DEQ in the Classroom:
Inversion in a Cup

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY

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Grade Level:
4 - 8

Time Required: Approximately 45 minutes (time will vary depending on discussion time)

Note: This activity can be done as a demonstration by the teacher, individually by students, or in small groups. It can also be done as an "inquiry" activity, by not giving students the background information first and not telling them what the purpose of the salt water is, and letting them discover for themselves what happens (start with Step 8), then discussing inversions and providing the background information. These instructions are written for students making their own inversions individually or in small groups.

Objective: To observe how temperature inversions are formed and how inversions influence air pollution levels.

Note: Because of topography, weather patterns, etc., some parts of Idaho (e.g., the Treasure Valley, the Portneuf Valley, the Pinehurst and Sandpoint areas) are much more likely to experience inversions than others. This activity is much more relevant in areas where inversions occur with some frequency, as children have had (or may have in the future) first-hand experience of an inversion.

Meets Idaho State Standards:
Grade 4: 4.S.1.2.3, 4.S.1.8.1, 4.H.1.1.10
Grade 5: 5.S.1.2.3, 5.S.1.6.2, 5.S.1.8.1, 5.S.5.1.1, 5.H.1.1.8
Grade 6: 6.S.1.2.3, 6.S.2.1.4, 6-9.GWH.2.5.2, 6-9.GEH.2.5.2, 6.S.5.1.1, 6.H.1.1.10
Grade 7: 7.S.1.2.3, 7.S.1.6.1, 6-9.GWH.2.5.2, 6-9.GEH.2.5.2, 7-8.H.1.1.9
Grade 8: 6-9.GWH.2.5.2, 6-9.GEH.2.5.2, 7-8.H.1.1.9

Meets standards in science, health, and social studies.

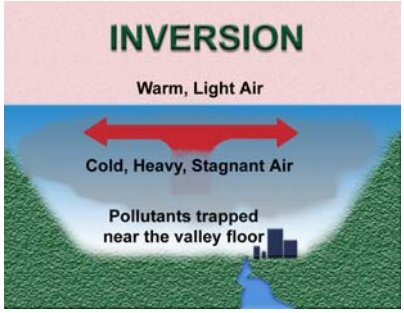
Focus: Air quality, inversions. Students create a temperature inversion, observe how the layer of cold air becomes trapped, and discuss how pollutants can become trapped with that cold air.

Materials: (per experiment; will need one set of each per student or group)
3 cups tap water, divided*
1/8 cup salt (or a little less)*
2 clear, 16-oz plastic cups (glass jars and glass bowls also work, as do other sizes of containers*)
1/8 (or 1/4)-cup measuring cup*
2-cup measuring cup*
Blue food coloring (in a container that allows you to meter out drop by drop)
Funnel
Rubber tubing (about 1-foot long; appropriate width to fit snugly on end of funnel)
Spoon

*Larger or smaller quantities of water can be used to accommodate the size of the containers. If you increase/decrease the quantity of water, be sure to increase/decrease the quantity of salt accordingly.

Background:

Typically, warm air rises and cold air sinks, causing the air around us to mix and move. This process is called "convection." In addition, winds continually move the air and disperse (scatter) pollution released into the air. However, sometimes the air does not mix and move, and a temperature (or "thermal") inversion may occur.



A temperature inversion occurs when a layer of warm air settles on top of a layer of cold air, and the cold air ends up trapped underneath. In this situation, the layers of air do not move, the air does not mix, and pollution from cars, industry, fires, and other sources becomes trapped in the colder layer close to the earth's surface. If an inversion persists for several days, this buildup of pollution can become significant. (A larger version of the graphic at right can be found on page 13.)

Temperature inversions are natural occurrences that occur year-round, but are of major concern in the winter. They are neither caused by, nor the cause of, air pollution. However, an inversion can trap air pollution near the ground, thereby increasing the potential for higher concentrations of air pollution in a specific area. Because of this, temperature inversions and air pollution issues are often linked.

Inversions can develop or intensify on clear winter nights when the earth's surface radiates (gives off) heat rapidly, which can cause the ground, and the air directly above it, to be cooler than the air at higher altitudes. Inversions can also form at night in valleys, when gravity pulls cold, dense air downhill into the valleys. The air in the valley bottoms is then colder than the air above.

As stated above, inversions can trap air pollution near the earth's surface. Pollution near the ground increases with the duration of the inversion, as more and more pollutants are released into the environment, and become concentrated in one location. Two pollutants that commonly become trapped near the ground during inversions are carbon monoxide (CO) and particulate matter ("particulates" or PM). Both CO and PM can adversely impact public health and visibility and are regulated air pollutants under the National Ambient Air Quality Standards (NAAQS).

Carbon monoxide forms when the carbon in fuels does not completely burn. Carbon monoxide concentrations typically are highest during cold weather because cold temperatures make combustion less complete. When this is coupled with inversion conditions, CO levels near the earth's surface can increase.

Particulate matter is made of small particles in the air including dust, dirt, soot, smoke, and liquid droplets. PM comes from exhaust from vehicles (especially diesel vehicles), such as cars, trucks, and buses, and from wood smoke, road dust, brake and tire wear, factories, construction sites, agricultural fields, and more. These pollutants can become trapped near the ground under inversion conditions. Unfortunately, the cold air temperatures that are part of an inversion also lead to increased use of fireplaces and wood-burning stoves, as people are heating their homes against the chill. The smoke from these fires, and the particulates it generates, can quickly lead to high levels of particulate pollution trapped near the ground.

Air quality is reported using the Air Quality Index (AQI). The AQI indicates how clean or polluted the air is in a particular area and identifies potential health impacts. In some instances, DEQ forecasts the following day's AQI so people who are especially sensitive to pollution can appropriately plan outdoor activities. As pollutants become trapped near the ground during an inversion, the AQI generally rises, indicating decreasing air quality and an increased chance of health impacts. See the fact sheet on pages 11 and 12 for more information on the AQI. Individuals can check the AQI for their communities at www.deq.idaho.gov/air/aqindex.cfm.

Vocabulary:

Air Quality Index (AQI)	A guide for reporting daily air quality that indicates how clean or polluted the air is in a particular area and identifies potential health impacts. The AQI works as a measuring stick that runs from 0 to 500. The higher the AQI value, the greater the level of air pollution and the greater the health risk. *See fact sheet, pages 11 and 12, for a more detailed explanation of the AQI.*
Alternative Fuel	A fuel that takes the place of traditional petroleum gasoline or diesel fuels.
Biodiesel (B5, B20, B100)	A mixture of diesel fuel with soybean or vegetable oil-based products. B20 (20% biodiesel and 80% petrodiesel) is a common blend.
Carbon Monoxide (CO)	A colorless, odorless, poisonous gas and one of six "criteria pollutants" for which the U.S. Environmental Protection Agency (EPA) has established protective standards. Carbon monoxide forms when the carbon in fuels does not completely burn.
Certified/Non-Certified Wood Stove	A certified wood stove is any wood stove manufactured since 1988. Since this time, EPA has required manufacturers of wood stoves to certify that their wood stoves offered for sale in the United States comply with particulate emissions guidelines in the Clean Air Act. Certified wood stoves are cleaner and more efficient than a wood stove manufactured before 1988. A non-certified wood stove is any stove manufactured before 1988. These stoves do not burn as clean and emit more air pollution.
Clean Air Zone Idaho	A statewide program designed to reduce an individual's exposure to vehicle exhaust by limiting vehicle idling, promoting alternative fuels, and retrofitting buses with cleaner diesel technologies.
Combustion	The process of burning.
Compressed Natural Gas (CNG)	Natural gas used to fuel vehicles. CNG vehicles may run exclusively on natural gas or on both natural gas and gasoline.
Convection	The vertical movement of heat within the atmosphere. The idea that warm air rises and cool air sinks.
Diesel Retrofit Technology	Equipment that can be added to diesel engines to reduce emissions.
Emission	The act or instance of discharging (emitting) something into the air, such as by an internal combustion engine (e.g., a vehicle).
Emit	To give off or discharge.
Ethanol (E10 and E85)	Alcohol, commonly derived from corn and other crops, that can be blended with traditional petroleum fuel. Common blends include E10 (10% ethanol and 90% petroleum) and E85 (85% ethanol and 15% petroleum).
Exhaust	The fumes or gases released from an engine.
Inversion ("Thermal" or "Temperature")	A reversal in the normal temperature layers. A layer of warm air settles on top of a layer of cold air, and the cold air ends up trapped underneath. (See graphic, page 13.)

National Ambient Air Quality Standards (NAAQS)	Federal, health-based standards for six "criteria pollutants" for ambient (outside) air. States are required to attain and maintain air quality at levels below the NAAQS. Particulate matter and carbon monoxide, two pollutants that commonly become trapped in inversions in Idaho, are two of the six criteria pollutants; the other four are nitrogen dioxide, sulfur dioxide, ozone, and lead.
Particulate Matter ("particulates" or PM)	Small particles suspended in the air including dust, dirt, soot, smoke, and liquid droplets.
$PM_{2.5}$	Particulate matter (PM or particulates) in the air less than 2.5 micrometers in diameter. Often referred to as "fine" particulate matter. Not visible to the naked eye; can only be seen with an electron microscope.
PM_{10}	Particulate matter (PM or particulates) in the air less than or equal to 10 micrometers in diameter. PM_{10} between 2.5 and 10 micrometers in diameter is referred to as "coarse" particulate matter. Individual particles are not visible to the naked eye.
Pollutant	Any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.
Pollution	The result of polluting or the state of being polluted, especially the contamination of soil, water, or air by the discharge of harmful substances.

Procedure:

Step 1. Pick a nearby high-altitude landmark that most of your students are familiar with (e.g., a nearby ski resort, town, or mountain peak that is significantly higher in elevation than your school). Ask for a show of hands of who has been there.

Step 2. Ask students what differences they notice in weather between the landmark and their town.
Answers may include: colder, more snow, windier (all referring to the landmark). If students don't say "colder," steer them in that direction.

Step 3. Ask the students what this tells us about temperature patterns in general.
It gets colder as elevation increases.

Step 4. Discuss with students how air typically moves, heats, and cools.
Generally, warm air rises. As it rises, it cools (because it gets higher), which makes it heavier, so it sinks, then warms, then rises again. This process is called "convection." Cold air is denser than warm air, which makes it heavier, which is why it "sinks."

Step 5. Ask students if they have heard the terms, "invert," "inverted," or "inversion" (in any context). Ask what they mean.
Look for answers that generally mean "upside down."

Step 6. Ask students if they have heard the term "inversion" related to weather. If any have, ask what it means. *An inversion is a reversal in the normal temperature layers. A layer of warm air settles on top of a layer of cold air, and the cold air ends up trapped underneath. The end result is that areas of lower elevation are colder than areas of higher elevation; the opposite of normal temperature regimes. That is, the temperatures are "upside down." (See graphic, page 13.)*

Step 7. Tell students you are going to build an inversion out of water. You are using water because it is easier to see than air.

If students are doing on their own or in small groups, have each student/group do the following.

If you are doing as a demonstration, get one or two student volunteers to do or help with the following steps.

Step 8. Place the plastic cups on a stable (not wobbly) table or desk where everyone (or everyone in the small group) can see them. If you are doing as a demonstration, allow students to position themselves around the table/desk so that everyone has a good view, but keep them back far enough that the table/desk doesn't get jostled.

Step 9. Measure 1.5 cups of tap water* using the 2-cup measuring cup. Pour into one of the plastic cups. Label this cup "1."

Step 10. Measure ¾ cup of tap water* in the 2-cup measuring cup and pour into the second cup. Label this cup "2."

Step 11. Measure a second ¾ cup* of tap water in the 2-cup measuring cup and add 1/8-cup* (or slightly less) salt. Stir vigorously with a spoon until the salt is completely (or nearly completely) dissolved.

Step 12. Fit one end of the tubing over the end of the funnel. Lower the other end of the tubing into cup #2 so that the end of the tubing rests on the bottom of the cup. Have one student hold on to the tubing against the side of the cup so it stays in place. (This is important, as you don't want to agitate the water and you want the salt water you add to be added to the bottom of the cup.)

Step 13. Carefully pour the ¾ cup of salt water into the funnel so that it comes out of the tube at the bottom of the cup. It is OK if some bubbles come out of the tube, but try to keep agitation to a minimum.

Step 14. Gently remove the tubing from the cup, taking care not to disturb the water.

Step 15. Review what you have done so far and discuss what the water in the cups represents.

- The water in cup #1 represents normal weather conditions. The air (water) is free to mix and move. This is the "control."
- The water in cup #2 represents an inversion.
  - The first water you put in cup #2 represents warm air.
  - The second water (salt water) you put in cup #2 represents cold air. Cold air is denser/heavier than warm air. The salt makes the second cup of water denser/heavier than the first, so simulates cold air.
  - You now have an "inversion" in a cup (salty, heavy water [representing cold, heavy air] is trapped under un-salty, lighter water [representing warmer, lighter air]).
  - **Point out that, at this point, just as in real life, the different layers of air (water) are not visibly different** (unless or until pollution gets trapped). In real life, it is the trapped pollution that makes the different layers of air visible during an inversion. The air itself (if not polluted) all looks the same.

*Larger or smaller quantities of water can be used to accommodate the size of the containers. If you increase/decrease the quantity of water, be sure to increase/decrease the quantity of salt accordingly.

Step 16. Tell your students that you will now add food coloring to see what happens. Slowly, allowing 1 to 2 seconds between drops, drop 3 drops of food coloring into the water in cup #1. The food coloring should slowly mix with the water to make a more-or-less uniform color.

Step 17. Slowly, allowing 1 to 2 seconds between drops, drop 3 drops of food coloring into the water in cup #2. Take care to not disturb the water in the cup (don't bump the cup, table, etc.). The food coloring should stay in the top (unsalted, representing warm, light air) layer of water and will likely make a "swirl" pattern.

Step 18. Using a spoon, gently agitate the top ½-inch of the water in the top of cup #2. DO NOT dip the spoon in to the bottom of the cup. The layers should appear more obvious, and you may be able to see the boundary between layers as the water undulates. You may want to agitate more than once (getting a little more aggressive each time) to accentuate the layers. However, be sure to keep the spoon in the top ½-inch of water to keep from mixing the entire cup.

Step 19. Compare and contrast what you see in the two cups. Students should easily see the clear water (the "clear" water may be a little "foggy" because of the salt) on the bottom (represents the cold, trapped air) and the colored water on top (represents the warm air) in cup #2. Discuss how the warm (now colored) "air" traps the cold, heavy "air" beneath it and how pollution gets trapped with that cold air. (**Do not confuse the colored upper [warm] layer as being polluted. The food coloring does NOT represent pollution – it simply allows you to see the two layers of air.**)

Step 20. Gently swirl the water in the cup (or stir with a spoon) to simulate wind. Note how the "wind" breaks up the "inversion" (mixes the "air") so that all the water mixes and becomes homogenous (the same). Precipitation (e.g., rain or snow) can break up an inversion as well. (Some students may want to pour additional water into the cup to simulate rain instead of swirling or stirring the water to simulate wind.)

Step 21. Teacher/Leader. Lead a class discussion using Questions for Discussion, below.

Questions for Discussion (continued on pages 7 and 8):

1. How are temperature inversions formed?
Inversions can develop or intensify on clear winter nights when the earth's surface radiates (gives off) heat rapidly, which can cause the ground, and the air directly above it, to be cooler than the air at higher altitudes. Inversions can also form at night in valleys, when gravity pulls cold, dense air downhill into the valleys. The air in the valley bottoms is then colder than the air above.

2. Temperature inversions are directly related to the temperature of the air. In our experiment, all of the water we used was the same temperature. How/why did it work?
Cold air/water is more dense(and therefore heavier) than warm air/water. Water saturated with salt is more dense(heavier) than un-salty water (this is also why you float better in the ocean than in a lake). So the dense, heavy salt water was used to represent the dense, heavy cold air.

3. In an experiment, what is the "control"? In our experiment, which cup represented the "control"?
A "control" is a standard in a scientific experiment that you used to compare other things to. It is the "thing" that is not manipulated or changed. Cup #1 (the cup that did not have any salt water added) was the "control" in this experiment because it was just plain water.

(Questions for Discussion Continue on page 7)

Questions for Discussion, Continued

4. How does what we did relate to "real life"?
In "real life," inversions trap air pollution close to the ground, where we breathe it. Inversions and their effect on air pollution are especially problematic in the winter: inversions most often occur in the winter, people are most likely to be burning wood in stoves and fireplaces in the winter and the pollution from smoke (particulates) gets trapped by the inversion, and engines don't burn as efficiently when it is cold, which creates more carbon monoxide, which also gets trapped in an inversion.

5. Does our community experience inversions? How can we find out if an inversion is occurring? How can we find out about air quality in our community?
Local newscasts/weather reports on the TV or radio will report if an inversion is occurring. Checking weather sites on the Internet will also provide clues if there is an inversion (that is, the site may not specifically say there is an inversion, but if you check the air temperature in your community and for a nearby higher elevation area and the higher elevation is warmer, then your community may be experiencing an inversion). DEQ's Web site (www.deq.idaho.gov/air/aqindex.cfm) reports air quality daily using the Air Quality Index (AQI). If an inversion is occurring, a comment to that effect may appear in the "Comment" section on the Web site. (Learn more about the AQI on the fact sheet on pages 11 and 12).

6. Why should we care about air pollution?
It hurts the environment, is unhealthy, blocks views, stinks, can cause economic issues if air quality doesn't meet national standards (see www.deq.idaho.gov/air/data_reports/monitoring/overview.cfm), etc. Point out that many of these issues exist even in places with relatively clean air.

7. Do inversions cause air pollution?
No. Temperature inversions are natural occurrences. They are neither caused by, nor the cause of, air pollution. However, an inversion can trap air pollution near the ground, thereby increasing the concentration of air pollution in a specific area. Because of this, temperature inversions and air pollution issues are often linked.

8. What does cause air pollution? What are the biggest causes of air pollution in our town?
Vehicle exhaust (especially from diesel engines), industry, fires (wildfires, agricultural burning, fireplaces/wood stoves), blowing dust, volcanoes, gas-powered lawn tools (e.g., lawn mowers), etc. (These are general causes; the biggest polluters in your town will vary. Typically, vehicles are the biggest polluters in urban areas. Wood smoke can be a large polluter in rural areas.)

9. How can we prevent inversions from happening?
We can't. They are a natural weather phenomenon and have been occurring since long before humans altered the environment. However, human activity (pollution) can affect the duration and severity of some inversions. What we can do is take action to reduce air pollution so that when an inversion occurs, there is less pollution in the air to become trapped in the inversion.

(Questions for Discussion continue on page 8)

Questions for Discussion, Continued

10. How can we reduce (limit) air pollution?

- *Limit vehicle emissions*
  - *Limit driving: carpool, walk, combine errands, take the bus*
  - *Turn off engines while waiting (e.g., don't idle in drive through or while waiting to pick up kids)*
  - *Retrofit existing diesel engines (e.g., school buses, trucks, tractors) with emissions reduction technologies*
  - *Keep vehicles well-maintained (get better gas mileage, so produce fewer emissions per mile driven)*
  - *Purchase and use low emission vehicles (e.g., hybrid vehicles)*
  - *Use alternative fuels (e.g., biodiesel [B20], ethanol [E85], and compressed natural gas [CNG])*
- *Take care with fires*
  - *Comply with burn bans*
  - *Don't burn garbage*
  - *Convert your wood-burning fireplace to a gas fireplace or certified wood stove*
- *Cover dirt if carrying in a truck (to keep it from blowing out)*
- *Use an electric or non-motorized lawn mower and trimmer*

Expansion and Follow-Up Ideas:

- Have students conduct an educational campaign at their school or in their city to encourage activities that reduce air pollution. Write letters to the editor, make posters, etc.

- Have students research current (and future or experimental) technologies that can decrease the amount of air pollution we produce and prepare an oral or written report or poster on their findings. Examples of technologies could include hybrid vehicles, hydrogen fuel cell vehicles, alternative fuels (E85, B20, etc.), certified wood stoves, etc.

- Have students track air temperature and the AQI throughout the winter and graph the relationship between temperature and air quality. Students can check the air quality on DEQ's Web site (www.deq.idaho.gov/air/aqindex.cfm) (reported using the Air Quality Index [AQI]) and check weather conditions using local news media or weather-related Web sites. See fact sheet, pages 11 and 12, for more information on the AQI and how it represents pollution levels.

- Have students track weather conditions and air quality throughout the winter and note when inversions occur and what relationship, if any, they see between inversions and air quality. Students can check the air quality on DEQ's Web site (www.deq.idaho.gov/air/aqindex.cfm) (reported using the Air Quality Index [AQI]) and check weather conditions using local news media or weather-related Web sites. See fact sheet, pages 11 - 12, for more information on the AQI and how it represents pollution levels. Have students prepare an oral or written report on their findings.

- Encourage your school or school district to join the *Clean Air Zone Idaho* program (if it hasn't already). See www.deq.idaho.gov/air/educ_tools/clean_air_zone_idaho/index.cfm for more information.

- Plan a field trip to a local television station or National Weather Service or National Oceanic and Atmospheric Administration site to visit with a meteorologist about inversions and see the equipment they use to forecast the weather. Or, invite a local meteorologist to come to your class.

- Invite an air quality expert from your local DEQ regional office to visit your class to discuss air quality issues in your area. See page 10 to find your nearest DEQ office.

Additional Resources:

Air Quality Brochures, Fact Sheets, and More for Citizens and Communities
www.deq.idaho.gov/air/assist_citizen_comm/publications.cfm

Air Quality Educational Tools (includes information for students and teachers, activities, and more)
www.deq.idaho.gov/air/educ_tools.cfm

Air Quality: How it is Measured www.deq.idaho.gov/air/data_reports/monitoring/overview.cfm

Air Quality Index (check your air quality) www.deq.idaho.gov/air/aqindex.cfm

Air Quality Index (background) www.deq.idaho.gov/air/data_reports/monitoring/aqi.cfm

Air Quality Reports, North Idaho www.deq.idaho.gov/air/data_reports/reports/north_idaho/index.cfm

Air Quality in the Treasure Valley www.deq.idaho.gov/air/data_reports/monitoring/bro.cfm

Air Quality Reports, Portneuf Valley www.deq.idaho.gov/air/data_reports/reports/portneuf_valley/index.cfm

Clean Air Zone Idaho www.deq.idaho.gov/air/educ_tools/clean_air_zone_idaho/index.cfm

Dust and Air Quality www.deq.idaho.gov/air/prog_issues/pollutants/dust.cfm

Health and Environmental Effects of Particulate Matter www.epa.gov/ttn/oarpg/naaqsfin/pmhealth.html

Local Environmental Information www.deq.idaho.gov/about/office_locations.cfm

Motor Vehicles and the Clean Air Act www.epa.gov/otaq/consumer/11-vehs.pdf

National Ambient Air Quality Standards (NAAQS)
www.deq.idaho.gov/air/data_reports/monitoring/overview.cfm#NAAQS

Particulate Matter www.deq.idaho.gov/air/prog_issues/pollutants/health.cfm#pm

Smoke, Burning, and Air Quality www.deq.idaho.gov/air/prog_issues.cfm#burn

Vehicle Emissions www.deq.idaho.gov/air/prog_issues/pollutants/vehicles.cfm

Visibility and Haze www.deq.idaho.gov/air/prog_issues/pollutants/haze_overview.cfm

What Can Citizens Do to Prevent (Air) Pollution
www.deq.idaho.gov/multimedia_assistance/p2/citizens_overview.cfm#air

DEQ Regional Offices, Air Quality Contacts:

Boise Regional Office
Airshed Coordinator
1445 N. Orchard
Boise, ID 83706
ph: (208) 373-0550
fx: (208) 373-0287

Coeur d'Alene Regional Office
Airshed Coordinator
2110 Ironwood Pkwy.
Coeur d'Alene, ID 83814
ph: (208) 769-1422
fx: (208) 769-1404

Idaho Falls Regional Office
Airshed Coordinator
900 N. Skyline, Suite B
Idaho Falls, ID 83402
ph: (208) 528-2650
fx: (208) 528-2695

Lewiston Regional Office
Airshed Coordinator
1118 "F" Street
Lewiston, ID 83501
ph: (208) 799-4370
fx: (208) 799-3451
toll free: (877) 541-3304

Pocatello Regional Office
Airshed Coordinator
444 Hospital Way, #300
Pocatello, ID 83201
ph: (208) 236-6160
fx: (208) 236-6168

Twin Falls Regional Office
Airshed Coordinator
1363 Fillmore St.
Twin Falls, ID 83301
ph: (208) 736-2190
fx: (208) 736-2194

You Are What You Breathe: The Air Quality Index and YOU

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www.deq.idaho.gov

"A red air quality alert has been issued…"

"DEQ is reporting that the AQI is 120…"

"Air quality is considered unhealthy for sensitive populations…"

Headlines such as these pepper Idaho's news media from time to time, but alone may not have much meaning to individuals. This fact sheet will help explain the Air Quality Index (AQI) and what it means to you, your family, your health, and air quality in Idaho.

Each day, concentrations of air pollutants are measured in areas across Idaho. A federal standard, or limit, has been established for each air pollutant. These limits are based on the health effects of the pollution and vary by type of pollutant.

After the amount of pollution is measured, it is compared to the federal standard. To help us compare the various pollutants and determine the air quality, the U.S. Environmental Protection Agency (EPA) developed the AQI.

What is the Air Quality Index?

The AQI is a guide for reporting daily air quality. Its purpose is to help individuals understand what local air quality conditions can mean to their health. The AQI indicates how clean or polluted the air is in a particular area and identifies potential health impacts. The AQI focuses on health effects that can happen within a few hours or days after breathing polluted air. DEQ uses the AQI for five major air pollutants regulated by the Clean Air Act: ground-level ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide. For each of these pollutants, EPA has established National Ambient Air Quality Standards to protect against harmful health effects.

How Does the AQI Work?

The AQI works as a measuring stick that runs from 0 to 500. The higher the AQI value, the greater the air pollution and the greater the health risk. For example, an AQI value of 50 represents good air quality and little potential to affect public health, while an AQI value over 300 represents hazardous air quality with potentially serious health impacts.

An AQI value of 100 generally corresponds to the national air quality standard for the pollutant, which is the level EPA has set to protect public health. So, AQI values below 100 are considered healthful. When AQI values are above 100, air quality is considered to be unhealthy—at first for certain sensitive groups of people, then for everyone as AQI values get higher.

How is the AQI calculated?

Air quality in Idaho is measured by monitors that record the concentrations of several air pollutants throughout the state each day. The raw measurements are then converted into AQI values using standard formulas developed by EPA.

An AQI value is calculated for each of the pollutants in an area. Finally, the highest AQI value for an individual pollutant becomes the AQI value for that day. For example, if on one day an area had AQI values of 90 for ozone and 88 for sulfur dioxide, the AQI value would be 90, because the highest AQI value of all pollutants for that day (in this case, ozone) was 90.

What Do the Color-Coded Alerts Mean? How Do They Correspond to the AQI?

The AQI scale is divided into six categories, each of which indicates a level of "healthy-ness" of the air and is represented by a particular color. These are the colors you may see listed as indicators of air quality in the news media or on DEQ's Web site.

Good: The AQI value is between 0 and 50. Air quality is considered satisfactory and air pollution poses little or no risk. Color: Green. How does this affect me? The air quality is good. No precautions necessary. Breathe deeply and enjoy!
Moderate: The AQI is between 51 and 100. Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of individuals. For example, people who are unusually sensitive to ozone may experience respiratory symptoms if ozone levels fall into this range. Color: Yellow. How does this affect me? Sensitive people* should plan strenuous outside activities when air quality is better.
Unhealthy for Sensitive Groups: The AQI is between 101 and 150. Members of sensitive groups may experience health effects. Color: Orange. How does this affect me? Sensitive people* should cut back or reschedule strenuous outside activities. Everyone else should consider limiting strenuous outdoor activities.
Unhealthy: The AQI is between 151 and 200. Everyone may begin to experience health effects. Members of sensitive groups may experience more serious health effects. Color: Red. How does this affect me? Sensitive people* should avoid strenuous outside activities. Everyone else should cut back or reschedule strenuous outside activities.
Very Unhealthy: The AQI is between 201 and 300. This will trigger a health alert, meaning everyone may experience serious health effects. Color: Purple. How does this affect me? Sensitive people* should avoid all outside physical activities. Everyone else should significantly cut back on outside physical activities.
Hazardous: The AQI is over 300. This triggers health warnings of emergency conditions. The entire population is likely to be affected. Color: Maroon. How does this affect me? Everyone should avoid all outside physical activities.

** Sensitive people/groups include children, the elderly, those with existing health conditions, and people who have high exposure (those who work, exercise, or spend extensive time outdoors).*

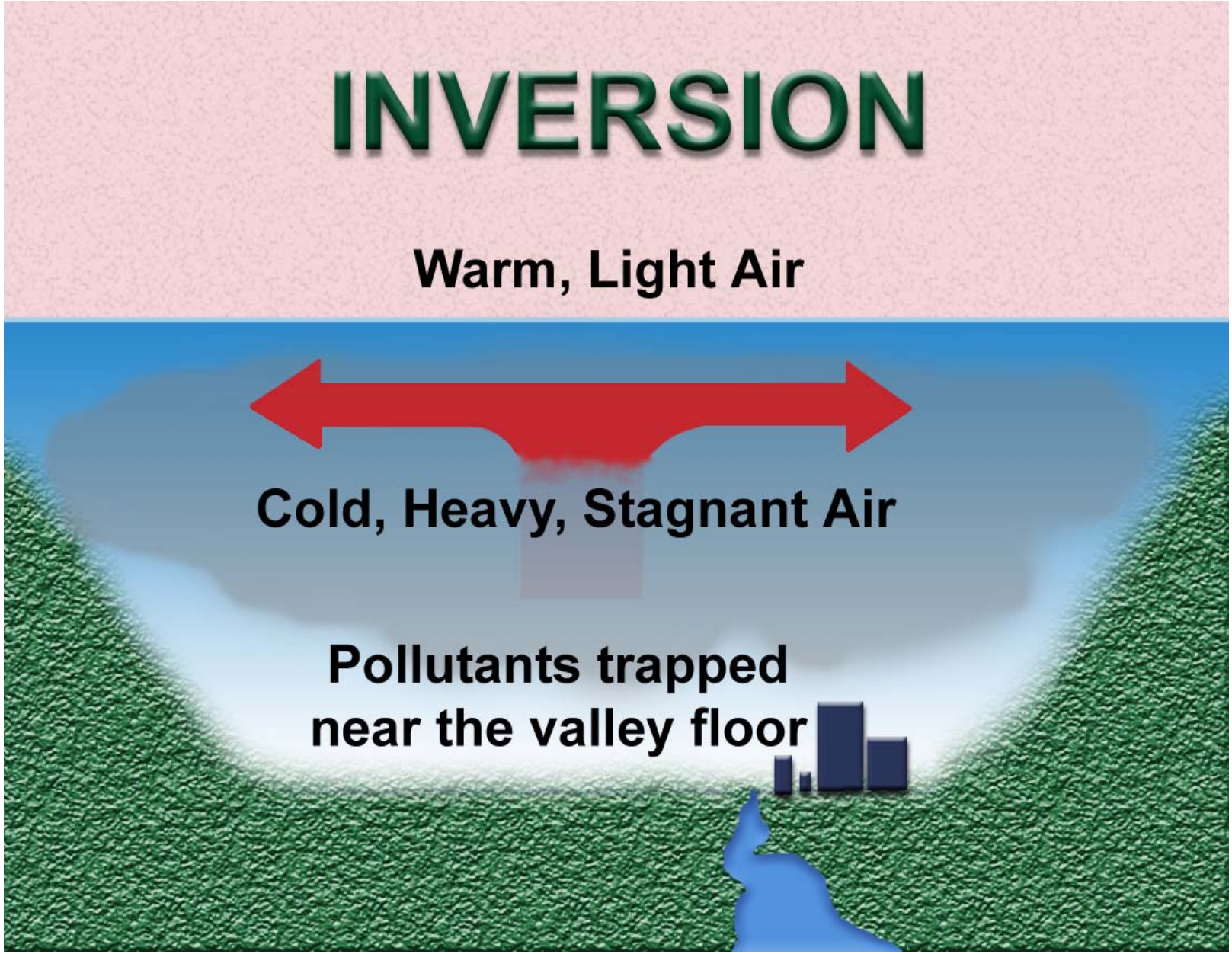
How Can I Find Information on the AQI Where I Live?

- DEQ reports the AQI for 18 communities around Idaho where air quality is measured. You can find the AQI for your (or a nearby) community at www.deq.idaho.gov/air/aqindex.cfm.
- Subscribe to EPA's EnviroFlash at www.airnow.gov/index.cfm?action=airnow.enviroflash to receive air quality alerts.
- Subscribe to DEQ's email subscription service for email bulletins at www.deq.idaho.gov (look for the box that says "Sign up for E-mail Updates").
- Check your local newspaper, TV and radio stations, and state and local telephone hotlines.

For More Information…

DEQ's AQI Web site: www.deq.idaho.gov/air/data_reports/monitoring/aqi.cfm

EPA's AIRNow AQI Web site www.airnow.gov/


INVERSION
Warm, Light Air
Cold, Heavy, Stagnant Air
Pollutants trapped
near the valley floor