Science 9

Air Pollution, Asthma & Allergies

Abstract

Through activities, students learn about air pollution, its impacts on asthma and allergies, and simple steps people can take in their daily lives to reduce air pollution.

Logistics

Time Required

- **Class Time:** One 50 - 60 minute class to complete Parts A & B.
  Extensions will take additional time.
- **Prep Time:** 20 minutes

Materials – Part A

- Teacher Answer Key – Respiratory System

Materials – Part B

- Asthma Fact Sheet
- Air Pollutants & Sources Information Sheet (one per class)
- Air Pollution Solutions Activity (one per class)
- Air Pollutant Sources & Solutions Table Worksheet (one per student)
- Teacher Answer Key – Air Pollution Sources & Solutions Table (one per class)
- Air Quality Health Index Card
- 8 pairs scissors; 8 glue sticks; 8 differently coloured sheets of 8.5” x 14” paper

Classroom Requirements

- Projector display connected to computer with Internet access

Learning Objectives

- Understand the respiratory system and the connection to the air we breathe.
- Understand asthma and the connection between air quality and health.
- Identify air pollution sources, and actions to help ensure a healthier environment and to promote healthier lifestyles.
- Identify resources that can assist students in protecting their health.

Prescribed Learning Outcomes, B.C. Curriculum

- Perform experiments using the scientific method.
- Represent and interpret information in graphic form.
- Demonstrate scientific literacy.
- Demonstrate safe procedures.
- Demonstrate ethical, responsible, cooperative behavior.
- Describe the relationship between scientific principles and technology.
- Demonstrate competence in the use of technologies specific to investigative procedures and research.
- Relate electrical energy to power consumption.

Preparation

1. Assemble necessary materials.

    a. Cut out and post around the room the seven types of air pollutants from the **Air Pollutants & Sources Information Sheet**. Below each source, post a large blank sheet of 8.5" x 14" paper.
    b. Cut out the eight solutions from **Air Pollution Solutions Activity**.

Classroom Implementation – Part A

Students will express their understanding of the respiratory system.

1. Begin a discussion with students about the respiratory system using the following questions as a guide (style of discussion is up to the instructor):

    a. What is the function of the respiratory system?

    The primary function of the respiratory system is to supply our blood with oxygen. The cardiovascular system then delivers the oxygen to all parts of the body. The respiratory system does this through breathing. When we breathe, we inhale oxygen, and we exhale carbon dioxide.

    b. What are some of the things that can impact the health of our lungs?

    Inactive lifestyles, smoking, air pollution, inhaling toxic substances, and diseases.

    Refer to the **Teacher Answer Key – Respiratory System** for more information.

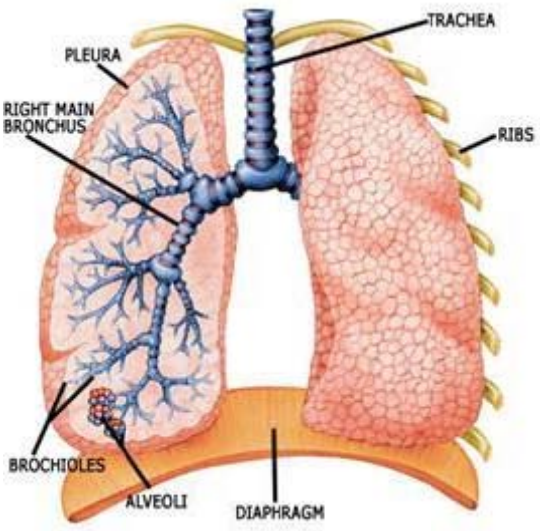
Materials – Part A

Teacher Answer Key - Respiratory System

Breathing is the process by which oxygen in the air is brought into the lungs. The blood absorbs the oxygen and carries it to all parts of the body. At the same time, the blood gives up waste matter (carbon dioxide), which is carried out of the lungs with the air breathed out.

When we breathe in (inhale) through our nose and mouth, air travels down our trachea (windpipe) and into our lungs through the left and right bronchi. Each bronchus splits into smaller bronchioles and then leads to small sacs called alveoli.

It is in the alveoli that the oxygen-rich air we have inhaled is absorbed into our blood. In the blood, the oxygen is carried to the heart and is then pumped to the trillions of cells throughout our body. Our cells use the oxygen to make energy and then release carbon dioxide (CO_2), a waste product that is removed from the body as we exhale.



Classroom Implementation – Part B

Students will investigate sources of air pollution, pollutants, and ways to reduce pollution.

1. Present information on asthma to students using the **Asthma Fact Sheet**. Share the following facts about asthma:
   a. Three million Canadians suffer from asthma.
   b. Asthma is the most common chronic respiratory disease of children and young adults.
   c. 60% of people with asthma do not have their asthma under control.
   d. Despite the progress made, approximately 20 children and 500 adults die from asthma each year in Canada.

   Sources: Asthma Society of Canada; Statistics Canada, Health Reports, Vol. 16: No. 2, March 2005.

2. The students will now take part in an activity that will investigate seven different types of air pollutants, (identified in the **Air Pollutants & Sources Information Sheet** and previously posted around the room) the sources of those pollutants, and what we can do to reduce this air pollution. The best way to protect our health is to reduce the amount of air pollution that is created and to minimize our exposure to it. Students will explore eight possible solutions.
3. Divide students into eight groups. Give each group one of the solutions from the **Air Pollution Solutions Activity** and have the group read the information on their solution.
4. Provide each group with a different coloured 8.5" x 14" sheet of paper. Ask the group to cut the paper into eight sections and then write the name of their solution (e.g. walking) on each section.
5. Provide each of the groups with a glue stick.
6. When groups are ready, assign an air pollutant to each group (two groups will have to be assigned to the same station). Tell students they will hear a sound when it is time for them to rotate to the next station. Indicate whether they will rotate clockwise or counter clockwise.
7. Give the groups 15 to 20 minutes to rotate through the seven air pollutant stations, with two to three minutes at each station to discuss how their solution may reduce emissions of the pollutant. Direct students to glue their solution to whichever pollutants they feel would be positively impacted. Use a noisemaker to indicate the time to move to the next station.
8. After the groups have been through all the stations, distribute a copy of **Air Pollutant Sources & Solutions Table Worksheet** to each student. They will now rotate through the stations a second time to fill in their tables with solutions listed under each pollutant.
9. After the groups rotate through each station and complete their individual tables, have them complete the questions at the bottom of the worksheet.
10. Finally, review and discuss their answers to the table questions. Make use of the **Teacher Answer Key – Air Pollution Sources & Solutions Table** during the discussion.

11. Ask students to identify challenges they may have in incorporating active solutions into their daily lives. Have them brainstorm ways they could overcome these challenges.
12. Consider making a display using the **Air Pollutants & Solutions Table** to help educate others about air pollution, health impacts, and solutions for reducing air pollution.
13. Tell students that since air quality can affect out health, it's important to have accessible information on current air quality conditions. Using the Internet and LCD projector or SMART Board, showcase the **Air Quality Health Index** (AQHI) website: http://www.bcairquality.ca/readings/
14. Discuss why the AQHI rating is the number it is today. Discuss how the AQHI number might be related to today's weather. When could the AQHI rating be higher? Discuss what the AQHI measures, how the scale works, who is most at risk and how the AQHI forecast can help when planning activities.
15. Post an Air Quality Health Index banner in your classroom, available at the end of this lesson or at http://www.bcairquality.ca/readings/ or at www.airhealth.ca. Update the AQHI rating daily or give this responsibility to students.

Materials – Part B

Asthma Fact Sheet

air aware
getting active for cleaner air

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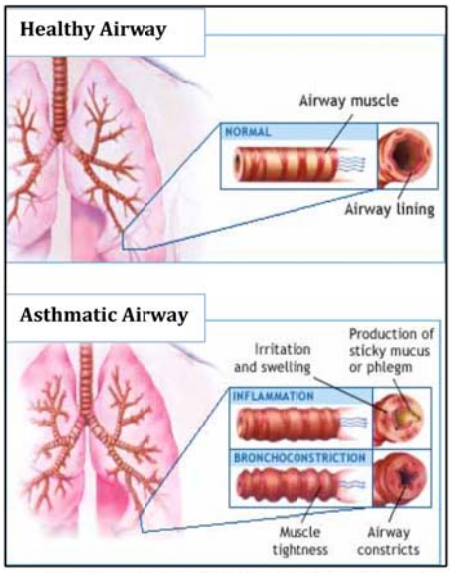
Asthma

What is Asthma?
Asthma is a chronic inflammatory disease of the airways – the small tubes that carry air in and out of the lungs. The short story is that having asthma makes it harder to breathe. The long story is that it can be challenging to manage and it significantly impacts the quality of life for many Canadians. In rare cases an asthma attack can be fatal. The good news is that asthma can be treated.

Asthma is caused by swelling and inflammation of the airway lining. Increased mucus production and tightening of muscles around the airways blocks the flow of air through the lungs. In people with asthma, the lining of the airways is more sensitive to things such as cold air, exercise, and allergens, which can cause asthma attacks.



Images courtesy of Asthma Society of Canada

What are the symptoms?
When someone is suffering from asthma, their symptoms could include:

- Shortness of breath
- Tightness in the chest
- Coughing
- Wheezing

Asthma symptoms can be very unpredictable, which can create challenges for those learning to control them. Symptoms may vary over time and will vary from person to person. The severity of episodes can fluctuate from mild to moderate or severe.

Who gets it and why?
Anyone can develop asthma at any age, though it is most often diagnosed in children and youth.

The causes are not well understood although asthma can run in families (i.e. have a genetic connection), and is often associated with allergies. Environmental factors may also play a role in some cases, with repeated exposures to certain substances or pollutants believed to cause asthma in some individuals.

What triggers an attack?
While triggers will be different for every person, most people with asthma will be triggered by at least one of the following:

- Air pollutants
- Animals
- Cold temperatures
- Dust mites
- Exercise
- Mould
- Pollen
- Stress/anxiety
- Tobacco smoke
- Viral infections

The Top 10 Asthma Myths*

1. Asthma is all in your head.
2. Asthma can be cured.
3. Everyone who has asthma is the same.
4. I only have asthma when I have trouble breathing.
5. I only need to take my medication when I have trouble breathing.
6. I can stop taking my controller medication as soon as I feel better.
7. My child will outgrow her asthma.
8. Steroids are dangerous, so I do not want my child taking them.
9. Steroids will stunt my child's growth.
10. If I have asthma, I have to avoid sports and physical activity.

*Courtesy of National Asthma Patients

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Controlling asthma

Asthma is controlled best through a combination of asthma medications and good lifestyle choices like healthy diet, adequate rest, and keeping a lid on stress. Doctors and certified asthma educators will work with patients suffering from asthma to develop a customized asthma action plan (AAP). The AAP describes when to increase or decrease medications, and when to seek emergency help.

Successful asthma control means:

- No daytime symptoms
- No nighttime symptoms
- No need to use reliever medication more than 4 times in a week
- No school or work absenteeism due to asthma
- Normal breathing tests

Asthma and allergy

People with asthma may also have allergies that make their asthma worse. For people with both conditions, effective management of allergies will support better asthma control. The essentials are to know and avoid allergy triggers, take allergy medicines as prescribed by a doctor, and follow the AAP. For more information on allergy, see our Allergy Fact Sheet.

The benefits of clean air and active lifestyles

Being physically active is a key building block of health. It's especially important for children who need it for growth and development. Research is showing that regular activity can help support better asthma control. Exercise also reduces the risk of developing other chronic diseases, reduces stress, and supports better sleep and well-being.

Fast Facts on Asthma

- Affects 3 million Canadians and 10-18% of Canadian children
- Well controlled asthma enables totally normal lifestyles and activity levels – yet more than half of asthma sufferers don't have it under control
- It's the leading cause of school absenteeism, and third leading cause of work absenteeism
- The prevalence of asthma is twice as high in boys as it is in girls under 14 years of age.
- Women aged 40 years have a greater prevalence of asthma than do men of the same age.

Anyone with asthma can exercise safely but it's important to work with a doctor or health care professional to get it right. Be sure to check the Air Quality Health Index to choose when and where to exercise.

For more information on asthma:

Asthma Society of Canada
Asthma Kids
Canadian Lung Association
National Asthma Patients Alliance

Funding for this project has been made possible through a contribution from the Public Health Agency of Canada

Program Partners: AllerGen, Asthma.ca Asthma Society of Canada, green learning.ca

Air Pollutants & Sources Information Sheet

1 – Nitrogen Oxides: NO_X

Sources

The burning of fossil fuels such as coal, oil and natural gas releases nitrogen oxides (NOx) into the air. We use oil for transportation, coal for power and natural gas for heating. In the atmosphere, NOx reacts with SO_2 and water vapour to form acidic droplets called acid rain. NOx also reacts with Volatile Organic Compounds (VOCs), which are carbon compounds that evaporate easily into the air to create ground-level ozone, a highly irritating gas. Nitrogen dioxide (NO_2) is one of three substances measured in the Air Quality Health Index (AQHI), along with ozone and particulate matter.

Health Impacts

NO_X hurts the lung's ability to function. NO_X causes tightness in the chest, difficulty breathing, coughing and wheezing. It can harm tissues and cells in the body.

2 – Sulphur Dioxide: SO_2

Sources

When we burn fossil fuels such as coal, oil and natural gas, or when we refine metal ores such as iron or copper, sulphur dioxide (SO_2) is released. The metal ores also contains other substances such as sulphur. Smelting is a process that uses high heat and chemical reactions to release metal from the other substances. In the smelting process, SO_2 is released into the air.

Health Impacts

Exposure to SO_2 causes wheezing and shortness of breath. It can also lead to lung disease such as asthma.

3 – Carbon Monoxide: CO

Sources

Carbon monoxide (CO) is mainly produced by the combustion of gasoline in vehicles – 76% of all CO in the atmosphere comes from vehicles, according to Environmental Protection Agency data. Wild fires, other sources of burning wood, and volcanic eruptions, also release CO.

Health Impacts

CO reduces the body's ability to use oxygen. Even a little exposure to CO for a short amount of time can hurt an athlete's performance or worsen the symptoms of someone with heart problems.

4 – Volatile Organic Compounds: VOCs

Sources

Volatile Organic Compounds (VOCs) are natural and human-made compounds containing carbon that are readily released into the air based on their chemical properties. Examples of these compounds are found in gasoline, natural gas, paints, cleaners, inks and acetone. Vegetation can also release VOCs. NO_x also reacts with VOCs to create ground-level ozone, a highly irritating gas.

Health Impacts

VOCs irritate the eyes and nose and cause headaches. Some types of VOCs may cause cancer when people are exposed at high enough levels over a long period of time.

5 – Airborne Particulate Matter: PM

Sources

Particulate matter (PM) can be coarse or fine. Coarse PM includes dust from construction, dirt from plowing farmland, smoke from burning wood, and diesel soot. Fine PM is formed through chemical reactions when NO_x, SO_2, water vapour, VOCs and ammonia combine to create particulates of sulphate, nitrate and ammonium. Fine PM can also come wood burning smoke and diesel exhaust. PM is one of three substances measured by the Air Quality Health Index (AQHI) and is classified as a toxic substance by Environment Canada.

Health Impacts

PM irritates the nose and throat. It can cause coughing and breathing difficulties and hurt the lung's ability to function. PM can get lodged in lung tissue and cause damage. PM can also negatively impact heart health and lead to heart disease.

6 – Ground-Level Ozone: O_3

Sources

Ground-level ozone (O_3) is a colourless gas that forms just above the earth's surface when NO_x and VOCs react in sunlight and still air. Ground-level zone is different than the natural ozone in the stratosphere that protects the earth from harmful ultraviolet (UV) rays. Ground-level ozone is one of the three substances measured as part of the Air Quality Health Index (AQHI).

Health Impacts

Ozone makes the eyes itch and burn. Ozone can weaken our immune systems, making us more susceptible to catching colds and contracting pneumonia. Ozone can also aggravate existing respiratory conditions such as asthma or bronchitis. Ozone can also cause permanent lung damage and lead to early death.

7 – Smog

Sources

Smog is mostly made up of ground-level ozone (O_3) and particulate matter (PM). Because sunlight is needed to create ground-level ozone and ground-level ozone is needed to create smog, smog usually appears on sunny days with little wind. Smog can be a year-round phenomenon as it is also influenced by weather patterns, so smog may occur in rural as it is in urban settings. Smog levels usually peak in mid-afternoon due to higher temperatures and higher levels of fossil fuel consumption. In the Fraser Valley, smog can lead to air quality advisories on hot summer days.

Health Impacts

Smog, made up of several types of air pollutants, irritates the eyes, nose and throat. Smog can cause coughing and wheezing. People with lung or heart conditions are affected by smog as it makes their symptoms worse. Smog also lowers our resistance to infections and can lead to early death.

Air Pollution Solutions Activity

A - Take a walk, to school, to work, wherever

Walking, like biking, is easy on the air. Unlike riding in a vehicle, walking produces ZERO air pollution and is an excellent form of physical activity. Oil, which is refined into gasoline for transportation, releases pollutants in the air when it is refined and again when it is burned for fuel.

B - Bicycle, rollerblade or skateboard

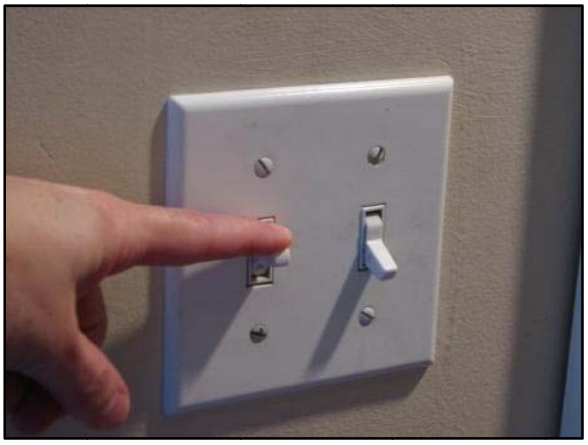
Biking, rollerblading, skateboarding and walking are easy on the air. Unlike vehicles, these forms of transportation do not require fossil fuels. Oil, which is refined into gasoline for transportation, releases pollutants into the air when it is refined and again when it is burned for fuel. The bicycle is the world's most widely used form of transportation and is the most energy efficient. Studies show the fastest way to travel less than five kilometres in urban centres is by bicycle.

C - Use public transit or carpools

Public transportation or carpools can be a breath of fresh air. Public transit and sharing rides reduces the number of vehicles on the road burning fossil fuels. A single bus, subway or train can carry a lot of people. Carpooling allows a few people to travel together to work or school. When fewer people drive, they reduce the amount of pollution that is emitted into the air.

D - Turn off lights and appliances

Turning off electrical items, such as lights, TVs, computers, air conditioners, and other appliances, reduces the amount of air pollution that comes from generating electricity. In Canada, most electricity is generated from coal-fired power plants that release pollutants and greenhouse gases into the air. In BC, the production of pollutants and greenhouse gases is lower, as we mostly use hydroelectricity generated from dams.



E - Unplug cell phone chargers

Cell phone chargers are usually left plugged in all the time, but they only need to be plugged in while a cell phone is charging. A cell phone charger uses electricity even when it is not charging a cell phone. In fact, only about 5 per cent of the electricity used by cell phone chargers is actually used to charge phones. The other 95 per cent is wasted energy. Think of all the cell phone chargers that are left plugged in across Canada and the rest of North America! In Canada, most electricity is generated from coal-fired power plants that release pollutants and greenhouse gases into the air. In BC, the production of pollutants and greenhouse gases is lower, as we mostly use hydroelectricity generated from dams.

F - Purchase EcoLogo products

EcoLogo products are reviewed to ensure they meet strict environmental standards. EcoLogo products such as paints, glues, cleaners and adhesives are made using less toxic materials that release fewer pollutants into the air. EcoLogo products are identified by the EcoLogo shown below. Encourage family members and others to purchase EcoLogo products when they can.

G - Turn down the heat, put on a sweater

Turning down the heat is an easy way to save energy. The best time to lower the heat is at night when everyone is sleeping or during the day when everyone is out. A programmable thermostat can be programmed to automatically turn down the heat at certain times of the day or night. Programmable thermostats are helpful in saving energy because once they are programmed, people don't have to remember to turn down the heat.

In BC, natural gas, electricity, or wood burning stoves generate heat. In Canada, much of the electricity we use is produced from coal-fired power plants, which release pollutants into the air, and greenhouse gases that contribute to climate change. In B.C., the production of pollutants and greenhouse gases is lower, as we mostly use hydro power from dams. However, emissions from natural gas and wood stoves contribute to air pollution.

H - Reduce the use of hot water

Natural gas or electricity heats the water in our homes. In Canada, much of the electricity we use is produced from coal-fired power plants, which release pollutants into the air, and greenhouse gases that contribute to climate change. In B.C., the production of pollutants and greenhouse gases is lower, as we mostly use hydro power from dams.

By taking shorter showers or washing clothes in cold water, we can reduce the amount of natural gas or electricity used for heating water. We can reduce our heating bills and the negative impact on our air quality. Another way to reduce the use of hot water is to turn down the thermostat on the hot water tank a few degrees to reduce the temperature, and insulate the hot water tank to prevent heat loss.

Air Pollutant Sources & Solutions Table - Worksheet

Place a check mark in the table below for each solution posted that would reduce emissions for each air pollutant.

	Nitrogen Oxides (NOx)	Sulphur Dioxide (SO_2)	Carbon Monoxide (CO)	Volatile Organic Compounds (VOCs)	Airborne Particulate Matter (PM)	Ground Level Ozone (O_3)	Smog
Walking							
Biking/rollerblading/etc.							
Using public transit or carpooling							
Turning off lights and appliances							
Unplugging cell phone chargers, electronics							
Purchasing EcoLogo products							
Turning down the heat							
Reducing the use of hot water							

Which air pollution solutions can help reduce many sources of air pollution?

Discuss other sources of pollution, e.g. industry, commercial diesel trucks, marine and aerospace traffic, agriculture, gravel mining, pesticides and herbicides, small engines like lawn mowers and leaf blowers. Can you suggest any solutions or responses to these sources?

Which air pollution solutions promote an active lifestyle?

What situations in your daily routine would have to change for you to lead a more active lifestyle?

Teacher Answer Key – Air Pollution Sources & Solutions

	Nitrogen Oxides (NOx)	Sulphur Dioxide (SO_2)	Carbon Monoxide (CO)	Volatile Organic Compounds (VOCs)	Airborne Particulate Matter (PM)	Ground Level Ozone (O_3)	Smog
Walking	✓	✓	✓	✓	✓	✓	✓
Biking/rollerblading/etc.	✓	✓	✓	✓	✓	✓	✓
Using public transit or carpooling	✓	✓	✓	✓	✓	✓	✓
Turning off lights and appliances	✓	✓			✓	✓	✓
Unplugging cell phone chargers, electronics	✓	✓			✓	✓	✓
Purchasing EcoLogo products				✓		✓	✓
Turning down the heat	✓	✓			✓	✓	✓
Reducing use of hot water	✓	✓			✓	✓	✓

Which air pollution solutions can help reduce many sources of air pollution?

- *Walking, biking, rollerblading, skateboarding, using public transit, carpooling, turning off lights/appliances, unplugging cell phone chargers, turning down heat, reducing hot water use.*

Discuss other sources of pollution, e.g. industry, commercial diesel trucks, marine and aerospace traffic, agriculture, gravel mining, pesticides and herbicides, small engines like lawn mowers and leaf blowers. Can you suggest any solutions or responses to these sources?

- *These sources also contribute to all of the air pollutants listed. Possible solutions are: strict emissions controls on industry, emissions testing for diesel trucks, electric lawn mowers, etc.*

Which air pollution solutions promote an active lifestyle?

- *Biking, rollerblading, skateboarding and walking.*

What situations in your daily routine would have to change for you to lead a more active lifestyle?

- *Answers will vary.*

Air Quality Health Index

Helping you understand what air quality means to your health

Find out what the **AQHI** value is in Fraser Valley right now at **www.airhealth.ca**

1
2
3
4
5
6
7
8
9
10
+

Risk: Low (1–3)

General population: Ideal air quality for outdoor activities.

At-risk population: Enjoy your usual outdoor activities.

Moderate (4–6)

General population: No need to modify your usual outdoor activities unless you experience symptoms such as coughing and throat irritation.

At-risk population: Consider reducing or rescheduling strenuous activities outdoors if you are experiencing symptoms.

High (7–10)

General population: Consider reducing or rescheduling strenuous activities outdoors if you experience symptoms such as coughing and throat irritation.

At-risk population: Reduce or reschedule strenuous activities outdoors. Children and the elderly should also take it easy.

Very High (10+)

General population: Reduce or reschedule strenuous activities outdoors, especially if you experience symptoms such as coughing or throat irritation.

At-risk population: Avoid strenuous activities outdoors. Children and the elderly should also avoid outdoor physical activity.

Fraser Basin Council

Fraser Valley Regional District

Canada

For additional lessons and to complete an evaluation survey, visit: www.fvrd.ca/airquality