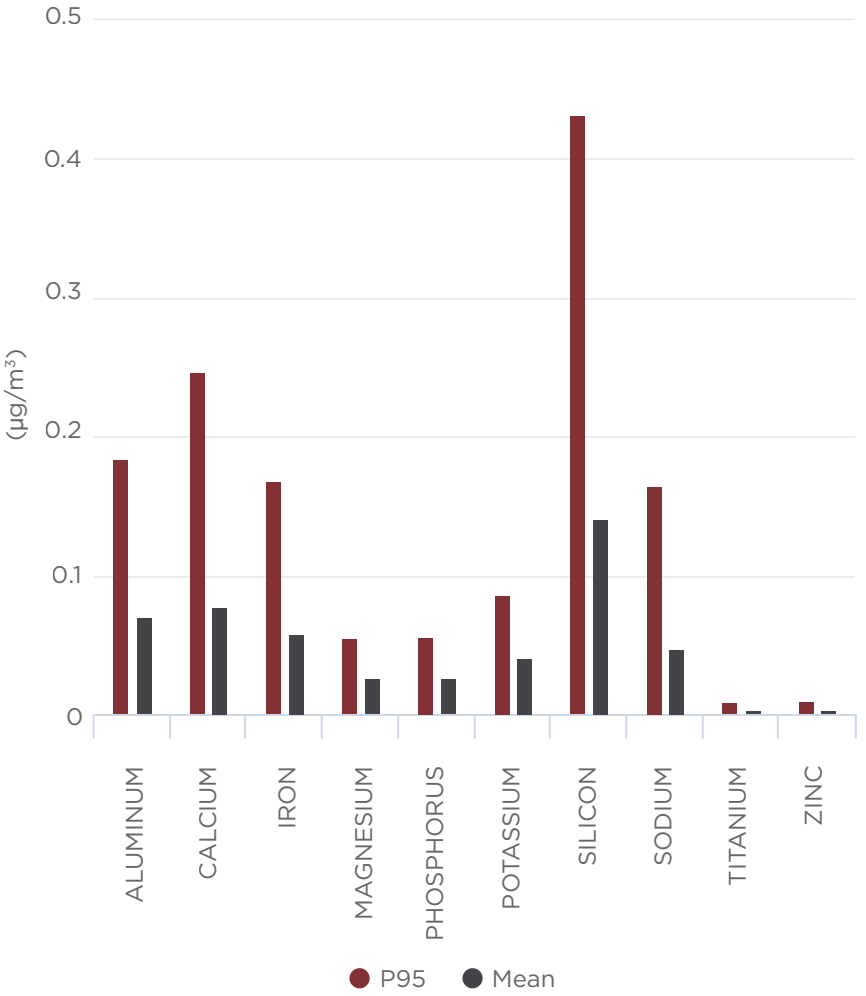
Athabasca Valley



Bertha Ganter - Fort McKay



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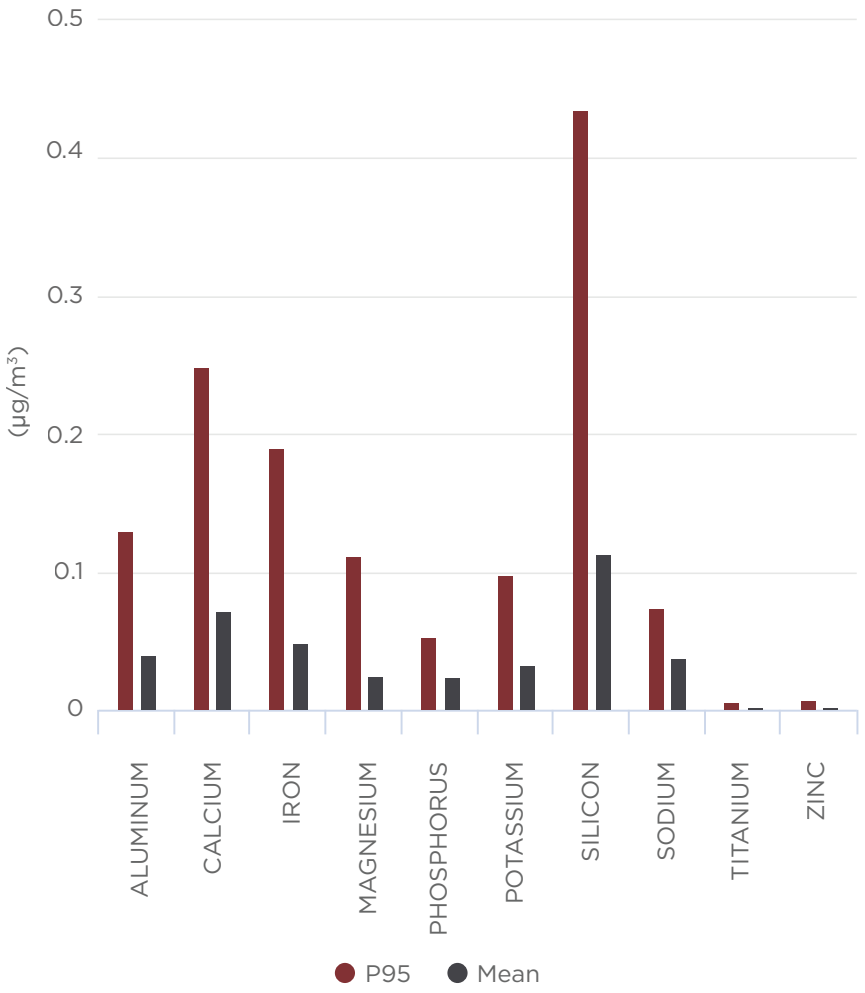
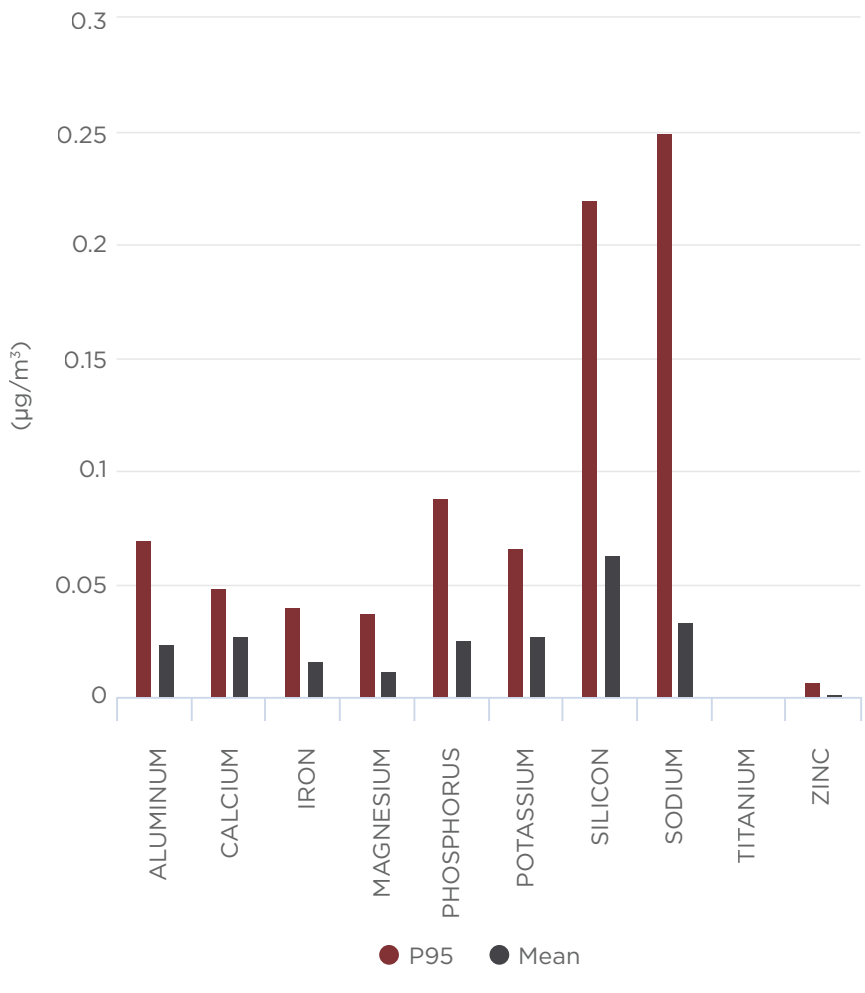
Conklin



Fort Chipewyan



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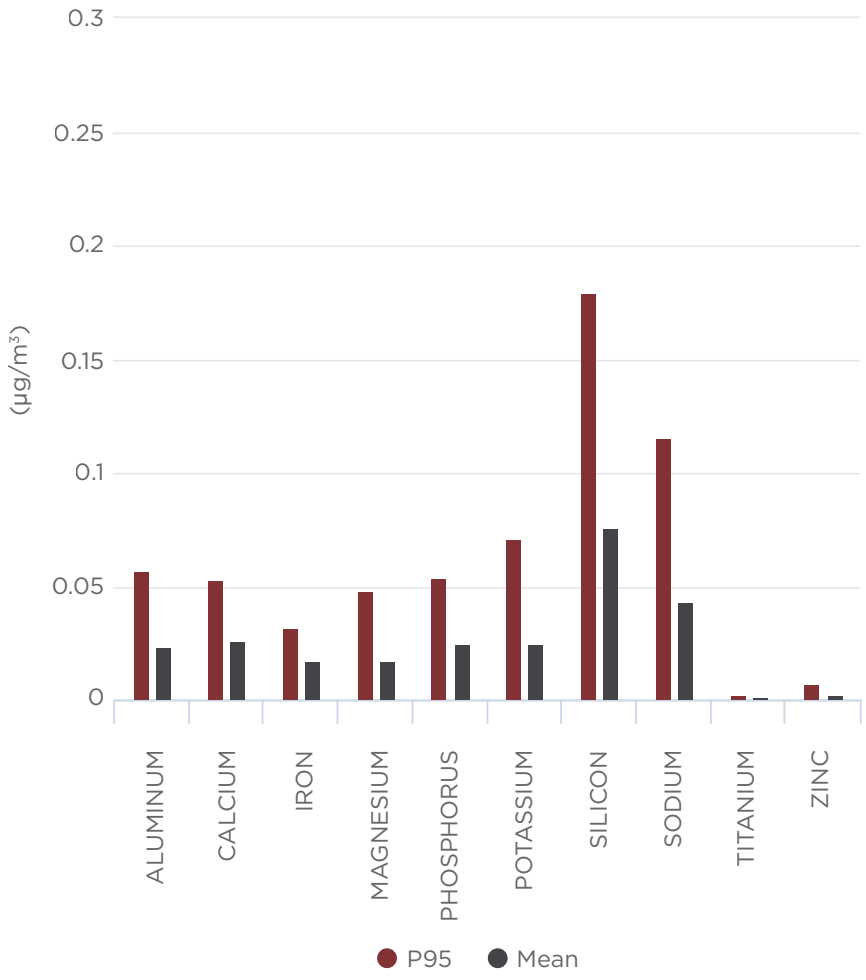
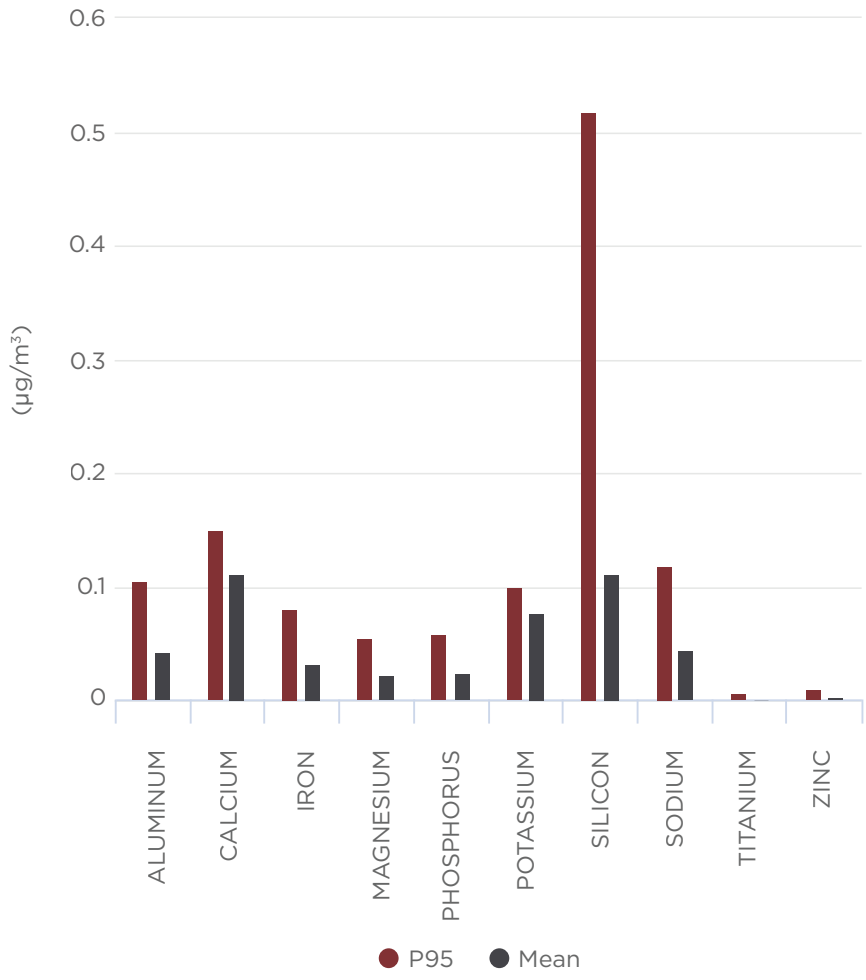
Janvier



Patricia McInnes



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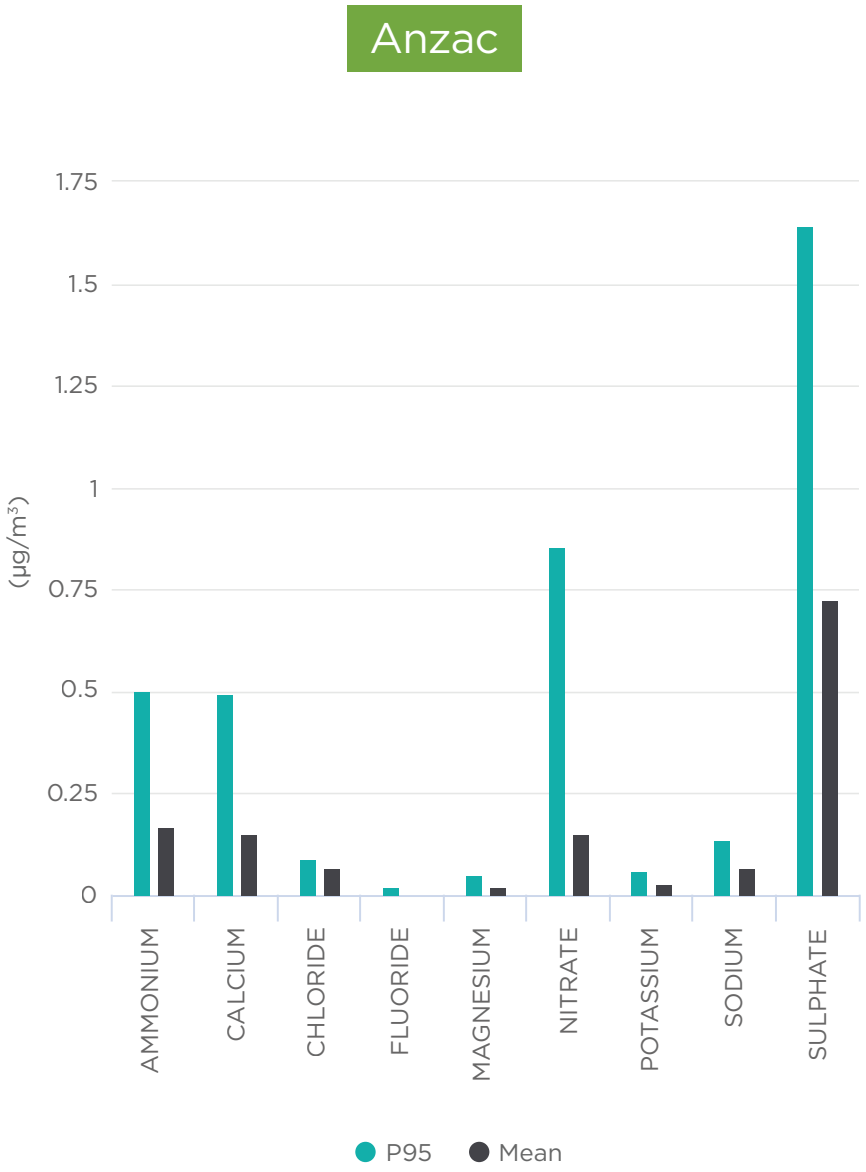

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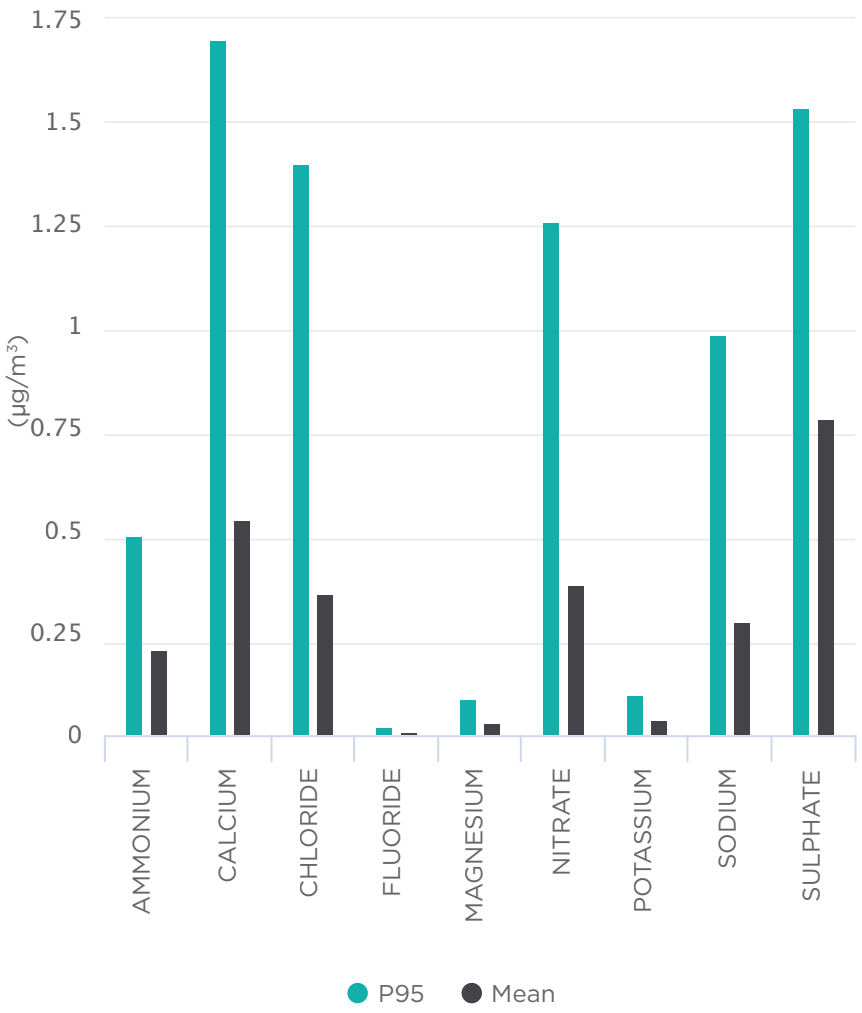
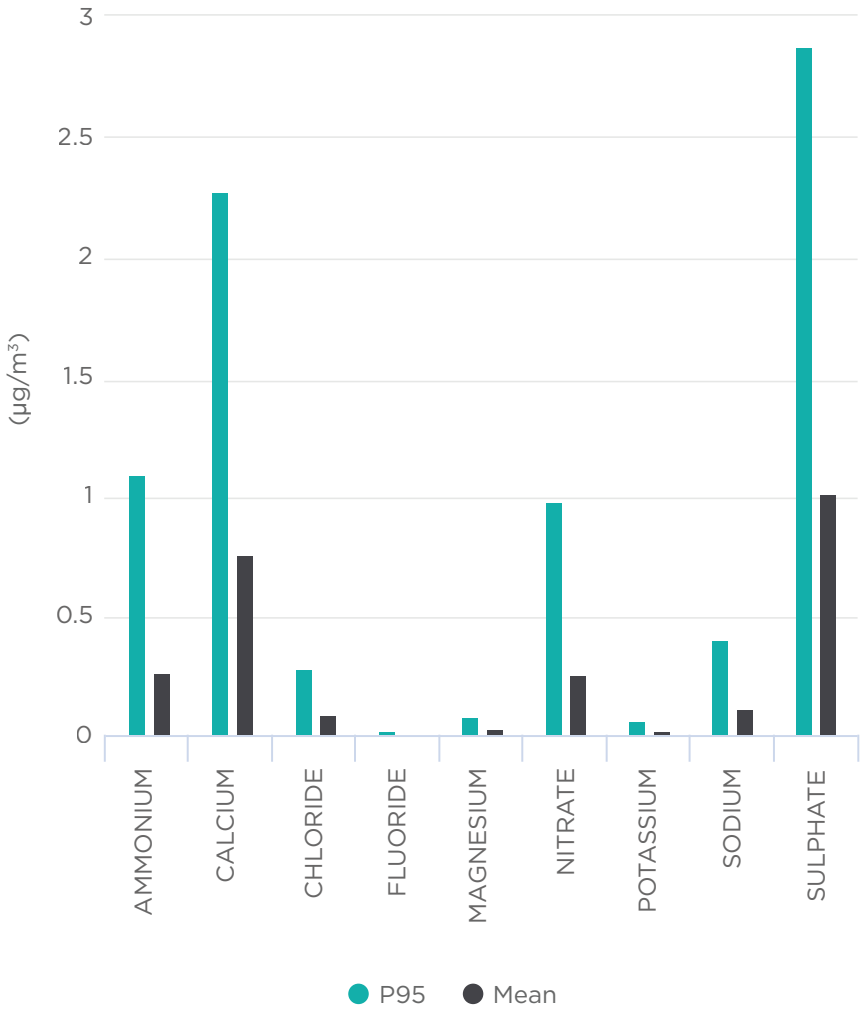
Athabasca Valley



Bertha Ganter - Fort McKay



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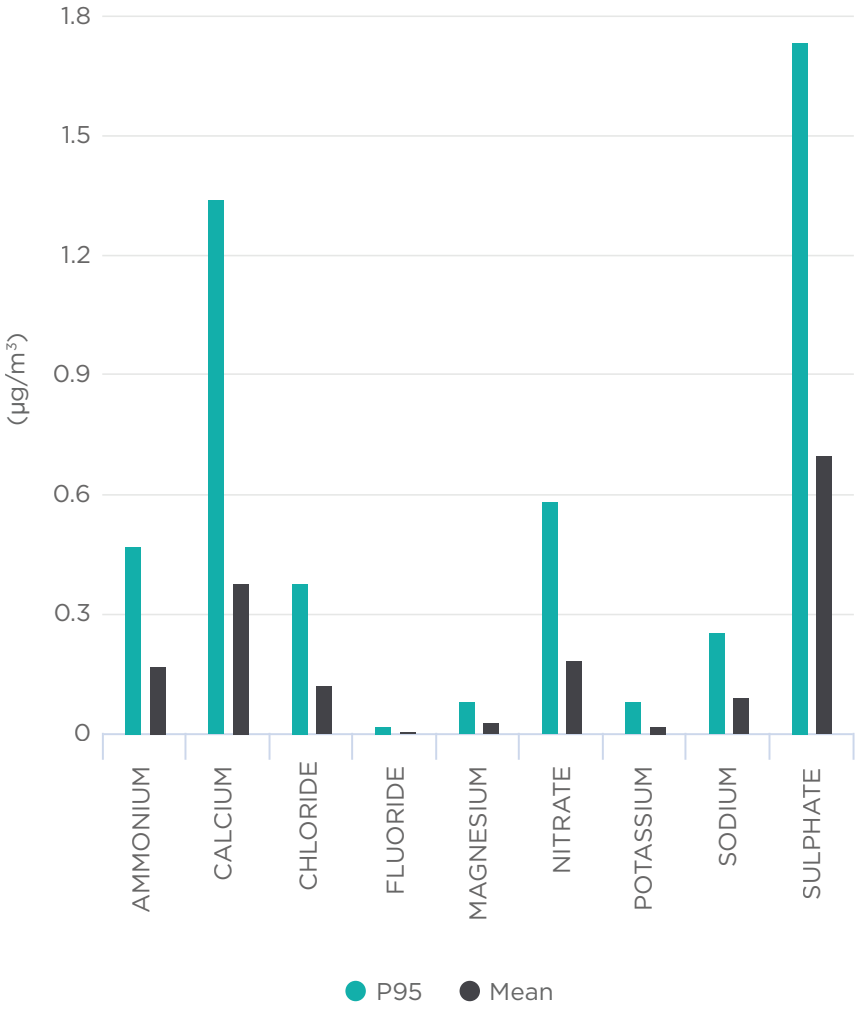
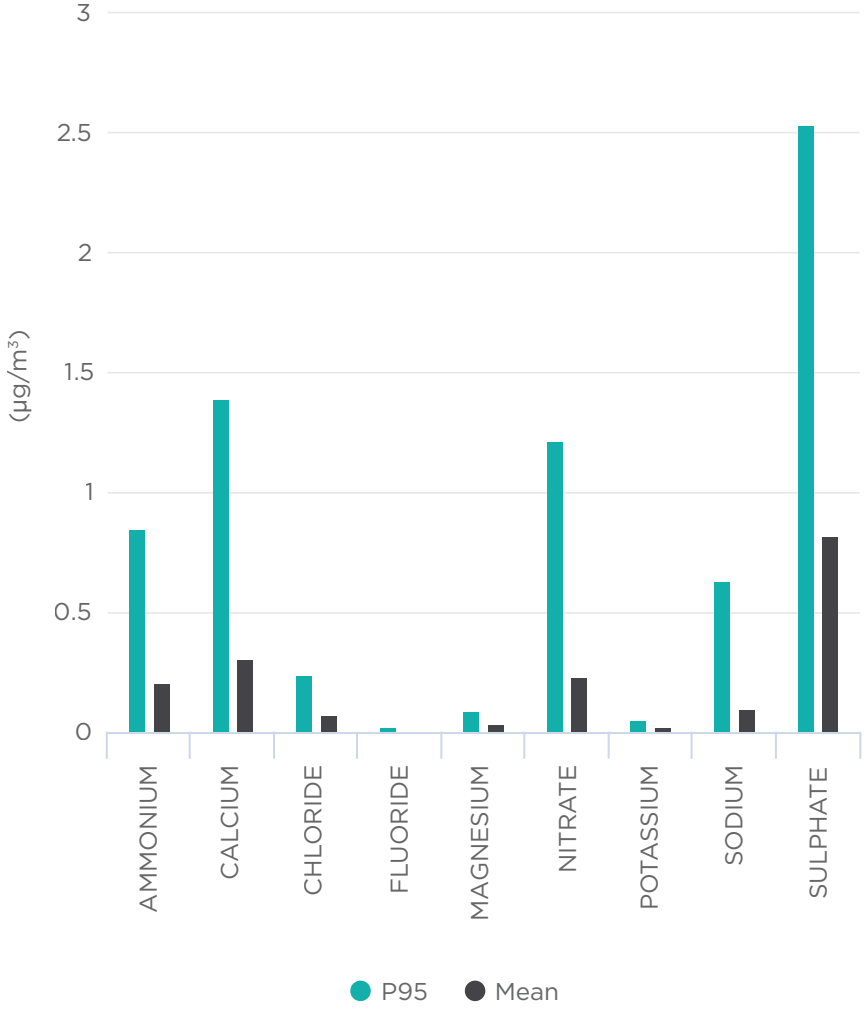


Ells River



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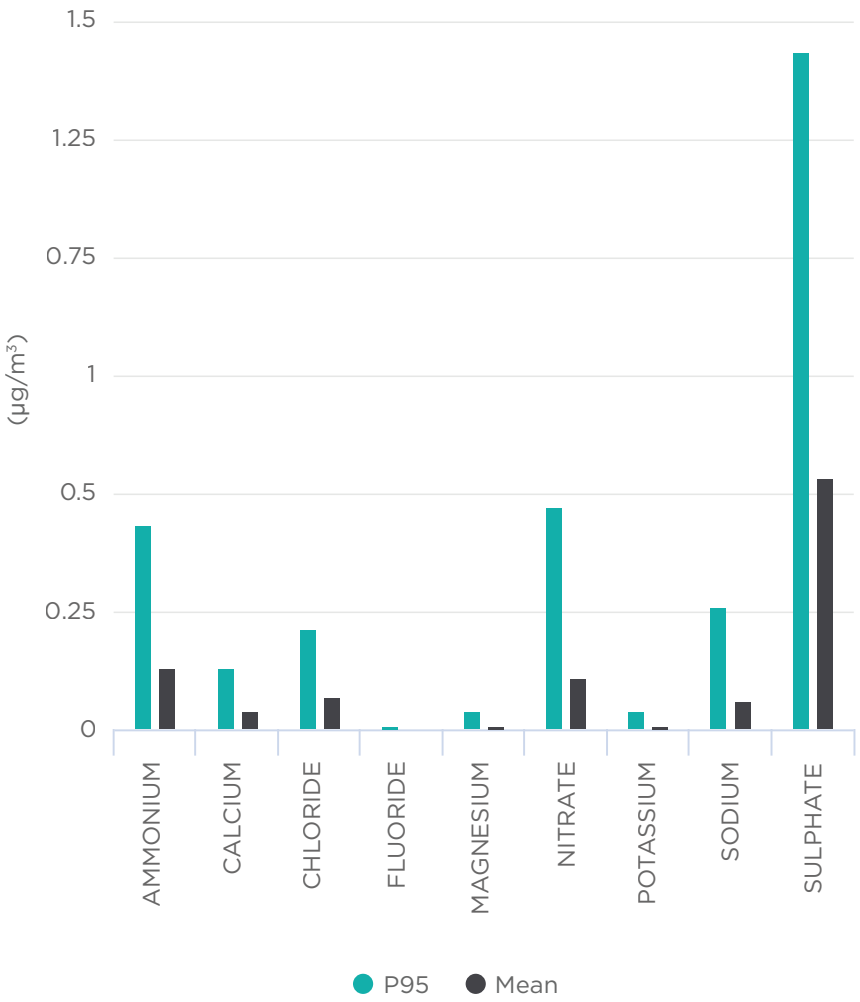
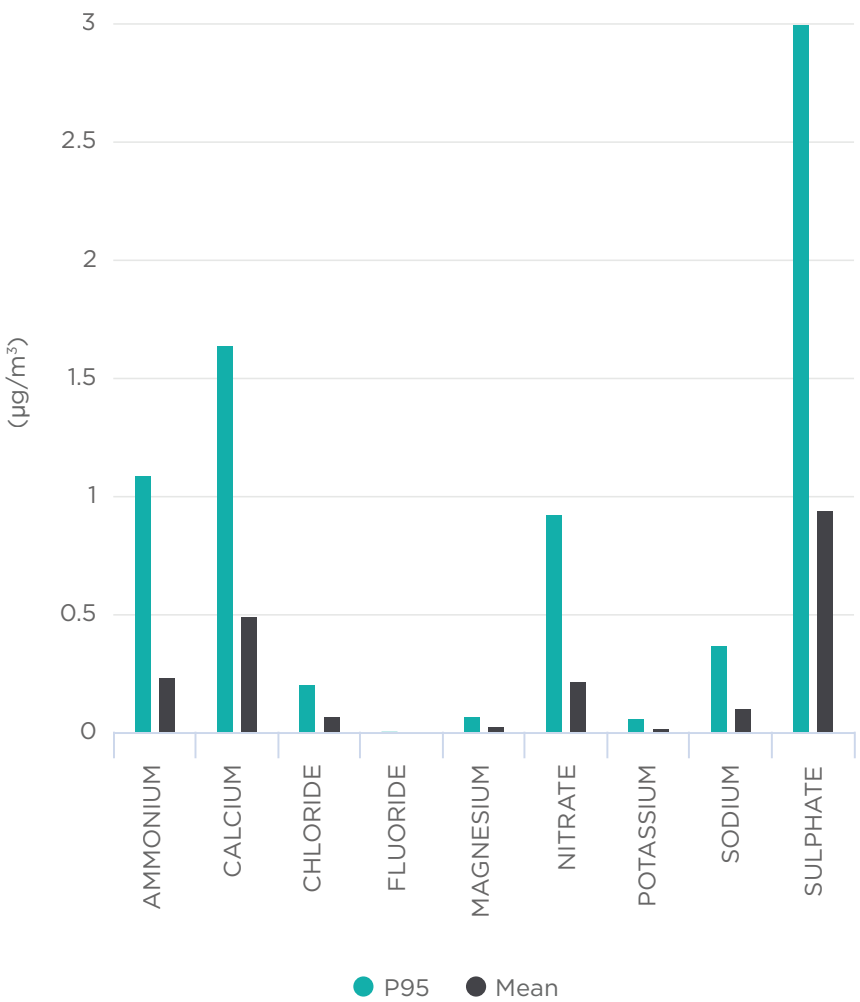
Fort Chipewyan



Fort McKay South



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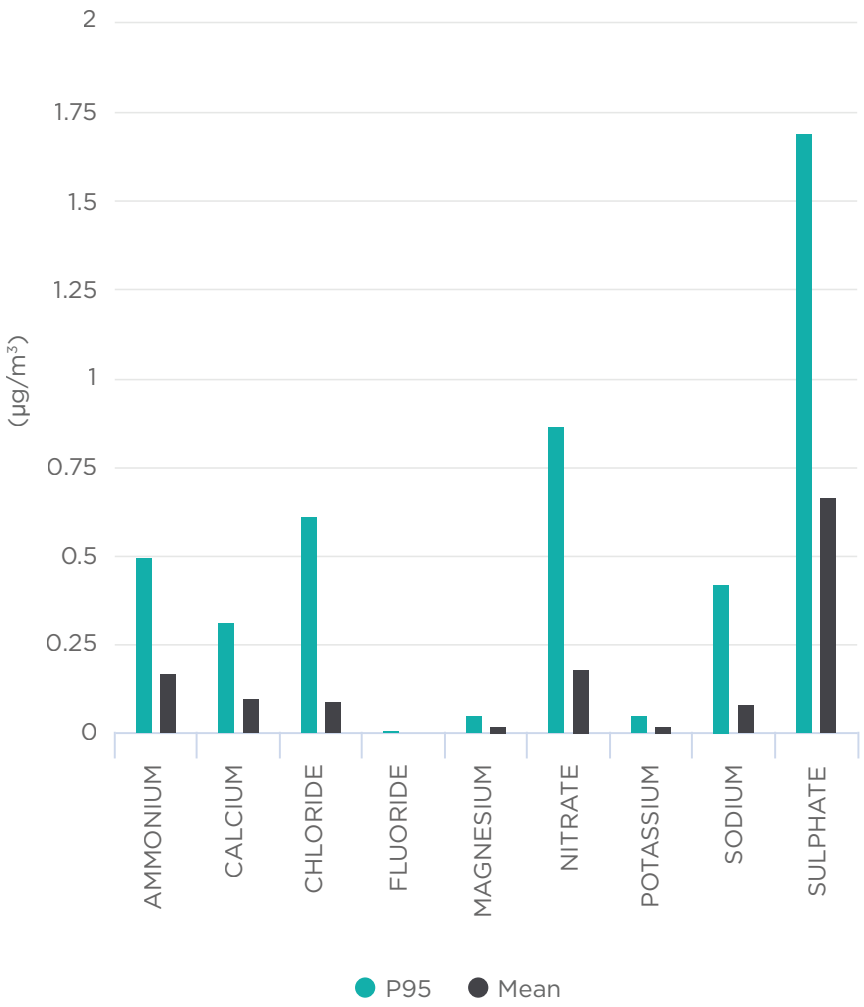
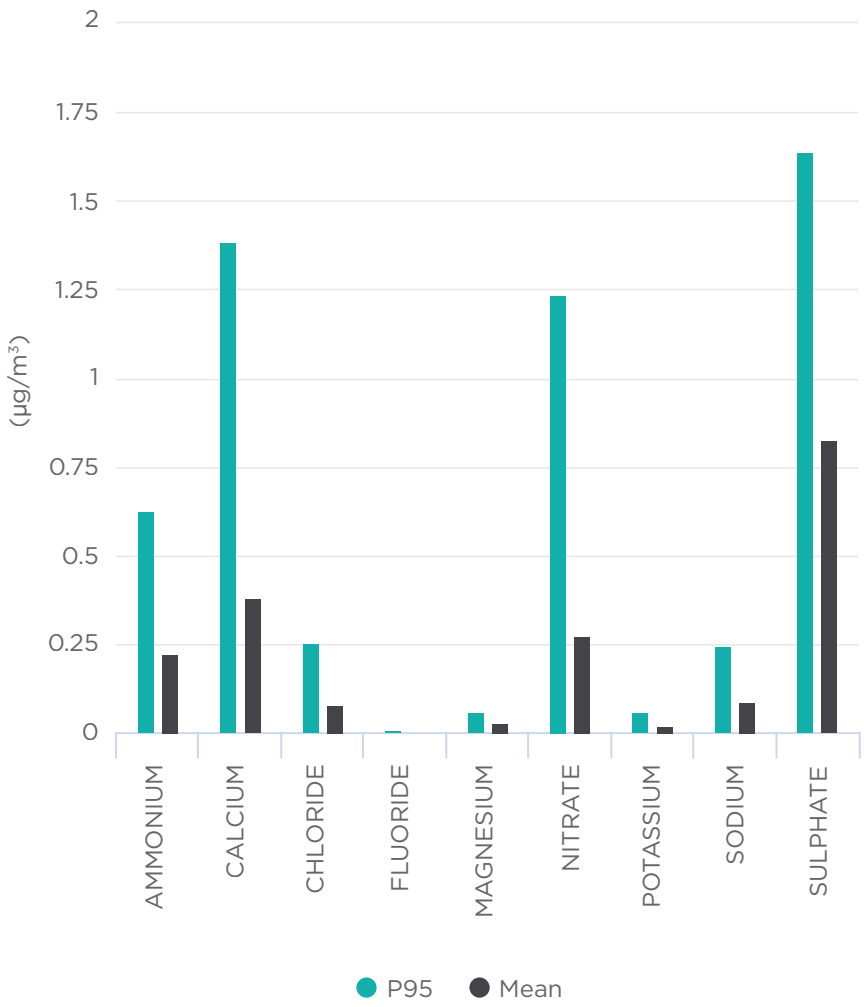
Janvier



Patricia McInnes



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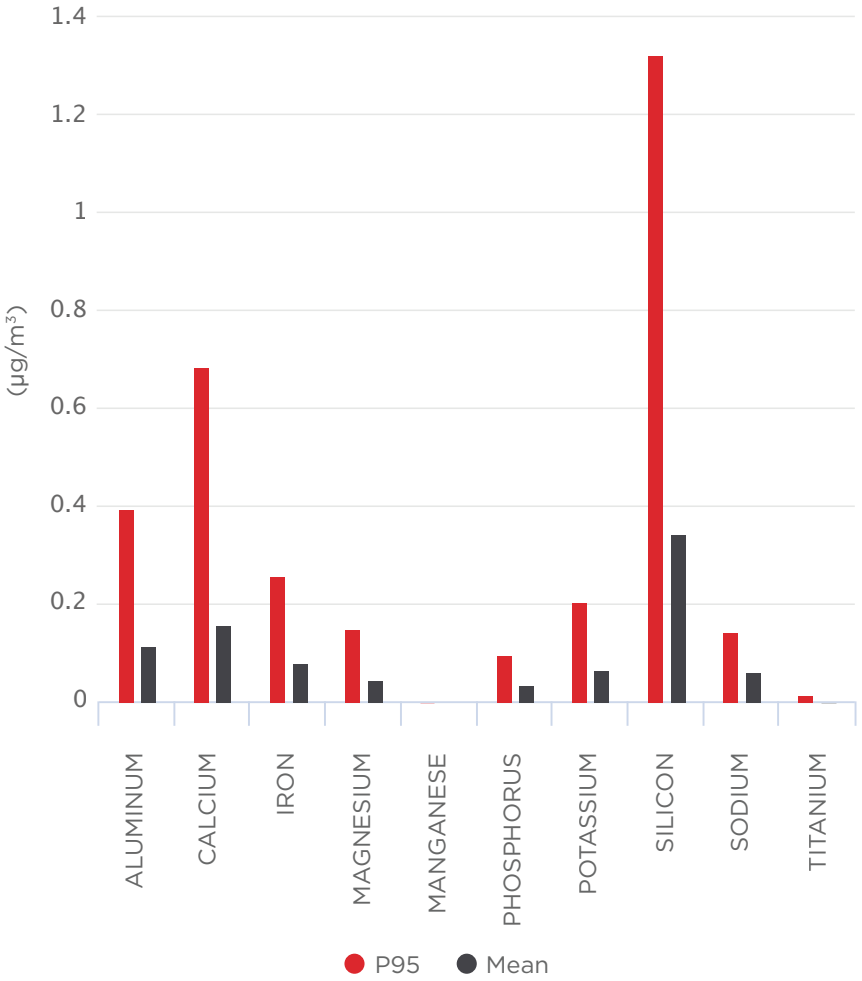
Anzac



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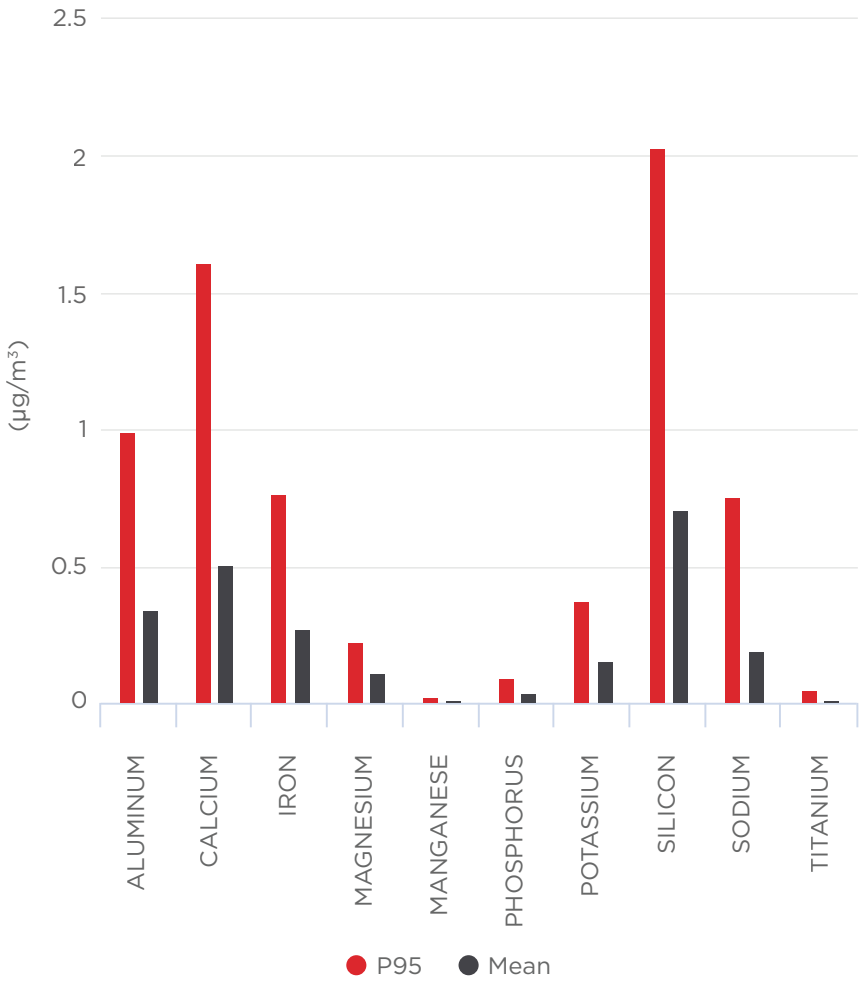
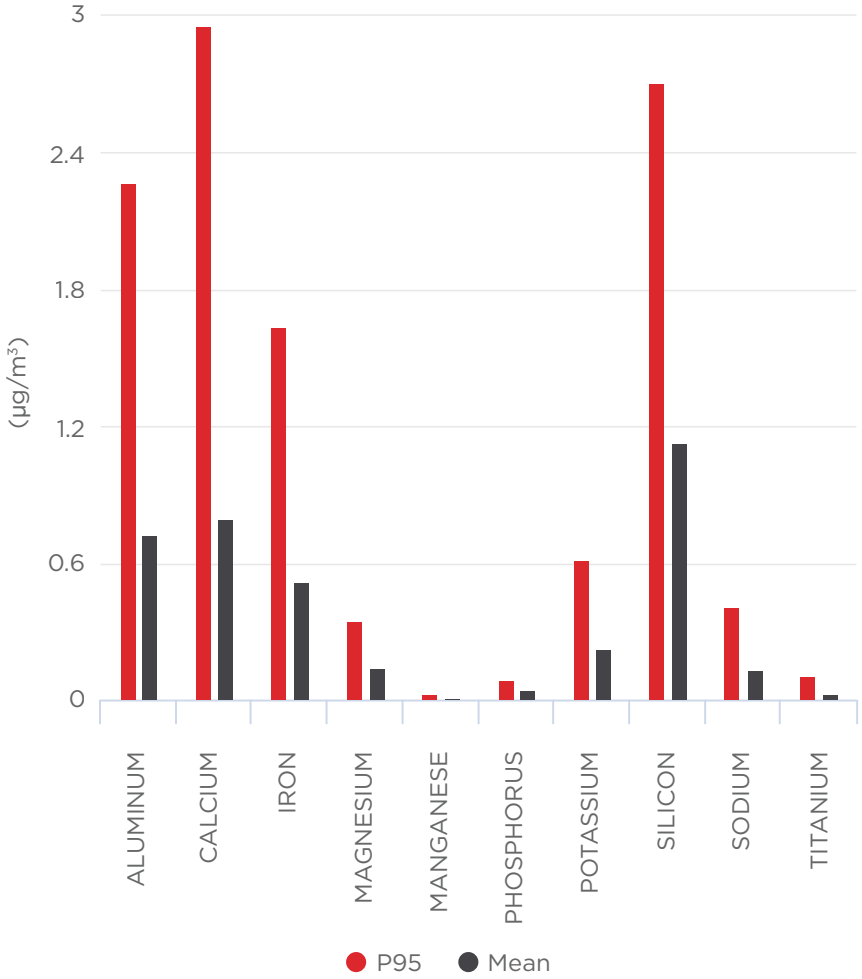
Athabasca Valley



Bertha Ganter - Fort McKay



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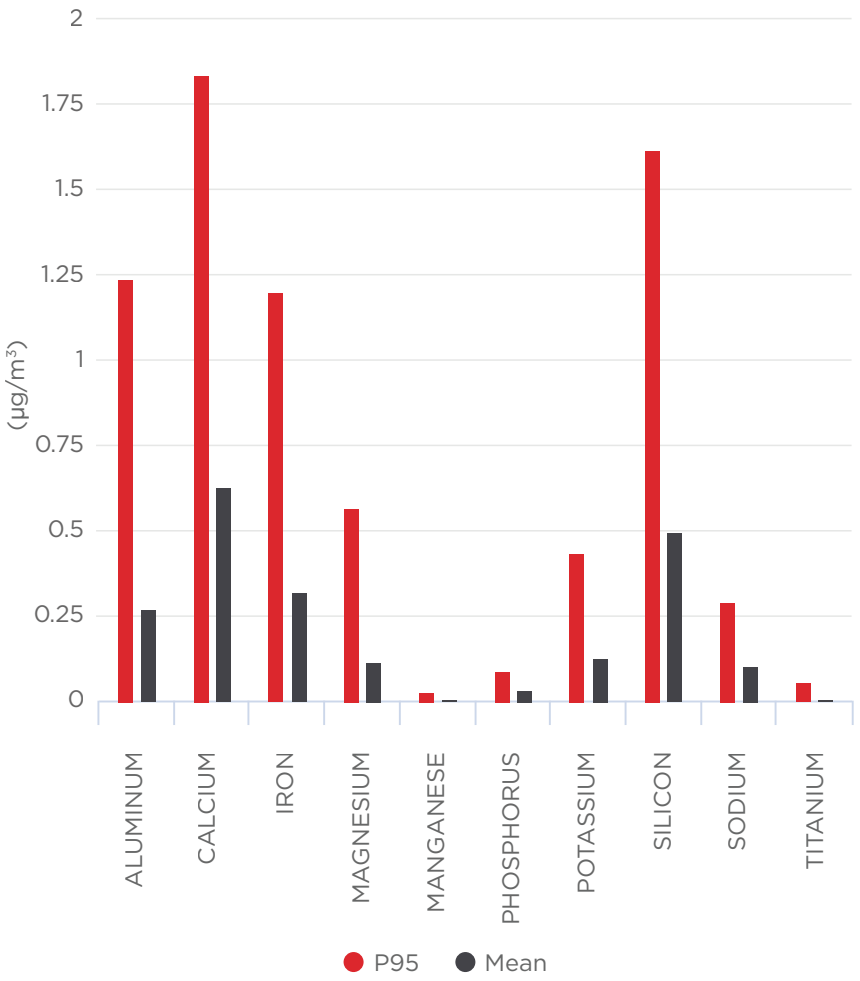
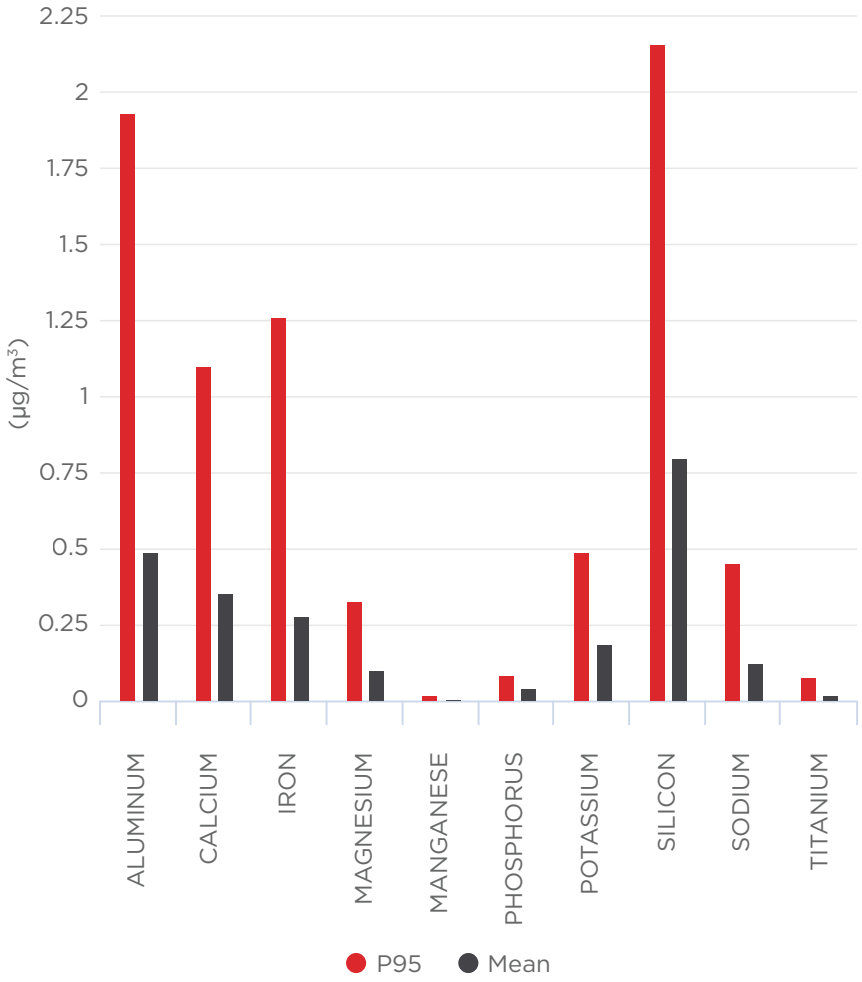
Conklin



Ells River



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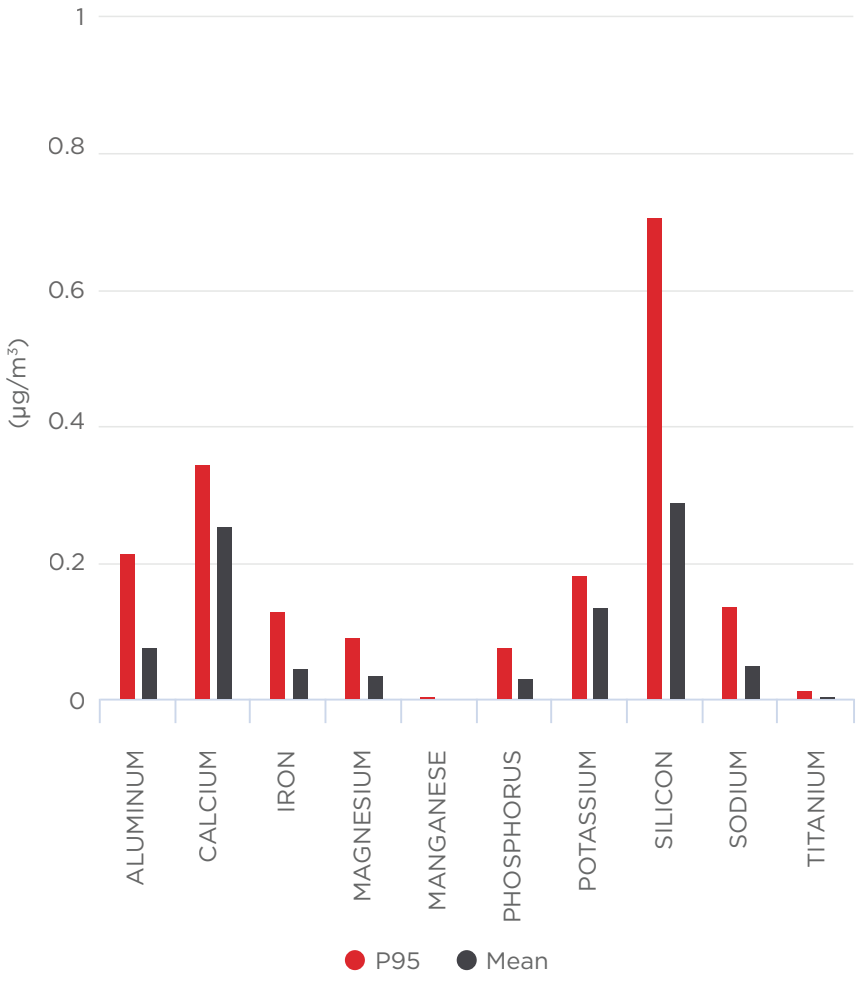
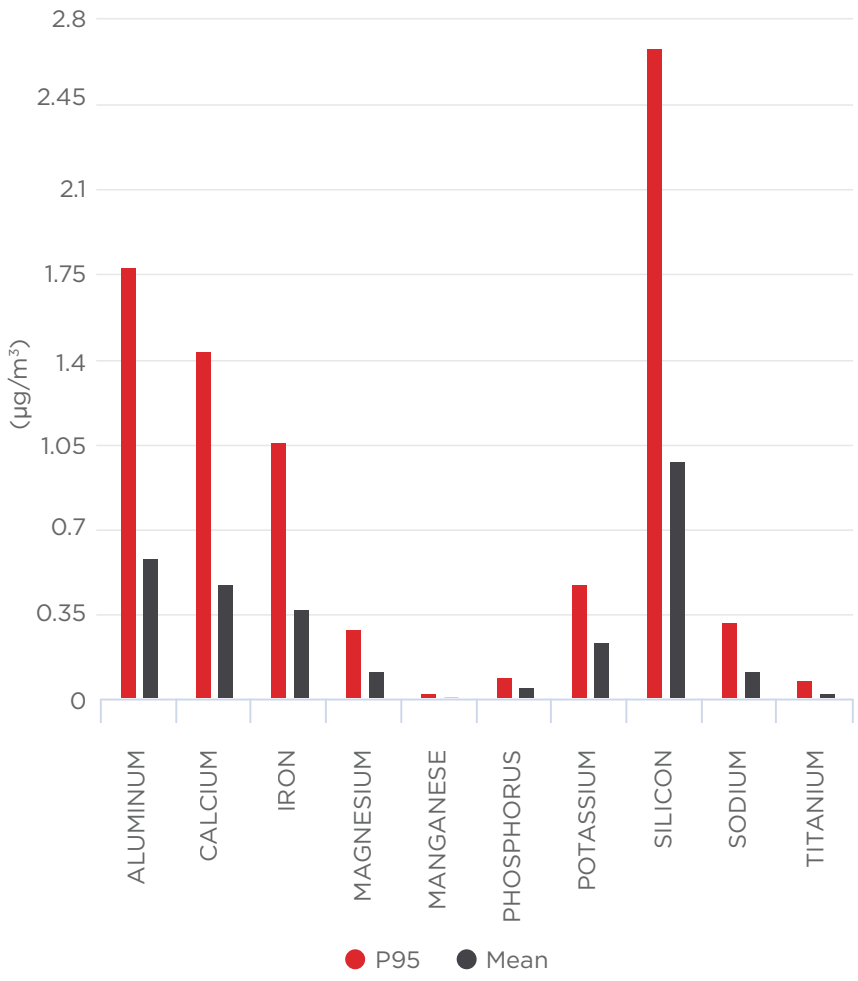
Fort Chipewyan



Fort McKay South



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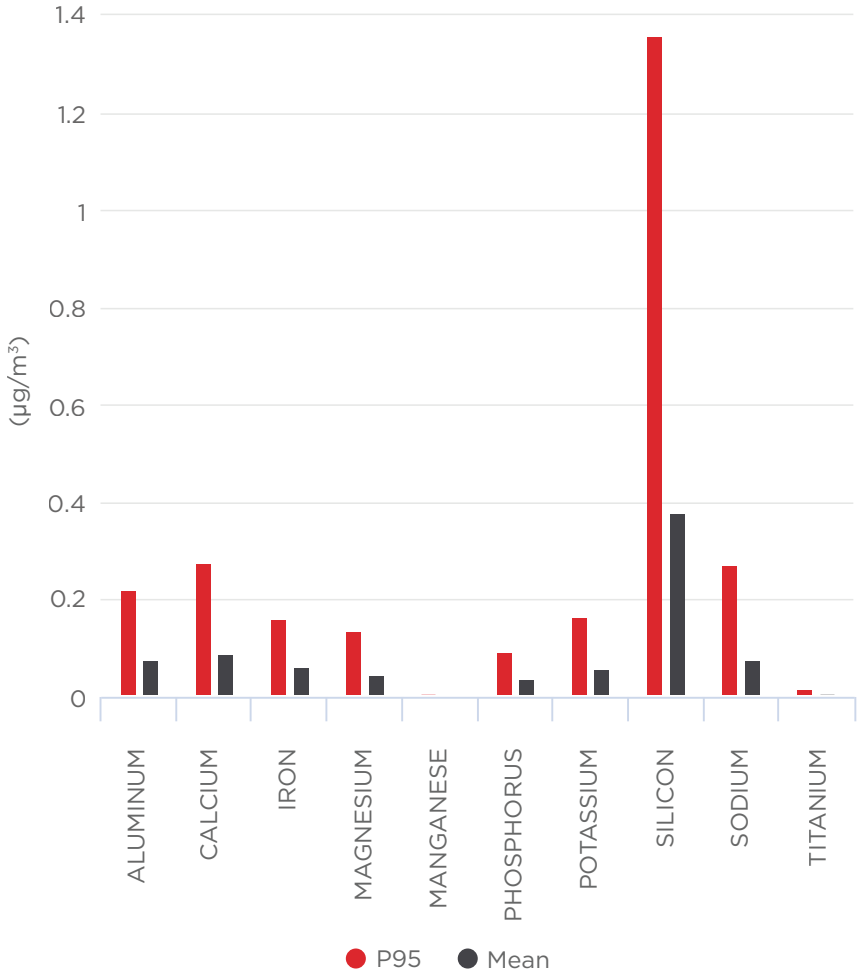
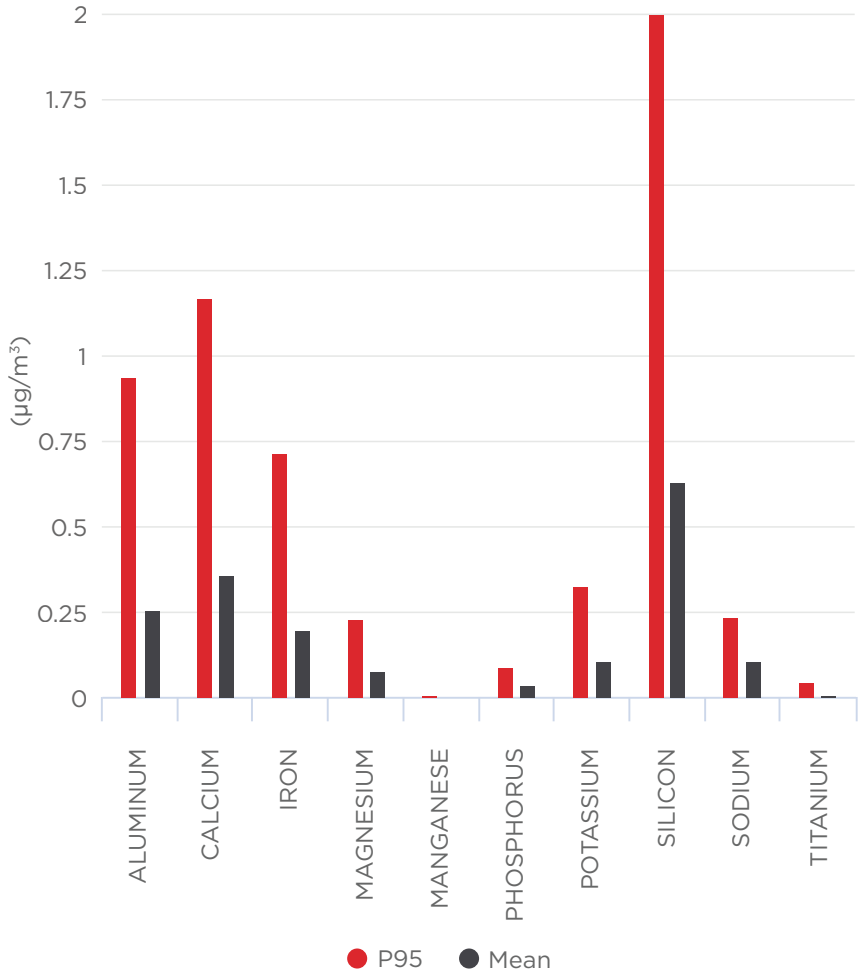
Janvier



Patricia McInnes



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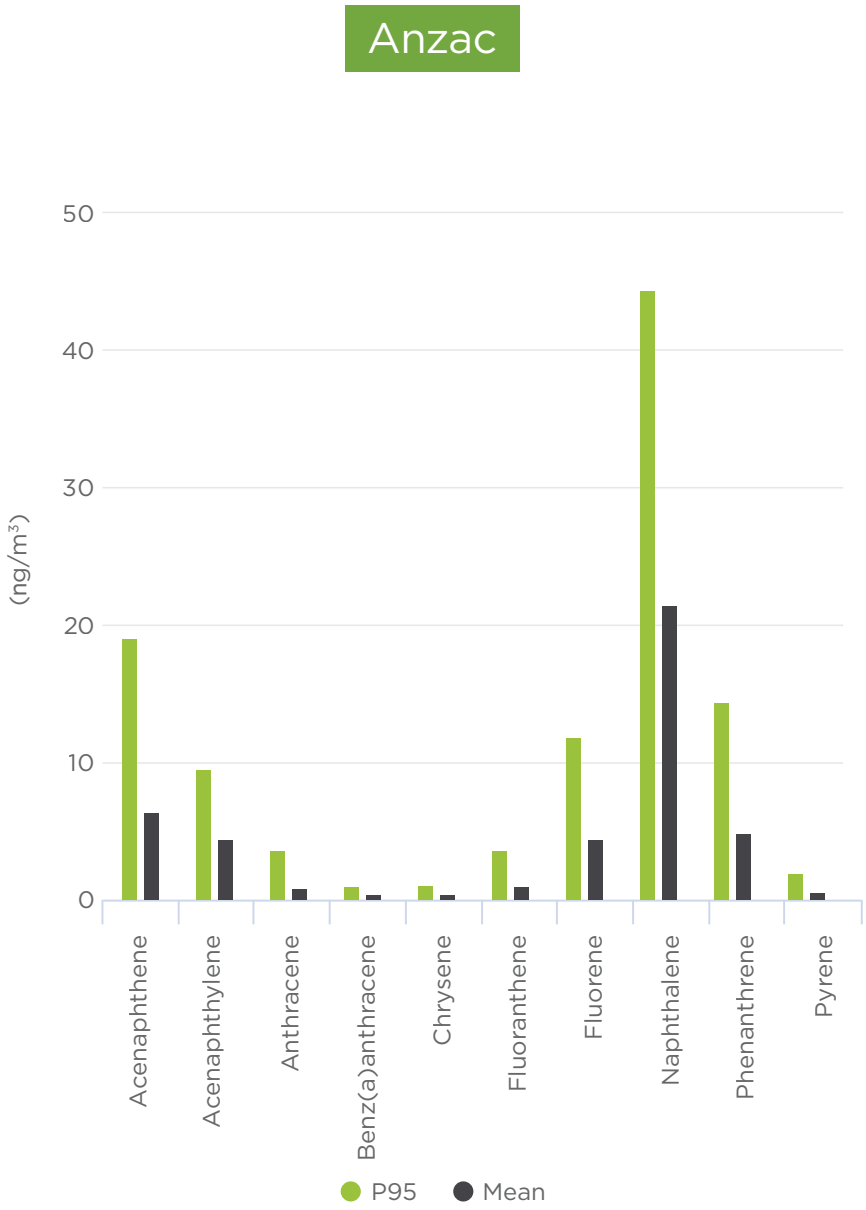
Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are a type of hydrocarbon – an organic compound containing carbon and hydrogen – that are produced from natural sources, such as the incomplete combustion of organic matter, and can be found in oil sand deposits. There are more than 100 different PAHs – some of which can be detrimental to human health and the environment.

In the WBEA's time-integrated sampling program, PAHs are collected on a sample media for a 24-hour period, every six days. These samples are collected and sent to the lab where they are analyzed to determine what PAHs were present in the air.



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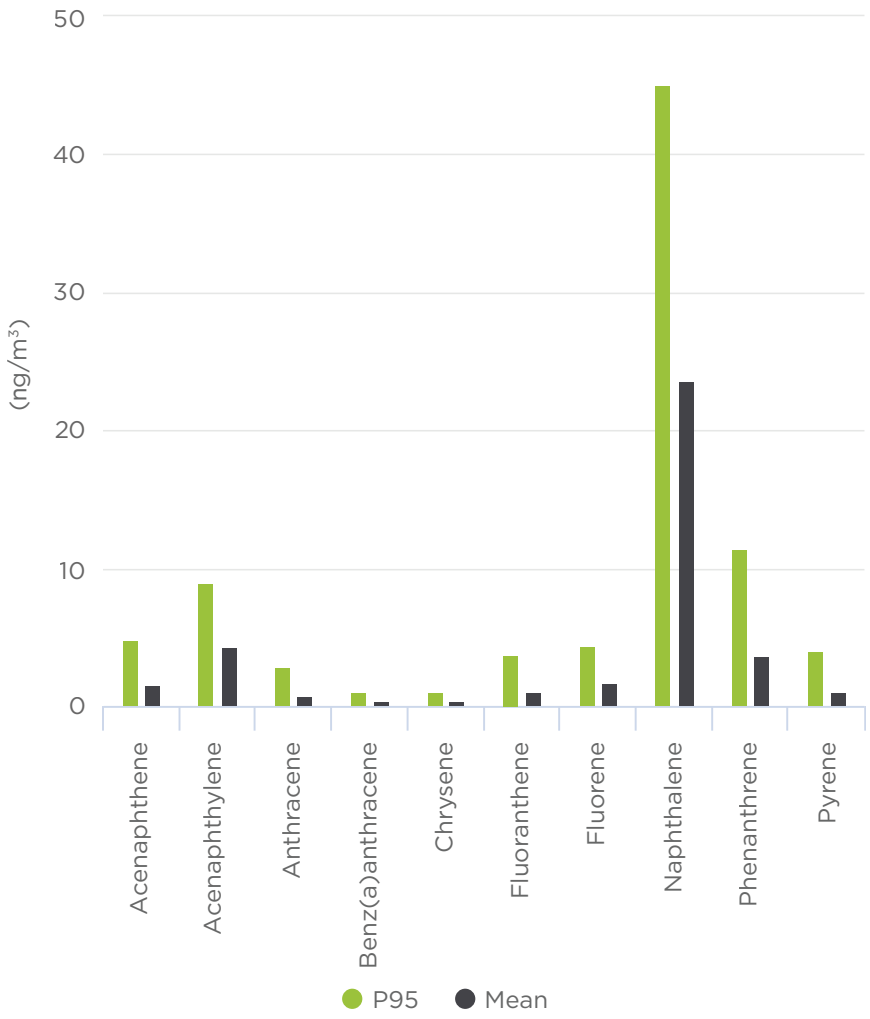
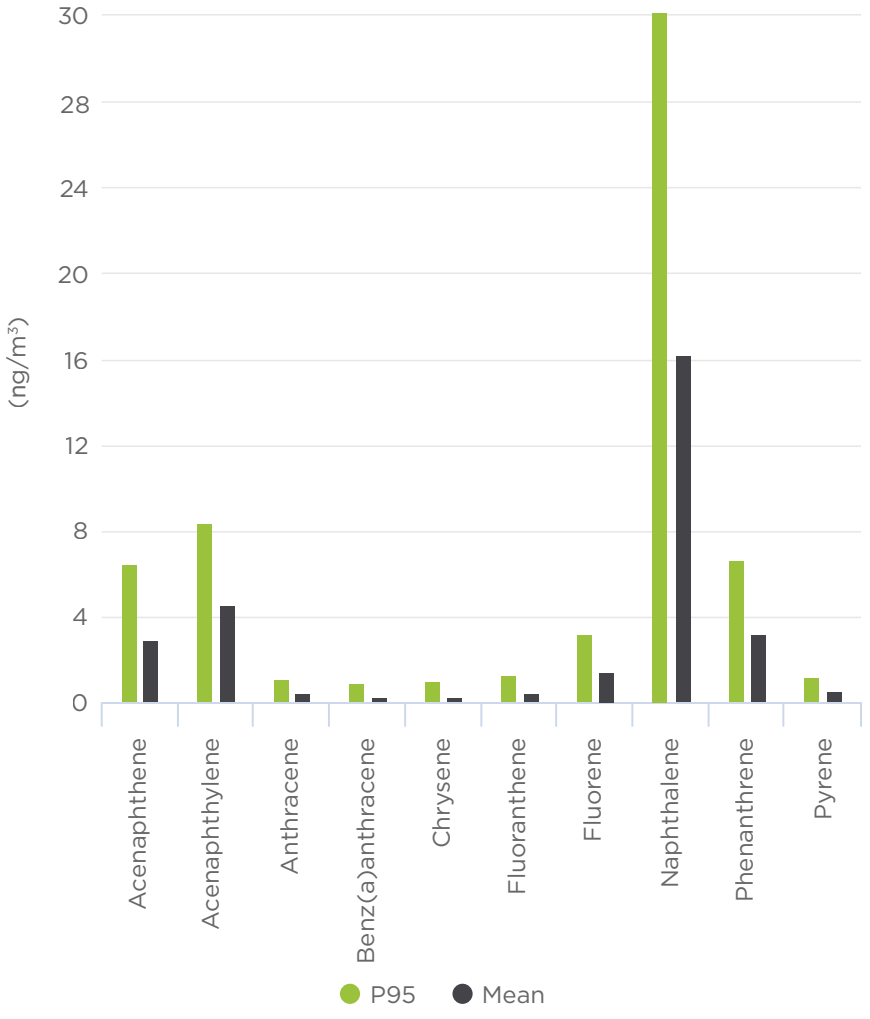
Athabasca Valley

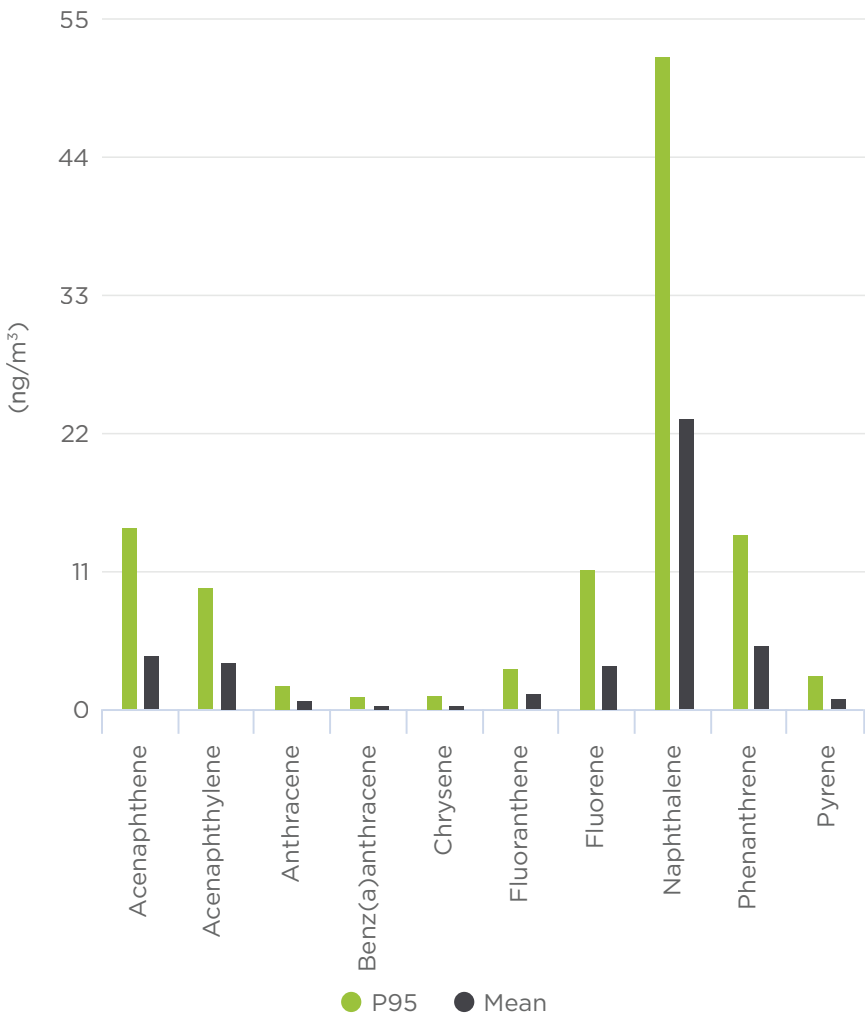


Bertha Ganter - Fort McKay

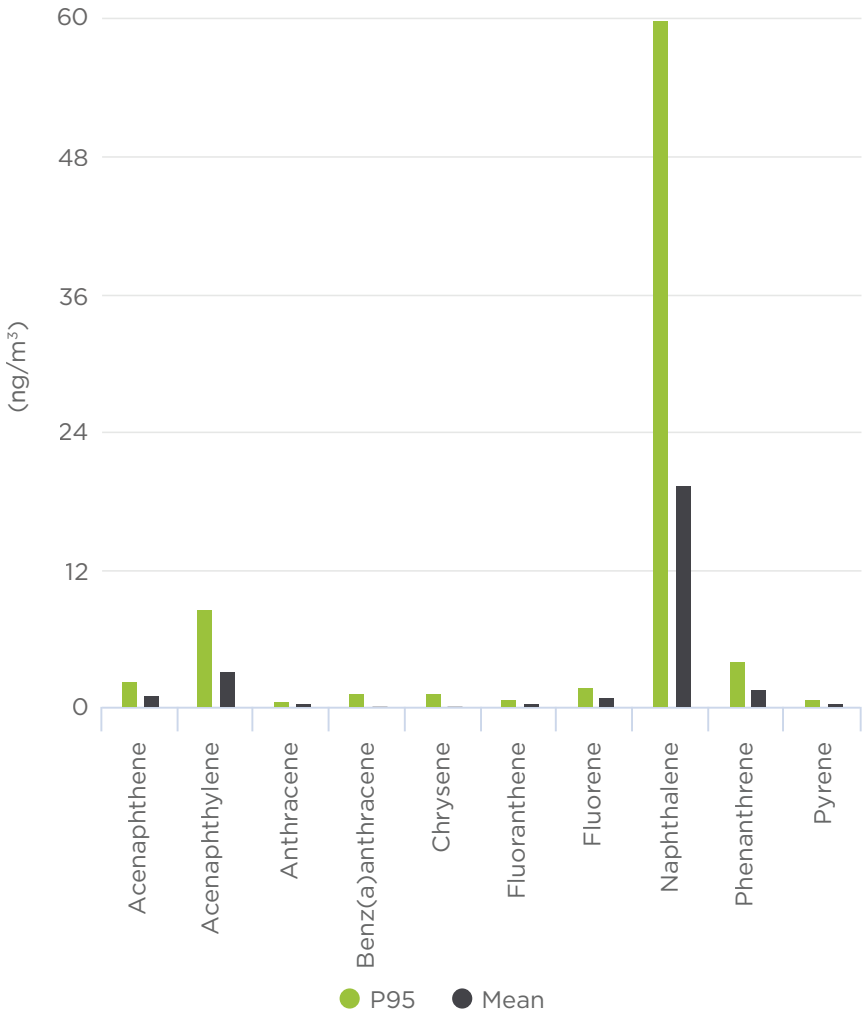


Note: Averages may be too small to be visible on some graphs.

Conklin

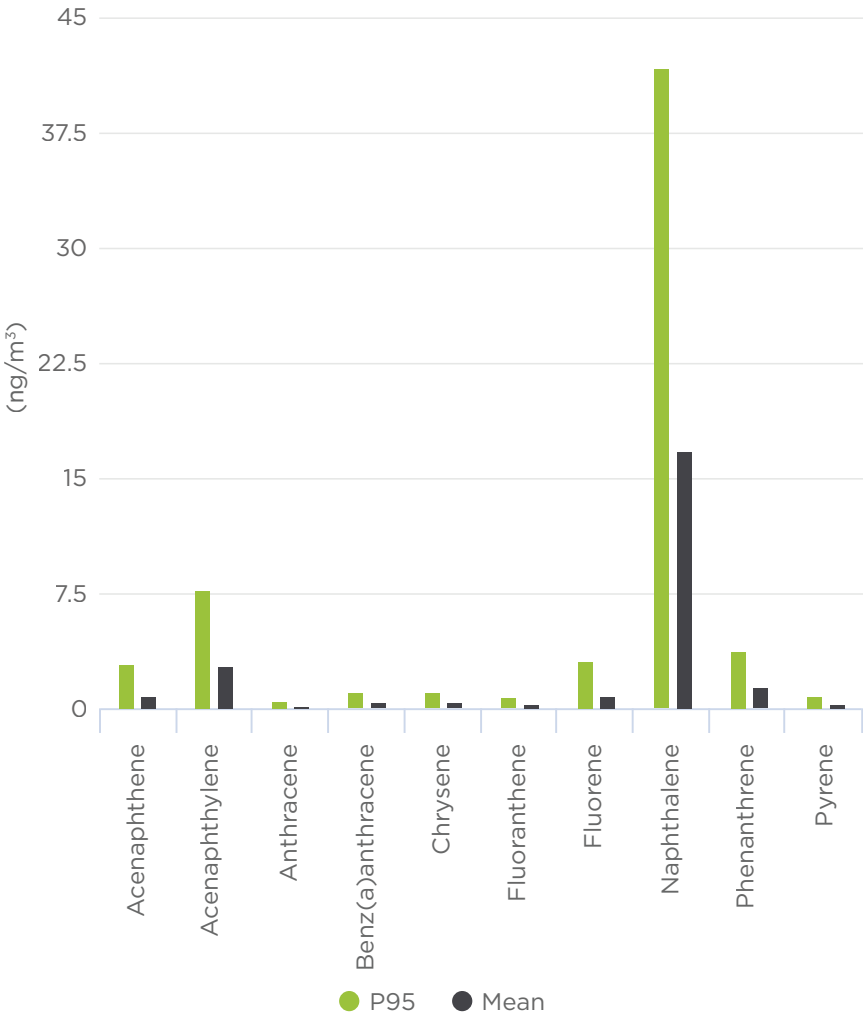


Fort Chipewyan

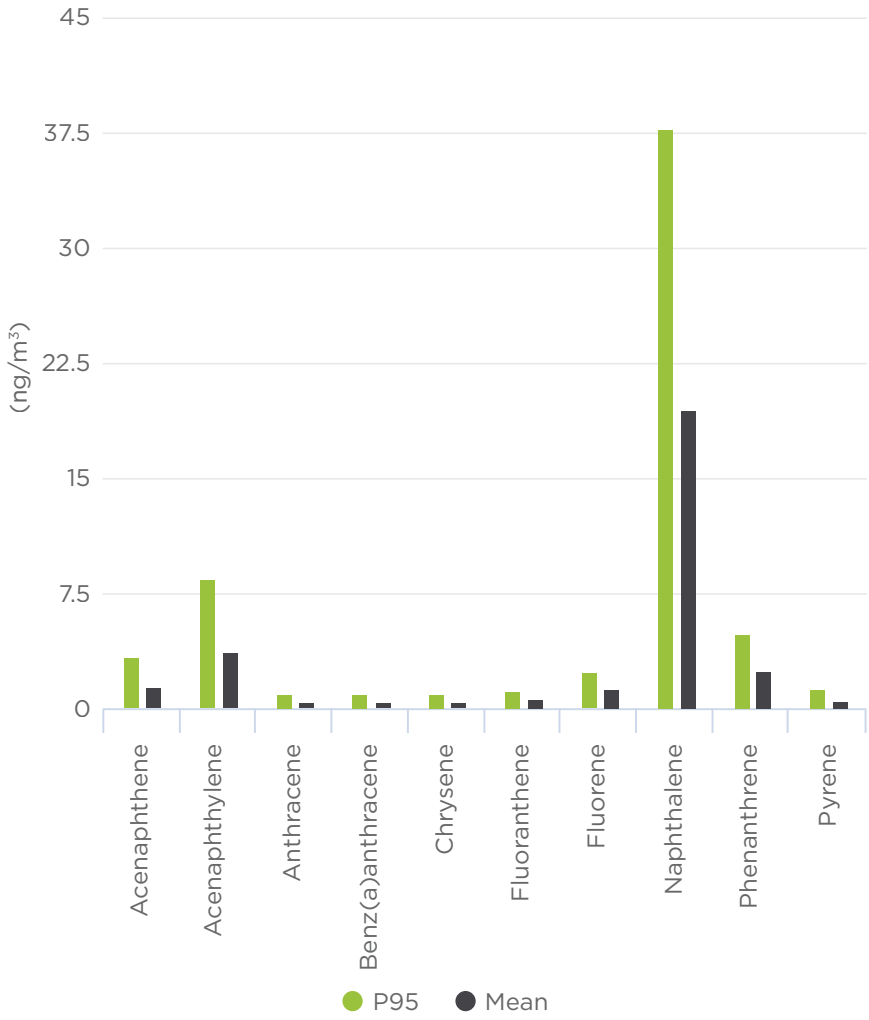


Note: Averages may be too small to be visible on some graphs.

Janvier



Patricia McInnes

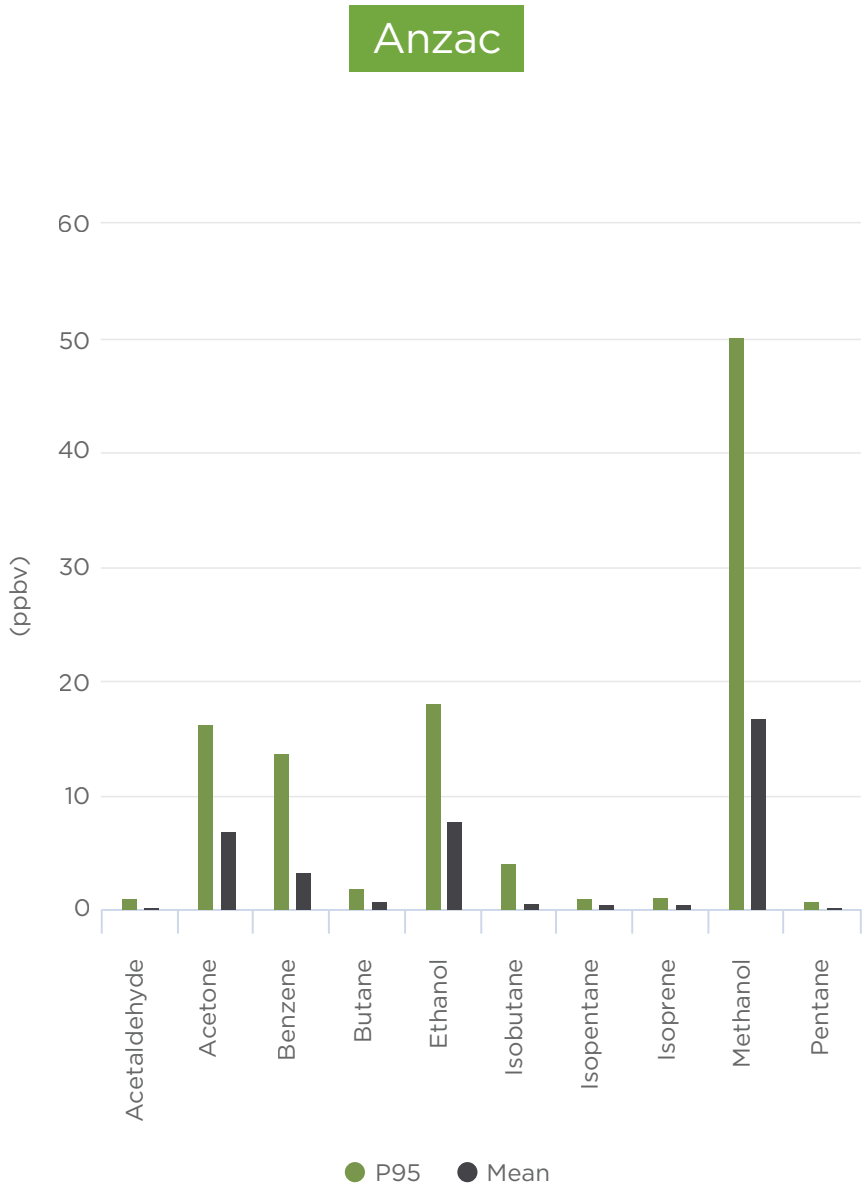


Note: Averages may be too small to be visible on some graphs.

Volatile Organic Compounds (VOCs)

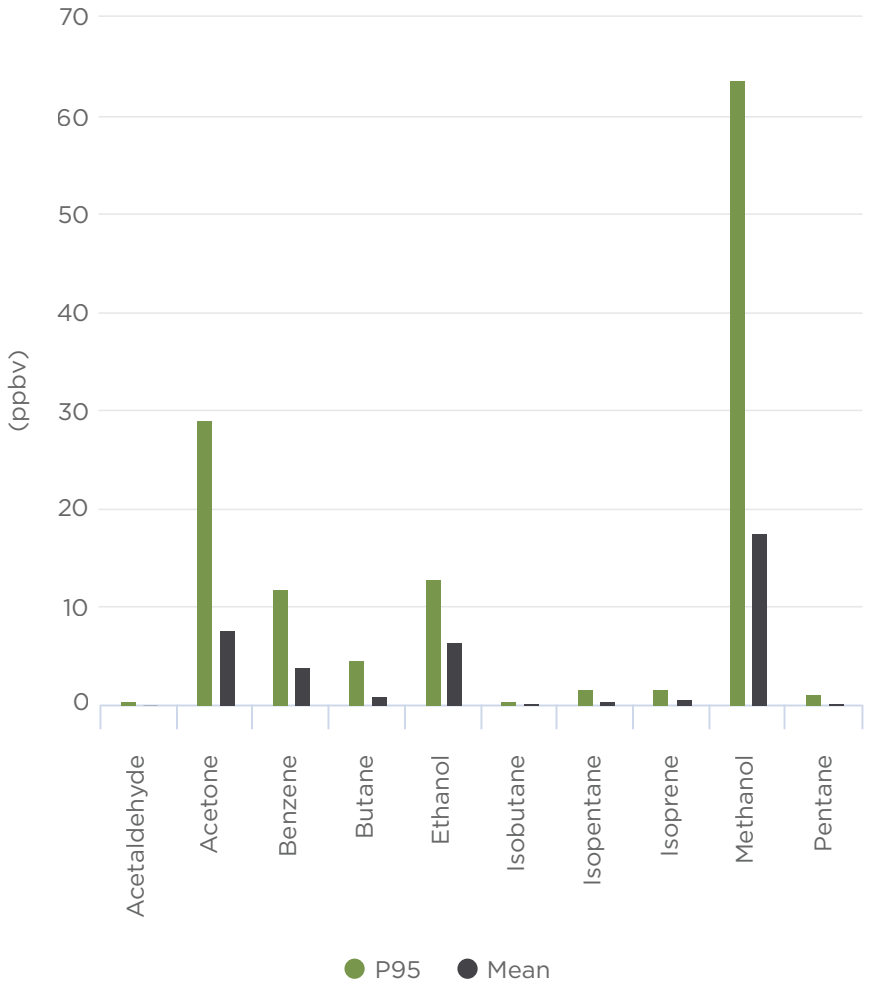
VOCs are a group of chemical species that contain carbon, and react easily to become a gas. They may contain additional elements such as hydrogen, oxygen, fluorine, chlorine, bromine, sulphur, or nitrogen. VOCs are numerous, and come from both natural and human sources, and certain VOCs may contribute to ozone formation, odours, and long-term health effects.

In the WBEA's time-integrated sampling program, an air sample is collected in a stainless-steel canister for a 24-hour period, every six days. These samples are then sent to the lab where they are analyzed to determine what VOCs were present in the air.

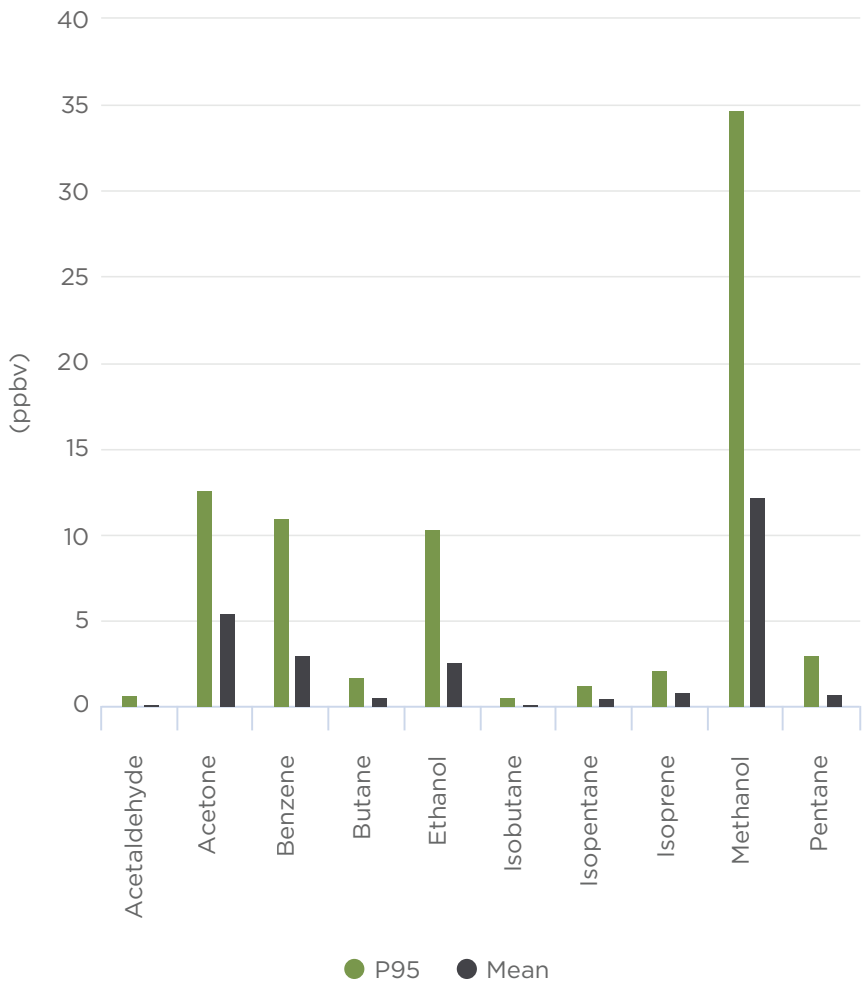


Note: Averages may be too small to be visible on some graphs.

Athabasca Valley

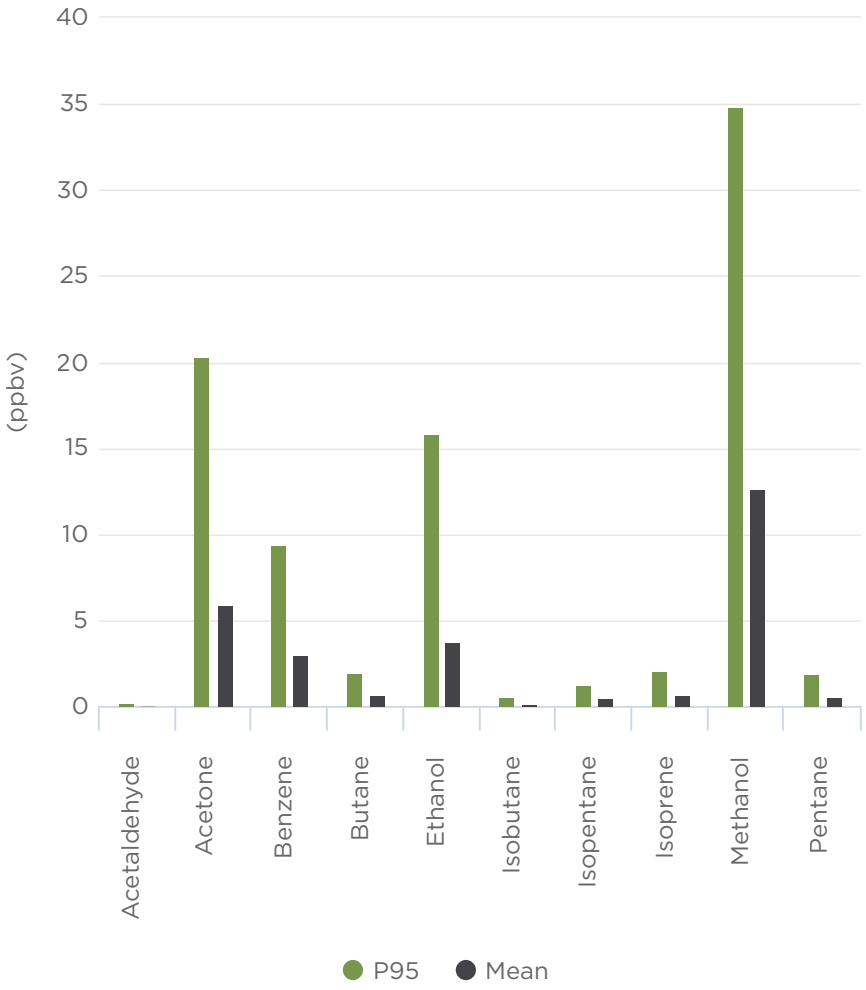


Barge Landing

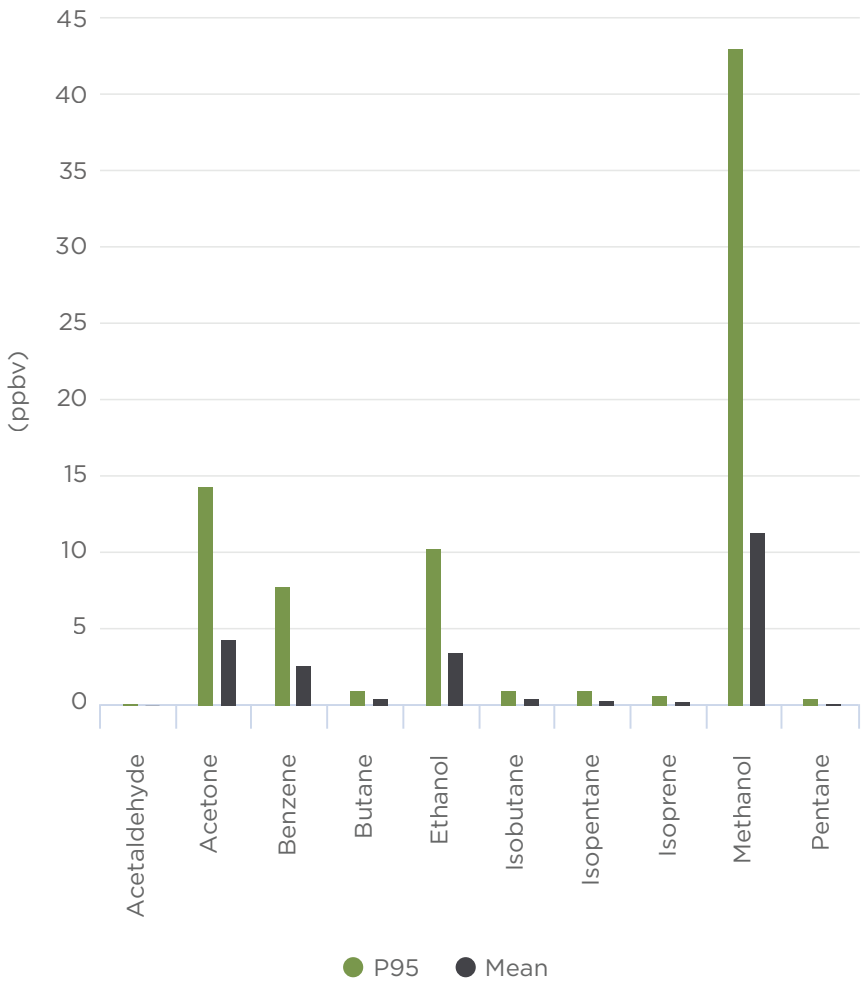


Note: Averages may be too small to be visible on some graphs.

Bertha Ganter - Fort McKay

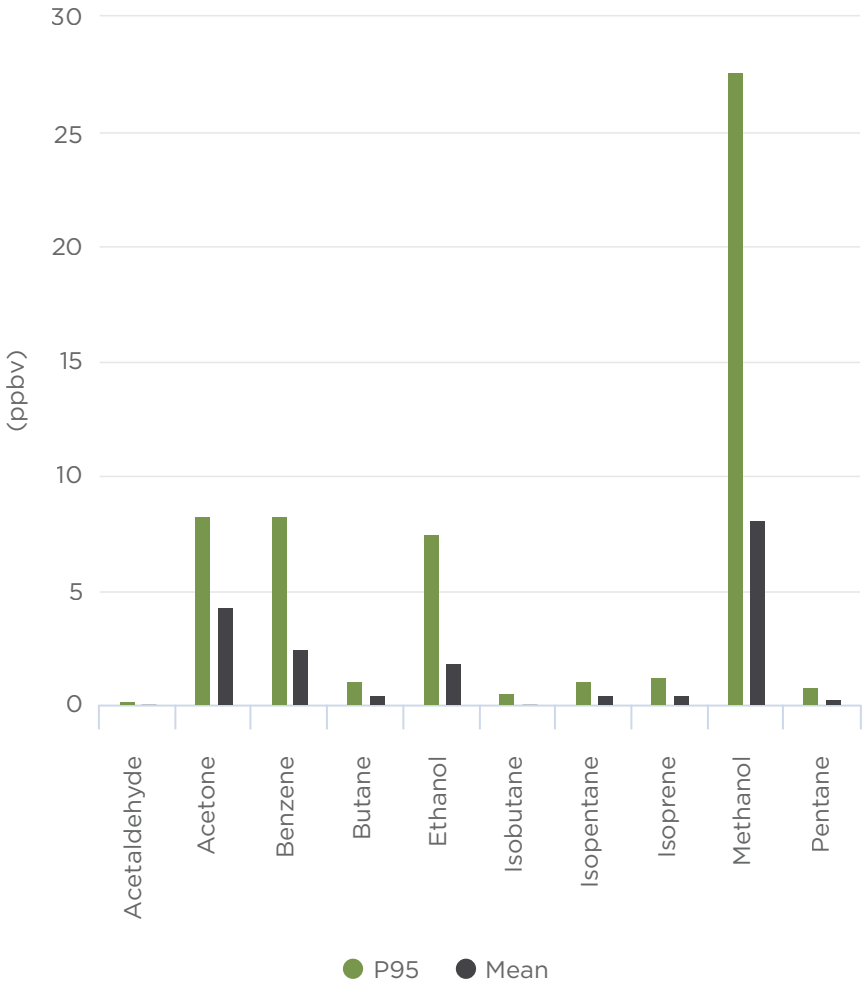


Conklin

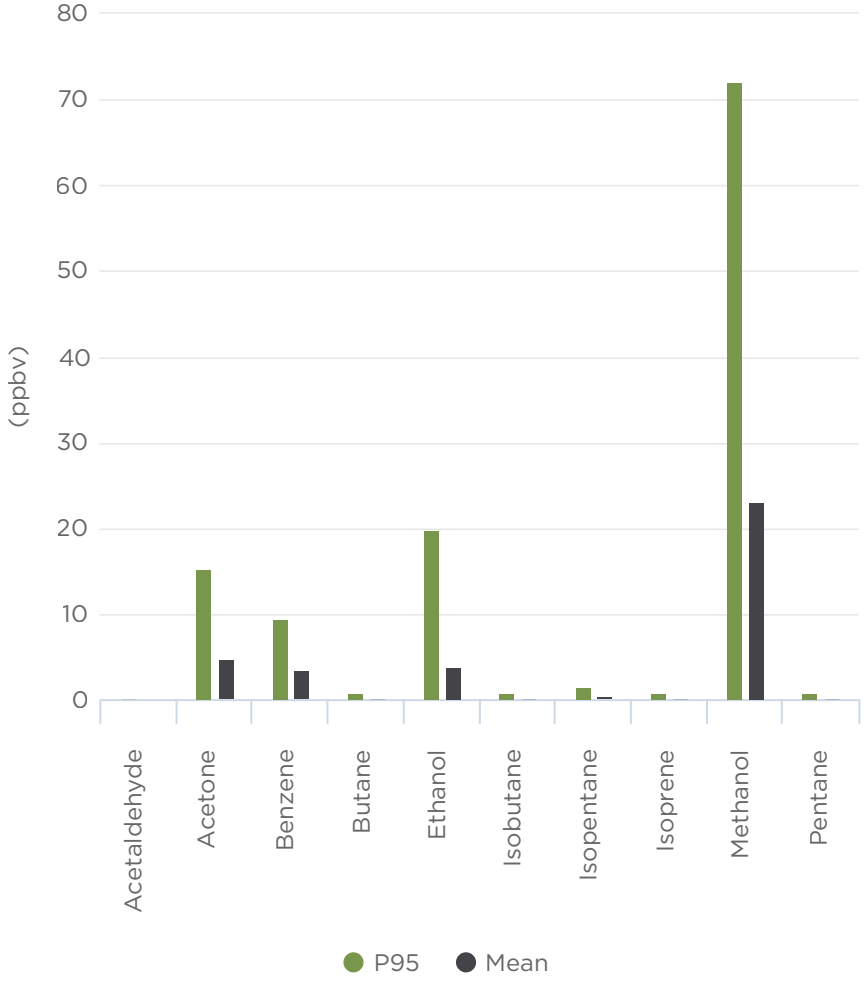


Note: Averages may be too small to be visible on some graphs.

Ells River

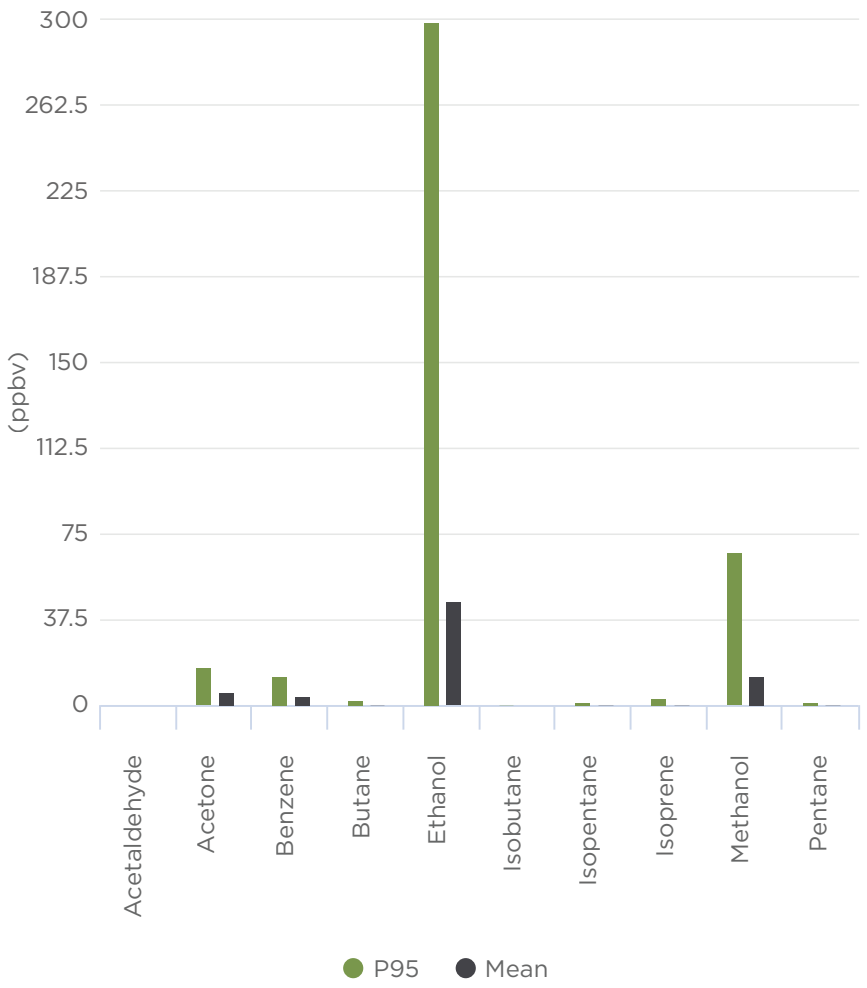


Fort Chipewyan

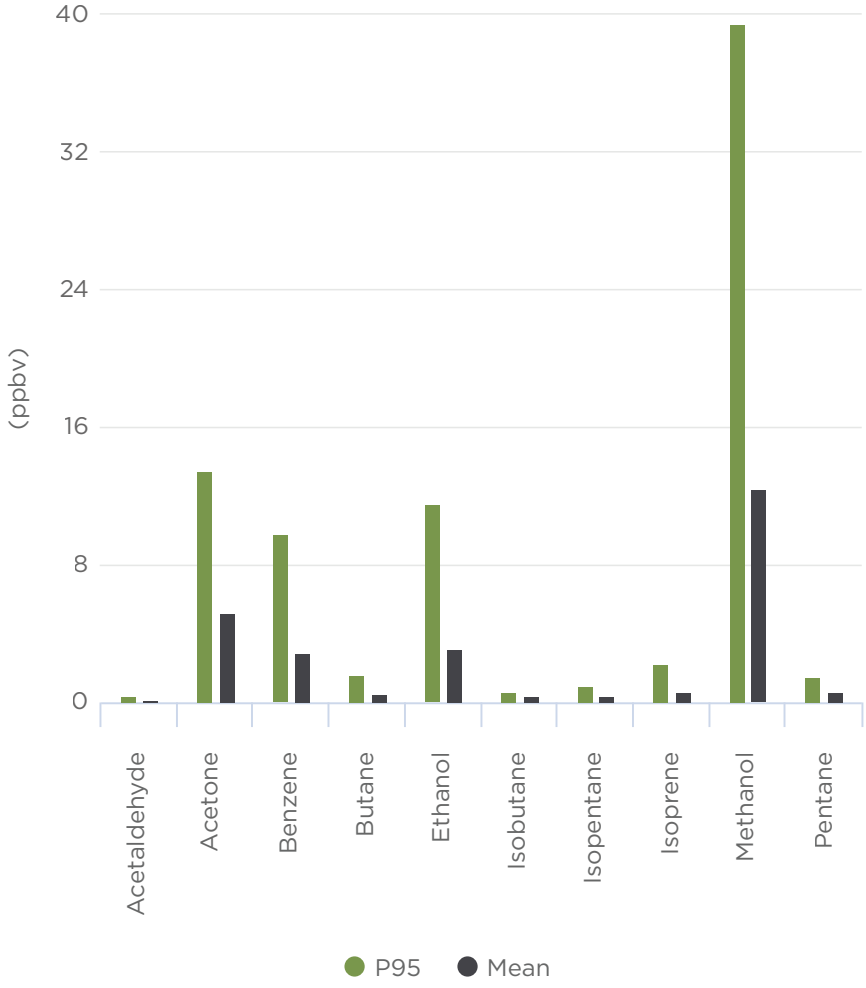


Note: Averages may be too small to be visible on some graphs.

Fort Hills

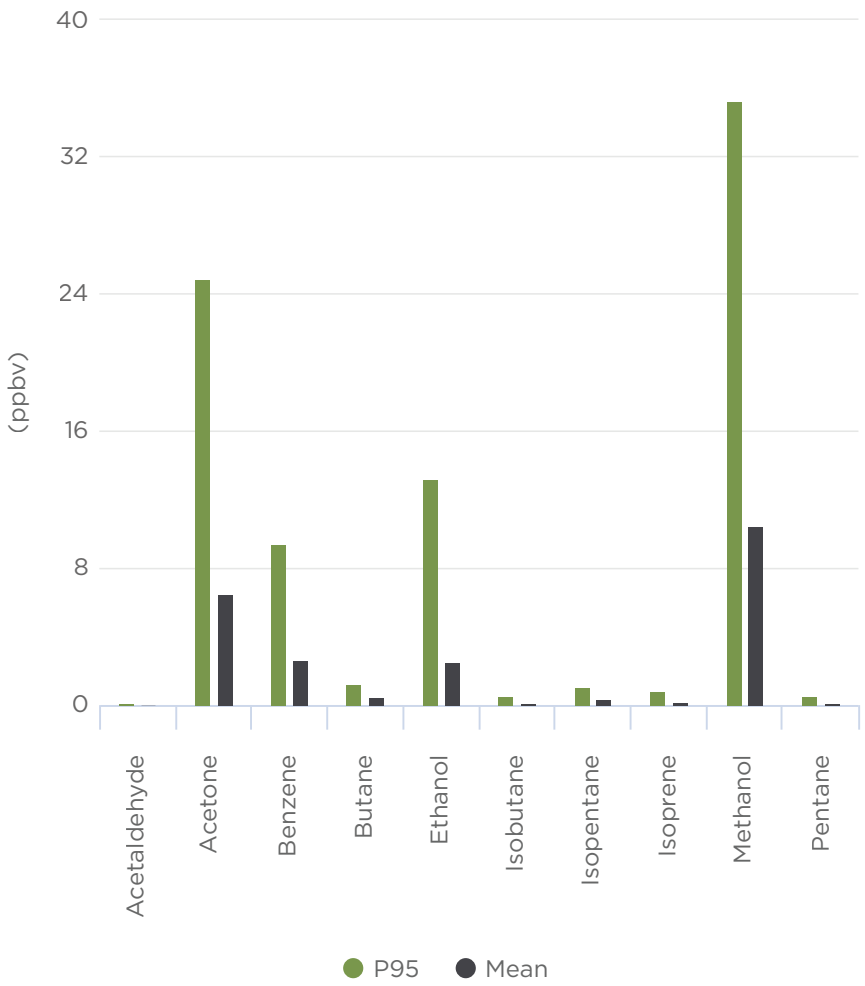


Fort McKay South

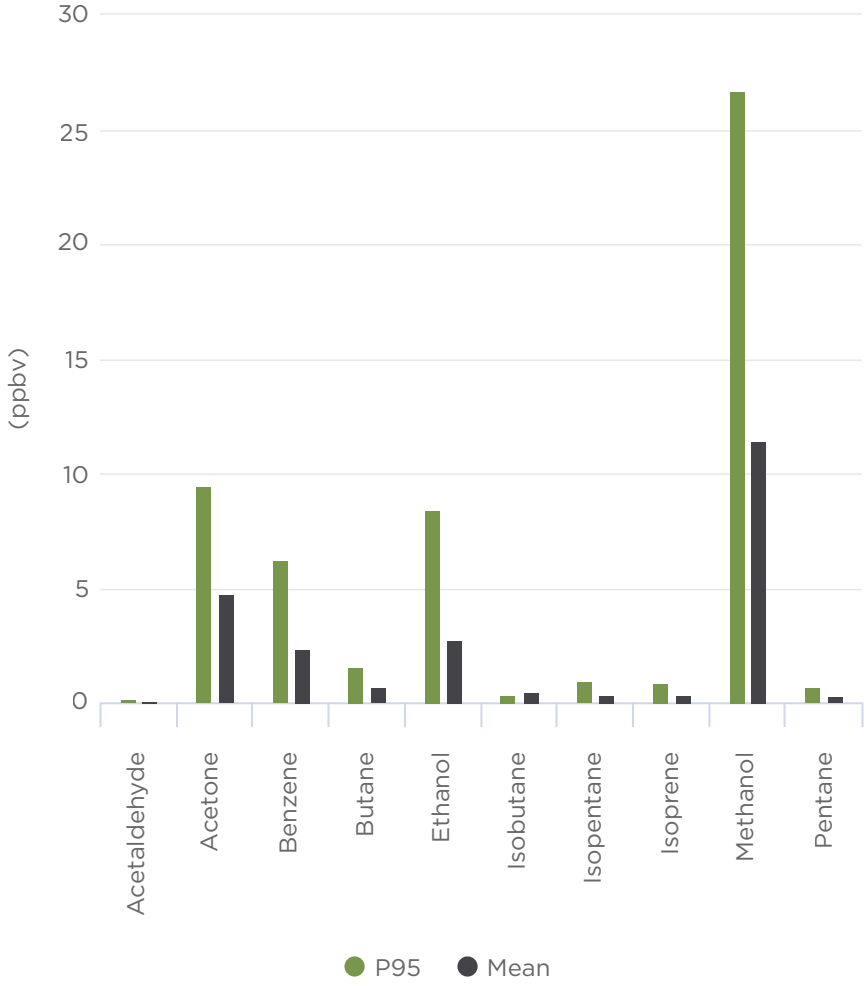


Note: Averages may be too small to be visible on some graphs.

Janvier



Patricia McInnes



Note: Averages may be too small to be visible on some graphs.

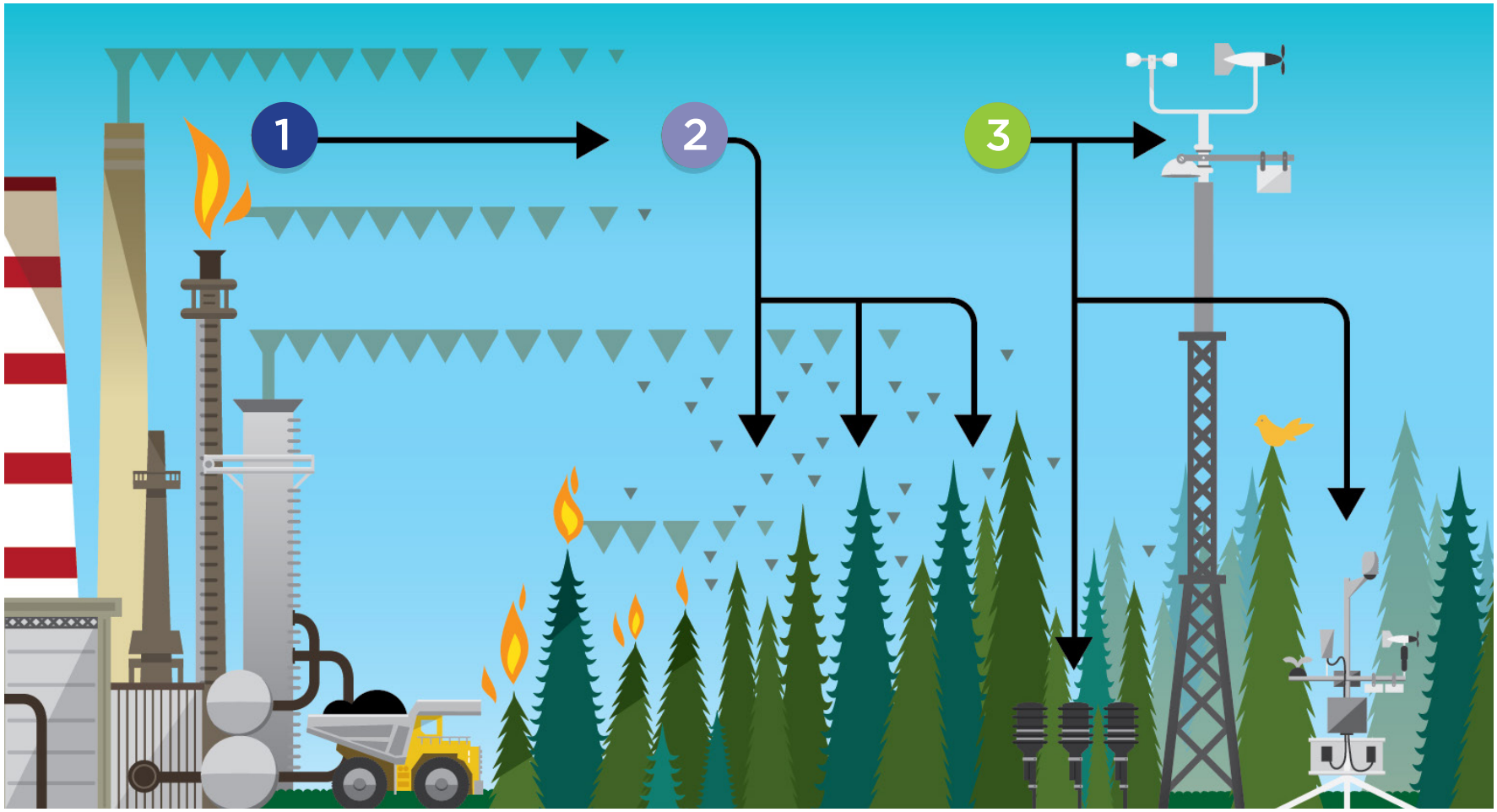
Deposition Monitoring

The Deposition Monitoring program, also referred to as the Terrestrial Environmental Effects Monitoring (TEEM) program, was established to address community, industry, and government concerns about impacts to regional forests from industrial development.

The objective of the program is to determine cause-effect relationships between air pollutants and forest ecosystem health in the region. To meet this objective the WBEA operates both a long-term **Forest Health Monitoring Program** and an **Atmospheric Pollutant Deposition Monitoring Program** which monitor stressors (acidification/eutrophication) along the pathway (atmospheric transport) from source (industrial emissions) to the receiving environment (jack pine forests).

To understand changes in regional deposition over time, data derived from the program must be integrated and analyzed every several years. The most recent comprehensive analysis of historical data was completed in 2019. At that time, the WBEA developed 75 recommendations for program improvements and also published nine open access manuscripts in a Virtual Special Issue of the journal Science of the Total Environment. The issue, entitled "Relationships Between Air Pollutants and Forest Ecosystem Health in the Oil Sands Region, AB, Canada", is available online by visiting **http://sciencedirect.com/journal/science-of-the-total-environment/specialissue/10LW6CG6CPT**.

In 2022, the WBEA completed the next data analysis exercise that will be published in 2023. This publication will supplement the previous findings and continue to explore changes in deposition over time. In addition, the WBEA continued to address the program recommendations by finalizing the evaluation of all Deposition Monitoring programs. In late 2022, the TEEM Technical Committee approved proposals for an optimized deposition network, which includes strategic placement and use of ion exchange resins, passives, remote ozone monitors, and denuders, to yield better spatial resolution and higher data quality.



1 Source

Pollution is emitted into the air from a variety of sources.

2 Deposit

The pollution may be deposited onto the surrounding forest.

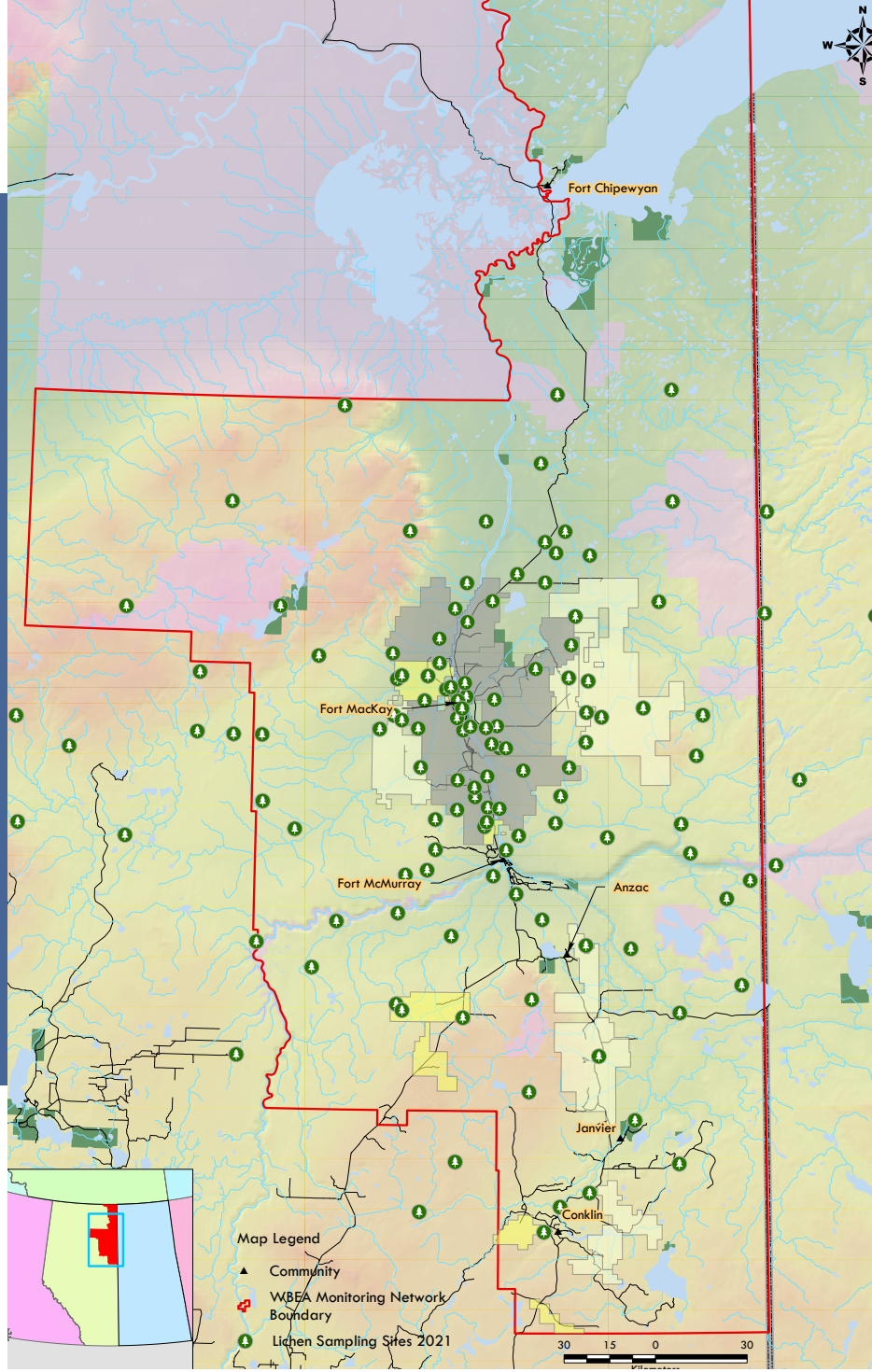
3 Measure

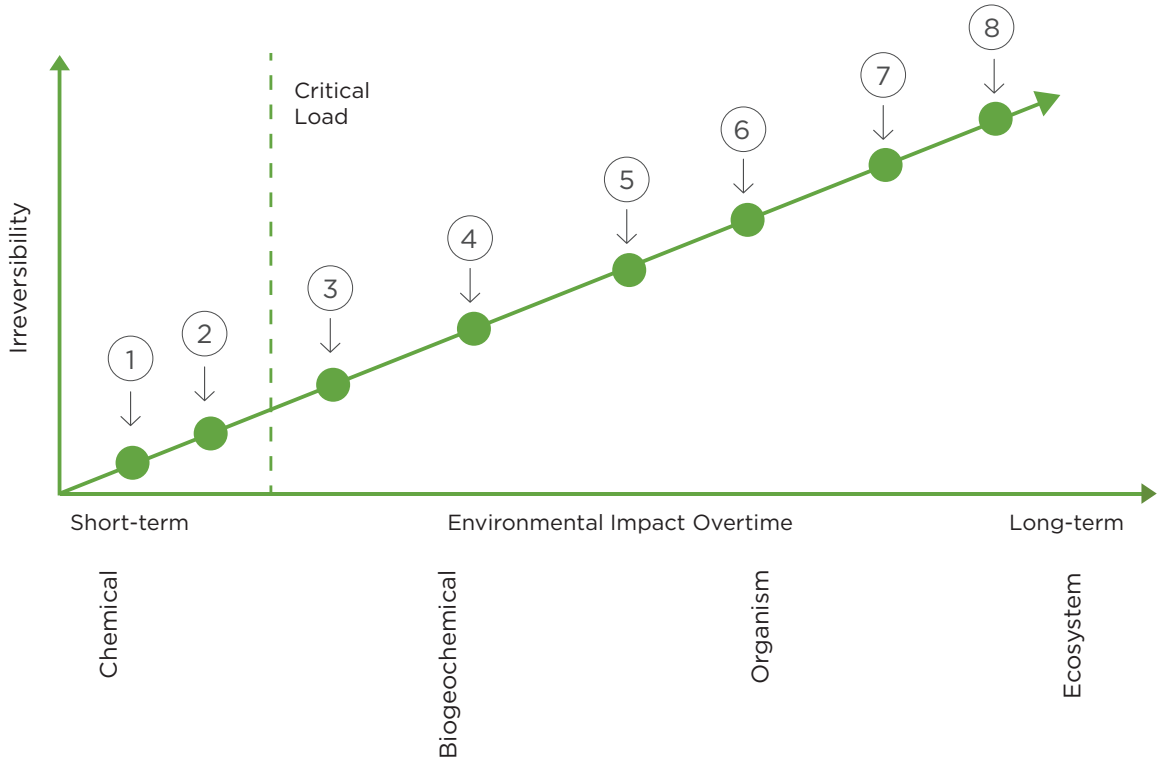
The WBEA collects samples and information to measure the effects of pollution on the environment.

Forest Health Monitoring

The Forest Health Monitoring program monitors jack pine forest sites to assess whether there are changes to biological, physical, and chemical indicators through a sampling campaign of soils and vegetation every 6-years, as well as lichen sampling at varying intervals. During initial program development, the upland jack pine (Pinus banksiana) ecosystem was identified as the most sensitive receptor to acidification due to their characteristically dry, nutrient poor soils with limited buffering capacity. In these ecosystems, the effects of acid deposition are expected to be observed in a cascading manner from soils to vegetation, first impacting individual organisms, then the tree stand, and onward to landscape level impacts. The bigger impacts will take a longer time but will be harder to correct. This concept is depicted in the **Critical Load Graph** on the following page.

In 2022, the WBEA completed the extensive task of cleaning over 150 lichen samples before submission to the lab for analysis. These lichen samples, of the species *Hypogymnia physodes*, were collected in 2021 as part of the regional lichen monitoring program from all over the region, as shown on the adjacent map. This species of lichen receives its nutrients from the air and rain making it a very effective natural tool for monitoring air pollution. Data obtained from these samples is critical to the program and is used to determine changes in atmospheric deposition over time and across the regional landscape.





1. Emissions (stack, fleet)
2. Deposition (wet, dry) below CL & no effect
3. Altered jack pine soil chemestry (BC:Al, BS% C:N, nutrients)
4. Altered jack pine growth
5. Altered jack pine understory community composition
6. Altered aspen soil chemistry (BC:Al, BS% C:N, nutrients)
7. Altered aspen growth
8. Altered aspen understory community composition

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

Atmospheric Pollutant Deposition Monitoring

Passive Air Sampling - Passive Samplers

Passive air sampling, specifically using passive samplers, is a cost-effective method for coverage of a broad spatial range, including remote locations, because they have no moving parts and require no power. Passive sampler data, along with meteorological data, is used to model deposition trends. In 2022, the WBEA finalized a program evaluation and approved a new passive program for 2023 that will focus on NO_2 and O_3 in strategic locations, co-located with active air sampling. The new program will provide adequate spatial coverage for deposition estimates in the region while being cost-effective.

Active Air Sampling – Denuders

Active air sampling uses a pump to provide a known volume of air to a continuous analyzer or sample media. For this reason, in addition to a low detection limit, active air sampling provides higher quality data than passive air sampling, however, because they require power, they can be less versatile. In 2022, ammonia (NH_3) and nitric acid (HNO_3) continued to be monitored monthly at eight sites using solar-power annular denuder systems. In addition, the WBEA finalized a program evaluation and approved an expansion of the denuder network, to be executed in 2023, which will provide better qualitative data.

Passive Deposition Sampling - Ion Exchange Resin

Ion exchange resin (IER) technology is a passive sampling technology, comprised of a column of resin beads that capture anions and base cations to characterize spatial gradients of atmospheric deposition of nitrogen, sulphur, and base cations in the region. IERs are critical to the deposition program as they provide actual deposition measurements required to validate the critical loads mapping and modelling exercises. In 2022, the WBEA finalized a program evaluation and approved an optimized IER program that includes an increase in base cation collection, a change that was due to recent findings that suggest base cation deposition plays a greater role in deposition effects than anticipated during the developmental years of the program.

Instrumented Regional Meteorological Network

The WBEA's regional meteorological network provides key data for calculating deposition rates, modelling dry deposition, and evaluating the performance of deterministic models. The network is comprised of six 30-meter instrumented towers ("met towers") that provide continuous, hourly data on climatic conditions throughout the Wood Buffalo region. Each met tower is co-located with a Forest Health Monitoring (FHM) site and monitors air temperature, relative humidity, wind speed, wind direction, and solar radiation at four levels within and above the jack pine canopy, as well as temperature and volumetric water content within forest soil.

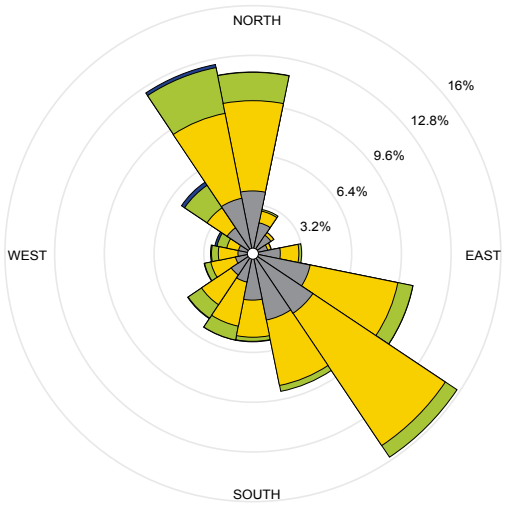
The map to the right shows where each of the six 30-meter meteorological towers are located within the WBEA's network. The wind data collected from these towers, measured above the tree canopy, are used to characterize wind flow in a wider geographical area, calculate emission deposition, and evaluate ecological data. The corresponding wind roses for each tower are on the following page.

Access tower data online by visiting:
https://wbea.org/historical-monitoring-data/

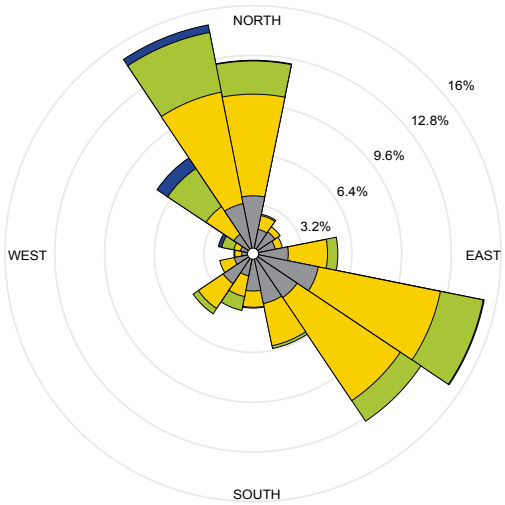
2022 Meteorological Tower Wind Roses

Meteorological Tower 1004

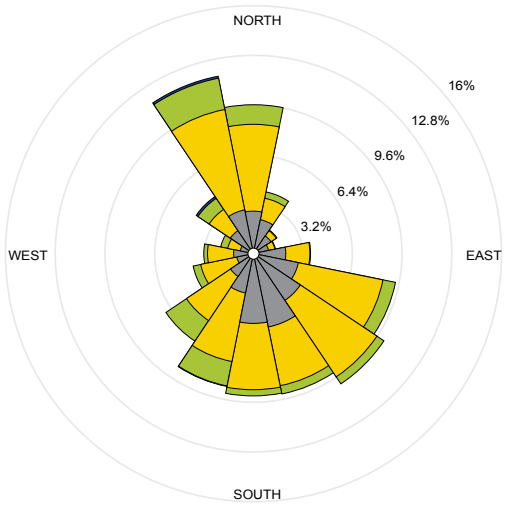
Annual Average



Spring



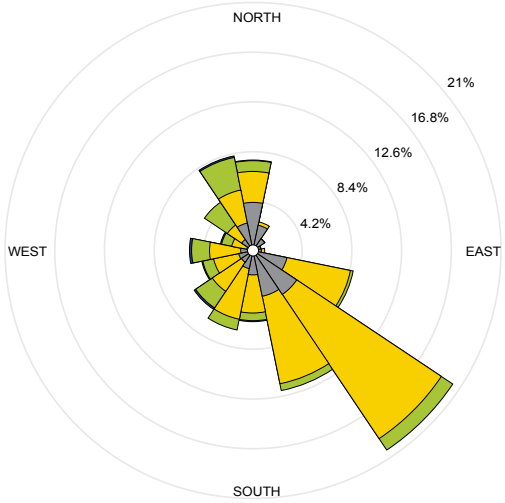
Summer



WIND SPEED (km/h)
Tower Height: 30m

- 0.5 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- > = 25

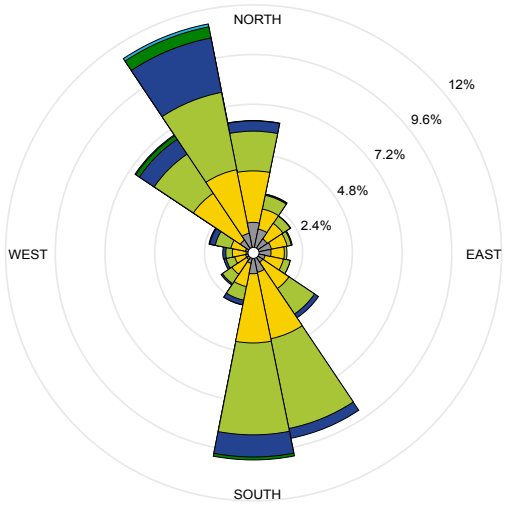
Fall



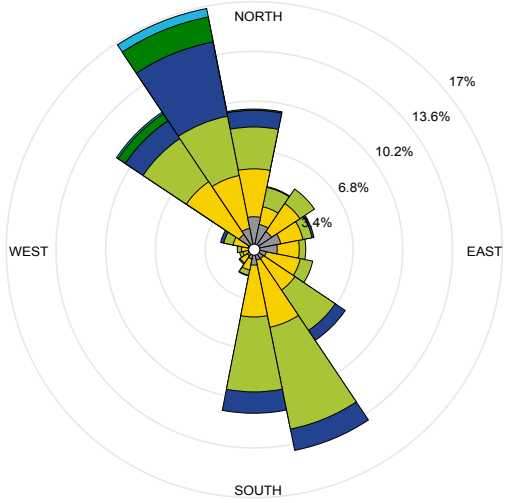
Winter

Meteorological Tower 1007

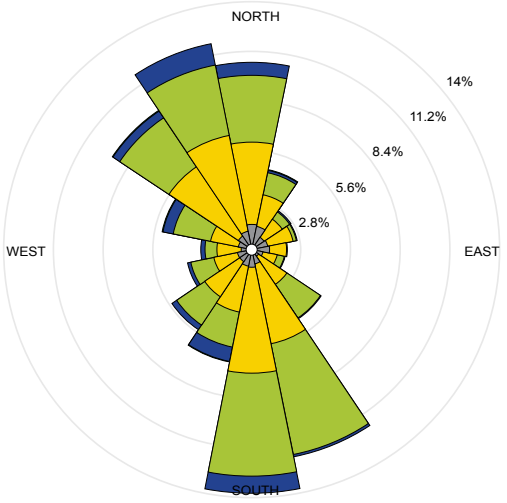
Annual Average



Spring



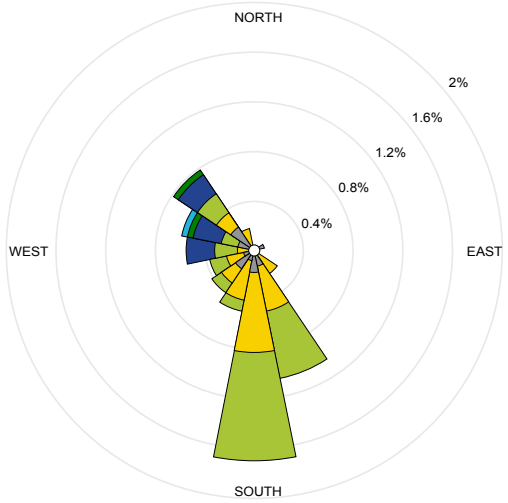
Summer



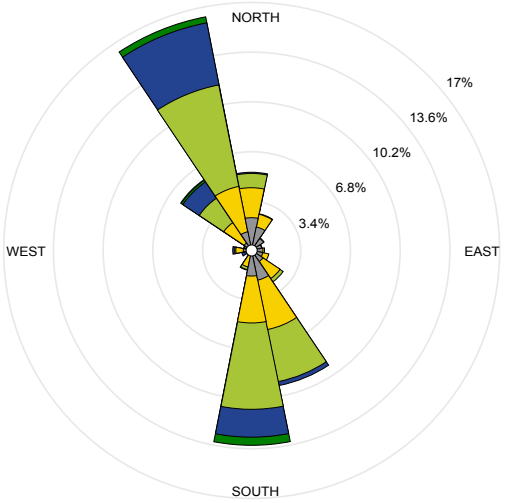
WIND SPEED (km/h)
Tower Height: 30m

- 0.5 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- > = 25

Fall

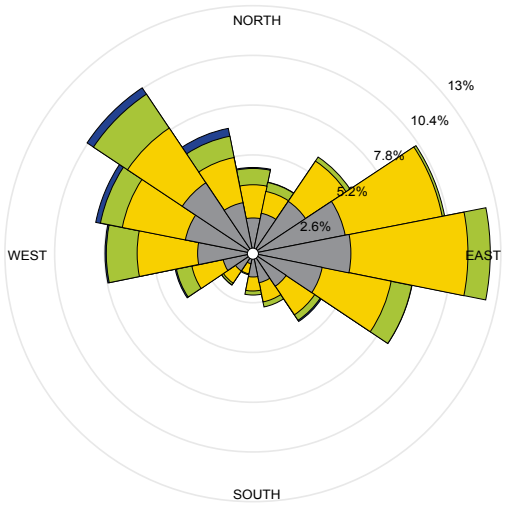


Winter

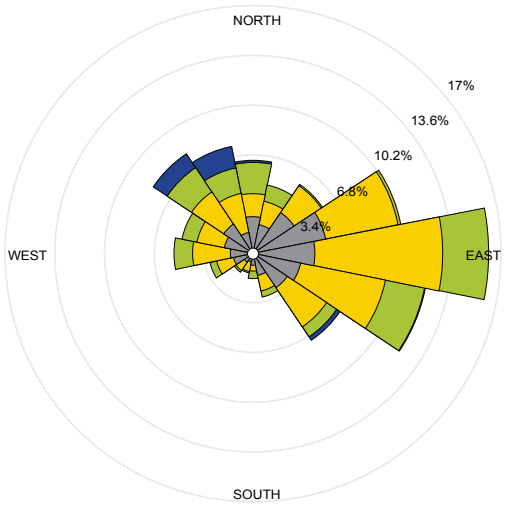


Meteorological Tower 2001

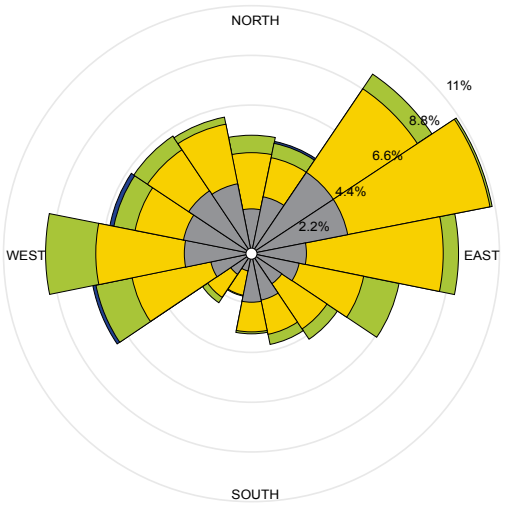
Annual Average



Spring



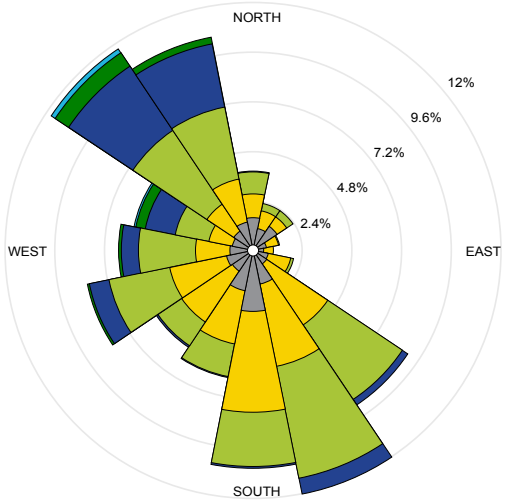
Summer



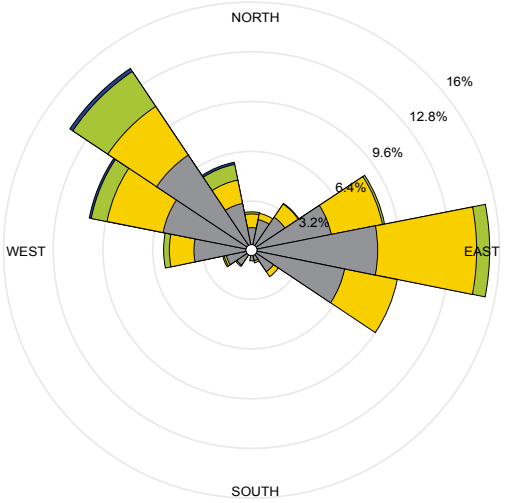
WIND SPEED (km/h)
Tower Height: 30m

- 0.5 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- > = 25

Fall

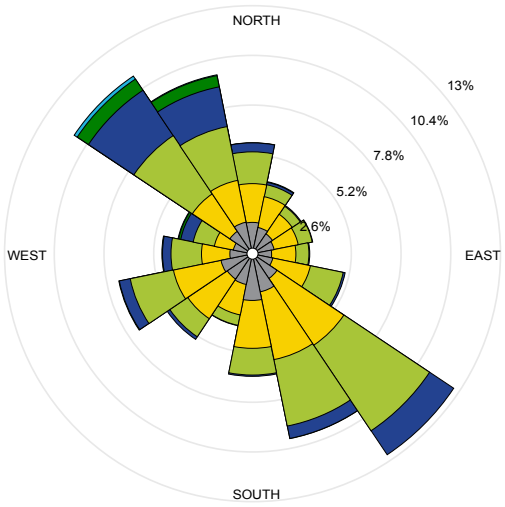


Winter

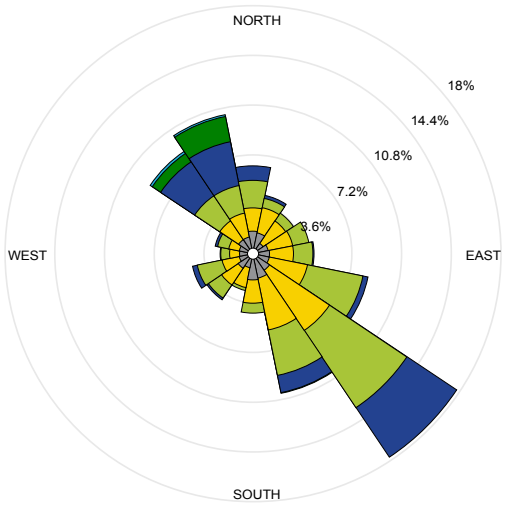


Meteorological Tower 2013

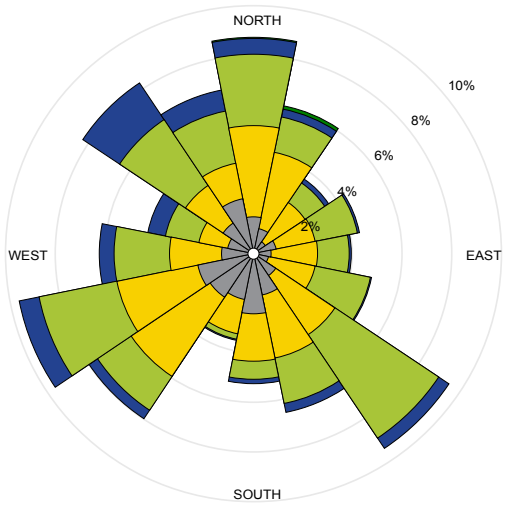
Annual Average



Spring



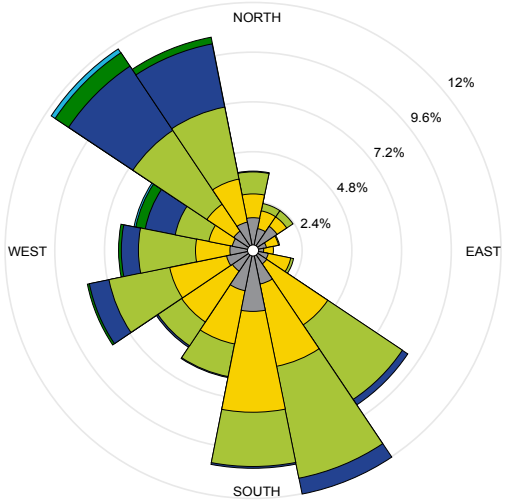
Summer



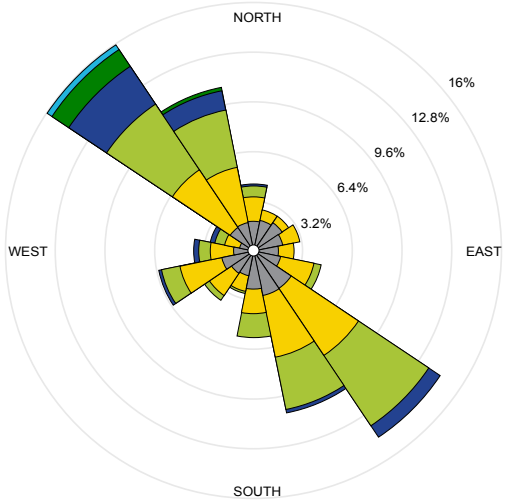
WIND SPEED (km/h)
Tower Height: 30m

- 0.5 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- > = 25

Fall

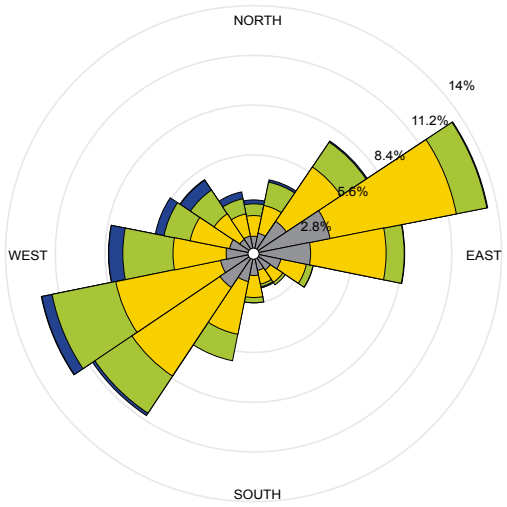


Winter

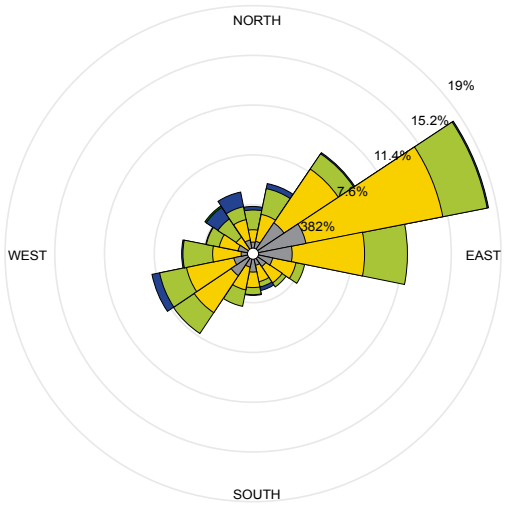


Meteorological Tower 3011

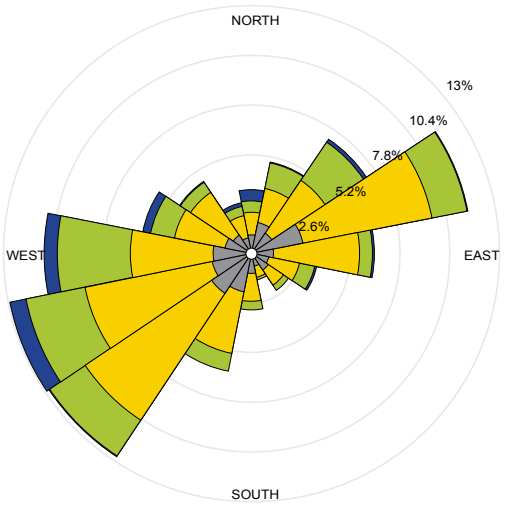
Annual Average



Spring



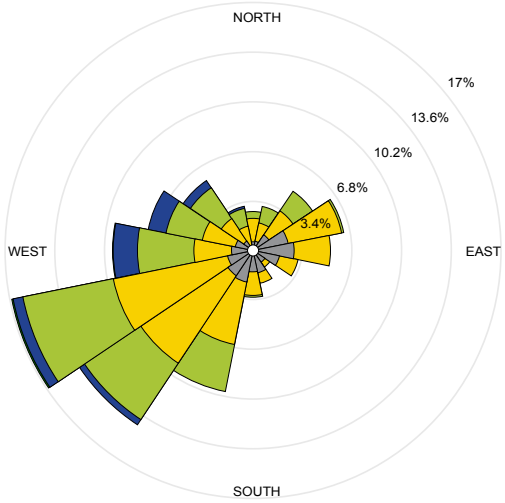
Summer



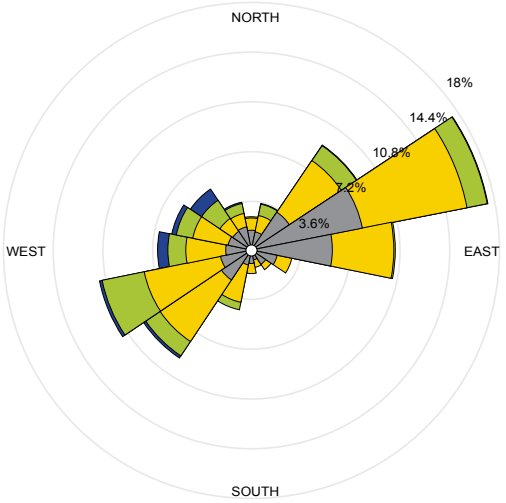
WIND SPEED (km/h)
Tower Height: 30m

- 0.5 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- > = 25

Fall

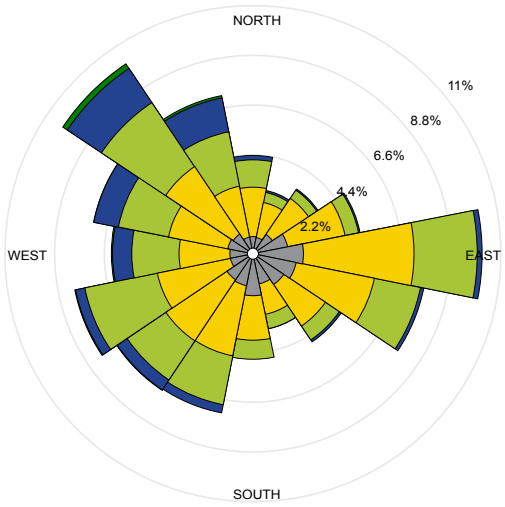


Winter

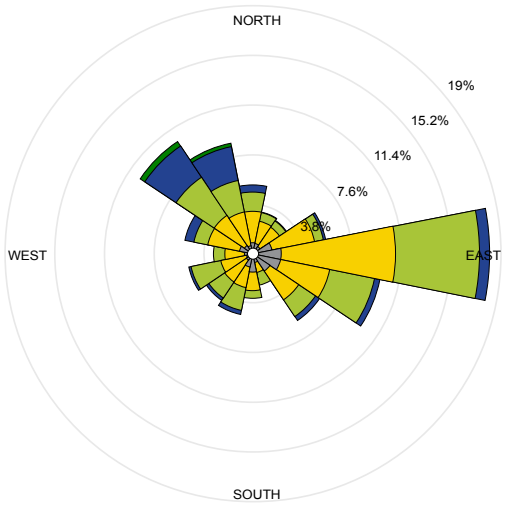


Meteorological Tower 3016

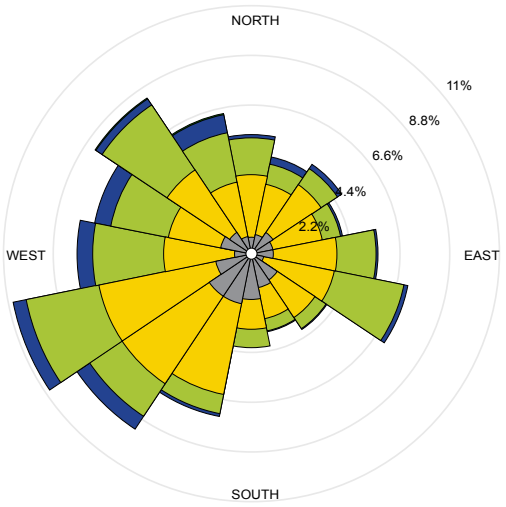
Annual Average



Spring



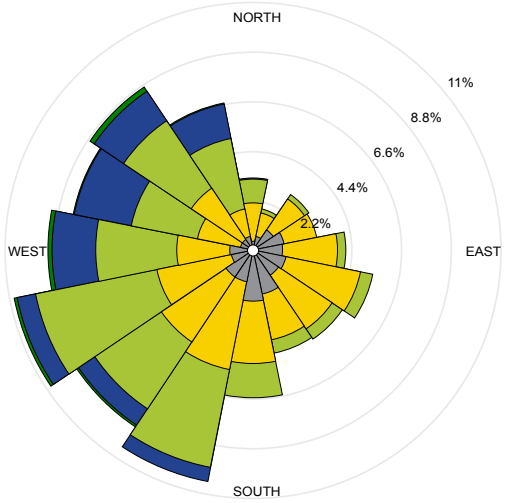
Summer



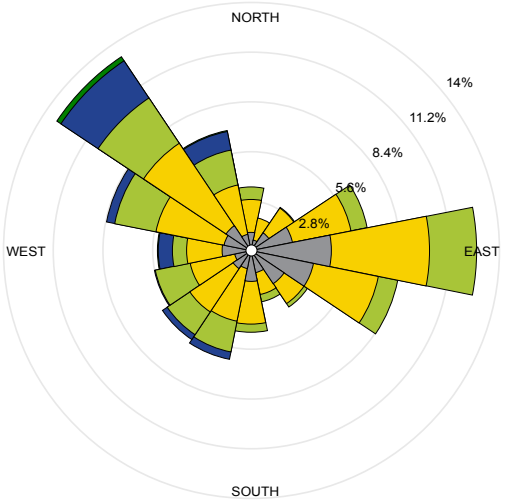
WIND SPEED (km/h)
Tower Height: 30m

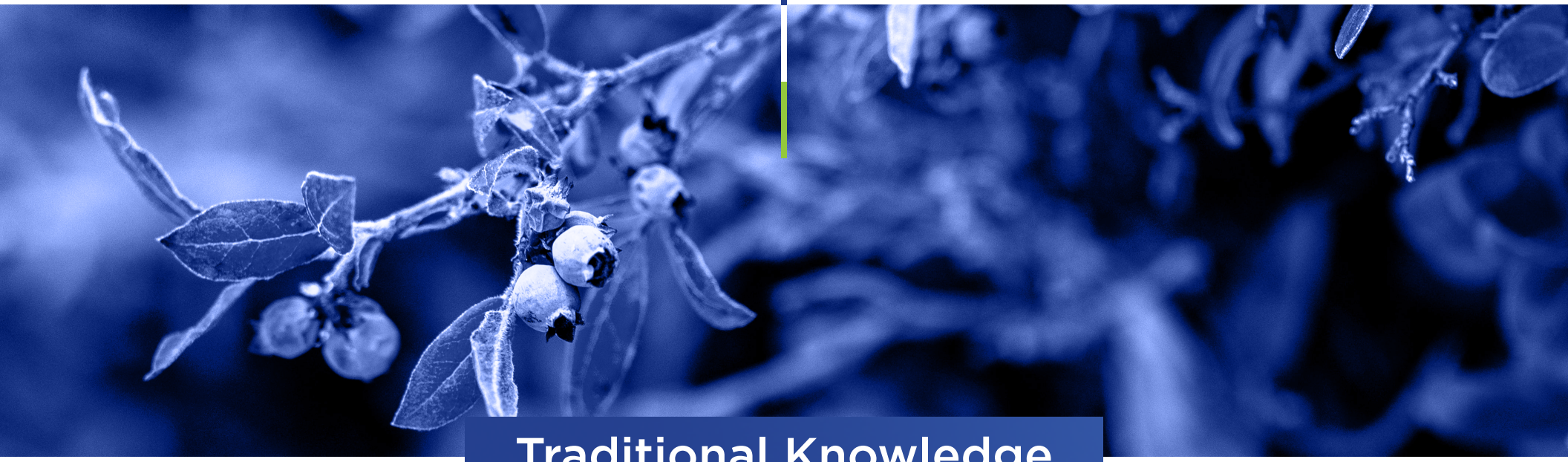
- 0.5 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- > = 25

Fall



Winter





Traditional Knowledge

The WBEA has fostered collaborative relationships with Indigenous communities in the Wood Buffalo region since its formation. In 2022, the WBEA released its 2022-2026 Strategic Plan which outlined the WBEA's continued commitment to demonstrating respect for Indigenous ways of knowing through braiding Indigenous Knowledge and western science in its monitoring programs. In 2022, and in previous years, the Community-Led Berry Contamination Study has strived to use best practice methodologies that appropriately braid Indigenous and western knowledge systems to build trusted relationships between participating Indigenous communities, academic researchers, and provincial and federal government scientists.

The Community Led Berry Contamination Study is a multi-year community-based monitoring project that builds upon work initiated by Fort McKay First Nation, with support from the Wood Buffalo Environmental Association, since 2010. The project has grown to include Conklin Métis, Fort McKay Métis Nation, and Fort McMurray 468 First Nation.

The study objective is to monitor berries from culturally significant patches to inform the community questions, including “are the berries safe to eat?” and is driven by the concerns of the participating community members about changes to berry quality and health due to oil sands-related development. The cultural identity of Indigenous peoples is intertwined with their food sovereignty and food security, therefore, the continued access to cultural keystone species of berries is paramount for community health and well-being.

In 2022, participating communities continued monitoring with a visit to each berry patch to spend time on the land, share lived experience and knowledge, observe the environmental condition, and harvest berries for laboratory analysis of health compounds and contaminants.

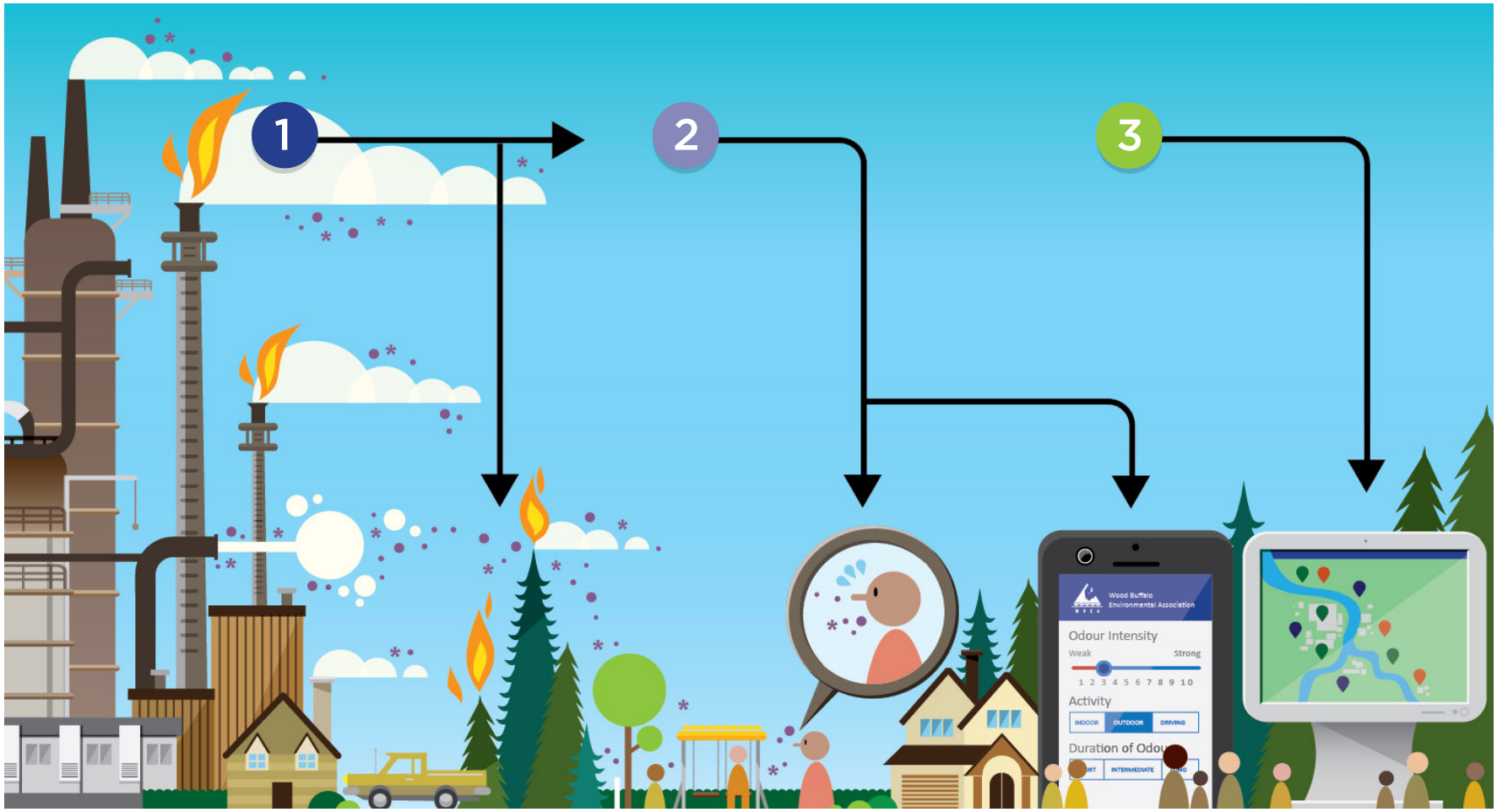
The study has produced qualitative and quantitative data for each community that has provided meaningful insight into their berry condition. While the WBEA provides support to the communities, the WBEA does not share the data on the communities’ behalf; however, there is some indication from this study that levels of contaminants of concern are elevated in berries from patches considered unclean by Indigenous members, which are located closer to oil sands development, versus berries from patches considered clean or sacred by Indigenous members, which are located farther away from development.

Odour Monitoring

Community Odour Monitoring Program

The WBEA created the Community Odour Monitoring Program (COMP) app as an opportunity for people to provide information about the odours they experience throughout the RMWB, as outlined in the image on the following page. Currently, analyzers can measure the concentration of specific pollutants or groups of pollutants, but they cannot measure if an odour is present or how strong the odour would be. Therefore, the app allows the WBEA to compare the information people provide about odours to the ambient air data collected at WBEA air monitoring stations. The intent is to find whether there are trends in the ambient data when odours are present—such as elevated concentrations of odour-causing compounds.

View near-real time observations, access the COMP 2022 Annual Report, and find links to download the app to your iOS or Android Device on the COMP website: **comp.wbea.org.**



1 Source

Pollution is emitted into the air from a variety of sources.

2 Smell

The pollution may cause odours - anyone who experiences an odour in the RMWB can submit their observations via the WBEA's COMP app.

3 Share

Users can learn about odours and view all observations submitted at comp.wbea.org

WBEA 2022 Membership

INDIGENOUS MEMBERS

Athabasca Chipewyan First Nation
Chard Métis Nation
Chipewyan Prairie Dene First Nation
Christina River Dene Nation Council
Conklin Resource Development Advisory Council
Fort McKay First Nation
Fort McKay Métis Nation
Fort McMurray 468 First Nation
Lakeland Métis Community Association
McMurray Métis
Mikisew Cree First Nation

NON-GOVERNMENT ORGANIZATION MEMBERS

Keyano College
Pembina Institute

GOVERNMENT MEMBERS

Alberta Energy Regulator
Alberta Environment and Protected Areas
Alberta Health
Alberta Health Services
Environment and Climate Change Canada
Health Canada
Parks Canada
Regional Municipality of Wood Buffalo

INDUSTRY MEMBERS

Athabasca Oil Corporation
Canadian Natural
Cenovus Energy Inc.
ChemTrade Logistics
CNOOC International
Connacher Oil and Gas Ltd
ConocoPhillips Canada
H.J. Baker Sulphur Canada ULC
Hammerstone Corporation
Harvest Operations Corp.
Imperial Oil Limited
Inter Pipeline Limited
Keyera Energy Ltd.
MEG Energy Corp.
Parsons Creek Aggregates
PetroChina Canada Ltd.
Suncor Energy Inc.
Sunshine Oilsands Ltd.
Surmont Energy
Syncrude Canada Ltd.
Teck Resources Ltd.
Titan Tire Reclamation Corporation

WOOD BUFFALO
ENVIRONMENTAL ASSOCIATION

3 - 805 Memorial Drive, Fort McMurray, Alberta T9K 0K4
Telephone: 780.799.4420 | email: info@wbea.org | wbea.org