

AAir Pollution Near You

By Alyssa Dehn

Topic: Local sources of potential air pollution

Grade: 7th

Michigan Standard:

E.ES.07.42 Describe the origins of pollution in the atmosphere, geosphere, and hydrosphere, (car exhaust, industrial emissions, acid rain, and natural sources), and how pollution impacts habitats, climatic change, threatens or endangers species.

Scientific Background (Attached)

Objectives:

- The students will learn about the potential sources of air pollution in their local area
- Students will be able to describe some of the variables that may lead to increased levels of air pollution.
- The students will learn which sources produce the most air pollution in their area.
- The students will explain possible ways to reduce the amount of air pollution particles in their area.
- The students will learn how air pollution impacts humans, other living organisms, and the environment.

Materials and Setup:

- Index cards (several per student or group)
 - Petroleum jelly
 - Plastic spoons
 - Popsicle sticks
 - Duct tape or masking tape
 - Scissors
 - One plastic sandwich bag (control)
 - Magnifying glass
1. Label each index card with the location where it will be placed
 2. Draw a circle about 2 inches wide on the index card
 3. Tape index card to popsicle stick
 4. Smear petroleum jelly within the circle on the index card using the plastic spoon.
 5. Place in locations to collect air pollution particles

Safety:

If students are placing their experiments along a road, students should remain on the side of the road and aware of cars on the road.

The petroleum jelly should not be consumed or touched to the eyes.

Misconception:

- If the air smells alright or looks clear, it isn't polluted
- Air pollution is a result of human activity, not natural sources

Requisite Knowledge/skills for students:

- Scientific method
- Some knowledge about the layers of Earth's atmosphere
- What clean air is composed of

Engage:

The teacher will show an image via projector of smog over a city and have students write down what comes to mind. Students can share their ideas. The teacher will ask the students about where air pollution might come from in their community and how they know it is present.

Suggested Questions:

- Do you think there is air pollution in our area?
- Where do you think the pollution comes from?
- How does air pollution affect humans? Animals? The environment?

Explore:**Part One**

The students will discover the sources of pollution in their area (Grand Rapids for example) using the following website:

“EPA 2013 Toxic Release Inventory Factsheet: City – Grand Rapids, MI”

http://iaspub.epa.gov/triexplorer/tri_factsheet.factsheet?&pstate=MI&pcity=Grand%20Rapids&pyear=2013

(If the students don't have access to computers, the factsheet can be printed out)

This is a factsheet that reviews the Toxic Release Inventory (TRI) of a city (ex. Grand Rapids, MI). The TRI tracks the management of certain toxic chemicals that may pose a threat to human health and the environment. Industries must report annually how much of each chemical is recycled, combusted for energy recovery, treated for destruction, and disposed of or otherwise released on- and off-site.

The teacher will start the students off by pointing out the graphs and information they should be paying attention to and how to look at those graphs before the students begin answering the provided questions and posing their own questions.

Part Two

After completing the worksheet that follows the fact sheet, the teacher will project the map of the TRI facilities in the city area and ask students to look carefully at the map, point out where the school is located and have them think about where they live in relation to the facilities.

Suggested Discussion Questions:

- Are there any facilities close to our school?
- Are there any facilities close to your home?
- Which facilities pose the biggest threats to the area?
- Are there any concerns we should have?
- What sources, other than the industrial facilities on the map, could produce air pollution?
 - Possible answers: Cars, trains, gas stations.

Part Three

Using the ideas from “Science Buddies” website, students will perform class research on which locations in their town have the most pollution using air pollution particle catcher.

After reviewing the map and thinking about other sources of air pollution, students will be divided into groups of 3 or 4 and asked to hypothesize where in town they think produces the most pollution and where there might be less pollution. Each group will choose three different locations to test their air pollution particle catchers and write them down in their science journal or the provided handout. They will write their hypothesis for each location.

Possible locations include:

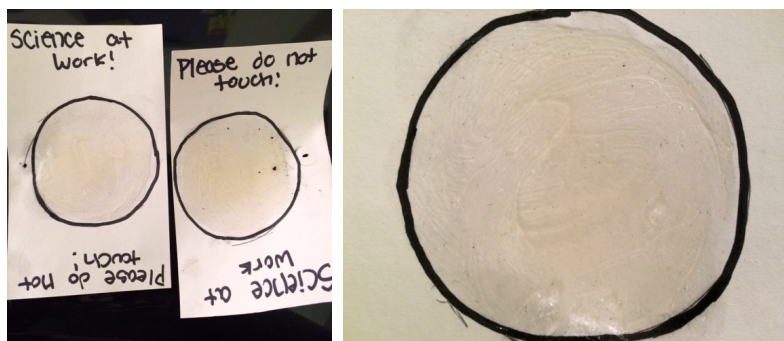
- At a truck stop
- By a gas station
- Near a busy road
- Next to a factory
- By railroad tracks
- In a park or yard
- Cornfield
- Next to a tree
- School grounds

A control should also be made with the same process, but placed within a forest.

The teacher can then place some of the index cards in their locations after school, since they might be too far from the school for the students to go to. The students can place other index cards, such as the one that is on the school grounds, in a park, or next to a tree. Students can determine when observations of their index cards should be made, whether it's every two days for two weeks or once each week for three weeks. When students make their observations, they can use a magnifying glass or microscope to examine the number of particles attached to the petroleum jelly. Each time the students observe their index card, they will count and record the number of particles attached to the petroleum. The control should also be observed to compare. They will record the data in their science journal or provided handout.

At the end of the designated data collection time, the index cards are collected for further analysis. They should be able to determine which of their cards has the most solid, air pollution particles on it. Students will then reflect on their hypotheses and determine if it was correct. They can write down the results of the experiment and their own reflections in their science journals or on the handout.

Example of air pollution particle catcher:



Explain:

The teacher will facilitate a class discussion going over each group's results from the experiment. After discussion, the teacher will introduce the paper the students will write for their evaluation.

Suggested Questions:

- What particles did you observe? Was that expected?
- Which locations showed more air pollution? Less pollution?
- Why do some locations have more pollution than others?
- Were there any problems with the experiment that might affect the results?
- Based on your results, should we be concerned about the local sources of air pollution? Which local sources are of most concern?
- What can we do to reduce air pollution? Possible answers:
 - Conserve energy
 - Limit driving- carpooling, using public transportation, biking and walking
 - Show EPA webpage for "Ways to Reduce Air Pollution"
http://www3.epa.gov/airquality/peg_caa/reduce.html

The teacher will then describe further background information about air pollution such as particulate contaminants, primary and secondary pollutants, and sources of air pollution. Also, factors that affect air quality including topography, weather, and physical and chemical properties of pollutants.

Elaborate:

The teacher will ask the students if air pollution is the same all around the state/country/world.

The students will use the following website, titled MyEnvironment, from the EPA, to research environmental information based on their location.

<http://www3.epa.gov/enviro/myenviro/>

The teacher will introduce the website by modeling what the students should be looking at and pointing out the graphs to pay attention to. They will enter the city and state (ex. Grand Rapids, MI) on the entry page, then go to "MyAir." He/she should point out different pieces of information including the Historical Air Quality Index and Current Particulate Matter. This is just a source of information for students to know the actual quality of their air and whether they should have any concerns.

Using their own devices, students can use the same site to look up their city and compare it with the quality of air in other cities in the state or country.

The teacher can share the following website that goes over the 10 smoggiest cities in the U.S. <http://www.cbsnews.com/pictures/top-10-smoggiest-cities-in-us/>

Evaluate:

Students will write a short paper on their conclusions and reflections of the experiment. They will think about why some of the cards collected more pollution than others, what evidence proves that some areas have more pollution than others, what factors might affect the amount of air pollution in the different locations (population, size of city, number of industrial facilities), what concerns they may have about air pollution in their city, and what they can do to change the amount of air pollution particles in the area.

Holistic rubric:

15	10	5	0
<p>The student has written a thorough understanding about their conclusions and reflections of the experiment, including their hypothesis, procedure, and evidence. They have reflected on why some locations create more pollution than others and what may cause that pollution. The student has included health concerns people should have in their town. Lastly, the student has considered possible solutions to reducing air pollution.</p>	<p>The student has written a somewhat thorough understanding about their conclusions and reflections of the experiment. The hypothesis, procedure, and evidence are present but not clear or complete. The student somewhat reflected on why some locations create more pollution than others and what may cause that pollution. The student has attempted to include health concerns but is not clear. The student partially considered possible solutions to reducing air pollution</p>	<p>The student has not written a thorough understanding about their conclusions and reflections of the experiment. They did not include hypothesis, procedure, or evidence, or only included one of the three. The student did not reflect on why some locations create more pollution than others. The student did not include health concerns people should have in their town. The student did not consider possible solutions to reducing air pollution.</p>	<p>The student did not complete the assignment</p>

References:

Air pollution experiment: http://www.sciencebuddies.org/science-fair-projects/project_ideas/EnvSci_p009.shtml

MyEnvironment: <http://www3.epa.gov/enviro/myenviro/>

EPA TRI Homepage: <http://www2.epa.gov/toxics-release-inventory-tri-program>

TRI Factsheet for Grand Rapids, MI:

http://iaspub.epa.gov/triexplorer/tri_factsheet.factsheet?&pstate=MI&pcity=Grand%20Rapids&pyear=2013

10 Smoggiest Cities in the U.S.: <http://www.cbsnews.com/pictures/top-10-smoggiest-cities-in-us/>

Background information of air pollution: <http://www.nps.gov/shen/learn/nature/airpollution.htm>
<http://www.bcairquality.ca/101/air-quality-factors.html>

EPA "Ways to Reduce Air Pollution": http://www3.epa.gov/airquality/peg_caa/reduce.html

Misconceptions: <http://acta.tums.ac.ir/index.php/acta/article/viewFile/4406/4596>

Name:

Date:

Toxic Release Inventory (TRI) for Grand Rapids, MI

The toxic release inventory (TRI) tracks the management of certain toxic chemicals that may pose a threat to human health and the environment. Industries must report annually how much of each chemical is recycled, combusted for energy recovery, treated for destruction, and disposed of or otherwise released on- and off-site. Go to the following website to review the TRI factsheet for Grand Rapids, MI:

http://iaspub.epa.gov/triexplorer/tri_factsheet.factsheet?pstate=MI&pcity=Grand%20Rapids&pyear=2013

Look over the data and information, and then answer the following questions:

1. Most of the on-site disposal of emissions goes where? How many pounds of emissions are released into this place?
2. Michigan is ranked _____ out of 56 states/territories nationwide based on _____.
3. What is the *mitigation* used to reduce waste generated and moving toward safer waste management methods.
4. Describe the trend of the bar graph, "Production-related waste managed in Grand Rapids, MI, 2003-2013." What are the most common waste management practices for Grand Rapids facilities?
5. Describe the trend of the bar graph, "Total On-Site Releases by Environmental Medium in Grand Rapids, MI, 2003-2013." Why has it declined?

6. From the bar graph, "Top Five Facilities by Total On-Site Disposal or Other Releases Grand Rapids, MI, 2013" choose one of the facilities and answer the questions.

- a) Facility name:
- b) Type of in industry:
- c) Disposal types:
- d) Total on-site disposal and/or other releases (lbs):
- e) Other observations:

7. What was the top five chemicals released to the air in Grand Rapids, MI in 2013?

8. Choose one of the five chemicals, click on it, and answer the questions.

- a) Name of chemical:
- b) Percent of total chemicals:
- c) Health Effects:

10. Look at the map of TRI Facilities in Grand Rapids, MI. Are there any facilities near your home? What are they?

Name: **Answer Key**

Date:

Toxic Release Inventory (TRI) for Grand Rapids, MI

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Look over the data and information, and then answer the following questions:

1. Most of the on-site disposal of emissions goes where? How many pounds of emissions are released into this place?
Air; 126.2 thousand pounds
2. Michigan is ranked 25 out of 56 states/territories nationwide based on total releases per square mile.
3. What is the *mitigation* used to reduce waste generated and moving toward safer waste management methods.
The preferred management method is recycling, followed by energy recovery, treatment, and as a last resort, disposing of or releasing the waste.
4. Describe the trend of the bar graph, "Production-related waste managed in Grand Rapids, MI, 2003-2013." What are the most common waste management practices for Grand Rapids facilities?
**The amount of waste managed increased in 2004 and 2005, and then decreased into 2009. It increased again until 2012, and decreased a little into 2013.
The most common waste management practices are recycling and treatment.**
5. Describe the trend of the bar graph, "Total On-Site Releases by Environmental Medium in Grand Rapids, MI, 2003-2013." Why has it declined?
The graph shows a sharp decrease from 2006 to 2007, and has remained low since then. Facilities have used better waste management practices, such as recycling.

6. From the bar graph, "Top Five Facilities by Total On-Site Disposal or Other Releases Grand Rapids, MI, 2013" choose one of the facilities and answer the questions.

- f) Facility name: **Paulstra CRC Corp**
- g) Type of in industry: **Plastic and Rubber**
- h) Disposal types: **On-site air; off-site disposal**
- i) Total on-site disposal and/or other releases (lbs): **Air- 27,799lbs; Other- 3,391lbs. Total- 31,190lbs**
- j) Other observations: **Produced the most waste**

7. What was the top five chemicals released to the air in Grand Rapids, MI in 2013?

Toluene
Nitric Acid
Methyl Isobutyl Ketone
N-Hexane
Xylene.

8. Choose one of the five chemicals, click on it, and answer the questions.

- d) Name of chemical: **Toluene**
- e) Percent of total chemicals: **51%**
- f) Health Effects: **Neurological- impaired sensory and motor signaling; Ocular-eye irritation, itching and impaired vision; Renal- decreased filtering capacity/efficiency, blood in the urine and/or increased/decreased blood pressure; Respiratory- inflammation of the lungs, increased/decreased breathing rate, respiratory failure.**

10. Look at the map of TRI Facilities in Grand Rapids, MI. Are there any facilities near your home? What are they?

Name:

Data Table for Air Pollution Experiment

Card Location			
	Particle Count for each location		
Date:			
Date:			
Date:			
Date:			
TOTAL			
Average			

Hypothesis: Which index card location will collect the most particles? Why?

Conclusion: Based on your data, which index card location collected the most particles? Why do you think this may be?

Scientific Background

Air pollution occurs in many forms but is typically thought of as gaseous and particulate contaminants that are present in Earth's atmosphere. The **Gaseous pollutants** include sulfur dioxide (SO₂), nitrogen oxides (NO_x), ozone (O₃), carbon monoxide (CO), volatile organic compounds (VOC), hydrogen sulfide (H₂S), hydrogen fluoride (HF), and various gaseous forms of metals. These pollutants are emitted from large stationary sources, such as fossil fuel fired power plants and manufacturing facilities, as well as from mobile sources. They can be corrosive to various materials, which cause damage to cultural resources, and cause injury to ecosystems and organisms, aggravate respiratory diseases, and reduce visibility.

Particulates come in both large and small or "fine" solid forms. Large particulates include dust, asbestos fibers, and lead. Fine particulates include sulfates (SO₄) and nitrates (NO₃). **Toxic air pollutants** are a class of chemicals, which may potentially cause health problems in a significant way. Sources include power plants, industries, pesticide application, and contaminated windblown dust. **Primary pollutants** are those emitted directly into the air from pollution sources. **Secondary pollutants** are formed when primary pollutants undergo chemical changes in the atmosphere (ex. Ozone=smog; not the good ozone in the stratosphere).

Stationary source refers to an emission source that does not move, also known as a point source. Examples include factories, power plants, and dry cleaners. **Area source** describes many small sources of air pollution located together whose individual emissions may be below concern, but whose collective emissions can be significant. Can be thought of as non-point sources. Examples include residential wood burners, landfills, or construction of housing developments.

Mobile sources refer to a source that is capable of moving under its own power. This includes vehicles such as cars, sport utility vehicles, and buses. Also includes "off-road" category, which refers to lawn mowers, boats, farm and construction equipment, planes, and trains.

Natural sources of "pollution" include wildfires, dust storms, and volcanic activity, which also contribute gases and particulates to our atmosphere.

Air transport refers to the mechanism by which air pollution moves from an emissions source to a receptor. The atmosphere itself is a transporter of pollutants through wind currents. Wind speed contributes to how quickly pollutants are carried away from their original source. Once pollutants are emitted into the air, the weather largely determines how well they disperse. Turbulence mixes pollutants into the surrounding air. Hot air rising results in vigorous mixing, while cooler air near the surface is heavier and won't want to move up to mix with the warmer air above it (**temperature inversion**). Any pollutants released near the surface will get trapped and build up in the cooler layer of air near the surface. Temperature inversion is common in mountain valleys because the inversion and valley walls can trap the pollution (image to the right).

