



# Pre/Post Visit Activities

## H<sub>2</sub>O Below Lesson

Recommended for 4<sup>th</sup> - 6<sup>th</sup> grade

**Lesson Description:** Get to know groundwater and its important role in Boise's water supply. Observe movement of water through different sediment samples. Discover how the water cycle cousins, groundwater and surface water, interact as students infiltrate water and "pollution" through an aquifer model. Take home ideas of ways to prevent pollution, and build an edible aquifer to get a yummy taste of what you learned!

**Objective:** Students will demonstrate how water moves through different substrates, and understand the uses and importance of groundwater.

### Idaho State Science Standards Met for Grades 4-6

4: 4.S.1.1.1, 4.S.1.2.3,

5: 5.S.1.2.3, 5.S.5.1.1, 5.S.5.3.1

6: 6.S.1.2.3, 6.S.5.1.1, 6.S.5.3.1

<b>Contents:</b>	<b>1. Background Information</b>	<b>pages 2-7</b>
	<b>2. Stewardship</b>	<b>pages 8-10</b>
	<b>3. Student Activities</b>	<b>pages 11-13</b>
	<b>4. Answer Keys</b>	<b>page 14</b>
	<b>5. Library Resources</b>	<b>page 15</b>
	<b>6. Internet Resources</b>	<b>page 16</b>

### Copyright Disclaimer:

The information contained in this document is strictly for educational purposes. The Boise WaterShed Environmental Education Center does not take full credit for creating all of images and text found in this document. Images have been acquired from various Internet sources. In some cases, text has been acquired and modified from various Internet and print sources. If any copyrighted material is found here that is not properly sourced, please contact us immediately so that the images or text can be removed, or appropriate credit given (whichever is preferred).

### For more information, please contact:

Boise WaterShed Environmental Education Center ■ (208) 489-1284 ■ [www.BoiseEnvironmentalEducation.org](http://www.BoiseEnvironmentalEducation.org)

# Background Information

**Groundwater** is water that is present under the ground surface. This water is stored within the cracks and **pores**, or open spaces, in earth materials such as soil and rock. Groundwater occurs in **aquifers**, underground reservoirs of water-filled porous earth material from which people can obtain useful quantities of groundwater. People drill **wells** into aquifers and pump groundwater from underground up to the surface, where we can use the water for drinking, cleaning, irrigation, and industrial uses such as cooling power plants. Groundwater is connected to surface water; water from precipitation, and from lakes and rivers on the surface, can **infiltrate**, or move downward through, soils in the **unsaturated zone** where most pores are filled with air. Eventually, infiltrating water reaches the **water table**, the upper boundary of the **saturated zone** where most pore spaces are filled with water. Water that replenishes the groundwater reservoir is known as **recharge**.

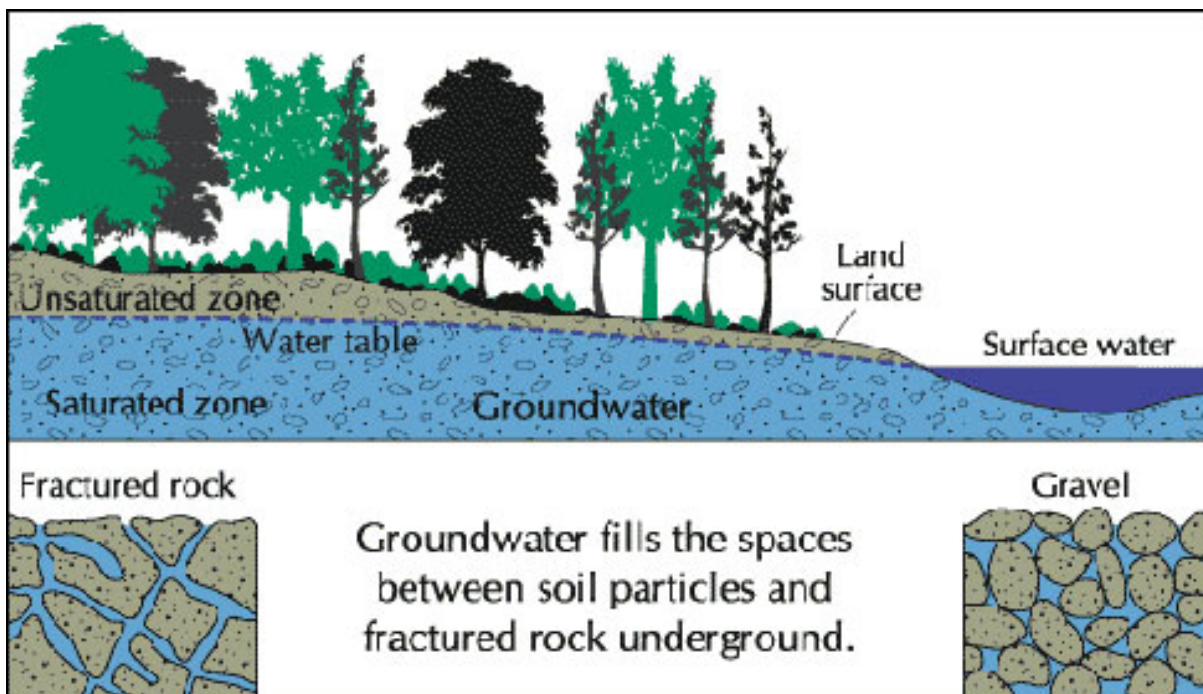
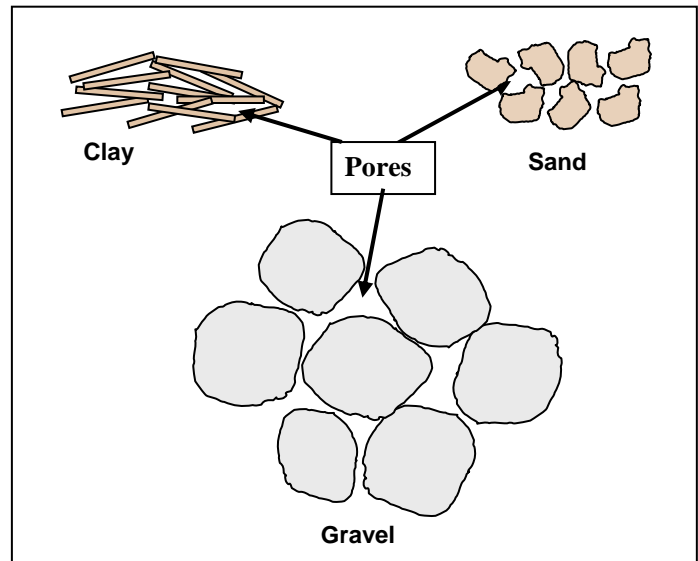


Figure courtesy of <http://www.groundwater.org/gi/whatisgw.html>.

## Does Groundwater Flow?

Groundwater does flow, like water on the surface, but in contrast to **surface water**, groundwater moves very slowly since it must move through tiny openings in ground materials such as rock or soil. Some groundwater moves as slowly as one inch per century, while some may move one hundred inches per day.



Groundwater moves at different **rates**, or speeds, depending on the **permeability** of the earth material it is moving through. For example, the large, connected pore spaces between rounded particles of sand and gravel allow groundwater to move through relatively fast; such sand and gravels are **permeable**. Permeable materials let water pass through readily, just like ice cubes allow juice to pass through to the bottom of a glass. The small, disconnected pores in clay can prevent water from moving; such materials are **impermeable**. Impermeable materials act as a wall that blocks water from moving, like the bottom of a glass prevents juice from spilling onto the table!

Did you know that groundwater can flow upward? This is because groundwater flows to the region of lowest pressure; if water pressure is greater lower in the aquifer, water will move upward to the lower-pressure area.

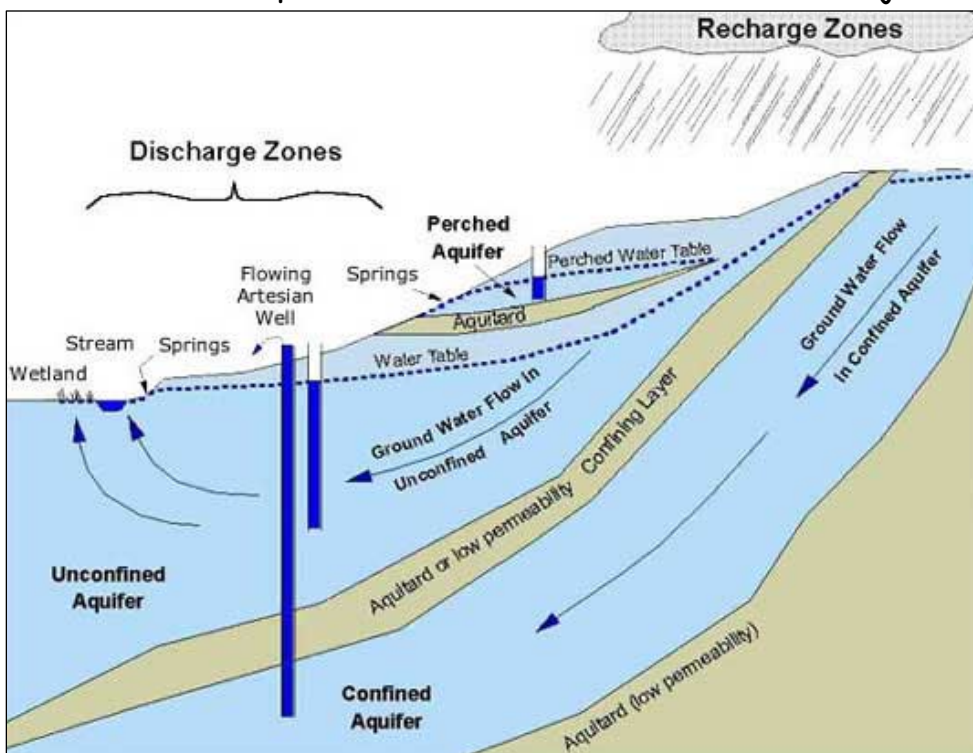
## What Does an Aquifer Look Like?

If you could cut a slice of the earth and lift it up, it would be sort of like looking at a slice of layered cake, but instead of tasty layers of chocolate and vanilla, the layers could be earth materials such as soil, gravel, sandstones, basalt, or granite, for example. Impermeable materials can form an **aquitard**, or **confining layer**, a layer of earth that water can move across only very slowly, or



Image courtesy of <http://saraleefoodservice.com>

not at all. **Confined**, or **artesian aquifers** are located below an aquitard. When a well is drilled into an artesian aquifer, water in the well can rise above the level of the aquifer because the artesian aquifer is under pressure greater than atmospheric pressure. The level to which artesian water rises in a well is the **potentiometric surface**. When a well is drilled into an artesian aquifer, the well may be a **flowing artesian well** if the potentiometric surface is higher than the top of the well. A **perched water table** can form when an aquitard exists above the water table, just like a bird on a branch is



“perched” above the ground. Groundwater is **discharged** on the surface at springs, rivers, wells and wetlands, when the water table or potentiometric surface intersects (or meets) the ground surface.

Figure courtesy of <http://www.johnston-independent.com/images/General/aquifer%20discharge.jpg>

## Can Groundwater Become Contaminated?

Groundwater can be **contaminated**, or negatively affected, by activities on the ground surface, as well as by below-ground sources. For example, industrial wastes, landfill **leachate** (liquid waste), chemicals, and fertilizers can infiltrate into the groundwater and make water unfit for human use. **Underground storage tanks (USTs)** which hold industrial chemicals such as petroleum and oil, or buried **septic tanks**, where some homes treat their sewage, can develop leaks over time and release contaminants into the groundwater. **Abandoned wells**, wells which are no longer used to obtain water, are sometimes left open at the surface and can become conduits for contaminants to migrate into aquifers. Since groundwater is underground, we can not see when it becomes contaminated. The contamination can **disperse**, or spread throughout an aquifer, before we even know it is there. Contaminants in groundwater can persist for decades or even centuries. Contaminated groundwater can be extremely difficult to **remediate**, or clean up, because it is located underground and because contaminants can disperse unpredictably. Contaminated groundwater can even spread to surface waters through springs and streams. Remediation methods depend on the type of contaminant,

but range from pumping the water out, to adding microorganisms which can convert the contaminant to a less harmful product.

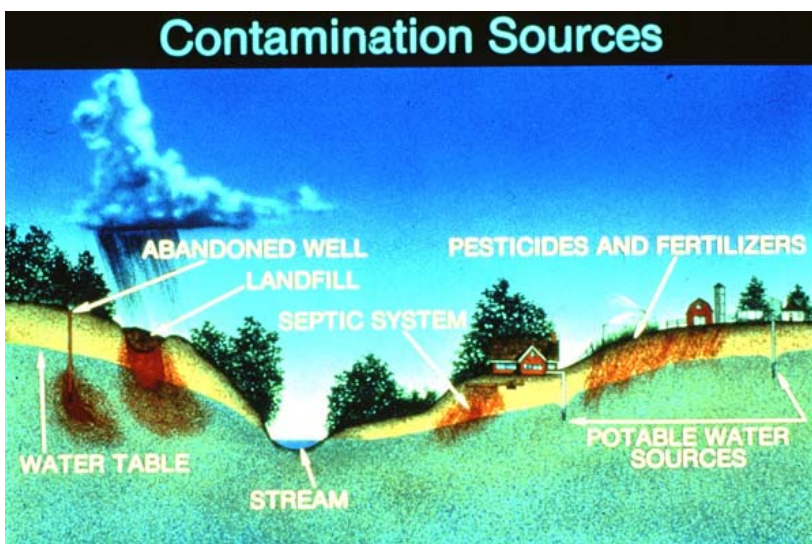


Figure courtesy of <http://www.wesleyan.edu/>

## The Snake River Plain Aquifer

Southern Idaho is the home of one of the most productive aquifers in the world, the **Snake River Plain Aquifer**. This aquifer is estimated to contain more than twice the volume of water of Lake Erie. It extends over more than 10,000 square miles, and supplies most of the water used in over 100 industrial plants, 200 Idaho cities and towns, in addition to more than 1.5 billion gallons of irrigation water each day. In the Boise area, about **80%** of our drinking water comes from groundwater pumped from part of the Snake River Plain Aquifer. The aquifer materials include volcanic rock and sedimentary materials such as sand, gravel, and mud.

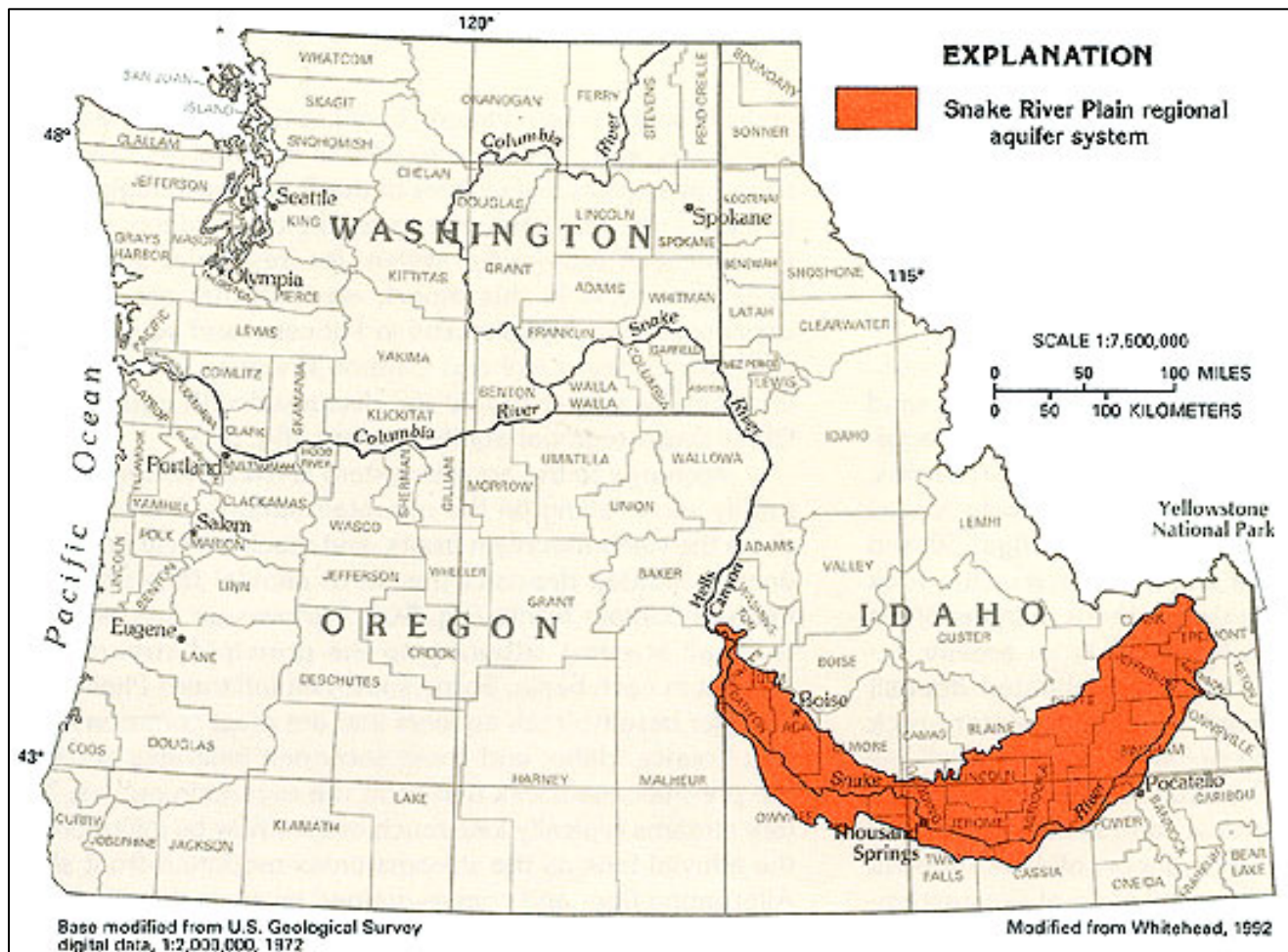


Figure courtesy of [http://geology.isu.edu/Digital\\_Geology\\_Idaho/Module15/mod15.htm](http://geology.isu.edu/Digital_Geology_Idaho/Module15/mod15.htm)

## What is Geothermal Water?

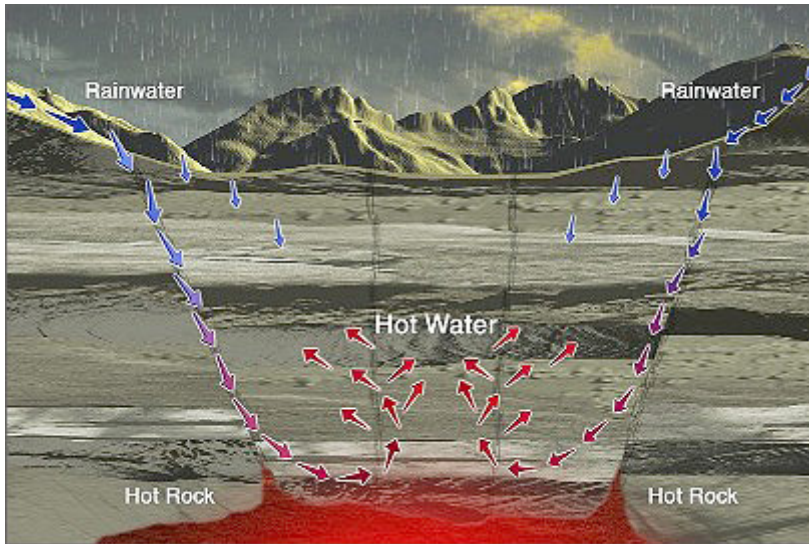


Figure courtesy of <http://www1.eere.enerav.aov/>

**geysers**. You may have visited or seen pictures of the Old Faithful Geyser in Yellowstone, where hot geothermal water sprays forcefully out of the ground (see below right). In Idaho, the steam associated with some geothermal water is used to spin turbines and generate power. Geothermal water is also used directly to heat homes, buildings, resorts, and greenhouses, and is used in **aquaculture** (farming of aquatic organisms such as fish and plants). The Boise Capitol Building and Zoo Boise are heated by geothermal water, and the Boise Warm Springs Water District is one example of a district heating system, a series of multiple buildings connected by distribution lines for geothermal water.



Image courtesy of  
<http://www.destination360.com/north-america/us/wyoming/old-faithful.php>

# Stewardship

**Environmental stewardship** is taking personal responsibility for the natural environment. It is up to you and everyone on our planet to take care of our natural resources for today—and tomorrow.

**Sustainability** is widely defined as the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs.



*Image courtesy of*  
<http://computing.fs.cornell.edu>

## How You Can Help

Every person—including you—has the chance to make a difference by practicing environmental stewardship. Look for opportunities at home, at school, at work, in your community, and while shopping and traveling. The possibilities are endless, and the cumulative impacts of individual actions can really add up.

### **Dispose of Hazardous Materials Properly** - Pouring hazardous materials into the



*Image courtesy of Ada County*  
[www.adaweb.net/](http://www.adaweb.net/)

sewage system can be as dangerous as pouring them right into the Boise River. Automotive, cleaning, and lawn care products, and household materials like shoe polish, rodent poison, aerosols, pool chemicals, and prescription drugs can pollute the river and impede wastewater treatment processes. You can minimize your use of such products, and choose

environmentally safe alternatives to them, such as baking soda instead of harsh

cleansers. When you dispose of such materials, take them to the Ada County Household Hazardous Materials Collection Facility, or look for the mobile collection EnviroGuard vehicle. The facility also offers a free material reuse program, where unused portions of hazardous materials can be donated and obtained- for free!

**Join a citizen water monitoring group** - Take a snapshot of the health of the Boise River watershed by monitoring water quality. Citizen groups, families, schools and individuals may check out a water quality testing kit throughout the year from the Boise WaterShed. Each group will be provided with a basic water quality testing kit to test the water's temperature, pH, dissolved oxygen and turbidity. Sign up today by calling the Boise WaterShed at 489-1284 or send an e-mail to [BoiseWaterShed@cityofboise.org](mailto:BoiseWaterShed@cityofboise.org). You can also contact the Boise WaterShed to find out when they plan to host a community-wide Water Monitoring Day event.



Image courtesy of Partners for Clean Water

**Mark storm drains in Boise** - Storm drain marking is a visible reminder that storm drains are for stormwater only. Marking involves people educates and increases awareness about the importance of the river and the environment. Contact Aimee Hughes, Environmental Education Specialist, with Boise Public Works at 384-3901 or send an e-mail to [AHughes@cityofboise.org](mailto:AHughes@cityofboise.org) to reserve marking kits. Aimee will assist you with selecting an area in town that needs marking, such as neighborhoods, shopping malls or parking lots.

**Clean up a designated area** - Any day of the year, you can call the Boise WaterShed for gloves and trash bags for a cleanup. The Boise RiverSweep is an annual event the second Saturday in September designed to give back to the river that gives so much to us. Volunteers, students, and concerned citizens join together to clean up the Boise River to help provide a safe and clean Boise River for our community to use for many generations to come. The City of Boise's Adopt the Greenbelt program is designed to help keep the Greenbelt and Boise River clean and safe to use. As a participant, you can adopt a 1/2 to 2/3 mile section of the Greenbelt to inspect and care for throughout the year. This program allows you to work when your schedule allows. To find out more about Boise RiverSweep or Adopt A Greenbelt, contact Jerry Pugh at 384-4060, Ext. 319.



Image courtesy of City of Boise

# Student Activity

Name \_\_\_\_\_

## H<sub>2</sub>O Below Vocabulary Matching Game

Match each word to its definition by writing the letter of the word next to its correct definition on the right.

- |                                     |   |
|-------------------------------------|---|
| <b>A.</b> Aquifer                   | ___ The specific source of most of the drinking water used in the Boise area.   |
| <b>B.</b> Permeability              | ___ To clean up contamination by removing or treating the contaminant.  |
| <b>C.</b> Contaminant               | ___ Taking personal responsibility for, and caring for, our natural resources.  |
| <b>D.</b> Snake River Plain Aquifer | ___ The level to which artesian water rises in a well.  |
| <b>E.</b> Fault                     | ___ The upper boundary of the saturated zone.   |
| <b>F.</b> Potentiometric surface    | ___ An underground reservoir of water-filled porous earth material from which people can obtain useful quantities of groundwater.     |
| <b>G.</b> Remediate                 | ___ Water that is heated deep within the earth and can be used to generate power and heat buildings.                                  |
| <b>H.</b> Artesian aquifer          | ___ A type of aquifer which is located beneath an aquitard, and which contains water under higher pressure than atmospheric pressure. |
| <b>I.</b> Stewardship               | ___ A crack or fracture within the earth.   |
| <b>J.</b> Geothermal water          | ___ How rapidly water can move through earth materials due to the size and interconnectedness of pores.                               |
| <b>K.</b> Water Table               | ___ A substance that can produce a negative effect in a natural system if enough of it is present.                                    |

# Student Activity

Name \_\_\_\_\_

## H<sub>2</sub>O Below Lesson Review

**1. What is groundwater?**

---

---

---

**2. Why is groundwater important? Name 3 uses of groundwater.**

---

---

---

**3. How does water get into an aquifer?**

---

---

---

**4. There are two types of aquifers: confined and unconfined. How are they different?**

---

---

---

**5. How do you use the Snake River Plain Aquifer?**

---

---

---

**6. What is geothermal water used for?**

---

---

---

---

**7. List 5 items or activities that could contaminate groundwater:**

1. \_\_\_\_\_

2. \_\_\_\_\_

3. \_\_\_\_\_

4. \_\_\_\_\_

5. \_\_\_\_\_

**8. Do you think groundwater moves faster through clay or gravel? Why?**

---

---

---

---

**9. How can you practice environmental stewardship?**

---

---

---

---

**10. Draw an aquifer, using as many concepts from this course as you can.**



# Answer Key

## H<sub>2</sub>O Below Vocabulary Matching Game

- A. Aquifer:** An underground reservoir of water-filled porous earth material from which people can obtain useful quantities of groundwater.
- B. Permeability:** How rapidly water can move through earth materials due to the size and interconnectedness of pores.
- C. Contaminant:** A substance that can produce a negative effect in a natural system if enough of it is present.
- D. Snake River Plain Aquifer:** The source of most of the drinking water used in the Boise area.
- E. Fault:** A crack or fracture within the earth.
- F. Potentiometric Surface:** The level to which artesian water rises in a well.
- G. Remediate:** To clean up contamination by removing or treating the contaminant.
- H. Artesian Aquifer:** A type of aquifer which is located beneath an aquitard, and which contains water under higher pressure than atmospheric pressure.
- I. Stewardship:** Taking personal responsibility for, and caring for, our natural resources.
- J. Geothermal Water:** Water that is heated deep within the earth and can be used to generate power and heat buildings.
- K. Water Table:** The upper boundary of the saturated zone.

## H<sub>2</sub>O Below Lesson Review

1. Groundwater is water stored underground in the cracks and pores in earth materials.
2. It is an important source of drinking water, as well as of water for irrigation and industrial uses.
3. Precipitation (rain, snow) infiltrates downward through soil and unsaturated earth materials until it reaches the water table and becomes groundwater.
4. Unconfined aquifers are at atmospheric pressure, and are not overlain by an aquitard. Confined, or artesian, aquifers are overlain by an aquitard and their water is under pressure greater than atmospheric pressure.
5. For example, drinking water, cleaning and bathing, watering pets and plants, irrigation, etc.
6. Power generation (steam makes turbines spin), heating buildings, aquaculture, recreation (hot springs).
7. For example: Leaky underground storage tanks, septic systems, leaking landfills, use of excessive pesticides and fertilizers in agriculture and landscaping, allowing cars to drip oil and gas, dumping hazardous materials on the land surface or in surface water bodies.
8. A good explanation goes a long way in this question. The reality is that water moves faster through gravel because the pore spaces are both larger and more connected than in clay.
9. Dispose of hazardous materials properly, monitor water, don't litter, mark storm drains, pick up trash, become aware of the impacts your activities have on water resources.
10. Extra points for incorporating new concepts like aquitards, wells, recharge and discharge areas, layered earth materials, and so on.

# Boise WaterShed Library Resources

Take advantage of these FREE resources available for check-out from the Boise WaterShed Library Resource Center. Call (208) 489-1284 to reserve for a two-week period.

## **Videos, DVDs & Software**

- 2005 Water Awareness Week Region #3 Exploring Groundwater: VHS, 43 minutes
- Blue Planet: IMAX Corporation; VHS, 1990, 42 minutes
- Protecting Idaho's Drinking Water: Association of Idaho Cities, DVD and CD Toolkit

## **Educator Resources**

- That Magnificent Groundwater Connection, A resource book for grades K-6: New England Interstate Water Pollution Control Commission, 1996
- Project WET Curriculum and Activity Guide: Project WET International/CEE 2008
- EPA Drinking Water Activities for Students, Teachers, and Parents: U.S. Environmental Protection Agency, 1999
- Making a Bigger Splash, A collection of water education and festival activities: The Groundwater Foundation

## **Kids Books**

- Water, See for Yourself: T. Day, DK, London, 2007.
- Water, the Amazing Journey: C. Trafford, Etram Pty Ltd, Australia 2006.
- A Drop Around the World: B.S. McKinney, DAWN Publications, Nevada City CA, 1998.
- Water Dance: T. Locker, Voyager Books, Harcourt Inc., Orlando, 2002.
- The Magic School Bus; Wet All Over: Scholastic Inc., New York, 1996.
- The Question and Answer Book, Rocks and Minerals: E. Marcus, Troll Associates, 1983.

## **Other Books**

- Water Follies; Groundwater Pumping and the Fate of America's Fresh Waters: R. Glennon, Island Press, Washington DC, 2002.
- Cadillac Desert; The American West and its disappearing water: M. Reisner, Penguin Books, New York, 1993.
- Water Wars; Privatization, Pollution, and Profit: V. Shiva, South End Press, Cambridge MA, 2002.
- Overtapped Oasis; Reform or revolution for western water: M. Reisner and S. Bates, Island Press, Washington DC, 1990.
- Not a Drop to Drink; America's Water Crisis (and what you can do): K. Midkiff, New World Library, Novato California, 2007.
- Water; A natural history: A. Outwater, Basic Books, New York, 1996.
- To Reclaim a Divided West; Water, Law, and Public Policy 1848-1902: D.J. Pisani, University of New Mexico Press, Albuquerque, 1992.
- Handbook of Water Use and Conservation: A. Vickers, Waterplow Press, MA, 2001.

## **Models**

- EnviroScape Stormwater/ Groundwater model
- Aquifer Model

## Internet Resources

<http://www.groundwater.org/gi/gi.html>

**The Groundwater Foundation** is a fantastic resource for information, educational activities, games, coloring sheets, and other free stuff for teachers, kids, and community members. Lots of useful and interesting items free for the taking.

<http://ga.water.usgs.gov/edu/index.html>

**Unites States Geological Survey (USGS) Water Science for Schools** contains great summaries, activities, diagrams and links for teachers and students. Terrific resource for water-related education.

<http://oceanworld.tamu.edu/resources/oceanography-book/groundwaterremediation.html>

**Oceanography in the 21st Century**, an Online Textbook contains articles on groundwater, contamination, and remediation. Great resource for students and teachers, with concise information and good diagrams.

<http://earthguide.ucsd.edu/earthguide/diagrams/groundwater/index.html>

Illustrative video of aquifers and groundwater, pumping wells, and the surface-groundwater interaction produced by Earthguide, part of the **Scripps Institution of Oceanography**. Highly recommended for a brief class demonstration.

<http://groundwateradventurers.org/h2Oexperiments.html>

**The National Groundwater Association** Groundwater Adventurers page offers grade-level specific activities, experiments, facts, news, and links involving groundwater topics. Lots of useful materials are available here.

[http://geology.isu.edu/Digital\\_Geology\\_Idaho/Module15/mod15.htm](http://geology.isu.edu/Digital_Geology_Idaho/Module15/mod15.htm)

**Digital Geology of Idaho** offers maps, information, a cool slideshow on the Snake River Plain, several "flythroughs" of regional features, and geologic information on development of the Snake River Plain Aquifer.

[http://pubs.usgs.gov/ha/ha730/ch\\_h/H-text13.html](http://pubs.usgs.gov/ha/ha730/ch_h/H-text13.html)

The **USGS** Groundwater Atlas of the United States contains articles and diagrams focusing on the Idaho, Oregon, and Washington regions. Geared toward more advanced students and curious teachers, the site is a comprehensive resource for local groundwater issues.

<http://water.usgs.gov/outreach/OutReach.html>

The **U.S. Geological Survey** provides multiple water-related posters free for downloading. [www.insideeducation.ca/](http://www.insideeducation.ca/) The Canadian website **Inside Education** offers several free posters and kits with minimal shipping costs to the United States.