LESSON 3 – GROUNDWATER

(Walt Sutterlin)

BENCHMARK:

SCI. V.2.MS.3—Explain how water exists below the earth's surface and how it is replenished.

SCI.I.1.MS.1—Generate scientific questions about the world based on observations.

SCI.I.1.MS.5—Use sources of information in support of scientific investigations.

SCI.II.1.MS.3—Show how common themes of science, mathematics and technology apply in real world contexts.

SCI.II.1.MS.5—Develop and awareness of and sensitivity to the natural world.

PURPOSE:

Students will expand their understanding of the water cycle through class discussion by observing demonstrations and participating in an experiment to conceptualize aquifers and their importance as a source of water.

TARGET AUDIENCE:	6th Grade
TIME:	1 – 45 minute class period
MATERIALS:	large boat sponge
	clear dish to hold the sponge
	300 ml beakers (one per group)
	mason jars (one per group)
	sand (enough to fill all jars)
	pea gravel mixture (enough for 2 inches per jar)

BACKGROUND CONTENT:

Groundwater is a major water source for many people and an important part of the natural water cycle. Not all rainwater results in runoff into open bodies of water because much is absorbed into the ground. Soil and rock in the earth are **permeable**, allowing water to collect in the spaces between until it reaches a depth where the ground is filled with water, called the **saturated zone**. The top of this zone is called the **water table**. The water table may be very near the ground's surface or it may be hundreds of feet below.

All of this stored water is called an **aquifer**. Aquifers are **recharged** by new rainwater or transferring surface water from lakes or rivers. Aquifers are **depleted** when people take water using a **well**, or by **artesian wells** and through the water cycle. Plants also use groundwater.

Vocabulary

Groundwater – water contained under the ground's surface

Water Table – the top of the saturation zone

Saturation Zone – the area where water fills the spaces between soil, sand and rock underground
Aquifer – the geologic formation of sand, soil and gravel where groundwater is stored
Recharge – to increase the amount of groundwater through precipitation or surface water that absorbs into the aquifer, also called infiltration
Permeable – any material that allows water to penetrate through
Depletion – occurs when water is used faster than it is replaced; can cause a shortage
Well – a hole or shaft drilled into the earth to pump water to the surface
Artesian well – a free-flowing well occurring when the level of confined water is above the land surface

Teacher Resources

USGS: Science for a changing world (2005). *Aquifer Basics.* Retrieved November 12, 2005 from http://capp.water.usgs.gov/aquiferBasics/.

Student Resource

National Atlas (2005). *Map Maker*. Retrieved November 12, 2005 from http://nationalatlas.gov/natlas/Natlasstart.asp.

The Groundwater Federation. (2003). *Kids Corner*. Retrieved November 12, 2005 from http://www.groundwater.org/kc/kc.html

ENGAGE:

Begin by placing a boat sponge in a clear dish. Pour enough water on the sponge so that it wets it thoroughly, but does not puddle in the bottom of the dish (100-200ml is usually enough). Have students share their observations of the demonstration and write them on the board or overhead. (This is a metaphor for how the ground is recharged by rainwater.)

Pre-assessment questions: Where did the water go? (it's in the sponge) What could these supplies resemble in nature? (dish=rock, sponge=soil, water=rain) How can we get the water back out of the sponge without wringing it? (leading question…wells)

EXPLORE:

1. Put students into groups no larger than 4 per group so all can participate.
2. Distribute jars, sand and gravel.
3. Direct students to pour about 2 inches of gravel into the jar.
4. Allow students to fill their jar to about 1 inch from the top with sand.
5. Have students slowly pour 200 ml of water into the jar.
6. After the water settles, have students write their observations, focusing on describing what the sand and gravel sections look like.

EXPLAIN:

1. Bring class back together from groups to share what each group's observations were. List these on the board or overhead. There is no need to duplicate observations if other groups agree to having seen the same thing.
2. Go through each observation and have students discuss why each occurred. Facilitate the discussion so that accurate concepts are developed, but let the students articulate the understandings.
3. Provide vocabulary words to identify accurate terminology for what is witnessed.

Expected results

- Water pooled in the gravel (**aquifer** was **recharged** because soil is **permeable**)
- From aquifer to about halfway up the jar, there is water and the sand is dark (**saturation zone**)
- Sand changes from dark to light where the water stops (**water table**)

Embedded assessment questions: Is the color of the mixture consistent? (should be darker at the bottom) Why or why not? (saturation zone) Can they see actual water? (pooled aquifer in the gravel) What would happen if the mixture were in a larger jar? (water table would be lower and saturation zone would be shorter) When would the water stop? (when it hit solid bottom) If this were the earth what are the different elements we've recreated? (sand=soil, gravel=rock layers, bottom of jar=parent rock) Is there still water above the water table? (yes, but it's not saturated.)

ELABORATE:

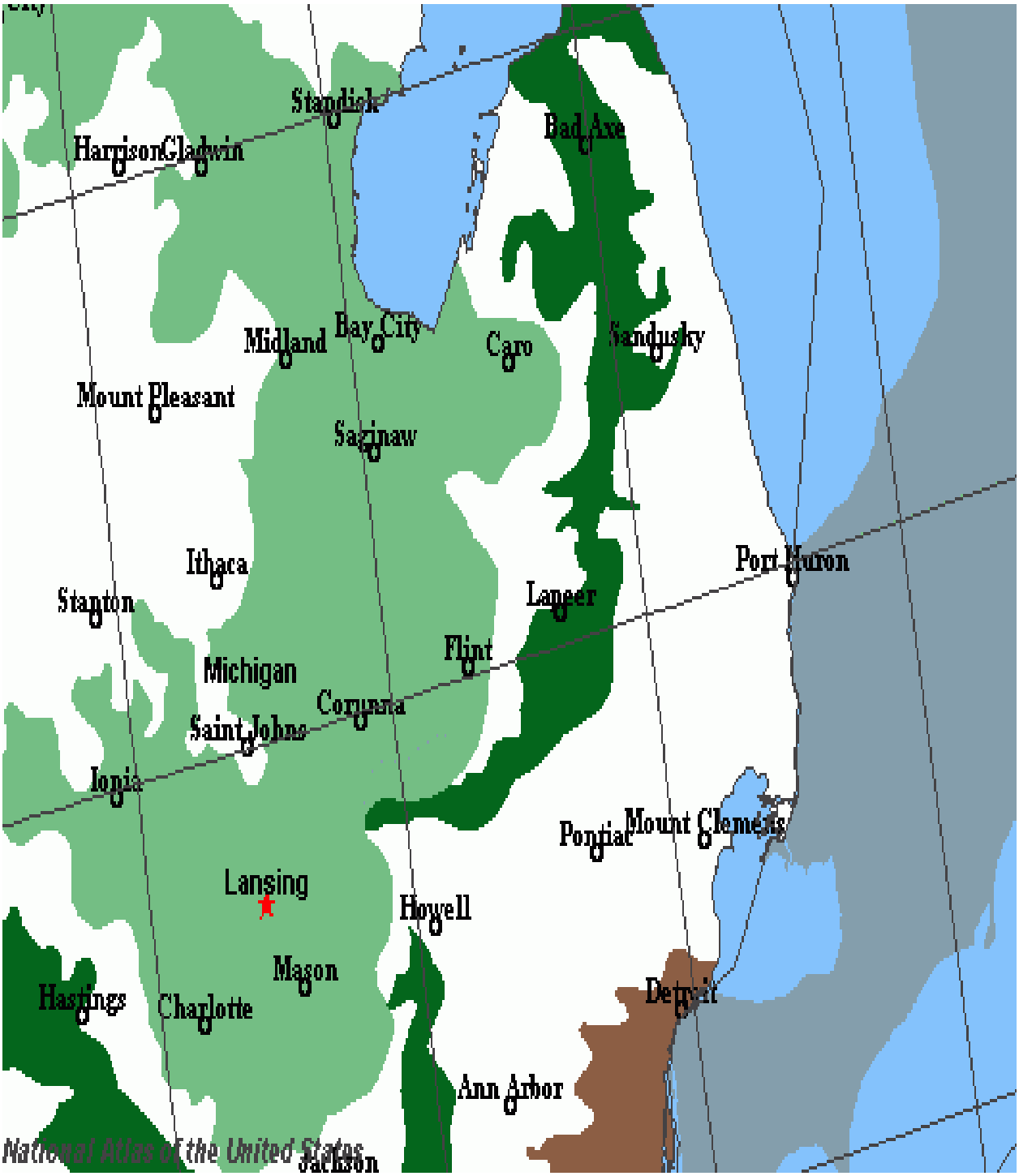
1. Ask students if they think the earth beneath the classroom could have an aquifer and discuss where rainwater goes at the school or their homes. Have students explain how the sponge demonstration relates to the jar experiment and what they now know about aquifers.
2. Show map of Michigan aquifers from NationalAtlas.gov (Appendix 3.1) and discuss where large aquifers are in proximity to their school or home. Discuss how this aquifer is recharged and who might use water from it (depletion).
3. Ask again, "How do we get water back out of the aquifer?" Discuss the difference between wells and artesian wells and find out which students use a well. Discuss the consequences if we take water faster than it can be recharged.

EVALUATE:

Post-assessment: Draw and label an aquifer, explaining how it works using the vocabulary discussed in class. The following rubric will be used to evaluate attainment.

	50 points	**35 points**	**30 points**	**Total Points**
Vocabulary	8 or more words used	4-7 words used (+1 point per word)	3 or fewer words used (+1 point per word)	
Accuracy	All labels accurate	>50% of labels accurate (+1 point per accurate label)	<50% of labels accurate (+1 point per accurate label)	

APPENDIX 3.1


Standish
Bad Axe
Harrison
Gladwin
Midland
Bay City
Caro
Sandusky
Mount Pleasant
Saginaw
Ithaca
Port Huron
Stanton
Lapeer
Flint
Michigan
Corunna
Saint Johns
Ionia
Pontiac
Mount Clemens
Lansing
Howell
Mason
Hastings
Charlotte
Detroit
Ann Arbor
National Atlas of the United States

LESSON 4 – WATER POLLUTION

(Walt Sutterlin)

BENCHMARKS:

SCI. V.2.MS.4—Describe the origins of pollution in the hydrosphere.

SCI.I.1.MS.1—Generate scientific questions about the world based on observations.

SCI.II.1.MS.3—Show how common themes of science, mathematics and technology apply in real world contexts.

SCI.II.1.MS.5—Develop and awareness of and sensitivity to the natural world.

PURPOSE: Students will create a miniature model of how water pollution occurs, then brainstorm the causes and consequences of water pollution and their role in prevention.

TARGET AUDIENCE: 6th Grade

TIME: 1 – 45 minute class period

MATERIALS:
1 gallon milk jug
1 jar that holds at least 27 ml
8 oz yogurt cups (one per group)
8x2x3 aluminum pie pan (one per group)
(paint trays work great but are expensive)
200 ml sand per group
liquid food coloring
1 bottle motor oil
pencil sharpener scrapings
1 oz scooper or eye dropper
1 feather per group
1 Nerf ball or soft object for throwing

BACKGROUND CONTENT:

Even though 75% of our planet is made of water, 99% of that water is relatively unusable because 97% is saltwater in the ocean and 2% is glaciers and not readily available. The 1% remaining is surface water, groundwater and rain, which is not completely accessible in certain phases of the water cycle. Humans create **pollution** in all of these sources regularly through industrial leaks and dumping of chemicals, agricultural **runoff** of fertilizers and animal waste, **sewage** leaks and dumping and oil spills. All of these activities contaminate the water affecting our **food chain**.

Fertilizer runoff can enhance growth of plant life unnaturally which throws off the equilibrium of oxygenation in water for other living organisms. Some fertilizers called **PCBs** can adversely affect living organisms by compromising their immune systems and reproductivity. **Acid rain** can be emitted into the atmosphere from factories, volcanoes or the natural production of carbonic acid from decomposing matter in the earth. Some

chemical pollutants have similar effects or simply kill living organisms, all of which affect the food chain negatively.

Vocabulary

Pollution – The contamination of soil, water, or the atmosphere by the discharge of harmful substances

Runoff – Water from snow melting or rain that flows over land to a river or other water body

Acid rain – Rain containing acids that form in the atmosphere when industrial gas emissions (especially sulfur dioxide and nitrogen oxides) combine with water

Fertilizer – Any of a large number of natural and synthetic materials, including manure and nitrogen, phosphorus, and potassium compounds, spread on or worked into soil to increase its capacity to support plant growth

PCBs (Polychlorinated Biphenyls) – Any of a family of industrial compounds produced by chlorination of biphenyl, noted primarily as an environmental pollutant that accumulates in animal tissue with resultant pathogenic and teratogenic effects

Sewage – Liquid and solid waste carried off in sewers or drains

Food Chain – A series of plants and animals within an environment of which each kind serves as a source of nourishment (food) for the next in the series

Teacher Resources

USGS: Science for a changing world (2005). *Water Science for Schools*. Retrieved November 13, 2005 from http://ga.water.usgs.gov/edu/earthhowmuch.html.

Bosak, S.V. (1998). *Science is…(2nd Ed.).* Markaham, Ontario, Canada: Scholastic Canada.

Student Resources

Kane Publishing (2002). ScienceSaurus: A Student Handbook. Wilmington, MA:Great Source Education Group.

Kean, Thomas H. (1995). *The Ocean, Exploring Interactions Beneath the Waves; Scholastic Science Place*. Camden: Scholastic.

ENGAGE:

Display a gallon jug full of water, explaining that this gallon (4000 ml) represents all of the water in the world. For review, have students name each form of water. Have a blank pie chart on the board or overhead and have students come up and fill in how our water is dispersed, using different colors (Oceans=97%, Glaciers=2%, Groundwater=.93%, Great Lakes=.04%, Rain=.02%, Rivers= .01%).

Pre-assessment questions: Which sources of water can we drink? (groundwater, lakes, rivers, rain) Why not the ocean or glaciers? (ocean is saltwater purifying it is costly; glaciers are frozen and difficult to access) Can we drink all of the 1% that's left? (no, some is polluted and it's always cycling)

Compare a 27ml jar of water to the gallon jug to show the dramatic difference in how much water there is and how much is at our disposal. Next, drip a few drops of food coloring into the jar (chemical runoff), then a drop of oil (oil spills/industrial pollution) and some pencil sharpener scrapings (solid pollution). Ask students if they would like to drink this water. Discuss what each substance represents and how they think those things get into each source of water.

EXPLORE:

1. In groups of 4 or less, hand out supplies. Each group gets one yogurt cup full of water, one dropper/scooper, 200ml of sand, one pie pan and one feather.
2. Direct students to pour sand into the pie pan and mound it on one side to create a "beach".
3. Direct students to pour almost all of the water into the bare side of the pie pan, leaving about a ¼ of the cup to be used later. (If they pour it all in, recharge them with water from the jug.)
4. As groups finish their beaches, walk around and pour a little oil into their water near the shore. Tell them there's been an oil spill. Ask one student to blow on the oil spill (making waves to simulate a storm). Explain this effect. Have students write their observations of what happens with the oil.
5. Instruct students to dip their feather in the oil and write their descriptions of what happens to the feather.
6. While students are writing, walk around and drop a few drops of food coloring into their beaches, not far from the water, but not in the water. Explain that this is chemical runoff from farms, factories or golf courses.
7. Instruct students to use the scooper/dropper and pour their remaining water on the food coloring, then write their observations of what happens. Does the "ocean" turn a color? What does the dye do to the oil? How long does it take the dye to get into their "ocean"?
8. Finally, walk around on sprinkle some pencil sharpener shavings on each "ocean" asking groups to dip their feather in the water again.

EXPLAIN:

1. Bring class back together to share each group's observations of their beach. List these on the board or overhead. Encourage descriptions as groups may have seen the same thing occur in different ways.
2. Have students discuss how each form of pollution got into the water. Facilitate the discussion so that accurate concepts are developed, but let the students articulate the understandings.
3. Provide vocabulary words to identify accurate terminology for what is witnessed.

Embedded assessment questions: What are some forms of pollution? (chemicals; sewage; oil spills; acid rain-volcanoes, factories, carbonic acid) How do these pollutants get into the water? (runoff from farms/golf courses, factories leaking or dumping, oil spills from tankers, people dumping oil or trash illegally, septic systems)

ELABORATE:

Discuss what the feather represented (birds) and how the oil and pencil shavings (litter) changed it. Lead students to answer these questions. How could this affect birds? (unable to fly or stay warm) What other living things could the pollution affect? (kills aquatic plants and animals) How does the chemical runoff affect these things? (PCBs) How does that effect us? (food chain is interrupted; we can consume tainted food/water) Does pollution across the world affect us? (yes) How? (ie. destroying a coral reef may affect fish population/supply; if other people's water is polluted we might have to share ours, acid rain can travel in clouds from far away and pollute our water, review how water gets from us to the ocean)

Embedded assessment: Assess whole class in an oral question/answer session reflecting on the experiment and information attained. Use a Nerf ball or some other soft object and toss to each student for "rapid fire" responses that will allow you to repeat questions, ensuring all students have same understanding and every student hears accurate responses repeatedly. Mention that they might want to take notes during this game…

Questions:

Name a source of water?

Name a source of pollution?

What effect does that pollution have on…humans…animals…you?

EVALUATE:

Post-assessment: Create three columns on your paper. In the first column, list water sources, in the second column list sources of pollution, and in the third column list effects of the pollution. After you have listed as many things as possible in each column, create a concept map using all of the items on your lists including accurate connections between all categories. The following rubric will be used to evaluate attainment:

	25 points	**20 points**	**15 points**	**Total Points**
Water Sources	All 6 included	3-5 included	0-2 included	
Pollution Sources	>5	3-4	<2	
Effects of Pollution	>5	3-4	<2	
Accurate Connections	All accurate	>50% accurate (+1 point per accurate connection)	<50% accurate (+1 point per accurate connection)	