# Smoke Exposure from Wildfire:
## Guidelines for Protecting Community Health and Wellbeing

Government of Northwest Territories
Gouvernement des Territoires du Nord-Ouest

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▲Photo with permission from Yves Panneton

▲▼Photo courtesy GNWT Environment and Natural Resources

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# 1 | BACKGROUND

Wildfires in Canada are expected to increase in size, severity and duration as a result of the changing climate. The Northwest Territories (NWT) typically experiences 245 wildfires per year on average affecting some 570,000 hectares each year. Wildfire smoke is increasingly recognized as an important health hazard. Approximately 100 wildfire evacuation events and 21,000 people were evacuated due to smoke in Canada over a 27-year period (1980-2007). This represents 19% of all evacuations and 10% of all evacuees for smoke and fire hazard combined. Public health response must be rapid, effective and informed by the best available evidence.

In 2014, moderate to severe drought conditions, as well as some unusual meteorological conditions, resulted in the NWT experiencing a record fire season that involved 385 fires, $56.1 million in cost and impacts on about 3.4 million hectares of forest resource. Public health decision makers were called upon to protect public health with limited local information (e.g., no fixed particulate matter (PM) monitors) and in unusual circumstances (e.g., wildfire smoke blanketing communities). In such events rapid assessment and rational response is required. Substantial work has been done elsewhere. The Northwest Territories Department of Health and Social Services (HSS) has reviewed and adapted components from guidelines created by Manitoba Health, British Columbia Centre for Disease Control and the Washington Department of Health to create NWT guidelines.

## Definitions and Acronyms

AQHI – Air Quality Health Index

CAS – Clean(er) Air Shelter

CFM – Cubic Feet per Minute

CHN – Certified Health Nurse

CHR – Community Health Representative

COPD – Chronic Obstructive Pulmonary Disease

CPHO – Chief Public Health Officer

CVD – Cardiovascular Disease

HSS – Department of Health and Social Services

HSSA – Health and Social Services Authority

DoT – Department of Transportation

EC – Environment Canada

EMO – Emergency Measures Organization

ENR – Environment and Natural Resources

FEMA – Federal Emergency Management Agency (USA)

GNWT – Government of the Northwest Territories

Health Authority – Department of Health and Social Services and the Regional Health Authorities

HEPA – High Efficiency Particulate Arrestance

Local Authority – governments such as villages, towns, municipalities, regional districts, regions, counties or First Nations

NP – Nurse Practitioner

NWT – Northwest Territories

OFM – Office of the Fire Marshal

PM – Particulate Matter or particles (interchangeable)

RERC – Regional Emergency Response Committee

TERC – Territorial Emergency Response Committee

Wildfire – An unplanned, unwanted wildland fire including unauthorized human caused fires, escaped prescribed fire projects, and all other wildland fires where the objective is to put the fire out (can be interchangeable with wildland fire).

Wildland – An area in which development is essentially non-existent, except for roads, railroads, power lines and similar transportation facilities. Structures if any are widely scattered.

## 1-1 OBJECTIVES/AUDIENCE

These guidelines are intended to assist the health sector, community governments and other stakeholders in communicating health risks and recommending actions or precautions to protect people from wildfire fire smoke exposure.

## 1-2 SMOKE FROM WILDFIRES

### 1-2.1 Wildfires

Wildfires are an annual occurrence throughout many parts of the NWT. They are typically caused by accidental or intentional human activity and lightning strikes. Though they often involve remote forested areas, wildfires can affect communities. Large fires may disperse smoke over great distances, exporting smoke to other regions of Canada and beyond, and importing smoke in the same manner. Depending on the location of the fire and wind currents, any community can be affected.

### 1-2.2 Smoke Composition

Wildfire smoke composition depends on many factors, including the types of vegetation burned. Pollutants in smoke can include gases like carbon monoxide and a variety of solid and liquid elements often referred to as particulates or particles. Some parameters from wildfire smoke, like acrolein, formaldehyde and benzene, are toxic or carcinogenic for humans. Particulate matter, both coarse and fine (PM10 and PM2.5 respectively- see 1-2.4 on page 6 for more information) is a commonly monitored air quality parameter used as an indicator for public health or population exposure. The concentrations of particulate monitored in the ambient air are useful information during a wildfire event to inform decision makers on the need to take measures to reduce health risk.

### 1-2.3 Air Quality

Air quality refers to the state of the air around us. Poor air quality occurs when pollutants, such as those in smoke, reach high enough concentrations to endanger human health (and/or the environment).

Individuals react differently to air pollutants. Air quality health effects are determined by the length of time exposed, how much air is breathed, personal health and the concentration of pollutants in the air.

The Air Quality Health Index (AQHI) is a public information tool that helps Canadians protect their health on a daily basis from the negative effects of air pollution. This tool has been developed by Health Canada and Environment Canada, in collaboration with the provinces and key health and environment stakeholders. The AQHI is calculated based on the relative risks of a combination of common air pollutants that are known to harm human health (ozone, nitrogen dioxide and fine particulate matter).

### 1-2.4 Particulates

Sources of airborne particulate in both urban and rural settings can include:

- exhaust from motor vehicles
- wood burning stoves and fireplaces
- dust from construction, landfills and agriculture
- wildfires and brush or waste burning
- industrial emission sources
- wind-blown dust

Particulate levels are a principal concern in wildfire smoke. The size of particulate in the air we breathe affects their potential to cause health problems. Particulate pollution may contain substances like carbon, sulphur and nitrogen compounds, metals and organic chemicals. Particulate size is usually measured in microns, which are units of one millionth of a metre. Particulate levels in the NWT are generally very low, with the PM2.5 typically below 6 μg/m3 on average which is well below the referenced standard of 28 μg/m3. Smoke related PM2.5 levels are the most closely connected with health outcomes.

Coarse particulate ranges from 2.5-10 microns in diameter (PM10). Fine particulate, with diameters less than 2.5 microns (PM2.5) are often linked to health effects. Particulate in this size range are slow to clear from the lungs when they are inhaled. For purposes of comparison, a human hair is about 60 microns in diameter.

Some particulate from smoke can be extremely small, with a size range near the wavelength of visible light (0.4 to 0.7 microns). At this size range, smoke particulate efficiently scatter light and make it difficult to see, explaining why people often become disoriented in smoke. It also explains why some smoke particulate can be inhaled deeply into the lungs and why these are a greater health concern than larger particulate.

### 1-2.5 Health Effects of Wildfire Smoke

How smoke conditions may affect an individual's health is determined by a number of factors, such as the length of time they are exposed, how much air they breath in, their health status and the concentration of smoke in the air. Exposure to smoke can quickly result in sore eyes, tears, cough and runny nose. If the smoke lasts several days to weeks or is very heavy, more serious lung problems and long-lasting cough may occur. At this time there are no studies into the long term impact of wildfire smoke exposure.

The smallest particles within the smoke make up the unhealthiest material. These are the ones that go deeper into the lungs. Small particles trigger coughing and make it harder to breathe. Exposure to smoke can also cause worsening of heart and lung diseases like asthma, chronic bronchitis, emphysema, and congestive heart failure. Elders and young infants are also at increased risk.

Those individuals at increased risk for adverse health effects include:

- people with existing respiratory conditions such as lung cancer, asthma or chronic obstructive pulmonary disease (COPD), which includes chronic bronchitis and emphysema;
- people with existing cardiovascular conditions including angina, previous heart attack, congestive heart failure or irregular heartbeat;
- infants and young children because they have elevated metabolic rates and immature immune systems that make them more at risk;
- the elderly because respiratory, cardiovascular and immune systems are not as strong as they may have been;
- pregnant women and the fetus, because smoke contains many of the same compounds as cigarette smoke, which can lead to a plethora of health risks for both mother and fetus;
- diabetics because they may have underlying conditions such as cardiovascular disease;
- smokers who may have compromised lung function;
- outdoor athletes and workers when they are breathing deeply and rapidly because they are processing substantially more of the harmful compounds contained in smoke.

Carbon monoxide exposure may happen to anyone close to a fire, especially if it is smouldering. Fire fighters and people with cardiovascular disease are at increased risk of carbon monoxide poisoning. Symptoms of carbon monoxide exposure may include headache, weakness, dizziness, confusion and visual impairment. Prolonged or heavy exposure may result in a coma and death. Chemicals like formaldehyde and acrolein can irritate eyes and the respiratory system. They may also trigger asthma.

Short term exposures to smoke-containing agents that can cause cancer, such polycyclic aromatic hydrocarbons or benzene, may increase one's lifetime risk of developing cancer. At this time the literature is unable to quantify those risks.

Particulate matter exposure is one of the main (or primary) public health threats from short-term smoke exposure. The health effects of smoke from wildfires range from eye, nose or throat irritation to serious problems such as reduced lung function, bronchitis, exacerbation of asthma and even risk of death. People who are otherwise healthy may have irritated eyes, increased mucus production in the nose or throat, and/or coughing or difficulty breathing, especially during exercise. People with existing respiratory or cardiovascular conditions may experience aggravation of existing conditions.

# 2 | THE IMPACTS OF WILDLAND FIRE SMOKE FOR HEALTH CARE FACILITIES

## 2-1 INCREASED PATIENT LOAD

Impacts on a health care centre can be substantial during smoke events caused by wildfire. Fires cause burns and these injuries are obvious but injuries to the lungs and airways from smoke inhalation are often less apparent and may not present for 24-36 hours after exposure. The following are several examples of the direct impact on health services delivery by wildfire smoke events.

### Hoopla California
### August 23- November 3, 1999

During the weeks of the forest fire, medical visits for respiratory illnesses increased by 217 visits (from 417 to 634 visits, or by 52%) over the previous year. The proportion of all visits for respiratory problems increased from 8.9% (95%confidence interval, 7.5%-10.3%) in September 1998 to 11.9% (10.4%-13.4%) in September 1999, from 10.7% (9.1%-12.3%) in October 1998 to 19.2% (17.2%-21.3%)in October 1999, and from 13.8% (9.4%-18.2%) during the first week of November1998 to 19.5% (15.2%-23.8%) during the first week of November 1999.

### California
### October 2003

These conditions were compared with PM2.5 concentrations in the pre-wildfire period and showed an increase of 34% in asthma admissions. The strongest associations between PM2.5 in smoke and hospital admissions were for people over 65 years old (10% increase per 10 μg/m3 PM2.5) and under 5 years old (8% per 10 μg/m3 PM2.5). Acute bronchitis admissions increased across all ages by 10% for every 10 μg/m3 in wildfire-related PM2.5. Chronic obstructive pulmonary disease admissions for ages 20–64 years also increased by 7% and pneumonia admissions for ages 5–18 years increased by 64%. There was limited evidence of a small impact of wild-fire-related PM2.5 on cardiovascular admissions.

Prescribed burns near Whati. *Photo courtesy of GNWT Environment and Natural Resources.*

### British Columbia
### April 1 to September 30, 2003-10

The Province of British Columbia is divided into 89 local health areas (LHAs). The information provided is extracted from data collected for the British Columbia Asthma monitoring system (BCAMS) using 4 monitoring approaches from April thru September in the years 2003 to 2010. 29 of the 89 LHAs were equipped with monitoring equipment throughout the study period. LHAs with monitoring equipment identified 10 µg/m3 in the PM2.5 was associated with a 4% increase in salbutamol dispensations during all fire season days. Days that measured over 25 µg/m3 in the PM2.5 aligned with an increase in visits to health care professionals.

### Northwest Territories
### 2014

Ecology North in partnership with Yellowknives Dene First Nation, Ka'a'gee Tu First Nation, and Canadian Association of Physicians for the Environment and with funding from Health Canada have been working on a mixed method study trying to identify the health impacts of the extreme forest fire season of 2014. This project's preliminary data from Ecology North's Summer of Smoke project did show increased Clinic and Emergency Room visits for respiratory issues during the extreme 2014 forest fire season. Ecology North is also developing a policy document that will outline how to improve our response to extreme forest fire seasons. Final results are not yet available but will be found of the Ecology North website at www.ecologynorth.ca near the end of June 2016. It was noted cough, asthma, and pneumonia saw significant increases in Yellowknife during the summer of 2014. The yearly average of pm2.5 in Yellowknife is about 6 µg/m3. During summer 2014 it averaged 55.8.

## 2-2 PREPARATION AND MITIGATION

### 2-2.1 Local Authority: Preparation and Planning

Suggested activities for the local Emergency Coordinator:

- develop a method to identify smoke conditions and changes in visibility – before the wildfire season; designates in each community can identify specific landmarks at various distances that can then be used to estimate smoke concentrations and risks (see appendices C/D)
- identify sites within the community that can be used as cleaner air shelters in the event of short-term smoke conditions within the community (see appendixes A/B)

### 2-2.2 HSS and HSSA: Preparation and Planning

1. Suggested activities for the HSS and HSSA:
    - ensure a plan is developed to monitor health effects
    - identify locations within health centre that could be used as cleaner air shelter
    - support health facilities
    - Be familiar with the community's Emergency Response Plan
    - Coordinate communications plans to share public messaging from CPHO
2. Suggested activities for the Health and Social Services Authority (HSSA) and Health Emergency Management Officer (HEM):
    - review emergency preparedness plans for each health facility and review roles and responsibilities of health staff
    - arrange a planning review with the community's emergency coordinator or contact person
    - maintain a telephone list of trained nurses and other health care staff
    - ensure the community has a plan to inform its citizens of hazards and procedures to follow in the event of a wildfire
    - if a health facility is located in a community, meet with the local authority's emergency coordinator and identify someone to assess smoke conditions and changes in visibility
    - ask local authorities to identify sites within the community to use as cleaner air shelters when the community experiences short-term smoke conditions and make sure they are available for emergency use (criteria for identifying and preparing cleaner air shelters is provided in Appendix A/B)

### 2-2.3 Health Facility: Preparation and Planning

1. Suggested activities for Health Facilities:

    - Review the stock of emergency supplies (first aid, oxygen and oxygen delivery systems, emergency kits, etc).
    - Coordinate with community to identify potential cleaner air shelters
    - Conduct wildfire exercises for all who will help in emergencies
    - Update the list of sensitive and vulnerable patients (as outlined in Section 1.2.5), including the patient's health information and specific care needs; during smoke threats, a list of priority risk people will be required and this will help – in larger communities, several care providers may be involved in preparing these lists Note: Individual health information records partially filled out in advance can help during a selective priority or full evacuation; a copy should be given to the evacuee and a copy kept at the facility
    - Evaluating a facility's ability to shelter people from smoke requires: knowledge of preparation of cleaner air shelters (Appendix A), identification of experts in heating, ventilation and air conditioning systems in hospitals or health care facilities, methods and supplies for monitoring air quality in the facility, available supplies such as filters for improving air quality.

Picture of the Birch Creek complex fire near Fort Providence taken July 14, 2014 (photo courtesy of Environment and Natural Resources, GNWT)

# 3 | SUPPORT TO THE COMMUNITY EMERGENCY RESPONSE COMMITTEE

## 3-1 ASSESSMENT OF SMOKE CONDITIONS

It is important for each community Health Centre and Community Emergency Response Committee to designate someone to assess health risks from wildfire smoke before determining the best and most appropriate course of action.

Assessing air quality, health effects and estimated duration of smoke, will help in making decisions. It is also important to take into account availability of local services such as access to health care and cleaner air shelters. More information on cleaner air shelters is located in Appendix A and Appendix B.

## 3-2 AIR QUALITY

It is important that health professionals get immediate information about air quality so that they can help make timely decisions that protect public health.

The following 4 methods are in place or being developed to help determine the air quality at any specific location in the Northwest Territories, and are especially useful during wildfire smoke events. All have value depending on location, time of day and internet/media access.

### 3-2.1 The Air Quality Health Index (AQHI):

The AQHI, which is currently available for Yellowknife and Inuvik, is a health risk communication tool which forecasts health risks related to wildfire smoke for the current and following day. The AQHI measures the air quality in relation to your health on a scale from 1 to 10 with 1 being good and 10 being bad, and provides some suggestions on how you might adjust your activity levels to protect yourself when air quality is poor. The AQHI is a joint effort between Environment Canada and Health Canada, with monitoring data provided in near real-time by Environment and Natural Resources. The AQHI will also be available in Fort Smith starting in the spring of 2016. An example of the AQHI is shown in Figure 1. To access the Government of Canada, Environment and Natural Resources site click on either the Yellowknife or Inuvik links above.

The table in Figure 2 works in conjunction with the above link and provides important messaging related to the activities which those people considered being at risk, as well as the general population should consider based on the current AQHI. To learn more about who is considered at risk and why go to: http://www.ec.gc.ca/cas-aqhi/default.asp?lang=En&n=8727DF6F-1

**Figure 1**

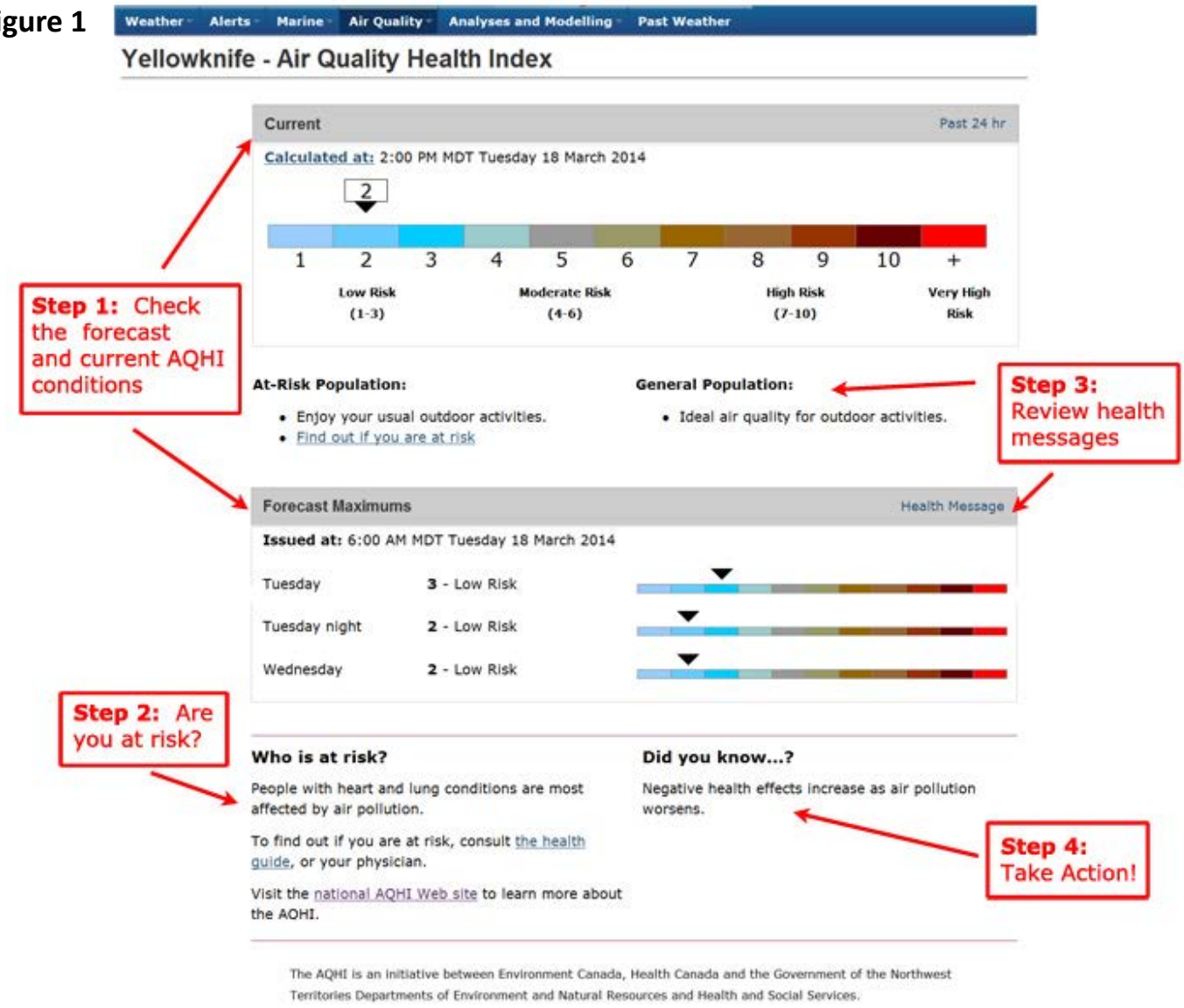


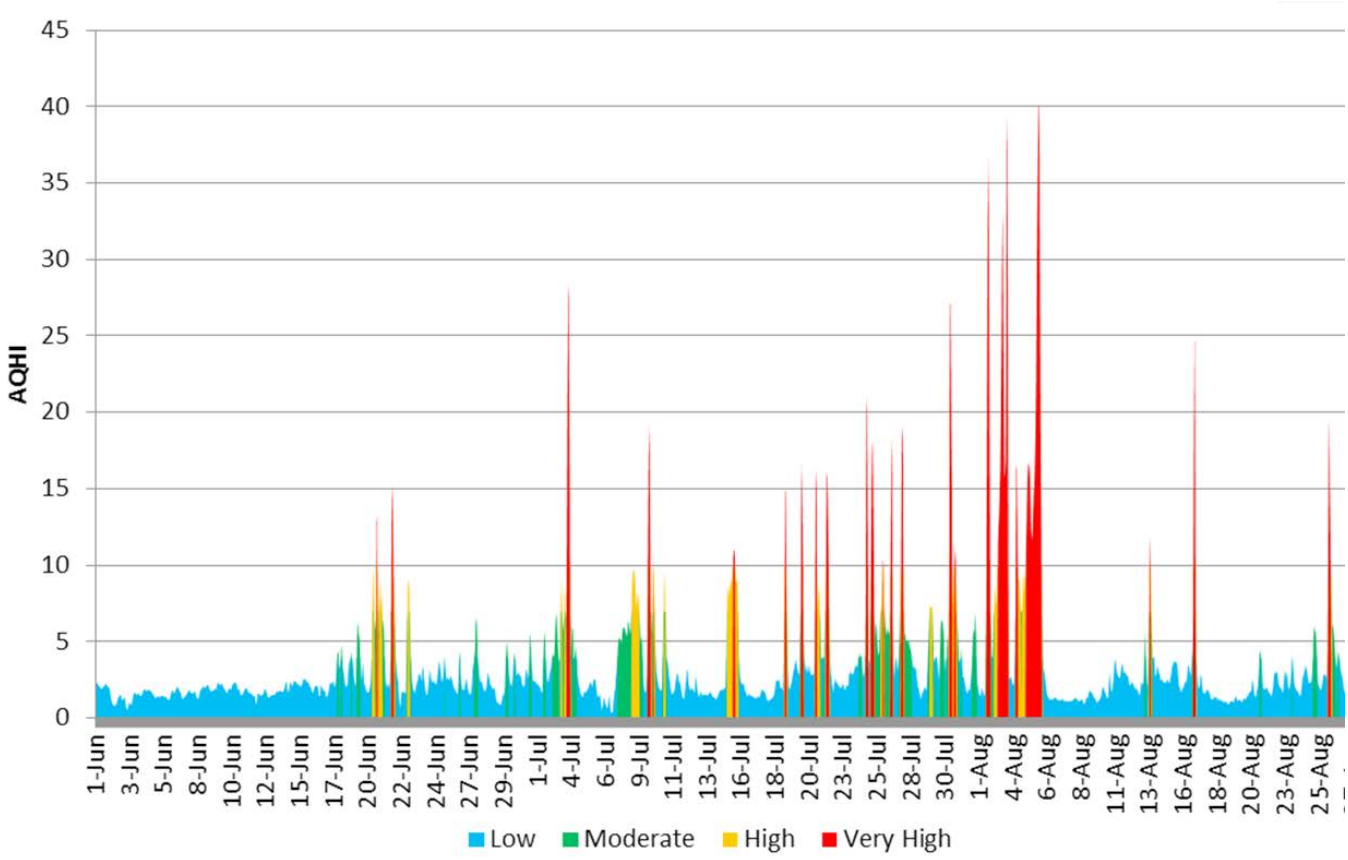

**Figure 2**

## Air Quality Health Index Messages

This table is a summary of air quality health messages by category

| Health Risk | Air Quality Health Index | Health Messages | |
|---|---|---|---|
| | | At Risk Population* | General Population |
| Low Risk | 1-3 | **Enjoy** your usual outdoor activities. | **Ideal** air quality for outdoor activities. |
| Moderate Risk | 4-6 | **Consider reducing** or rescheduling strenuous activities outdoors if you are experiencing symptoms. | **No need to modify** your usual outdoor activities unless you experience symptoms such as coughing and throat irritation. |
| High Risk | 7-10 | **Reduce** or reschedule strenuous activities outdoors. Children and the elderly should also take it easy. | **Consider reducing** or rescheduling strenuous activities outdoors if you experience symptoms such as coughing and throat irritation. |
| Very High Risk | Above 10 | **Avoid** strenuous activities outdoors. Children and the elderly should also avoid outdoor physical exertion. | **Reduce** or reschedule strenuous activities outdoors, especially if you experience symptoms such as coughing and throat irritation. |

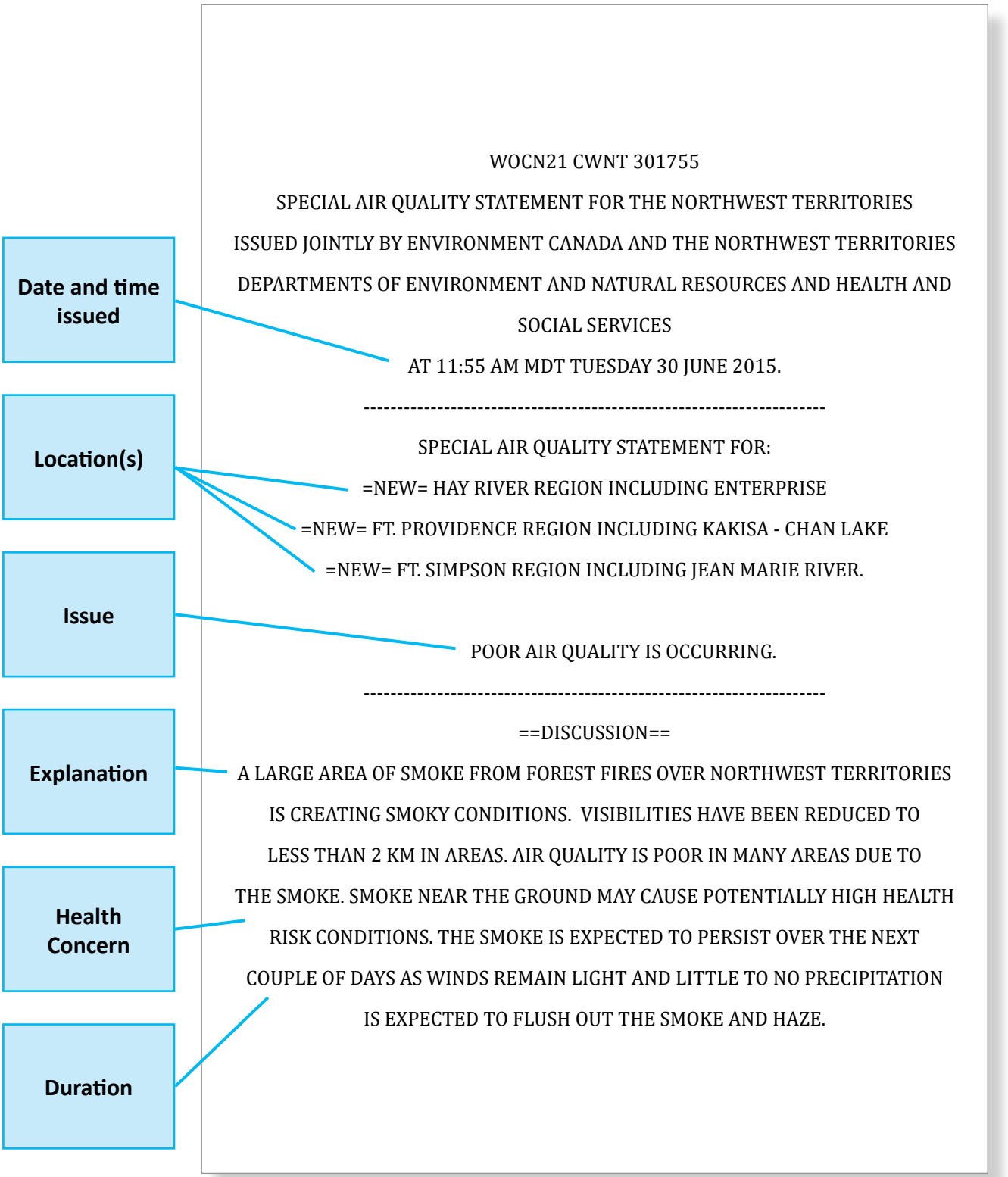
## AQHI readings for Yellowknife during the summer of 2014




Comparing the readings noted above with the chart in figure 1 on the previous page identifies several days that the AQHI reading was beyond the onset of very high risk for public health

### 3-2.2 Special Air Quality Statements

Environment Canada issues Public Alerts for all communities in the NWT jointly with ENR and DHSS. The alerts are presented on the following website (https://weather.gc.ca/warnings/index_e.html?prov=nt) and contain information such as weather and air quality conditions, health messaging, and the predicted duration of the event. Air quality conditions are based on EC weather and smoke forecasting models, and on-the-ground monitoring data. The alerts can be distributed to media outlets and weather applications on wireless devices. The limitation of this tool is that it requires internet access to receive personally, although statements are also picked up and broadcast by media outlets. The statements provide substantial information to assist in making decisions related to air quality. The following is an example of what these statements would look like.


Date and time issued
Location(s)
Issue
Explanation
Health Concern
Duration
WOCN21 CWNT 301755
SPECIAL AIR QUALITY STATEMENT FOR THE NORTHWEST TERRITORIES
ISSUED JOINTLY BY ENVIRONMENT CANADA AND THE NORTHWEST TERRITORIES DEPARTMENTS OF ENVIRONMENT AND NATURAL RESOURCES AND HEALTH AND SOCIAL SERVICES
AT 11:55 AM MDT TUESDAY 30 JUNE 2015.
---
SPECIAL AIR QUALITY STATEMENT FOR:
=NEW= HAY RIVER REGION INCLUDING ENTERPRISE
=NEW= FT. PROVIDENCE REGION INCLUDING KAKISA - CHAN LAKE
=NEW= FT. SIMPSON REGION INCLUDING JEAN MARIE RIVER.
POOR AIR QUALITY IS OCCURRING.
---
==DISCUSSION==
A LARGE AREA OF SMOKE FROM FOREST FIRES OVER NORTHWEST TERRITORIES IS CREATING SMOKY CONDITIONS. VISIBILITIES HAVE BEEN REDUCED TO LESS THAN 2 KM IN AREAS. AIR QUALITY IS POOR IN MANY AREAS DUE TO THE SMOKE. SMOKE NEAR THE GROUND MAY CAUSE POTENTIALLY HIGH HEALTH RISK CONDITIONS. THE SMOKE IS EXPECTED TO PERSIST OVER THE NEXT COUPLE OF DAYS AS WINDS REMAIN LIGHT AND LITTLE TO NO PRECIPITATION IS EXPECTED TO FLUSH OUT THE SMOKE AND HAZE.

### 3-2.3 Landmark Visibility Index

This index has value even in areas that do have continuous monitors, because smoke concentrations can vary widely within short distances and can change rapidly. A visibility index gives a quick, alternative way to estimate smoke levels. Using landmarks at known distances, an experienced observer can provide a reasonable estimate of particulate concentration. It is wise to identify visibility landmarks before they are needed.

The value of the visibility indicator is the ease in using it. The only knowledge required is the distance of certain landmarks from a person's present location to identify an approximate concentration of smoke being experienced. See appendix (C) for some basic measurements in communities throughout the NWT to use as examples.

The following is a guide for estimating particulate levels by using landmark visibility:

**Table 1 Estimating Particulate Matter Concentrations from Visibility Assessment**

| Air Quality Category | Equivalent approx. PM2.5 1- 3-hour average in µg/m3 | Visibility in Km |
|---|---|---|
| Good | 0-40 | 15 kms and up |
| Moderate/Unhealthy for Sensitive Groups | 41-175 | 5-14 kms |
| Unhealthy | 176-300 | 2.5-4 kms |
| Very Unhealthy | 301-500 | 1.5-2 kms |
| Hazardous | over 500 | Less than 1 km |

Adapted from Wildfire Smoke: a guide for public health officials: http://www.arb.ca.gov/smp/progdev/pubeduc/wfgv8.pdf

When estimating particulate matter concentrations visually, it is important to face away from the sun. Determine the limit of your visibility range by looking for landmarks at known distances. The visibility range is the point at which even high-contrast objects totally disappear (ex: a dark building viewed against the sky at noon). Once visibility has been determined in kilometers, use Table 2 (on page 16) to identify suggested health messaging and potential actions based on the air quality category. The visibility index is not effective at night or when humidity is high. A handy one page guide in either english or french is included as Appendix D: Visibility Index Chart.

### 3-2.4 Smartphone app

A smartphone app has been developed for android phones that processes a photo of the skyline, which is evaluated and the user receives a message detailing the pollution levels, including warnings on whether or not that person should head inside. The app can be found at: http://www.treehugger.com/clean-technology/android-app-measures-air-pollution-using-cell-phones-camera.html

## 3-3 HEALTH EFFECTS OF SMOKE

Assessing air quality, health effects and estimated duration of smoke, will help in making informed decisions regarding how to best care for the health of at-risk groups or the general population. It is also important to take into account availability of local services such as access to health care and cleaner air shelters.

Since wildfires are likely to occur in summer, precautions may involve staying indoors with windows and doors sealed. For this reason managing heat may also be required. Exposure to heat can lead to dehydration, exhaustion, heat stroke or other serious illnesses and even death. Fortunately, most heat-related illnesses can be prevented if people understand the causes. For more information about heat related illness, visit http://www.hc-sc.gc.ca/ewh-semt/pubs/climat/heat-adults-chaleur/index-eng.php

## 3-4 DURATION OF SMOKE/WEATHER FORECAST

To support decisions on how to best manage the safety of people exposed to wildfire smoke, determine how long the smoke has been affecting the community, and use weather forecasts to estimate how long it is expected to remain in the area. Consideration must also be given to whether smoke exposure is continuous or intermittent.

### The BlueSky Canada Smoke Forecasting System:

is a collaboration of 11 partners and is operated by the University of British Columbia. “BlueSky” is a software framework developed by the U.S. Forest Service (Larkin et al. 2008) that consists of data and models of fuel consumption, emissions, fire, weather, and dispersion. These are linked together into a single system that produces forecasts of hourly concentrations of PM2.5 from wildfires up to 48 hours into the future. The U.S. BlueSky SFS provides smoke forecasts in various areas throughout the continental U.S.

From April to September, the Western Canada BlueSky Smoke Forecasting System provides an hour-by-hour forecast of smoke from wildfires in Western Canada. However, the output is still considered experimental as the forecast is produced by a system that is an ongoing research project.

For more information on BlueSky or to review the current forecast, visit: www.bcairquality.ca/bluesky/

### The Air Quality Health Index (AQHI):

The AQHI, which is currently available for Yellowknife and Inuvik, is a health risk communication tool which forecasts health risks related to wildfire smoke for the current and following day. The AQHI measures the air quality in relation to your health on a scale from 1 to 10 with over 10 being very high risk, and provides some suggestions on how you might adjust your activity levels to protect yourself when air quality is poor. The site provides a short range forecast, generally up to 24 hours in advance. Internet access is required to use this site.

# 4 | SUPPORT TO THE PUBLIC

## 4-1 RECOMMENDATIONS FOR HEAVY SMOKE

The following table categorizes air quality based on the level of particulate matter and makes recommendations on potential health messages and health team actions for each category.

### Table 2 Recommended Messages and Actions by Air Quality Category during Wildfires

| Air Quality Category | Health Messages At-Risk (Sensitive*) Populations** | Health Messages General Population** | Actions for Health Team** |
|---|---|---|---|
| **Good**<br>Visibility: 15 kms and up<br>1-3 hour average PM2.5 0-40 µg/m3 | Enjoy your usual outdoor activities. | Ideal air quality for outdoor activities | Be aware of forecast (current, daily, tomorrow). |
| **Moderate/ Unhealthy for Sensitive* Groups**<br>Visibility: 5-14 kms<br>1-3 hour average PM2.5 41-175 µg/m3 | Reduce or reschedule prolonged strenuous activities and limit time spent outdoors. | IBe aware of health effects of smoke and related symptoms. | Advise public about: health effects of smoke, related symptoms, and ways to reduce exposure.<br>If the smoke event is projected to be prolonged, evaluate and notify possible cleaner air shelter sites and prepare evacuation plans for at-risk populations. |
| **Unhealthy**<br>Visibility: 2.5-4 kms<br>1-3 hour average PM2.5 176-300 µg/m3 | Avoid prolonged strenuous activities and stay indoors if possible. | Reduce or reschedule prolonged strenuous activities outdoors, especially if you experience symptoms. | Consider cancelling public events, based on public health and travel considerations (ex. number of people, level of physical exertion, etc.) |
| **Very Unhealthy**<br>Visibility: 1.5 -2 kms<br>1-3 hour average PM2.5 301-500 µg/m3 | Avoid all strenuous activities and stay indoors if possible. | Avoid prolonged strenuous activities and stay indoors if possible. | Consider having at-risk populations go to cleaner air shelters in the community. |
| **Hazardous**<br>Visibility: < 1 km<br>1-3 hour average PM2.5 >500 µg/m3 | Avoid all strenuous activities and stay indoors | Avoid all strenuous activities and stay indoors. | Cancel public and outdoor events (ex. competitive sports).<br>At-risk populations go to cleaner air shelters in the community.<br>If smoke event is projected to be prolonged, consider evacuation of at-risk populations. |

Adapted from Wildfire Smoke: a guide for public health official: http://www.arb.ca.gov/smp/progdev/pubeduc/wfgv8.pdf

*Sensitive: People with existing respiratory and cardiovascular conditions, infants and young children, the elderly, pregnant women and possibly other groups (diabetics, smokers and people participating in sports or strenuous work outdoors).

**GENERAL MESSAGE ON WHEN TO SEEK CARE:**
Seek medical care if experiencing symptoms of heart or lung disease. Symptoms of heart or lung disease may include: repeated coughing, shortness of breath or difficulty breathing, wheezing, chest tightness or pain, heart palpitations, unusual fatigue or light-headedness.

** Higher advisory levels automatically incorporate all of the guidance/ recommended actions offered at lower levels of concern.

# 5 | RECOVERY

## 5-1 ASSESSMENT/EVALUATION

When the smoke emergency is over the whole experience should be assessed by the local government emergency management committee, and the health authority's emergency management officer should conduct a review and use it to update emergency plans, if needed. Plan for it, schedule it, and make it a high priority.

- What worked well?
  - Why did it work well?

    This evaluation will assist in determining what tools and processes need to be kept and which ones did not perform.
- What could be improved?

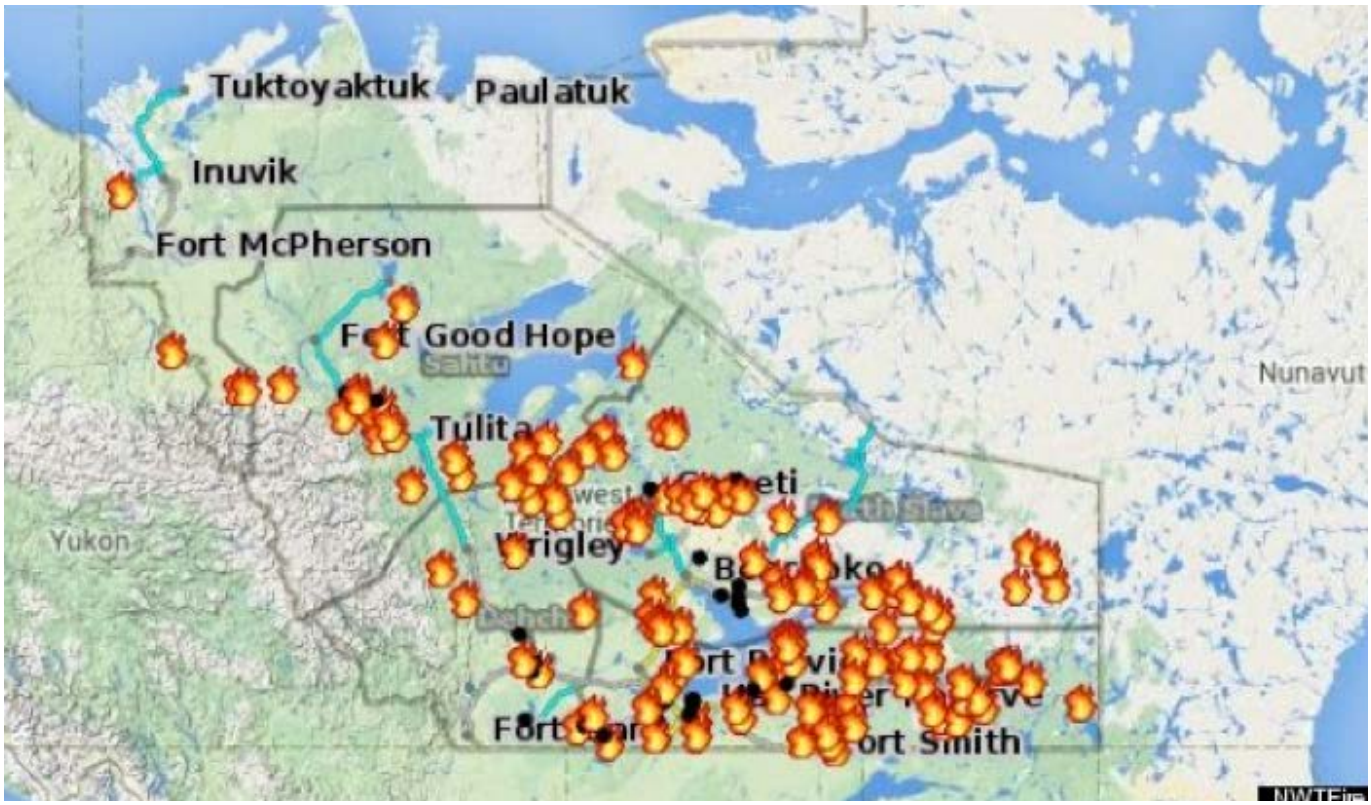
  Communications?

  Forms;  Digital?  Hardcopy?

  Emergency Management Team? Too large? Too small?
- Additional resources?

  What was missed in the plan that had to be added on the spot?
- What did not work well?
  - Why did it not work well?
  - What could have improved it?
- Facilities used
  - General report card on facilities to assist planning

The smoke experience during the summer of 2014 through many communities was worse than had ever been experienced in the NWT previously. The conditions of 2015 were less adverse, but would still be considered extreme. Tools and experiences need to be shared. Lessons learned are important to the development of a territory wide approach to wildfire smoke incidents. Preparing facilities such as cleaner air shelters will be more easily accomplished before an incident requiring its use than during.




NWT Fire Live Map during wildfire season 2015. www.nwtfire.com

# 6 | REFERENCES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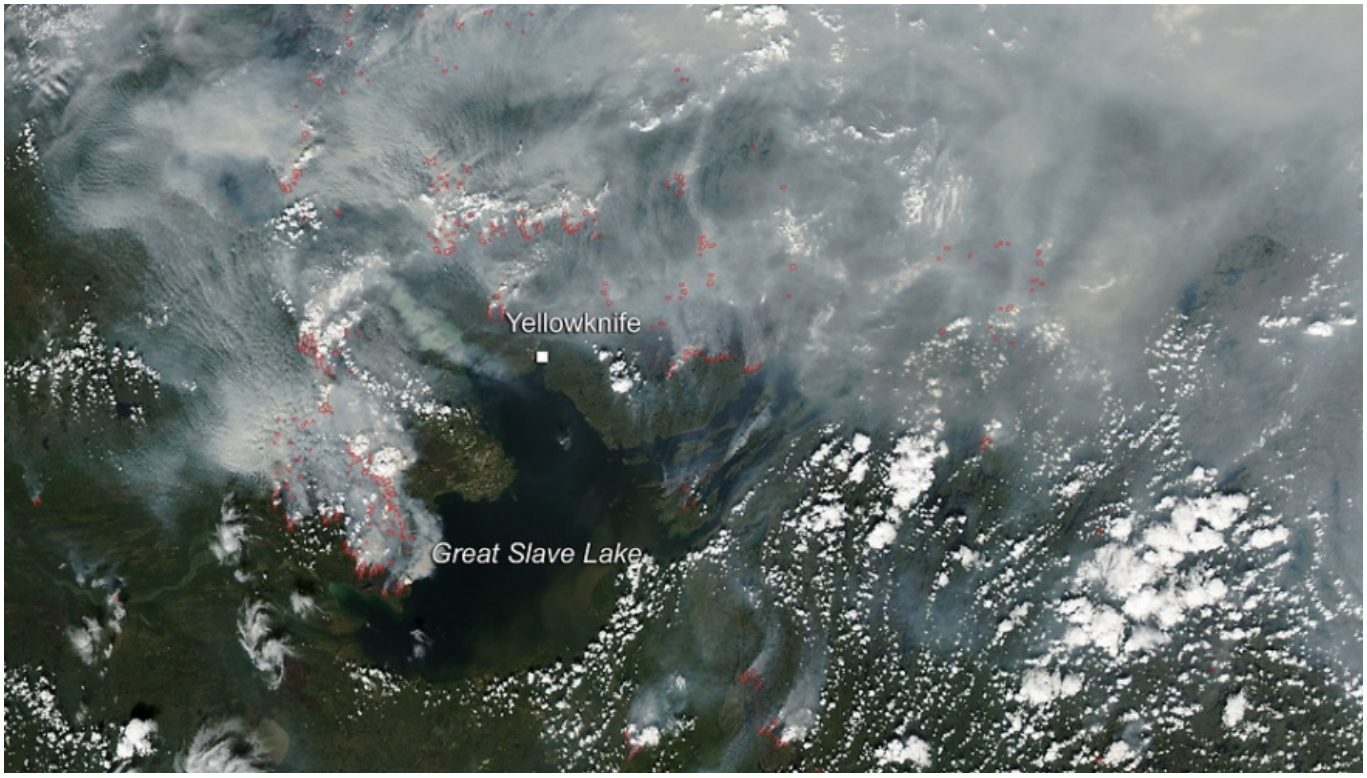
# 7 | APPENDICES

- Appendix A: Identification and Preparation of Cleaner Air Shelters
- Appendix B: Create a Cleaner Air Shelter at Home: Checklist
- Appendix C: Sample air quality visual index distances in communities
- Appendix D: Visibility Index Chart

Fire near Jean Marie River 2015. Photo courtesy of Environment and Natural Resources, GNWT.

# Appendix A | Identification and Preparation of Cleaner Air Shelters




Satellite image of smoke from fires burning in Northwest Territories. Photo courtesy NASA.

Before the wildfire season, community emergency management authorities should identify cleaner air shelters. Cleaner air shelters can provide residents, especially sensitive or vulnerable individuals, with a safe place to get away from smoke. A cleaner air shelter is essentially an airtight location that holds clean air in and prevents polluted air from entering. In some cases, older homes may be poorly sealed and may not adequately protect people when outdoor air leaks inside. Most NWT homes do not have central air conditioning and homeowners rely on open windows and doors for cooling. During summer, when outdoor temperatures are high, people who do not have proper ventilation or cooling may be at risk for heat-related illness such as heat stroke or heat exhaustion.

All of the information provided below was extracted and adapted from the Federal Emergency Management Agency (FEMA 453) document, Chapter 3; Design Guidance for Shelters and Safe Rooms. The FEMA document provides information about the design and construction of shelters for the protection of people against a variety of hazards (explosives, release of toxic substances and natural disasters). Some of the information is highly technical and consultation with a heating, ventilation and air conditioning (HVAC) expert may be needed. The FEMA document does not deal with wildfire smoke, but some information about handling smoke may be adapted from it.

## SELECTION CRITERIA

Table 1 presents criteria for selecting a cleaner air shelter for protection against airborne smoke. Although the protective envelope can be defined as the whole building, a room within the building (safe room) can provide a higher level of protection if it is tighter than the building as a whole or the location of the room is less subject to wind or buoyancy forces that induce infiltration.

### Table 1 Criteria for Selecting a Cleaner Air Shelter

| Criteria | Description |
|---|---|
| Accessibility | The shelter should be located so it can be reached quickly and must be accessible to persons with mobility, cognitive or other disabilities. |
| Size | Identify facilities than can comfortably occupy large groups (could include educational facilities, large commercial buildings, halls or anyplace), preferably facilities with central air conditioning and filtration. |
| Tightness | Newer buildings may be more desirable than older ones. They should have a low rate of air exchange between outdoors and indoors, a minimum number of doors and windows and ceilings should be of solid construction. |
| Heating Ventilating and Air Conditioning (HVAC) | The shelter should be capable of being isolated quickly from the HVAC system so that smoke or fumes do not enter the shelter. Assure that the facility can handle the increased cooling load due to high occupancy. Ductless mini split-type air-conditioner, fully enclosed air-handling unit (only if the unit and its ducts are fully within the cleaner air shelter) can be used. Conventional air conditioning systems must not be operated in the protective mode because the fans introduce outside air. |
| Ventilation | Class 1 shelters (see Table 3): 15 cubic feet per metre (cfm) per person is the desired ventilation rate; however, the minimum ventilation rate is 5 cfm per person if that rate is adequate for pressurization. Class 3 and unventilated Class 2 (see Table 3) shelters are suitable only for short-duration use, not only because the low ventilation rate when occupied can cause carbon dioxide levels to rise, but also because protection diminishes as the time of exposure to the hazard increases. |
| Water and Toilets | Drinking water and a toilet should be available to occupants of a clean air shelter. This may involve the use of bottled water and a portable toilet. |
| Communications | Cleaner air shelters should contain a radio to receive emergency instructions for terminating sheltering. A telephone or cell phone can be used to receive emergency instructions and to communicate with emergency management agencies. |
| Power | Electrical power and lighting are required. Class 1 and Class 2 (see Table 3) Cleaner air shelters require power for the air-filtration units. If power is lost in a Class 1 or Class 2 shelter, it will continue to protect at the level of a Class 3 shelter as long as the room remains sealed. Also consider a building with a backup generator. |

## IDENTIFICATION

Table 2 and Table 3 describe ventilated and unventilated shelters and further categorize them into three classes of shelters. Table 3 provides a description as well as general protection and cost projections, as well as advantages and limitations of each category of cleaner air shelter.

### Table 2 Ventilated and Unventilated Shelters

| Shelter Type | Description | Advantage | Disadvantage |
|---|---|---|---|
| Ventilated Shelter | Can be designed to provide filtered and conditioned fresh air. | May provide filtered and conditioned fresh air. Can be used for a longer period of time. | May be more difficult to find a building with this capability |
| Unventilated Shelter | Tightly sealed room or building. | Any room or building can be turned into an unventilated shelter. | Cannot be occupied for long periods of time. Shelter is never perfectly tight and may have leakage paths. |

### Table 3 Categories of Shelters: Class 1, 2, 3

| Shelter Class | Description | Protection | Cost | Advantage | Limitations |
|---|---|---|---|---|---|
| CLASS 1 Ventilated and pressurized with filtered air | Air is drawn from outside the room, filtered and discharged inside the room at a rate sufficient to produce an internal pressure. The clean air shelter is ventilated with filtered air and the internal pressure produced with filtered air prevents infiltration of outside air | HIGH | HIGH | Protection has no time limits; Eliminates accumulation of carbon dioxide ($CO_2$) | It provides no protection against some toxic chemicals of high vapour pressure |
| CLASS 2 Filtration with little or no pressurization | Includes air filtration, but with little or no internal pressure. Without positive pressure, the cleaner air shelter does not prevent the infiltration of contaminated air.<br>Class 2 unventilated: air is drawn from inside the cleaner air shelter, filtered, and discharged inside it.<br>Class 2 ventilated: air is drawn from outside but at a flow rate too small to create a measurable differential pressure. | MED | MED | Protective against all gases | Protection diminishes with duration of exposure (and against non-filterable gases) |
| CLASS 3 Unventilated, no filtration | Derives protection only by retained clean air within its tight enclosure. | LOW | LOW | Protective against all agents;<br>No air-filtering capability and is unventilated. | Protection diminishes with time of exposure; $CO_2$ build-up may limit time in the shelter. |

### High-efficiency air filtration

The protection a cleaner air shelter provides can be increased substantially by adding high-efficiency air filtration. Filtration may remove contaminants from the shelter as it enters the cleaner air shelter or remove contaminants as air is circulated within the room. With a filtration system drawing outside air, the level of protection the shelter provides is a function of the filter efficiency. It is important to recognize that increasing the efficiency of the filter will add stress to the system overall because of the added pressure needed to force the air through the new filter. All filters have limited service life. In operation, a HEPA filter loads with dust and other particulate to increase the resistance to flow.

Commercial filter units that are designed for indoor air quality can be used in an unventilated Class 2 Cleaner air shelter. There are many different models available from several manufacturers; however, the filtering performance varies over a wide range. The HEPA filter element provides protection against liquid and solid aerosols such as those found in smoke, while the adsorber element protects against gases and vapours.

## PREPARATION

After the room or location for the cleaner air shelter has been decided based on the criteria listed in Tables 1-3 above, the first decision is to determine the class of cleaner air shelter. Details for preparation and maintenance for the three classes of cleaner air shelters are presented below.

### CLASS 3 Cleaner air shelter

Features of the Class 3 cleaner air shelter can be either permanent or expedient. Guidance for preparing the cleaner air shelter is presented below.

### Checklist for preparing both Class 2 and 3 Cleaner air shelters

☐ Ceiling/Floor:
Temporarily seal baseboards by removing them and applying foam sealant in the gap at the floor-to-wall juncture or use caulk to seal the top and bottom of baseboards and quarter rounds. Electric baseboard heaters could be temporarily removed to seal the wiring penetrations and the gap at the floor-to-wall juncture.

☐ Pipes/Conduits/ Cables:
Seal penetrations using caulk, foam sealants, or duct seal by placing weather-stripping.

☐ Doors:
During the event, door sweeps or duct tape can be used to seal the gap beneath the door temporarily.

☐ Windows:
If older windows, reduce leakage by measures such as taping plastic sheeting over them.

☐ Electrical outlets and switches:
Expanding foam can be used or ready-made outlet sealers can be used to seal gaps behind switches and outlets.

☐ Ducts for supply, return, and exhaust:
Temporarily closing the ducts to the clean air by placing duct tape or contact paper over the supply, return, and exhaust grilles. Automatic dampers or hinged covers can be custom-made of sheet metal or wood, to be attached above or beside the opening for all applications except the door periphery.

☐ Fans:
Some shelter systems have been designed with the capability of automatically deactivating all fans in the building with a single switch. The low-cost alternative to automatic fan shutoff is to record on a checklist the location of switches for all fans in the building.

☐ Air conditioning:
Cover window-type or through-the-wall air conditioner with plastic sheeting and tape over the inside of the window and/or air conditioner.

### Maintenance for a Class 3 Cleaner air shelter

The Class 3 cleaner air shelter has no air filtration equipment and, therefore, requires little or no routine maintenance. It has no mechanical equipment unless there are dampers for isolating the air conditioner. Maintenance requirements are limited to periodically checking supplies for deterioration or loss.

## CLASS 2 Cleaner air shelter

The design details of the enclosure presented above also apply to the Class 2 cleaner air shelters (ventilated and unventilated).

### Unventilated Class 2 Cleaner air shelter

For the unventilated Class 2 cleaner air shelter, the improvement in protection over the Class 3 cleaner air shelter is determined by the flow rate and the efficiency of the particulate filter (also known as air purifiers, indoor air cleaners, or indoor air quality units) for aerosols and the efficiency of the adsorber for gases and vapours. These filter units re-circulate air within the cleaner air shelter. There are four configurations: free-standing table top unit, free-standing floor unit, ceiling-mounted unit, and duct-mounted unit.

The protection provided by an unventilated Class 2 cleaner air shelter is determined by the clean-air delivery rate of the filter unit and the tightness of the enclosure. The clean-air delivery rate is a product of the filter removal efficiency (expressed as a decimal fraction) and the actual flow rate of the filter unit. If a high-efficiency filter unit is used, the clean-air delivery rate approaches the actual flow rate of the unit.

For the unventilated cleaner air shelter, floor/table model filter units and ceiling-mounted models should be placed in the center of the room to maximize air mixing. There should be no obstruction to the airflow into and out of the filter units. Duct-mounted models must conform to the requirements stated below. Ducts cannot be outside the envelope formed by the walls, ceiling, and floor.

1. The filter unit must have both an adsorber containing activated carbon and a particulate filter. The adsorber must have at least one pound of activated carbon for each 20 cfm of flow rate. For example, a 200-cfm unit requires at least 10 pounds of carbon adsorbent.
2. The particulate filter must have an efficiency of at least 99 per cent against one-micron particulate.
3. The unit(s) must provide a total clean-air delivery rate of at least one cfm per square foot of floor area.
4. The adsorber must have the capability for chemisorption (removal of gases that are not removed by physical adsorption).

### Ventilated Class 2 Cleaner air shelter

These are shelters for which the filter unit has inadequate capacity to produce a measurable overpressure with the size of the selected cleaner air shelter. In essence, the filter units are overrated by the filter unit manufacturer. Generally, if a filter unit capacity in cfm is less than one-fourth the area of the selected cleaner air shelter, depending on the type of construction, it will not produce a measurable overpressure. Matching the filter unit capacity to cleaner air shelter size for Class 1 (pressurized) cleaner air shelters is addressed later in this document.

### Maintenance for a Class 2 Cleaner air shelter

The filter unit used in a Class 2 cleaner air shelter is an indoor air quality filter unit and, as such, it can be used routinely to improve the air quality in the spaces in or around the designated cleaner air shelter. A spare filter set, both adsorber and HEPA filter, should be stored in a sealed bag in the clean air shelter along with instructions and any tools needed for changing the filter quickly in an emergency.

## CLASS 1 Cleaner air shelter

Designing and installing a ventilated cleaner air shelter is much more complex than an unventilated cleaner air shelter, particularly with regard to the filter unit. Pressurization requires introducing air from outside the protective enclosure; therefore, the removal efficiency of the filters is more critical in determining the protection provided. The system must employ ultra-high efficiency filters, and it must allow no air to bypass the filter as it is forced into the safe room.

Operating procedures for Class 1 cleaner air shelters are similar to those of Classes 2 and 3. The system is turned on immediately upon receipt of a warning. Tape, plastic, and carbon dioxide detectors are not necessary in the Class 1 cleaner air shelter.

### Selecting a Filter Unit for a Class 1 Cleaner air shelter

Generally, filter units available commercially are not designed to standards that ensure protection against highly toxic chemical, biological, and radiological materials. The ideal requirement is a certified filter unit that has both a HEPA filter and an ultra-high-efficiency gas absorber in series. To protect against very fine particulate, a Class 1 system requires ultra high-efficiency filtration, at least 99.999 percent removal in a single pass. HEPA filters, which are defined as having at least 99.97 percent efficiency against the most penetrating particulate size (about 0.3 micron), have efficiencies greater than 99.999 percent against aerosols of 1 to 10 micron size.

## Sizing the Filter Unit for Pressurization

If a filter unit is undersized (provides inadequate flow for pressurization), the result is substantially lower protection factors and the system becomes a ventilated Class 2 cleaner air shelter. Filter unit(s) must be sized to provide makeup air at a flow rate sufficient to produce a pressure of at least 0.1 inch water gauge (iwg) in the shelter. The airflow rate needed to achieve this pressure in a cleaner air shelter varies with the size and construction of the cleaner air shelter. For cleaner air shelters of frame construction and standard ceiling height, most can be pressurized to 0.1 iwg with airflow in the range of 0.5 to 1 cfm per square foot.

## Maintenance for a Class 1 Cleaner air shelter

Maintenance of the Class 1 cleaner air shelter consists primarily of serviceability checks and replacing filters. Serviceability checks should be performed about every two months by turning the system on and checking for the following while it is operating:

## Checklist for maintenance of a Class 1 Cleaner air shelter

☐ System pressure:
The system pressure is indicated by a gauge typically mounted on the control panel, with the correct operating range marked on the gauge.

☐ Isolation dampers:
Correct damper positioning is indicated by damper status lights on the control panel.

☐ Relief damper:
It should be visually inspected while the system is operating. A properly functioning relief damper should be open when the cleaner air shelter is pressurized, and it should close immediately when a door is opened into the cleaner air shelter, releasing pressure.

☐ Cooling system:
If the cleaner air shelter supply air is cooled and heated, the temperature of the air flowing from the supply register should be checked with a thermometer during serviceability checks.

☐ Door latches:
All doors into the cleaner air shelter should be adjusted to latch automatically with the force of the door closer. For cleaner air shelters with multiple doors, leakage past unlatched doors can cause internal pressure to fall below the specified operating range.

☐ Weather stripping:
The weather stripping on each door on the boundary of the cleaner air shelter should be visually inspected to ensure it has not been removed or damaged through wear and tear. For wipe seals at the bottom of the door, the alignment and height of the seal above the floor should be inspected and adjusted as necessary.

☐ Filters:
Routine maintenance includes replacing filters. If a canister-type filter is used, it is replaced as a unit at its expiration date. For other types of filter units, three types of filters are replaced: the pre-filter, HEPA filter, and carbon adsorber. Ideally, with only intermittent operation, all three types of filters should be replaced at the same time, every three to four years. This period is defined mainly by the service life of the adsorber. A spare filter set should be stored in a sealed bag in the clean air shelter along with instructions and any tools needed for changing the filter quickly in an emergency.

Yellowknife, August 2, 2014 AQHI=18. Photo courtesy of Matthew Seaboyer.

# Appendix B | Create a Cleaner Air Shelter at Home: Checklist

Sheltering in place, at home, is basically the same as the Class 3 clean air shelter. Air will tend to move from areas of high pressure to areas of low pressure through any opening. The goal is to seal in the good air by closing the gaps and avoiding bringing in the bad air. The pressure differences that come from wind and temperature are hard to control, but any appliance that actively removes air from the home will create a negative pressure that will pull in outside air and should therefore not be used.

- ☐ Close all windows and doors: The effectiveness of the seals can be checked by determining whether air moves through at the edges. This movement of air may be seen by observing the path of a small puff of smoke such as from a match or by observing the movement of a small strip of paper or plastic.
- ☐ For extra protection, apply tape to the periphery of the door, unless there are good weather seals on the door.
- ☐ Do not operate exhaust fans, window air conditioners, clothes dryer vented outside or combustion heaters in the home. The air conditioner or central air conditioning system, if you have one, may be considered when necessary. If the air conditioner provides a fresh air option, keep the fresh–air intake closed to prevent smoke from getting inside. Make sure the filter is clean enough to allow good air flow indoors.
- ☐ If there is no telephone in the cleaner air shelter, take a cell phone or portable phone into the cleaner air shelter for emergency communications.
- ☐ Turn on a radio or TV in the cleaner air shelter and listen for emergency information.
- ☐ If your home has a carbon monoxide detector, monitor it, particularly if the time in the sealed cleaner air shelter exceeds one hour.
- ☐ Consider the size of the home, the number of occupants and the time spent in the shelter. The shelter may feel stuffy as the carbon dioxide exhaled by the shelter occupants may build up over time and cause discomfort.
- ☐ If it is too warm to stay inside with the windows closed, or if you are very sensitive to smoke, seek shelter elsewhere.
- ☐ Do not smoke in the house.
- ☐ Do not burn anything such as wood stoves, gas stoves or candles anywhere in the house.
- ☐ If you have room air cleaners with HEPA filters, turn them on.
- ☐ Keep in mind that many particulate and other pollutants may enter your home even if you take all these steps.
- ☐ When air quality improves, even temporarily, residents should air out their homes. Clean by using a damp cloth or mop to pick up settled particulate and vacuum preferably with a HEPA filter-equipped vacuum.

### Supplies for the cleaner air shelter:

- ☐ rolls of duct tape for sealing doors and securing plastic over vents and windows
- ☐ pre-cut plastic sheeting to fit over supply and return vents (also for windows if they are judged to be less than airtight)
- ☐ battery operated radio with spare batteries
- ☐ flashlight with spare batteries
- ☐ drinking water
- ☐ first aid kit
- ☐ telephone (cell phone) for emergency instructions

# Appendix C | Sample air quality visibility index distances in communities

The following examples were created to provide a sampling of what each community might use as visibility landmarks. While the distances are accurate the information was retrieved from a mapping program that does not include elevations. You may not physically be able to see from the first point to the second.

### Aklavik
- From the front of the Health Centre to the channel across the river is about 1km
- From the Community office building to the elbow of the river is about 1km

### Behchokǫ̀
- From the 4 way stop by the health centre to the corner of the access road is 1.2km
- From Arnie's point across the water to the nearest point is 1.8km
- From the tip of the island across the water is 1km

### Colville Lake
- The old airstrip is.9km long

### Deline
- The airstrip is .8km long (1)
- From the main dock to the road at the west end shore is just less than 1km (2)

### Dettah
- From ice road launch to far shore of Yellowknife Bay is 2.7km

### Enterprise
- The straight stretch of the main highway passing from south of the built up area thru the Hay River side of the intersection is 1km

### Fort Good Hope
- From the 3 way intersection to the intersection by the northern store is .75km
- From the road beside the northern store to the other side of the river is 1.6km

### Fort Liard
- The runway is 1km
- Main street from the motel intersection to Caragana Road is 1km

### Fort McPherson
- From the Hamlet Office to the opposite side of the river is 1.2km
- From the Health Centre to the opposite side of the river is just over 1.1km
- From the Health Centre the length of the road on the straight north is 1km

### Fort Providence
- From the motel to the island is .5 km
- Road to other side of river north of island is 1.3km

### Fort Resolution
- The runway is 1.3km long

### Fort Simpson
- Main road straightaway hru town is 1.2km
- In town airstrip runway is 1km

### Fort Smith
- Breynat st is 1km long (.6km from hospital intersection north)
- Runway is 1.9km

### Gamètì
- Straight stretch on main road is 1.3km
- Runway is 1km long

### Hay River
- Runway is 1.9km
- Main road straight stretch is 2.7km long

### Hay River Reserve (K'atlodeechee First Nation)
- The main street straightaway is .8km (Dene Village Road)

### Inuvik
- From the hospital to the far side of the excavation to the east is .9km
- The runway is 2km
- The Navy Road straightaway is 3km long

Fire burning near Whati July 24, 2014. *Photo courtesy of Environment and Natural Resources, GNWT.*

### Jean Marie River
- The runway is .8km long
- Across the river from the edge of the community is .85km

### Kakisa
- Straight run of road through community is .6km
- extended to far side of river is 1.1km

### Łutselk'e
- the airstrip is 1.1km
- from shore across to point on lake is 1.2km

### Nahanni Butte
- from shore across to point is 1.2km
- airstrip is 1km long

### Norman Wells
- runway is 1.9km long
- river access point to river access point is 1.5km

### Paulatuk
- airstrip is 1.4km long
- shore to shore is 2.2km

### Sachs Harbour
- the airstrip is 1.3km long
- from the point at the center of the community to the next point looking east is 1.6km

### Trout Lake
- the airstrip is .9km long
- from the front of the arbour to the turn in the road is .7km

### Tssighetchic
- building on shore near delta of Arctic Red River to access across Mackenzie River is 1.5km

### Tuktoyaktuk
- from reindeer point across channel is 2.3km
- across Kugmalit Bay is 1.1km
- airstrip is 1.7km long

### Tulita
- airstrip is 1.2km long
- straightaway in front of R.D. Clement Building is .4km
- kitty corner across river is 4km

### Ulukhaktok
- The airstrip is 1.4km long
- From shore to the edge of the cove is 1.2km

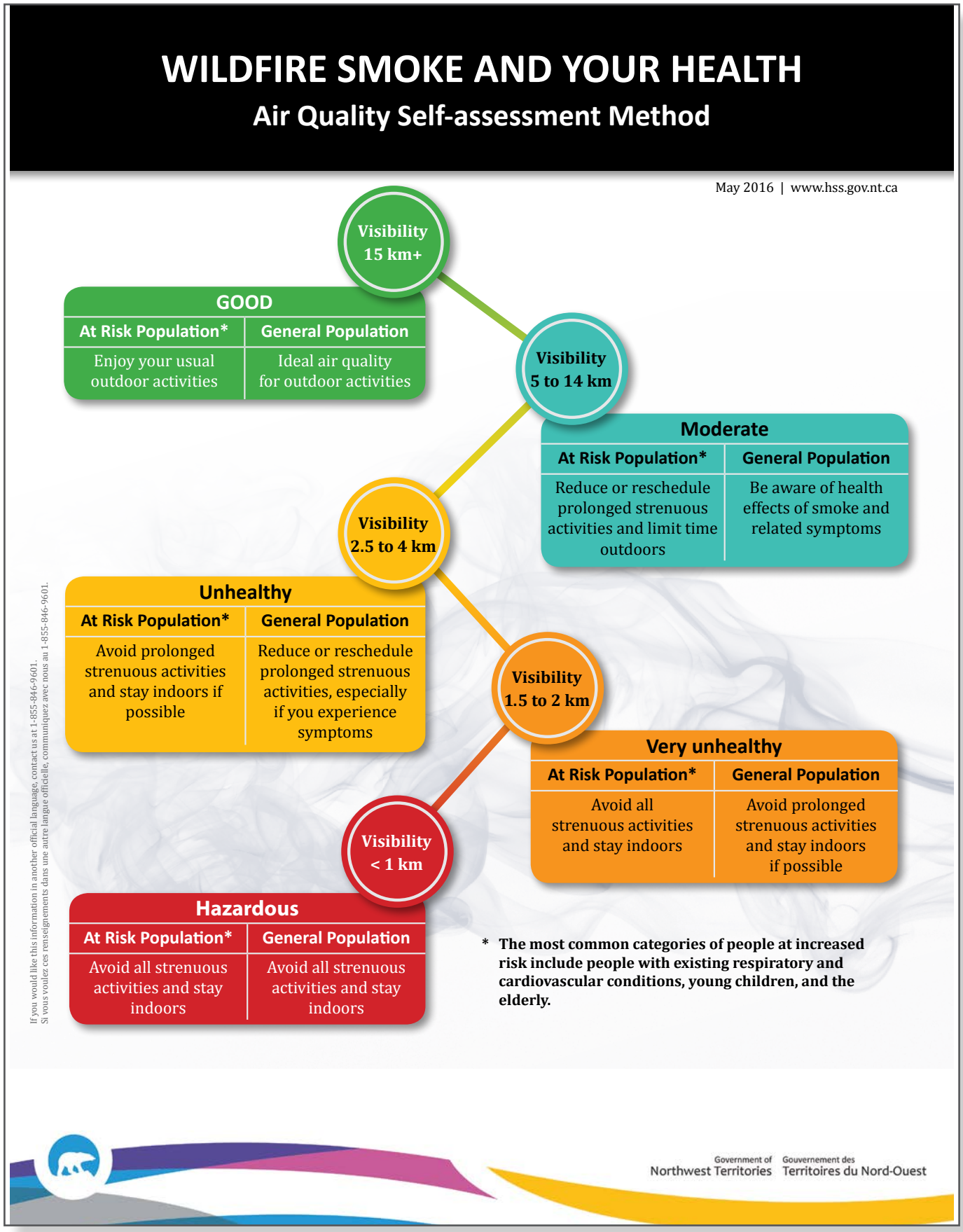
### Wekweètì
- The hotel to the airstrip is 4.6km
- The airstrip is 1.1km long

### Whatì
- The airstrip is 1.1km long
- From the point on lac la marte due south is 1.8km

### Wrigley
- From the Mackenzie highway to far shore of Mackenzie River is 1.5km
- The airstrip is 1.1km long
- The Mackenzie Highway from one end of Wrigley to the other is 1.1 km

### Yellowknife
- Franklin Avenue from 48street to Matonabee Road is .7km
- From city hall to Arctic Sunwest Hangar is 2.3km
- From New Office Building to Dump is 2.2km
- From Center Square Tower to Robertson Headframe is 2.3km
- Long runway is 2.2km long

# Appendix D | Visibility Index Chart



If you would like this information in another official language, call us.
English

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Si vous voulez ces informations en français, contactez-nous.
French

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Kīspin ki nitawihtīn ē nīhīyawihk ōma ācimōwin, tipwāsinān.
Cree

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Tłı̨chǫ yatı k’ę̀ę̀. Dı wegodı newǫ dè, gots’o gonede.
Tłı̨chǫ

---

ʔerıhtł’ís Dëne Sųłıné yatı t’a huts’elkër xa beyáyatı theɔ́ą ɔ́at’e, nuwe ts’ën yółtı.
Chipewyan

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Edı gondı dehgáh got’ı̨e zhatıé k’ę́ę́ edatł’éh enahddhę nıde naxets’ę́ edahłí.
South Slavey

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K’áhshó got’ı̨ne xədə k’é hederı ɔedı̨htl’é yerınıwę nídé dúle.
North Slavey

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Jii gwandak izhii ginjìk vat’atr’ijąhch’uu zhit yinohthan jì’, diits’àt ginohkhìi.
Gwich’in

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Uvanittuaq ilitchurisukupku Inuvialuktun, ququaqluta.
Inuvialuktun

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ᑲᑲᓂᐊ ᑎᑎᕃᑲᐃᑦ ᐱᕐᒪᔪᐃᕈᑦ ᐃᓄᒃᑎᑐᑦᓯᓕᓗᑎᒃ, ᐅᕙᑦᑎᓐᓄᓂᑦ ᐅᕃᑲᓕᕐᓇᖅᑐᑎᑦ.
Inuktitut

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Hapkua titiqqat pijumagupkit Inuinnaqtun, uvaptinnut hivajarlutit.
Inuinnaqtun

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