Water’s Journey: The Hidden Rivers of Florida

Teacher’s Guide Based on the Documentary

Written by

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Introduction

*Water’s Journey: The Hidden Rivers of Florida* is an award-winning documentary that has been aired many times on public television broadcasting stations. The film is designed for us to learn more about our underground water and the need to protect and conserve our precious water supply. In doing so, a team of divers and scientists lead us through a section of the Floridan Aquifer system, simultaneously above and below ground. This unique experience allows us to track above ground the route of the underground divers as we explore the aquifer, springs, and sinkholes through their eyes. Throughout this journey, the impact humans have made on our water source is evident. You will experience the thrill of adventure, but also feel the agony of dismay as you too explore this underground phenomenon.

The film reveals a great need to increase awareness of responsible human action and conservation of our valuable water sources. Therefore, the producers of the video, Karst Productions, along with the Florida Department of Environmental Protection, are making this curriculum guide available to educators. The curriculum guide was designed to complement the documentary, *Water’s Journey: The Hidden Rivers of Florida*, and includes support specifically for 6th-8th grade educators. While the video can be shown to the students as a stand-alone product, this guide provides the tools necessary to expand far beyond the video. The middle school teacher will now have:

- Keys to identified Sunshine State Standards
- Reading connections including literature selections, vocabulary activities, as well as before, during, and after reading strategies
- FCAT-like prompts with scoring rubrics for reading, writing, mathematics, and science
- Hands-on, minds-on activities including reproducible student activity pages

The guide was developed with a strand for physical science, earth science, and life/environmental science. Additionally, strands are included for mathematics, language arts, and social studies. Each strand, utilizing the 5Es instructional design model, can be used in isolation, or in a “mix and match” plan to meet the needs of all members of middle school educators and teams. All middle school educators will find this guide a valuable resource for addressing the needs of Florida’s middle school students. If a teacher has as little as forty-five minutes or as much as forty-five days, teachers can utilize components of the *Water’s Journey* program. A traditional teacher wishing to stay within the bounds of one subject area, an eclectic teacher who likes to pick and choose from a variety of offerings, or a team member working to integrate the curriculum—all needs will be met.
Since the focus of this video is to promote water conservation and responsible human action, each strand in this guide addresses three Florida geological phenomena—aquifers, sinkholes, and springs—that are closely tied to water use in our state. Additionally, home/community connections and “taking action” suggestions are included in each strand. The producers of the video have also made available a variety of teacher support activities and materials, which can be accessed at the following websites:

www.floridasprings.org
www.floridasprings.com

The 5Es Learning Cycle

The learning cycle is an established planning method in science education and consistent with contemporary theories about how individuals learn. It is easy to learn and is useful in creating opportunities to learn science. You can think of the learning cycle model as having five parts, though these parts are not discrete or linear.

Engage: In most instances you will want to begin with Engage. In this stage you want to create interest and generate curiosity in the topic of study; raise questions and elicit responses from students that will give you an idea of what they already know. This is also a good opportunity for you to identify misconceptions in students’ understanding. During this stage students should be asking questions (Why did this happen? How can I find out?). Examples of engaging activities include the use of children’s literature and discrepant events.

Explore: During the Explore stage students should be given opportunities to work together without direct instruction from the teacher. You should act as a facilitator helping students to frame questions by asking questions and observing. Using Piaget’s theory, this is the time for disequilibrium. Students should be puzzled. This is the opportunity for students to test predictions and hypotheses and/or form new ones, try alternatives and discuss them with peers, record observations and ideas, and suspend judgment.
**Explain:** During Explain you should encourage students to explain concepts in their own words, ask for evidence and clarification of their explanation, and listen critically to one another’s explanation and those of the teacher. Students should use observations and recordings in their explanations. At this stage, you should provide definitions and explanations using students’ previous experiences as a basis for this discussion.

**Extend:** During Extend students should apply concepts and skills in new (but similar) situations and use formal labels and definitions. Remind students of alternative explanations and to consider existing data and evidence as they explore new situations. Explore strategies apply here as well because students should be using the previous information to ask questions, propose solutions, make decisions, experiment, and record observations.

**Evaluate:** Evaluation should take place throughout the learning experience. The teacher should observe students’ knowledge and/or skills, application of new concepts and a change in thinking. Students should assess their own learning. The teacher should ask open-ended questions and look for answers that use observation, evidence, and previously accepted explanations. Ask questions that would encourage future investigations.


**Suggestions for Using Subject Strand Matrix with 5Es Model**

The Subject Strand Matrix is divided into the following areas: Physical Science, Earth Science, Life/Environmental Science, Social Studies, English, and Mathematics. Within each strand, a suggested path of instructional options is given for each of the 5Es: Engage, Explore, Explore/Explain, Extend, and Evaluate.

There are multiple approaches to consider for instructional use of this matrix, for example:

- A middle school team could interweave the matrix vertically as well as horizontally to make choices from the activities presented for each of the 5Es within each content area. Students will be exposed to new experiences in each strand of the matrix without repeating learning activities.
Another approach is to view the matrix vertically by individual strand. In this manner, a teacher can deliver instruction via the 5Es listed for one content area (an integrated science teacher might want to pull from all three science strands).

An eclectic approach would allow a teacher to choose activities to meet student needs from any or all strands.

Suggestions for Use of the Documentary Materials

30 or 60-Minute Video:
In each of the six subject area strands, suggestions are given for establishing a purpose for viewing the feature thirty-minute or sixty-minute video. In addition, a suggested response activity is also provided for teacher use. These suggestions for viewing and responding are listed in the Explore portion of the Subject Strand Matrix with the 5Es Model for each of the six subject area strands.

6-minute Video:
This documentary communicates what karst is and could be used for note-taking purposes (see directions given in the Social Studies strand).

1-minute Video:
This short documentary gives a good explanation of what a spring and an aquifer are.
Earth Science

Grade Levels: 6-8

Overview: The video, *Water’s Journey: The Hidden Rivers of Florida*, tracks the arterial network of an underground waterway, both above and under ground, in real time. Content in this program includes properties of matter; changes of properties of matter; motions and forces; transfer of energy; and interactions among science, technology, and society.

Concept: The major concept is to provide opportunities for the study of general concepts, theories, and processes relating to the earth/space sciences, and their applications through exploratory investigations and activities.

Sunshine State Standards:

Science

Strand C: Force and Motion
- Knows that many forces act at a distance (i.e., without contact). (SC.C.2.3.1)

Strand D: Processes that Shape the Earth
- Knows that mechanical and chemical activities shape and reshape the Earth’s land surface by eroding rock and soil in some areas and depositing them in other areas, sometimes in seasonal layers. (SC.D.1.3.1)
- Knows how conditions that exist in one system influence the conditions that exist in other systems. (SC.D.1.3.3)
- Understands concepts of time and size relating to the interaction of Earth’s processes. (SC.D.1.3.5)
- Understands that quality of life is relevant to personal experience. (SC.D.2.3.1)

Strand G: How Living Things Interact with Their Environment
- Knows that some resources are renewable and others are nonrenewable. (SC.G.2.3.1)
- Knows that all biotic and abiotic factors are interrelated and that if one factor is changed or removed, it impacts the availability of other resources within the system. (SC.G.2.3.2)
- Understands that humans are a part of an ecosystem and their activities may deliberately or inadvertently alter the equilibrium in ecosystems. (SC.G.2.3.4)
Strand H: The Nature of Science

- Knows that scientific knowledge is subject to modification as new information challenges prevailing theories and as a new theory leads to looking at old observations in a new way. (SC.H.1.3.1)
- Knows that the study of the events that led scientists to discoveries can provide information about the inquiry process and its effects. (SC.H.1.3.2)
- Knows that accurate record keeping, openness, and replication are essential to maintaining an investigator’s credibility with other scientists and society. (SC.H.1.3.4)
- Knows that a change in one or more variables may alter the outcome of an investigation. (SC.H.1.3.5)
- Recognizes the scientific contributions that are made by individual of diverse backgrounds, interests, talents, and motivations. (SC.H.1.3.6)
- Recognizes that patterns exist within and across systems. (SC.H.2.3.1)
- Understands that contributions to the advancement of science, mathematics, and technology have been made by different kinds of people, in different cultures, at different times, and are an intrinsic part of the development of human culture. (SC.H.3.3.5)
- Knows that no matter who does science and mathematics or invents things, or when or where they do it, the knowledge and technology that result can eventually become available to everyone. (SC.H.3.3.6)

*Benchmarks for other subject areas will be identified with individual activities as appropriate.

Suggested Path for Implementation: (Using the 5Es Model)

Engage:
- Literature Connection: The Missing ‘Gator of Gumbo Limbo by Jean Craighead George pp. 16-18
  - Student Reading Response ES p. 5 (LA.A.1.3.1 LA.A.2.3.1)
- What is a swallet hole? ES p. 5
- Dissolving Rock activity ES pp. 6-7
  - Lab response sheet

Explore:
- View the thirty-minute video, Water’s Journey: The Hidden Rivers of Florida noting important facts, details, impressions or other interesting information.
  - Water’s Journey Note-Taking Sheet ES p. 9 (LA.B.2.3.1 LA.B.2.3.2 LA.C.1.3.1 LA.C.2.3.1)
Explore/Explain:
- Connect 2 vocabulary word sort  ES p. 10-12  (LA.A.1.3.2)
- Sinkhole Report activity  ES pp.13-16  (LA.A.2.3.6)
- Hands-on Aquifer Activity  ES pp. 17-18  
  o  Student response
- Aquifers of Florida text  ES pp. 19-20  
  o  Aquifer Maps  ES p. 21  
  o  Florida Counties Map  ES p. 22  (SS.B.A.3.1)

Extend:
- Taking Action:
  o  Protecting Florida’s Springs, a Magic School Bus-type book  ES  p. 23  
    (LA.B.1.3.1  LA.B.1.3.2  LA.B.1.3.3  LA.B.2.3.1  LA.B.2.3.2)
  o  Rhyme-Time Riddles (home/community connection)  ES  pp. 24-26

Evaluate/Assess:
- Many assessments embedded throughout tasks and activities, for example:
  o  Literature connection reading prompts
  o  Dissolving Rock lab sheet
- Rhyming pun vocabulary evaluation

Materials

Book:  *The Missing ‘Gator of Gumbo Limbo* by Jean Craighead George  
*Water’s Journey: The Hidden Rivers of Florida* DVD/Video (30 minutes) 
Various materials depending on chosen activities

Vocabulary – (see glossary)

Additional Resources

*Florida’s Geology Unearthed*, specifically Parts 2 and 3

*Florida’s Aquifer Adventure* (CD-ROM) available from Florida Geological Survey

Project WET Activities:
- *Get the Ground Water Picture*
- *Old Water*
- *Water Works*
Websites

Watersheds.org - teacher resources and interactive quizzes
http://www.watersheds.org/index.html

AskERIC - Karst topography - Students use icing and sugar cubes to learn about karsts, sinkholes, and cave formation.
http://ericir.syr.edu/cgi-bin/printlessons.cgi/Virtual/Lessons/Science/Geology/GLG0001.html

Sinkholes from Central Florida GLOBE - Interactive site with quiz questions
http://www.k12science.org/curriculum/waterproj/earthscienceactivities.shtml
Teacher/Student Pages

What Is a Swallet Hole?
Engaging Activity

Have the students get out a piece of paper and ask them to describe in words a swallet hole. They will then share their definitions orally with the class. This should provide a bit of humor because most descriptions will not be accurate. After the video viewing, students should return to their definitions to revise and laugh over their original misconceptions.

The Missing ‘Gator of Gumbo Limbo
Student Activity and Responses
(Excerpt pp. 16-18)

Read pp. 16-18 of the book orally to the students. Then read the following prompt aloud or distribute a printed copy.

Short Response  (2-point rubric)

- The setting for The Missing Gator of Gumbo Limbo is above the Tamiami aquifer. Using information that the author shares, explain the connection of the water cycle to the aquifer.

Read pp. 16-18 again and direct students to take notes or distribute printed copies of pages 16-18, display on a screen with a projector, etc.
Dissolving Rock!
Background for Teacher

Millions of years ago, when sea creatures died, their shells fell to the ocean floor and were pressed together over time to form a type of rock called limestone. Limestone forms a type of landform called karst topography, a type of terrain that contains many springs, sinkholes, and caves. Much of Florida, especially the northern areas of the state, contains large areas of karst terrain.

As rainwater falls, it absorbs some carbon dioxide from the surrounding air forming a weak carbonic acid. As the rainwater soaks through organic material on the surface of the land, it also picks up organic acids produced by decaying leaves and other organic materials. The slightly acidic rainwater sinks into the ground until it reaches layers of rock. In karst topography, the rock is usually limestone. The carbonic acid reacts with limestone to slowly dissolve the rock. The dissolution of the limestone often causes sinkholes and caves to form.

The chemical reactions involved in this process are:

\[
\text{carbon dioxide} + \text{water} \rightarrow \text{carbonic acid solution} \rightarrow \text{calcium bicarbonate calcite}
\]

This dissolution process, which plays a major role in karst formation, can be replicated through the following simple experiment or demonstration as shown on the student worksheet.
**Dissolving Rock Lab Sheet**

**Materials:**
- Small pieces of limestone (can usually be gathered easily in Florida) or use chalk which is ground, compressed limestone
- Vinegar (acetic acid 5% available from grocery stores or science lab suppliers)
- Distilled water
- Beakers or 6-8 oz. clear plastic cups

*Note: While the materials used in this experiment are relatively safe, proper lab safety rules should be followed to avoid any possibility of injury.

**Procedure:**
- Pour distilled water into a beaker
- Drop a small piece of limestone into the beaker; stir around in the water to dislodge any loose pieces of sand or other debris
- Pour approximately 100 mL vinegar into another beaker or plastic cup
- Carefully transfer the cleaned limestone piece into the container with the vinegar; if the vinegar does not cover the limestone completely, add more vinegar
- Complete the chart below with your observations at the selected intervals:

<table>
<thead>
<tr>
<th>Time lapse after placing limestone in vinegar</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-30 seconds</td>
<td></td>
</tr>
<tr>
<td>5 minutes</td>
<td></td>
</tr>
</tbody>
</table>
Predictions:
Based on your observations above, describe in words what will probably happen to limestone when it is exposed to acidic groundwater.

Explain how your prediction might explain karst features such as sinkholes and caves.
**Water’s Journey: The Hidden Rivers of Florida**

Note-Taking Sheet

Write a few words or details for each subtopic that you hear or see in the video.

**Note:** These are not in order; you may return to a subtopic several times to add additional details or information!

<table>
<thead>
<tr>
<th>Subtopic</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>aquifer</td>
<td></td>
</tr>
<tr>
<td>sinkhole</td>
<td></td>
</tr>
<tr>
<td>spring</td>
<td></td>
</tr>
<tr>
<td>karst</td>
<td></td>
</tr>
<tr>
<td>swallet hole</td>
<td></td>
</tr>
<tr>
<td>escarpment</td>
<td></td>
</tr>
</tbody>
</table>
Vocabulary Word Sort

A word sort is a strategy you can use to integrate vocabulary into a content area in a meaningful way. By emphasizing how words are connected to one another, these activities promote higher level thinking, rather than simply memorizing definitions.

Materials:
- word cards
- pencils
- scissors

Directions: Connect 2 (Connect 3; Connect 4)

1. The students will cut apart the word squares, then draw a picture or write clues that will help with the meaning of the word. Students will work in pairs to play Connect 2.

2. The first student will select two cards from his/her stack, and explain to the partner how these two words are connected (Do they mean the same thing? Does one cause another to happen? Does one find the two in the same place? etc.)

3. The second student will then select two cards from his/her stack, and explain to the partner how these two words are connected.

4. Players will continue in this way until all possible connections are made or time is called.

Variations on Connect 2:
- Try to connect three or four words at a time.
- Select any two cards at random and try to make connections if possible.
- Use the word cards for other word sorts (category, number of syllables, ABC order race, etc.)
<table>
<thead>
<tr>
<th>Connect 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>karst</td>
<td>water cycle</td>
</tr>
<tr>
<td>groundwater</td>
<td>surface water</td>
</tr>
<tr>
<td>aquifer</td>
<td>erosion</td>
</tr>
<tr>
<td>limestone</td>
<td>escarpment</td>
</tr>
<tr>
<td>conduit</td>
<td>labyrinth</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------</td>
</tr>
<tr>
<td>sinkhole</td>
<td>watershed</td>
</tr>
<tr>
<td>springshed</td>
<td>water quality</td>
</tr>
<tr>
<td>swallet hole</td>
<td>runoff</td>
</tr>
</tbody>
</table>
Sinkhole Report Activity

Use information from “What Kind of Sinkhole Is It?” website resources, newspaper and TV articles, to fill out a sinkhole report form. Your report should be fictional but based on fact, for example, your longitude and latitude should reflect a specified area in Florida and the type and size of your sinkhole should have characteristics of sinkholes that might be found in the area that you identify as your sinkhole location.

The following are useful references:

Institute of Food and Agricultural Services (descriptions of sinkhole types)
http://aquat1.ifas.ufl.edu/guide/sinkholes.html

Florida Department of Environmental Protection (sinkhole database, reporting form, information, distribution)
http://www.dep.state.fl.us/geology/geologictopics/sinkhole.htm

Florida Department of Environmental Protection (Sinkhole frequently asked questions)
http://www.dep.state.fl.us/geology/feedback/faq.htm#1

Florida Sinkhole Research Institute
http://www.cee.ucf.edu/RESEARCH/fsri/index.htm

Daytona Beach News-Journal articles on Florida sinkholes (many different sinkholes, some with pictures, are highlighted)
http://www.news-journalonline.com/special/sinkhole/

(Good descriptions about the kinds of sinkholes found in Florida and the most frequent causes)
http://www.sinkhole.org/facts.htm

The Florida Speleological Society (information about karst and karst features in Florida at varying levels of readability and background knowledge)
http://www.caves.com/fss/pages/misc/geology.htm

Note: A Google or other web search for Sinkholes or Sinkholes in Florida will yield these and similar results.
SINKHOLE DATA FORM

PLEASE COMPLETE and RETURN TO:
FLORIDA GEOLOGICAL SURVEY
903 West Tennessee St.
Tallahassee, FL 32304-7700
Phone: (850) 488-9380
Fax: (850) 488-8086
http://www.myflorida.com

PERSON FILLING OUT FORM:
Name _____________________________________________
Address ___________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Phone (____) ________________________________

This form has been prepared to help the observer in collecting data on new sinkhole occurrences. These reports, in conjunction with information from other sources, will provide a comprehensive data source on sinkhole events.

1. DATE and time sinkhole was first observed: Month _______  Day ____  Year  _____
   Time___________ am/pm.

2. LOCATION: LONGITUDE: ______ Degrees ______ Min ______ Sec.
   LATITUDE: ______ Degrees ______ Min ______ Sec.
   County: ______________________ T____ R ____Section _____, _____ 1/4 of _____ 1/4.
   7-1/2 min. Quad. Name_________________
   Name and Address of property where sinkhole occurred:
   _______________________________________________________________________
   _______________________________________________________________________
   _______________________________________________________________________
   _______________________________________________________________________
   Phone: (_____ ) _______________________________________________________

3. SINKHOLE DATA: (Circle or fill-in the blank).
   • SIZE and SHAPE: Are dimensions measured ____or estimated ____?
   • Is the sinkhole roughly circular ____or elongate ____?
   • Sinkhole DIMENSIONS at surface:  LENGTH_____ feet;  WIDTH_____ feet.
   • DEPTH of sinkhole below land surface: _____ feet.
   • Approximate SLOPE of sinkhole walls when first observed: ______. (Flat land slopes 0; a vertical wall slopes 90).
   • Is there WATER in the sink? ____ Y ____ N.
   • DEPTH of water below land surface: ______ feet.
• Is LIMESTONE visible in the walls of the sink? Y____ N____. Is a CAVERN or cavity visible in the sink? Y____ N____.

4. CIRCUMSTANCES OF COLLAPSE:
• How long did it take for the sinkhole to form?_________________________________________
• Were there any probable TRIGGERING MECHANISMS, such as: new construction nearby ___; new well-drilling nearby ___; blasting nearby ___; heavy loading of the ground ___; heavy rainfall ___; heavy ground-water pumpage___; other___.
• Were there any PRE-COLLAPSE INDICATORS, such as: ponding of runoff___; ground cracks___; tilting of posts or trees ___; small preliminary holes ___; turbidity in nearby well ___; changes in nearby vegetation (wilting) ___; other___.
• Was there any property damage? ____ Y ____N  Describe in COMMENTS, below.
• Was sink filled or repaired? ____ Y ____ N. Is this planned? ____ Y ____ N.

5. TERRAIN CHARACTERISTICS:
• TOPOGRAPHY: flat, hilltop, slope, valley bottom, depression.
• Please describe any drainage channels or structures that are in the immediate area: ___________________________________________
• LAND USE / COVER: cropland, pasture (or similar), forest, grove, wetland, suburban (low density), urban (high density), industrial.
• SOIL TYPE at the site (eg.: white clean sand, orange clay sand, etc.):
  _____________________________________________________
  • Is this sink in line with, or very near, other recent sinks? ____ Y ____ N
  • Is this sink in line with, or very near, older sinks or lakes? ____ Y ____ N. Please explain: _______________________________________

ADD ANY OTHER COMMENTS OR OBSERVATIONS HERE:

PLEASE SKETCH THE SINKHOLE ON BACK OF THIS FORM.

http://www.dep.state.fl.us/geology/geologictopics/sinkhole.htm
## What Kind Of Sinkhole Is It?

**Student Text**

<table>
<thead>
<tr>
<th>Type of Sinkhole</th>
<th>Word Study</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>collapse sinkhole</td>
<td>from Latin <em>collapsus</em></td>
<td>surface layers collapse suddenly forming deep, steeply-sided holes in the ground; the collapse is often caused by water level fluctuations below the ground</td>
</tr>
<tr>
<td></td>
<td>meaning to fall or slide</td>
<td></td>
</tr>
<tr>
<td>solution sinkhole</td>
<td>from Latin <em>solutio</em></td>
<td>surface layers of limestone are broken down by slow physical and chemical action resulting in a shallow bowl-shaped depression which forms slowly and continuously</td>
</tr>
<tr>
<td></td>
<td>meaning to loosen</td>
<td></td>
</tr>
<tr>
<td>subsidence sinkhole</td>
<td>from Latin <em>subsidere</em>, <em>sub-</em> under + <em>sidere</em>, meaning to sit down or sink</td>
<td>surface layers are thin; as the limestone slowly dissolves, it is replaced by sand granules which fill in the depression.</td>
</tr>
</tbody>
</table>
Hands-on Aquifer Activity

Materials:

- 2 clear plastic cups (approximately 10-12 ounce size)
- sand
- aquarium gravel
- large container of water
- pump from the top of a soap dispenser or other household cleaning container
- pen or marker

Procedure:

1. Place alternating layers of sand and gravel in both plastic cups.

2. Fill about ¾ full.

3. Slowly pour water into one of the cups. Notice what happens to the water. Does the water seem to move faster through the sand or through the gravel? Record your observations.

   Observations:
   _______________________________________________________
   _______________________________________________________
   _______________________________________________________
   _______________________________________________________

4. Add more water to the same cup until the water is above the sand and gravel. In the real world, water that is above the ground, like rivers and lakes, is called surface water. Below the surface, water is known as groundwater.

5. Slowly pour water into the second cup. Stop when it is 1 inch below the top of the sand and gravel. Use a pen to mark a line where the top of the water is. Look at the top of the water. (This line is known as the water table.) The area below the water table is called the saturation zone.

6. Place the pump into the second cup until it extends down below the water table. This pump represents a well.
7. Pump to withdraw water from the well.

8. Discard the water into the large container of water.

9. Repeat this action 4–5 more times. Use the pen to mark the water table.
   Withdrawing water from the aquifer, like wells do, reduces the amount of water
   available in the aquifer.

10. Now pretend the large container of water is a rain cloud. Sprinkle a little more
    water into your second aquifer until the water table is about ½ inch below the
    first line you marked for the water table. You have just recharged your
    groundwater supply. That is what happens when it precipitates and water sinks
    into the ground.

Think About This: What will be the effect if too much water is removed from the
aquifer and not enough precipitation falls to recharge the groundwater supply?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Aquifers of Florida
Student Text

Aquifers are underground reservoirs where water is stored. They fill up from rainwater that filters down through sand and soil. After the water is cleaned by the sand, it reaches a confining layer of limestone. Spaces in the rock hold the water until a well is drilled to bring the water to the surface, or until it bubbles up through holes in the surface and becomes a spring. Since most of the water we use in Florida (90%) comes from deep underground, it is important to understand the importance of conserving and protecting this valuable resource.

The Floridan Aquifer System is located under all of Florida, southern Alabama, southeast Georgia, and southern South Carolina. It provides water for many large Florida cities such as Jacksonville, Orlando and Tallahassee. In addition, many smaller communities and rural areas get their freshwater from this aquifer. Along the southeastern coast of Florida, saltwater can be found in the Floridan Aquifer System. Some of the saltwater is withdrawn and converted to freshwater by desalinization plants that remove the salt from the water. Pipes carry the freshwater for use in the Florida Keys.

Limestone and dolostone make up the Floridan Aquifer System. Some areas of rock are thicker than others, and form various layers in the aquifer. In most places, the Floridan Aquifer System is made up of three parts: The Upper Floridan, middle confining unit, and the Lower Floridan. The middle part helps control the movement of groundwater between the Upper and Lower aquifers.

Sand, clay, limestone, and dolostone can be found in the middle confining layer. These materials allow different amounts of water to pass through. Thickness of the Upper Floridan Aquifer System varies from a few feet in some parts of west central and north central Florida to hundreds of feet in southeastern Georgia, northeastern Florida, southeastern Florida, and the westernmost part of the panhandle. Recharge (water seeping into the ground and refilling the aquifer) occurs where well-drained natural areas have confining layers less than 25 feet thick.

The sand and gravel aquifer lies above the confining unit for the Floridan Aquifer System. This aquifer usually has very good water quality. It is the major source of groundwater for people in the western Florida panhandle.

Clay and limestone make up what is known as the intermediate aquifer system. It is less permeable (allows less water to pass through) than the Upper Floridan; it helps confine the water found in the Upper Floridan Aquifer System. The intermediate aquifer system is the major source of water supply for southwestern Florida.

The Biscayne Aquifer System provides the only source of drinking water for southern Florida. It is made of limestone and sand. Because these rocks are very permeable, surface water easily percolates down into the aquifer. However, problems have occurred.
Heavy development has reduced the amount of recharge area and large withdrawals of groundwater have resulted in saltwater intrusion (saltwater getting into the underground freshwater supply). The regional water management district has built canals, levees, pumping stations, and water conservation areas in southern Florida to help control flooding, conserve freshwater, and to lessen the saltwater intrusion.

**Aquifer Mapping Project Guidelines:**

Use information from this text and the “Aquifer Maps” to identify the various locations of Florida’s aquifer systems.

With the Florida map outline (showing counties), use the following color and symbol key to build a layered map showing the correct location of the following aquifers of Florida:

<table>
<thead>
<tr>
<th>Floridan</th>
<th>Biscayne</th>
<th>Sand and Gravel</th>
<th>Intermediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow</td>
<td>Green</td>
<td>Light Brown</td>
<td>Red</td>
</tr>
<tr>
<td>• • • (dots)</td>
<td>/// (diagonal lines)</td>
<td>- - - (horizontal dashes)</td>
<td></td>
</tr>
</tbody>
</table>

**Materials:**
- 2 maps of Florida
- Floridan Aquifer System map
- colored pencils
- overhead markers
- transparency film
- transparent tape or invisible glue-stick

**Directions for Layered Map:**
1. Color in the Floridan Aquifer System on the Florida map provided, according to the key.
2. Use a second copy of the Florida map to pencil in outlines of each aquifer, using the “Aquifer Maps” page to guide you.
3. Trace the other three aquifers onto transparency film (get from your teacher).
4. Using overhead markers from your teacher, color in the traced aquifers according to the key provided above.
5. Mark entire colored surface with symbols for appropriate aquifer.
6. Cut out each aquifer and use a little transparent tape or invisible glue-stick to correctly place each one on top of colored Floridan Aquifer System map.
Aquifer Maps

The carbonate rocks of the Floridan Aquifer System underlie all of Florida, most of the coastal plain of Georgia, and extend for short distances into Alabama and South Carolina.

The Biscayne Aquifer System underlies parts of four counties in southeastern Florida, and consists predominantly of limestone.

Regional perspective

The intermediate aquifer system is present in southwestern Florida.

The sand and gravel aquifer is an important source of water in southwestern Alabama and the westernmost part of panhandle Florida.
Protecting Florida’s Springs

In this activity, students will write a book for intermediate grade students based on the popular series, *The Magic School Bus*.

Materials:

- poster board or tag board for book cover
- paper for book pages (4 pages folded in half for each book)
- markers, crayons, water colors, etc.

Directions:

- Review all materials about springs that you have used in this unit of study
- Research other springs resources by accessing the websites and suggestions given in the teacher’s guide (your teacher will make copies for the class or will post them on the board for all to use)
- Working alone, with a partner, or with a small group, you will write a book styled after The Magic School Bus series. Your book must include:
  - A front and back cover (one poster board page folded in half or cut in half and bound together)
  - At least eight pages (4 sheets of paper folded in half)
  - A title which will include the words “Florida Springs” but may have other words, too
  - A fictional story with text on at least six pages
  - Factual information about protecting Florida springs included as sidebars, margin notes, or as part of the illustrations
  - Illustrations
- When the book is finished, you will read and share this book with intermediate (3, 4, and/or 5th) grade students

Assessment:

This activity will be assessed for the following:

- Quality of book
- Sharing with one or more younger students
Rhyme-Time Riddles

Step 1:

Give each team a copy of the list of riddles whose answers are at least two word rhymes. (e.g., What do you call a place where speed takes place? An acceleration station) Teams will work to write solutions for the riddles throughout the day. On the next class day, take the time to solve each one with the whole group.

Step 2:

Next, give the students the following directions:

- Goal: To create word rhymes and turn them into riddles.
- Rule: They all have to do with water, water properties, water conservation, etc.
- Directions: (display these on an overhead projector)
  - List about eight nouns from the Water’s Journey vocabulary list (e.g.: percolation, evaporation, karst)
  - List as many rhyming words as you can associate with each noun (e.g.: speed, need, feed, creed, etc.)
  - Then create riddles around TWO WORD rhymes (e.g.: a dish for a young dog = pup cup)
  - Each team will list its favorite riddle on the chart paper for other teams to solve by using two word rhymes.

Step 3:

Finally, make clean copies of the original riddles plus selected riddles created by the class. Students are to take these lists home for use by family members with the student facilitating the process.
### Rhyme-Time Riddles

Work with your team to solve these water-related riddles. Answers will be at least a two-word rhyme.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is another name for fruit juice?</td>
<td>Juice</td>
</tr>
<tr>
<td>What do you call a holy choir?</td>
<td>Choir</td>
</tr>
<tr>
<td>What would you call a thirsty fish?</td>
<td>Drink</td>
</tr>
<tr>
<td>What would you call cleaned water?</td>
<td>Water</td>
</tr>
<tr>
<td>What would you call a dry frown?</td>
<td>Frown</td>
</tr>
<tr>
<td>What would you call a dry nose?</td>
<td>Nose</td>
</tr>
<tr>
<td>What is a water party?</td>
<td>Party</td>
</tr>
<tr>
<td>What is the forming of a sinkhole?</td>
<td>Sink</td>
</tr>
<tr>
<td>What is an old diaper?</td>
<td>Diaper</td>
</tr>
<tr>
<td>What could you call talking drips?</td>
<td>Drips</td>
</tr>
<tr>
<td>What is missing hamburger bread?</td>
<td>Bread</td>
</tr>
<tr>
<td>What would you call renewing vows?</td>
<td>Vows</td>
</tr>
<tr>
<td>What are polluted worms?</td>
<td>Worms</td>
</tr>
<tr>
<td>What is a collapsed skating pond fee?</td>
<td>Pond</td>
</tr>
<tr>
<td>What is a culvert?</td>
<td>Culvert</td>
</tr>
<tr>
<td>What do you call wet country?</td>
<td>Country</td>
</tr>
<tr>
<td>What is a recharge area?</td>
<td>Recharge</td>
</tr>
<tr>
<td>Fruit Juice</td>
<td>Peach Leach</td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Holy Choir</td>
<td>Porous Chorus</td>
</tr>
<tr>
<td>Thirsty Fish</td>
<td>Drought Trout</td>
</tr>
<tr>
<td>Cleaned Water</td>
<td>Pollution Solution</td>
</tr>
<tr>
<td>Dry Frown</td>
<td>Drought Pout</td>
</tr>
<tr>
<td>Dry Nose</td>
<td>Drought Snout</td>
</tr>
<tr>
<td>Water Party</td>
<td>Spring Fling</td>
</tr>
<tr>
<td>Forming of a Sinkhole</td>
<td>Erosion Implosion</td>
</tr>
<tr>
<td>Old Diaper</td>
<td>Maturation Saturation</td>
</tr>
<tr>
<td>Talking Drips</td>
<td>Communication Percolation</td>
</tr>
<tr>
<td>Missing Hamburger Bread</td>
<td>Bun Off Runoff</td>
</tr>
<tr>
<td>Renewing Vows</td>
<td>Reclamation Proclamation</td>
</tr>
<tr>
<td>Polluted Worms</td>
<td>Nitrate Fish Bait</td>
</tr>
<tr>
<td>Collapsed Skating Pond Fee</td>
<td>Sinkhole Rink Toll</td>
</tr>
<tr>
<td>Culvert</td>
<td>Rain Drain</td>
</tr>
<tr>
<td>Wet Country</td>
<td>Precipitation Nation</td>
</tr>
<tr>
<td>Recharge Area</td>
<td>Percolation Station or Liquidation Station</td>
</tr>
</tbody>
</table>
Physical Science

Grade Levels: 6-8

Overview: The video, Water's Journey: The Hidden Rivers of Florida tracks the arterial network of an underground waterway, both above and below the ground, in real time. Throughout this documentary students will learn about Florida’s aquifer system and the importance of conserving and protecting this valuable natural resource. They also learn about sinkholes and how they are formed.

Concept: Students will be provided with opportunities to study the concepts of matter, energy, and forces of energy through exploratory investigations, activities, and applications.

Sunshine State Standards:

Science

Strand C: Force and Motion
- Knows that the motion of an object can be described by its position, direction or motion, and speed. (SC.C.1.3.1)
- Knows that many forces act at a distance (i.e., without contact). (SC.C.2.3.1)
- Knows that gravity is a universal force that every mass exerts on every other mass. (SC.C.2.3.7)

Strand G: How Living Things Interact with Their Environment
- Knows that some resources are renewable and others are nonrenewable. (SC.G.2.3.1)
- Understands that humans are a part of an ecosystem and their activities may deliberately or inadvertently alter the equilibrium in ecosystems. (SC.G.2.3.4)

Strand H: The Nature of Science
- Knows that scientific knowledge is subject to modification as new information challenges prevailing theories and as a new theory leads to looking at old observations in a new way. (SC.H.1.3.1)
- Knows that the study of the events that led scientists to discoveries can provide information about the inquiry process and its effects. (SC.H.1.3.2)
- Knows that accurate record keeping, openness, and replication are essential to maintaining an investigator’s credibility with other scientists and society. (SC.H.1.3.4)
- Recognizes the scientific contributions that are made by individuals of diverse backgrounds, interests, talents, and motivations. (SC.H.1.3.6)
- Recognizes that patterns exist within and across systems. (SC.H.2.3.1)
Knows that no matter who does science and mathematics or invents things, or when or where they do it, the knowledge and technology that result can eventually become available to everyone. (SC.H.3.3.6)

*Benchmarks for other subject areas will be identified with individual activities as appropriate.

Suggested Path for Implementation: (Using the 5Es model)

Engage:
  - Student responses PS p. 4 (LA.A.1.3.1 LA.A.2.3.1)
- “Springs” Anticipation/Reaction Guide PS p. 5 (LA.A.1.3.1)

Explore:
- View the thirty-minute video, *Water’s Journey: The Hidden Rivers of Florida* noting important facts, details, impressions or other interesting information.
  - Water’s Journey Note-Taking Data Chart PS p. 7 (LA.B.2.3.1 LA.B.2.3.2 LA.C.1.3.1 LA.C.2.3.1)

Explore/Explain:
- Vocabulary—Crossword Puzzle PS pp. 8-9 (LA.A.1.3.2)
- That Sinking Feeling Solution/Collapse Sink activity PS pp. 10-12
  - Student responses (LA.A.2.3.5)
- Read “Springs” text PS p. 6
  - Anticipation/Reaction Guide PS p. 5 (LA.A.1.3.4)
- Aquifer activity, “Underwater Photography” text (Appendix pp. 39-40)
  - Teacher Information PS p. 13 (LA.A.2.3.4 MA.B.A.3.1 MA.B.1.3.2)

Extend:
- Taking Action:
  - Protect Our Water (slogan and poster design) PS p. 14 (SS.B.2.3.6 SS.B.2.3.9)
Evaluate/Assess:

- Many assessments embedded throughout tasks and activities, for example:
  - *The Missing 'Gator of Gumbo Limbo* reading/writing prompts
  - Springs Anticipation/Reaction Guide
  - Data chart group activity

Materials

Book: *The Missing 'Gator of Gumbo Limbo* by Jean Craighead George

*Water’s Journey: The Hidden Rivers of Florida* DVD/Video (30 minutes)

Various materials depending on chosen activities

Vocabulary – (see glossary)

- atmospheres absolute - the atmospheric pressure at the surface of the water (14.7 psi or 1 atmosphere) plus the weight of the water at prescribed depths; for every 33 feet in depth, the atmospheres absolute increases by 1

- psi - pounds per square inch

Additional Resources

*Florida’s Geology Unearthed*, specifically Parts 2 and 3

*Florida’s Aquifer Adventure* (CD-ROM) available from Florida Geological Survey

Related Project WET Activities:

- *Energetic Water*
- *Water in Motion*

Websites:

Watersheds.org – interactive sinkhole site with quiz
www.watersheds.org/kids/

www.sjrwmd.com/
Short Response (2-point rubric)

- Use details from the text to compare and contrast green algae with blue-green algae. Use a graphic organizer to display your information.

*Note to teacher:* Several graphic organizers (e.g., Venn Diagram; Compare/Contrast Chart) can be found in the appendix pp. 18-20

- Humans and animals react to light and temperature in much the same way. Humans use air conditioners, humidifiers, and furnaces to control their environment. Keeping this in mind, give at least two purposes a culvert could serve for an alligator.
**“Springs”**

**Anticipation/Reaction Guide**

*Before* you read the text “Springs,” place a check in the “Agree” or “Disagree” column on the left for each statement below. Then, once you have read the text, place a check in the “Agree” or “Disagree” column on the right. You may discover some changes in your responses from “Before Reading” to “After Reading” because of what you will have learned.

<table>
<thead>
<tr>
<th>Before Reading</th>
<th>After Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agree</strong></td>
<td><strong>Disagree</strong></td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Springs are found only in areas with much rainfall.
2. The earth absorbs water like a sponge.
3. Florida has rock layers from just a few feet thick to 30,000 feet thick.
4. Groundwater can enlarge cracks in the earth’s crust.
5. Most springs are found along the coastline in north central Florida.
6. Water at the surface can flow back down into a spring.
7. Mineral springs should be avoided.
8. No animal or plant life can survive in a spring.
The springs have been important to mankind for thousands of years. For example, Native Americans often located villages near freshwater springs for food, water and transportation. The Spanish located at least two 17th century missions near North Florida springs. Explorer Ponce de Leon searched for a mineral spring believed to be the Fountain of Youth. Health resorts have been built around mineral springs because of the belief that they contribute to one’s health.

The land we live on is much like a sponge. When it rains, the earth absorbs water through the ground just as a sponge absorbs water. When full or squeezed, a sponge releases the water and so does the ground. Springs are the result of water returning to the surface because of pressure in the ground.

Under Florida lie massive layers of permeable carbonate rocks such as limestone and dolostone. They can vary in thickness from a few feet to 30,000 feet. These porous layers contain water that once fell as rain. They form the Floridan Aquifer, which is the primary source of our drinking water. As rainwater percolates down to the aquifer, it becomes slightly acidic from carbon dioxide in the air and compounds in the soil, and it dissolves the carbonate rock. Water may be confined within an aquifer by overlying and underlying layers of clay or rock. Over time, movement of the earth’s crust formed cracks in the aquifer limestone. Acidic groundwater has enlarged the cracks as it dissolved the rock. If the resulting tunnels and caves connect with the surface, pressure can force water up and form a spring.

In north central Florida, most springs are found close to rivers. Springs supply 25% of the Suwannee River’s flow. That percentage increases when water levels of rivers are low. While the volume of water emerging from Floridan Aquifer springs has generally remained the same over the years because of the large volume of water the aquifer contains, discharge rates of some springs can vary widely.

Spring water is usually clear, sometimes having a blue tint. However, when river levels rise above a spring mouth, gravity causes the river water to flow downward into the spring. Then, when river levels drop below the level of the spring head, the dark river water flows back out of the spring. To keep river and spring waters separate, several springs were enclosed within walls by resort developers in the early 1900s.

Most north Florida springs have steep-sided depressions with limestone or sand bottoms. They are often home to a variety of fish and crustaceans. Some rare and endangered species live and breed in spring-run systems. Birds hunt fish, amphibians and snails in the shallow spring runs. Sunlight reaches through the clear water and allows native underwater grasses to grow. However, these same growing conditions encourage the spread of troublesome exotic plants such as hydrilla. Though some springs have been developed, enclosed, or had the natural vegetation cleared away, a few are still in a natural state. Overuse and carelessness have had an effect on many spring areas. State agencies, conservation groups, and private landowners are working to preserve many spring systems.

Adapted text from “Springs” (SRWMD)
Water’s Journey Note-Taking Data Chart

Fold a piece of notebook paper in half, then in half again and again, and yet again to form 16 boxes. Unfold your paper, smooth it out and prepare to take notes during the video. Enter one important fact, detail, impression, or other interesting information that you want to remember in each box of your paper.

After viewing the video, work with your table group to select entries to post on a large poster sheet that has been divided into 8 sections. You and your group will summarize, prioritize importance, and/or combine similar ideas in order to capture the group’s data. Be sure to write as large as possible in each section. Post your data chart for others to see as one person from your group shares for the rest of the class. The teacher will direct one group at a time to share a square until all original ideas or details that have not yet been mentioned are read out.
Water X-Words
Created with Eclipse Crossword - www.eclipsecrossword.com

Across
3. methods that have been determined to be the most effective, practical means of preventing or reducing pollution from various sources of water run-off
6. highly porous rock formed over millions of years from shells and bones of sea animals
7. water below the ground usually found in aquifers
8. an underground layer of sand, gravel, or rock that stores and carries water
9. type of terrain underlain by limestone and characterized by caves, sinkholes and disappearing streams
11. a hole or depression in the ground caused by erosion of underground limestone
12. having a pH value of less than 7

Down
1. having absorbed all the liquid that is possible
2. the wearing away of the top layer of the Earth (such as soil, sand or rock) by wind, water, or glaciers
4. the process where water moves through the soil
5. a salt of nitric acid; nitrates are compounds in the environment containing nitrogen.
10. to remove soluble or other substances from by the action of a percolating liquid

Word Bank
acidic
aquifer
BMP
erosion
groundwater
karst
leach
limestone
nitrates
percolation
saturation
sinkhole

Physical Science PS 8
Water X-Words
Answers
Created with Eclipse Crossword - www.eclipsecrossword.com
That Sinking Feeling

This activity can be done as a demonstration or with small groups

Objective:
To understand how sinkholes form
To identify possible causes of sinkholes
To see that models represent things in the real world

Materials:
- oblong balloon (round balloons require a bigger box)
- cornstarch packing peanuts (found in packaging – not to be confused with styrofoam as only the cornstarch variety will dissolve)
- shoebox or other container (2)
- plastic tub (about the size of a small margarine container)
- moist builder’s sand or topsoil enough to almost fill the box
- empty plastic cups (2)
- straight pin
- container of water (about eight ounces)

Directions:
1. For the first model, cover the bottom of the box with 1 to 2 inches of sand.
2. Fill the small tub with cornstarch packing peanuts and place in the center of the box on top of the sand.
3. Fill the rest of the box with enough sand or soil to cover the cornstarch packing peanuts. Put a paper cup “house” on top of the sand. (optional, direct your cup as a house)
4. Sprinkle or “rain” water onto the sand, and
5. Allow at least 10 minutes to pass.
6. Complete the observation chart.

<table>
<thead>
<tr>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>What did the sand/soil look like before it “rained?”</td>
</tr>
<tr>
<td>Did you observe any changes in the sand after the “rain?”</td>
</tr>
<tr>
<td>What did you observe 10 minutes after the “rain?”</td>
</tr>
<tr>
<td>Read the article, “What Kind of Sinkhole Is It?” Based on the article, which kind of sinkhole is modeled with this activity?</td>
</tr>
</tbody>
</table>
7. For the second model, cover the bottom of the second box with 1 to 2 inches of sand.

8. Place an inflated, oblong balloon in the center of the box on top of the sand as shown in the picture to the right.

9. Fill the rest of the box with enough sand or soil to cover the balloon. Put a paper cup “house” on top of the sand.

10. Stick the balloon with the straight pin.

11. Complete the observation chart below.

<table>
<thead>
<tr>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>What did the sand/soil look like before the balloon was popped?</td>
</tr>
<tr>
<td>Did you observe any changes in the sand after the balloon popped?</td>
</tr>
<tr>
<td>Read the article, What Kind of Sinkhole Is It? Based on the article, which</td>
</tr>
<tr>
<td>kind of sinkhole is modeled with this activity?</td>
</tr>
<tr>
<td>Explain how this model demonstrated the way this kind of sinkhole forms.</td>
</tr>
</tbody>
</table>

Based on the St. Johns River Waterways Lesson 5
# What Kind Of Sinkhole Is It?

<table>
<thead>
<tr>
<th>Type of Sinkhole</th>
<th>Word Study</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>collapse sinkhole</td>
<td>from Latin <em>collapsus</em> meaning to fall or slide</td>
<td>surface layers collapse suddenly forming deep, steeply-sided holes in the ground; the collapse is often caused by water level fluctuations below the ground</td>
</tr>
<tr>
<td>solution sinkhole</td>
<td>from Latin <em>solutio</em> meaning to loosen</td>
<td>surface layers of limestone are broken down by slow physical and chemical action resulting in a shallow bowl-shaped depression which forms slowly and continuously</td>
</tr>
<tr>
<td>subsidence sinkhole</td>
<td>From Latin <em>subsidere</em>, sub-under + sidere to sit down or sink</td>
<td>surface layers are thin; as the limestone slowly dissolves, it is replaced by sand granules which fill in the depression.</td>
</tr>
</tbody>
</table>
“Underwater Photography”
Teacher Information

Materials:
- chart paper
- markers
- “Underwater Photography” text (see Appendix pp. 39-40)

Directions:

1. Brainstorm with students answers to the following question:
   - What are some of the things an underwater photographer might need to know?
2. Chart the responses.
3. Introduce the “Underwater Photography” article to the students by saying:
   - Wes Skiles, the underwater photographer for the Water’s Journey video, wrote the article that you are going to read. (Appendix pp. 39-40)
4. Have the students read the article to identify things that an underwater photographer needs to know.
5. Return to the brainstorming chart and add new items. If students did not identify tasks associated with physical science concepts, suggest these additions.
   - Did you think that knowing physical science would be important to an underwater photographer?
   - Now we are going to work with some of the data that was necessary for the divers in the Water’s Journey video and the National Geographic Journal video that the photographer mentioned.

Use facts from the article and the video to solve the following problems:

1. What was the pressure (measured in psi) on the divers at the deepest point of their dive into the aquifer?
2. What was the pressure (measured in psi) on the divers at the deepest point of their dive into the deepest ocean caves?

Use your answers to develop a graph showing the absolute pressure at the deepest point of each of these dives. Title and label your graph.

Note: 1 absolute pressure = 14.7 pounds per square inch (psi)
Protect Our Water
Slogan and Poster Contest

You will be working in pairs or small groups to create a poster that includes a message about protecting our water resources.

Your poster should include the following:

- **Theme:** Protect Our Waters
- **Text:** A message expressing the theme in a slogan, rhyme, etc.
- **Artwork:** Illustrate the slogan’s message

**Materials:**

Any variety of media could be used including, but not limited to:

- water color
- crayon
- chalk
- markers
- three-dimensional objects

**Size:**

Minimum 16” x 20”
Maximum 20” x 28”

Keep in mind that posters will be on public display and should be easy to see and read! Each poster, after being presented to the class and scored, will be displayed in a local store, community building, utility, ballpark, or other place for viewing by the public.

**Rubric Assessment**

<table>
<thead>
<tr>
<th>Category</th>
<th>Evaluation Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Message</strong></td>
<td>Message not clear or message not correct or message not meaningful 20 pts</td>
</tr>
<tr>
<td></td>
<td>Message is somewhat clear, correct, and/or meaningful 35 pts.</td>
</tr>
<tr>
<td></td>
<td>Message is clear, correct, and meaningful 50 pts.</td>
</tr>
<tr>
<td><strong>Creativity and Originality</strong></td>
<td>Artwork is minimally creative and original 10 pts</td>
</tr>
<tr>
<td></td>
<td>Artwork is somewhat creative and original 15 pts</td>
</tr>
<tr>
<td></td>
<td>Artwork is creative and original 25 pts.</td>
</tr>
<tr>
<td><strong>Visual appeal</strong></td>
<td>Poster has little or no visual impact 10 pts</td>
</tr>
<tr>
<td></td>
<td>Poster has moderate visual impact 15 pts</td>
</tr>
<tr>
<td></td>
<td>Poster has high visual impact 25 pts</td>
</tr>
</tbody>
</table>

| Column total                   | **Total**                                                                            |

Physical Science
PS 14
Environmental Science

Grade Levels: 6-8

Overview: The video, Water's Journey: The Hidden Rivers of Florida tracks the arterial network of an underground waterway, both above and below the ground, in real time. Students will learn about Best Management Practices (BMPs) that protect the aquifer. They will also learn that human interaction with the land may lead to the formation and pollution of sinkholes, a direct pipeline to the aquifer.

Concept: Students will understand that protecting, conserving, and reducing the use of water pumped from the aquifer will protect the quality of life. They will also understand consequences of pulling from this resource and not implementing BMPs. Students will understand that human activities such as increase in the pumping of ground water, retention pond building, and altering a landscape may induce sinkholes.

Sunshine State Standards:

Science

Strand D: Processes that Shape the Earth
- Knows that mechanical and chemical activities shape and reshape the Earth’s land surface by eroding rock and soil in some areas and depositing them in other areas, sometimes in seasonal layers. (SC.D.1.3.1)
- Knows how conditions that exist in one system influence the conditions that exist in other systems. (SC.D.1.3.3)
- Knows the positive and negative consequences of human action on the Earth’s systems. (SC.D.2.3.2)

Strand G: How Living Things Interact with Their Environment
- Understands that humans are a part of an ecosystem and their activities may deliberately or inadvertently alter the equilibrium in ecosystems. (SC.G.2.3.4)

Strand H: The Nature of Science
- Knows that scientific knowledge is subject to modification as new information challenges prevailing theories and as a new theory leads to looking at old observations in a new way. (SC.H.1.3.1)
- Recognizes the scientific contributions that are made by individuals of diverse backgrounds, interests, talents, and motivations. (SC.H.1.3.6)
• Knows that no matter who does science and mathematics or invents things, or when or where they do it, the knowledge and technology that result can eventually become available to everyone. (SC.H.3.3.6)
• Knows that computers speed up and extend people’s ability to collect, sort, and analyze data; prepare research reports; and share data and ideas with others. (SC.H.3.3.7)

*Benchmarks for other subject areas will be identified with individual activities as appropriate.

Suggested Path for Implementation: (Using the 5Es model)

Engage:
• Read aloud pages 48-51 from *The Missing ‘Gator of Gumbo Limbo* by Jean Craighead George
  o Student response ENV p. 5
    LA.A.2.3.1; LA.A.2.3.5
• Activate the students’ prior knowledge of BMPs by filling out the “K” and “W” sections on a KWL chart (Appendix pp. 13-16)

Explore:
• View video, *Water’s Journey: The Hidden Rivers of Florida*, noting the pollution problems and solutions for our water sources
  o V.I.E.W. Note-taking Activity with follow-up discussion
    ENV p. 6
    LA.B.2.3.1; LA.B.2.3.2

Explore/Explain:
• BMP Tile Puzzles and Teacher Answer Key (vocabulary) ENV pp. 7-9
  LA.A.1.3.2
• Best Management Practices Layer Book ENV p. 10
  SS.B.2.3.9
• Oh, My, What Do I Do? Overview ENV p. 11
  o Step 1 (BMP activity) ENV p. 12
  o Step 2 (Create a diorama) ENV p. 12
  o Step 3 (Contract) ENV p. 13
  LA.B.2.3.3; LA.D.2.3.5
• BMP information and overhead masters ENV pp. 14-19
  o Free-form mapping ENV p. 20
• “How Sinkholes Form” text: (Appendix p. 41)
“Sinkhole Sledding” text: ENV pp. 22-23
  • Teacher Information ENV p. 24
  • Sinkhole Habitats-student activity ENV p. 25
LA.C.1.3.1; LA.C.1.3.4

Extend:
• BMP Poster ENV p. 26
  SS.B.2.3.6; SS.B.2.3.9
• Taking Action:
  o BMP Public Service Announcement ENV p. 27

Evaluate/Assess:
• Many assessments embedded throughout tasks and activities, for example:
  o “The Missing ‘Gator of Gumbo Limbo” student responses
  o 3-2-1 Strategy (Appendix pp. 21)
  o Free-form mapping
  o Complete “L” section of KWL chart

Materials

Book: *The Missing ‘Gator of Gumbo Limbo* by Jean Craighead George
*Water’s Journey: The Hidden Rivers of Florida* DVD/Video (30 minutes)
Various materials depending on chosen activities

Vocabulary – see glossary

Additional Resources

*Florida’s Aquifer Adventure* (CD-ROM) available from Florida Geological Survey

Project WET Curriculum:
• *A Grave Mistake*
• *The Pucker Effect*
• *Get the Ground Water Picture*

Tapes:

*Science Friday on Location: Talk of the Nation National Public Radio*
The tapes and guide encourage the use of critical listening skills while providing information on sinkholes, swamps, wetlands, and rain.
**Websites:**

Center for Cave and Karst Studies - Karst Terrain  
http://www.dyetracing.com/karst/ka01000.html

Environmental Protection Agency - A Tale of Ooze  

Environmental Protection Agency - Wells: A Deep Subject  

Environmental Protection Agency - Stamp Out L.U.S.T.  

Florida Environment.com – radio segments about sinkhole-related accidents  
http://www.floridaenvironment.com/programs/fe00619.htm

Florida Environment.com - search to find radio segments on the “Florida Environment.”  
http://www.floridaenvironment.com/radio.htm

Florida Environment.com – aquifer storage  
http://www.floridaenvironment.com/programs/fe10430.htm

Southwest Florida Water Management District - Students design the new town of Waterful while balancing the needs of people and the preservation of the environment and water resources.  
http://www.swfwmd.state.fl.us/education/educators/splash/waterful.htm

Southwest Florida Water Management District - groundwater  
http://www.swfwmd.state.fl.us/education/waterweb/wwgroundwater.pdf

Southwest Florida Water Management District - Sources of Pollution in Our Watershed  
http://www.swfwmd.state.fl.us/education/waterweb/waterwebwatersheds.pdf

St. Johns River Water Management District - *How Sinkholes Form*  
http://sjr.state.fl.us/programs/outreach/pubs/order/pdfs/fs_sinkhole.pdf

Stream Watch – sources of nonpoint source pollution and Best Management Practices  
Teacher/Student Pages

*The Missing ‘Gator of Gumbo Limbo* by Jean Craighead George
Student Reading Response
(Excerpt pp. 48-51)

**Short Response:** (2-point rubric)

Liza K. is concerned that there are only a mere handful of gambusia in the water when there should have been thousands. Use details from the story to explain the importance of gambusia to the health of the habitat.
**VIEW**
Note-Taking Sheet

**Directions:** Use this form for taking notes as you watch the video. Write down information concerning best management practices and information about sinkholes and the aquifer. Be prepared to discuss what you viewed.

<table>
<thead>
<tr>
<th>V</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>E</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **V**  View the video  Write the title. List the names of the scientists and divers.
- **I**  Important Ideas  Write the important ideas that were presented.
- **E**  Encounter  What problems were encountered in the video?
- **W**  Write what you learned  Why do you think this video was made? What do you think Wes Skiles would like for you to take with you after viewing “Water’s Journey?”
Best Management Practices Tile Puzzles

For each of the following puzzles, unscramble the tiles to reveal a message. Choose from the words in the box to help you solve the puzzles.

| over-pumping | collapse | contribute | formation |
| increase | disposal | overburdened | paints |
| BMPs | protect | groundwater | Floridan |
| aquifer | materials | sinkholes | human |
| activity | avoided | altering | landscape |
| approved | site | changing | thickness |
| solvents | chemicals | fertilizers | pesticides |

(Bold words are vocabulary used in this section.)

**Puzzle 1:**

```
N A . P R O I N S T O T T I T
I D A E F W A L O R T H Q U I U N D H E
T E C U S G R O T E R T O F E R U P
```

**Puzzle 2:**

```
F O L A N D C H E I L I Z L U D E T I C I
L O W I R E A S O N A B E L B M P S D I N G
A N D M I C A I N C
```
Puzzle 3:

```
USED T Y M G O F A PSE O V E U N D W
WHI I A L H O L E C O L L A T E R S P E C
E A V Y A T I V I S D U A Y B H U M A
D. E S I N K M P I N G R O B Y C H I
R - P U . E T O S C A N A C O I D E
```

Puzzle 4:

```
N T S . V E D R O L E U L V E R O D U O S A L
I N S A N D P P R O D R A D I S P D I S P
I N S U M P C T S A T A S I T P E T
O S E T O R M O F P N O T
```
Puzzle 5:

ERIA ALT WATERED T R OR AN A
CREAS TH ER BU MAT N IN MAY
GRO E TO ION G A I BUT UN D
EO V SIN TH & THE BY LS.
ITIE RDEN NGIN ERIN HUM LAND
AND E FONE SSE E PU MANY G OF
SCAR PMAT KHOL CHASE I CTIV
MPIN HICK BE A ONTR AT C

Answers to Tile Puzzles

Puzzle 1:
It is up to us to protect the groundwater in the Floridan Aquifer System.

Puzzle 2:
BMPs include reading and following labels on chemicals, fertilizers, and pesticides.

Puzzle 3:
Sinkholes caused by human activity may be avoided especially a collapse which is due to over-pumping of groundwater.

Puzzle 4:
Dispose of paints, solvents, and petroleum products at approved disposal sites, not in storm drains or culverts.

Puzzle 5:
Many human activities that contribute to sinkhole formation may be an increase in the pumping of ground water or altering a landscape by changing the overburdened thickness and materials.
Best Management Practices Layer Book
Student Activity

Create a layer book based on Best Management Practices (BMPs). Directions for creating a layer book are found in the Appendix p. 9.

Note to Teacher: You may want to create a transparency or make student copies of the Best Management Practices text to use for instructional purposes.

Materials:

• paper
• pencils
• “Best Management Practices (BMPs)” text

Directions:

• Students should use the information from the “Best Management Practices” BMPs text and the “Major Sources of Nonpoint Source (NPS) Pollution and Best Management Practices (BMPs).” Each of the following categories should be illustrated and explained:
  • Homeowner
  • Road Construction
  • Logging
  • Mining
  • Agriculture
Oh, My, What Do I Do?

**Background Information**

Often people are affected by polluted water. Garbage and trash have been thrown in sinkholes causing contaminants to reappear in the aquifer. The practice of burying storage tanks underground has caused a problem with the supply of potable water. The tanks erode, causing chemicals and petroleum products to leak in the groundwater. As the contaminants such as heavy metals and other toxins from leaking pipes, landfills, septic tanks, wastewater disposal ponds, and runoff from highways flow into the aquifer, a well may pump the poisons for people to consume. Since many contaminants are colorless and odorless, it is necessary for water to be tested. Best Management Practices should be implemented in order to protect our groundwater supply.

**Student Activity:**

**Step 1: (Engage)**

Students will make preliminary choices about the “best” group of developers to purchase the family’s land.

**Step 2: (Explore/Explain)**

Divide the students into teams with each team representing one of the four groups of developers. Students will make dioramas designed to show the developer’s ideas for developing the land in an effort to convince the family to sell to them.

**Materials:**

- 4 boxes (may be shoeboxes, different boxes work well for this activity. For a larger class add a box for another group.)
- Scissors
- Construction paper
- Glue
- Markers
- Pipe cleaners (optional)
- Tissue paper (optional)
- Wooden sticks (optional)

**Step 3: (Evaluation/Assessment)**

Students are to write a contract stating the responsibilities of the owner of a land development company. Best Management Practices are to be stated in the contract.
Oh, My, What Do I Do?
Student Response Sheet

Step 1: (Engage)

Pretend that you are a member of a family who just inherited land from your grandparents. The family is now preparing to sell the land. The family insists that the land is worth $10,000,000 but is willing to negotiate a lower price if the developing team will implement Best Management Practices during and after construction. Some of the different groups of developers interested in purchasing the land:

- are very wealthy with an unlimited supply of money;
- have relatives on the town council;
- have family ties with the local factory; or
- have relatives who own the local amusement park.

Which developing team would you want your family to select as buyers? Why should this group be chosen?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Step 2: (Explore/Explain)

Work with your team to create a diorama representing land for sale. Your team’s diorama should depict your assigned developer’s special interests. Your intent is to convince the family to sell to you. Be prepared to display your diorama and give a sales presentation to the class.

Step 3: (Evaluation/Assessment using 4-point rubric)

Write a contract stating the responsibilities the owner of the land development company will have after buying your family land. Be sure to include the Best Management Practices that will be used by the company.
<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brainstorming - Solutions</td>
<td>Students identify more than 4 solutions or strategies to persuade the landowners to sell. The solutions implement more than 4 BMPs.</td>
<td>Students identify at least 4 solutions or strategies to persuade the landowners to sell. The solutions implement 4 BMPs.</td>
<td>Students identify at least 3 solutions or strategies to persuade the landowners to sell. The solutions implement 3 BMPs.</td>
<td>Students identify fewer than 3 solutions or strategies to persuade the landowners to sell. The solutions contain fewer than 3 BMPs.</td>
</tr>
<tr>
<td>Brainstorming - Problems</td>
<td>Students identify 4 problems or barriers which need to be addressed prior to construction.</td>
<td>Students identify 3 problems or barriers which need to be addressed prior to construction.</td>
<td>Students identify 2 problems or barriers which need to be addressed prior to construction.</td>
<td>Students identify 1 problem or barrier which needs to be addressed prior to construction.</td>
</tr>
<tr>
<td>Research/Statistical Data</td>
<td>Students include 4 sources of informational data to support their view of the land development.</td>
<td>Students include 3 sources of informational data to support their view of the land development.</td>
<td>Students include 2 sources of informational data to support their view of the land development.</td>
<td>Students include 1 source of informational data to support their view of the land development.</td>
</tr>
<tr>
<td>Diorama</td>
<td>All elements of the diorama are visually appealing and neat.</td>
<td>Most elements of the diorama are visually appealing and neat.</td>
<td>Some of the elements of the diorama are visually appealing and neat.</td>
<td>Few elements of the diorama are visually appealing and neat.</td>
</tr>
<tr>
<td>Organization &amp; Presentation</td>
<td>The team made a presentation that was consistently well organized and delivered in a manner that was easy to understand.</td>
<td>The team made a presentation in an organized manner that others could understand. There were very few lapses in organization.</td>
<td>The team made a presentation that displayed some organization, but was somewhat difficult to understand.</td>
<td>The team made a presentation lacking organizational skills and was difficult to understand.</td>
</tr>
<tr>
<td>Comments</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Major Sources of NPS Pollution and BMPs

<table>
<thead>
<tr>
<th>Source</th>
<th>Best Management Practices:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roads and Streets</td>
<td>• dispose of paints, solvents, and petroleum products at approved disposal sites, not in storm drains or street gutters</td>
</tr>
<tr>
<td></td>
<td>• fix automobile oil and fuel leaks</td>
</tr>
<tr>
<td></td>
<td>• stop oil dumping on rural roads</td>
</tr>
<tr>
<td></td>
<td>• use nonchemical deicers (sand and ash) on roads, sidewalks, and driveways</td>
</tr>
<tr>
<td></td>
<td>• construct a sediment catch basin to collect storm water runoff</td>
</tr>
<tr>
<td></td>
<td>• reduce road construction runoff by building terraces and catch basins, and by planting cover crops (grass)</td>
</tr>
</tbody>
</table>
Major Sources of NPS Pollution and BMPs

**Source**  
**Best Management Practices:**

**Agriculture**
- read and follow all labels and ask for application directions before using chemicals, fertilizers, and pesticides
- use conservation tillage, contour farming, strip cropping, and crop rotation
- institute pasture management
- leave filter strips and field borders along wetlands and streams
- use cover crops to reduce erosion and terrace areas prone to erosion
- fence waterways to reduce riparian zone impact from livestock
- construct livestock waste collection and treatment ponds for confined livestock
- avoid ditching and draining of small ephemeral wetland pools

**Logging**
- monitor water entering and leaving cut areas
- prevent sediments from reaching streams and lakes by building terraces, catch basins, and natural filters
- leave a vegetative buffer zone in riparian areas
- maintain and restore effective watersheds
- implement a plan to reduce erosion from roads

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Environmental Science  
ENV 15
### Major Sources of NPS Pollution and BMPs

<table>
<thead>
<tr>
<th>Source</th>
<th>Best Management Practices:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mining</strong></td>
<td>• monitor all water entering and leaving mine sites</td>
</tr>
<tr>
<td></td>
<td>• intercept and reroute uncontaminated water away from contaminated areas (keep clean water clean!)</td>
</tr>
<tr>
<td></td>
<td>• construct catch basins and terraces, and plant cover crops, to catch sediment and prevent erosion</td>
</tr>
<tr>
<td></td>
<td>• catch and treat contaminated water (clean contaminated water!)</td>
</tr>
<tr>
<td></td>
<td>• stabilize stream channels</td>
</tr>
<tr>
<td></td>
<td>• stabilize mining waste areas to prevent release of materials to streams</td>
</tr>
<tr>
<td></td>
<td>• maintain buffer strips along streams</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Construction</strong></th>
<th>Best Management Practices:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• implement a sediment control plan</td>
</tr>
<tr>
<td></td>
<td>• plant ground cover to reduce erosion</td>
</tr>
<tr>
<td></td>
<td>• dispose of solvent, paint, and other wastes at approved disposal sites</td>
</tr>
<tr>
<td></td>
<td>• build temporary, small dikes to slow and catch runoff</td>
</tr>
<tr>
<td></td>
<td>• build sediment catch basins to collect construction runoff</td>
</tr>
<tr>
<td></td>
<td>• build earth berms and filter runoff before water enters a stream</td>
</tr>
</tbody>
</table>

Used with permission from North Carolina Department of Environment and Natural Resources
Major Sources of NPS Pollution and BMPs

<table>
<thead>
<tr>
<th>Source</th>
<th>Best Management Practices:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>• use nonchemical deicers (sand and ash or non-clumping cat litter) on residential driveways, decks and sidewalks</td>
</tr>
<tr>
<td></td>
<td>• read labels prior to using pesticides and fertilizers</td>
</tr>
<tr>
<td></td>
<td>• consider xeriscaping or using native vegetation</td>
</tr>
<tr>
<td></td>
<td>• use nonchemical fertilizers (compost) on gardens</td>
</tr>
<tr>
<td></td>
<td>• dispose of household hazardous waste at approved disposal sites</td>
</tr>
<tr>
<td></td>
<td>• maintain septic tanks if sewers are not available</td>
</tr>
</tbody>
</table>
Best Management Practices

- Dispose of paint, oil, gasoline and other solvents at approved disposal sites.
- Fix fuel or oil leaks.
- Never put gasoline, mothballs, or rat poison in animal burrows.

- Implement a plan to reduce erosion from roads.
- Use plants as a buffer zone to keep pollutants from entering a waterway.
- Construct terraces, and catch basins to prevent sediments from entering streams and lakes.

- Monitor water entering and leaving area in which trees were removed.
- Monitor all water that enters and leaves a mining area.
- Livestock waste should not be allowed to enter a waterway.

- Read directions before using chemicals, fertilizers and pesticides.
- Remember to dispose of unwanted items properly.
- Storm drains are for rainwater, not grass clippings.

Substances that enter the aquifer affect all of us.
Keep it off the ground so it won’t be consumed later.
BMP Free Form Mapping
Teacher Information

Background Information
Best Management Practices (BMPs) are methods that have been determined to be the most effective, practical means of preventing or reducing pollution from various sources of water run-off. Two categories of pollution are identified as point source and nonpoint source pollution. Point source pollution is easily linked to a cause, thereby making it simple to rectify an unhealthy situation. Nonpoint source pollution is much more difficult to determine the source of the contamination.

Major sources of nonpoint source pollution include oil from vehicles and roads, which is carried into the watershed through runoff. Disposing of substances such as paint and other solvents improperly can add to the contamination of the water supply. Without adhering to the label directions on chemicals such as pesticides and fertilizers, the quality of groundwater may decline dramatically.

Various industries, which include logging, mining and agriculture, often implement best management practices. Homeowners are also encouraged to practice techniques that will limit contamination. Some examples of best management practices include:

- getting rid of petroleum products, paint, and solvents by taking them to approved disposal sites
- never pouring gasoline, mothballs, or rat poison into the burrows of animals
- fixing leaks
- keeping livestock waste from entering the water system by constructing catch basins
- monitoring water entering and leaving mining, logging, and construction areas
- using plants to keep pollutants from entering streams, lakes, and ponds
- properly disposing of unwanted items is the key to keeping our groundwater clean
- using only recommended amounts of fertilizers and pesticides as well as choosing environmentally friendly products whenever possible

Materials:

- overhead masters, “Major Sources of Nonpoint Source (NPS) Pollution and Best Management Practices (BMPs)” p. 14-19
- white paper
- markers

Directions:

1. Brainstorm with students some examples of pollution.
2. Lead a discussion about point source and nonpoint source pollution.
3. Give students the definition of best management practices.
4. Have students draw their ideas of best management practices.
5. Display the completed free form maps.
6. Have students look at the maps and state the best management practices that were drawn.
“How Sinkholes Form”
Teacher Information

Materials:
- “How Sinkholes Form” text (Appendix p. 41)
- paper
- pencils
- colored pencils

Directions:

1. Ask students to write answers to the questions that follow. They may work with a partner. Allow five minutes for this part of the activity.
   - What is a sinkhole?
   - How do sinkholes form?
   - Can sinkholes be prevented?
   - What are the warning signs of a sinkhole forming?

2. Explain to the students that they will read an article titled “How Sinkholes Form.” This will enable them to have more information in order to complete their answers to the questions. Students still work with their partners.
   - One partner reads aloud the first half of the article while the other partner jots down information for the questions.
   - After the first half of the article is read, the partners trade jobs. The writer is now the reader, and the reader now jots down information to answer the questions.

3. Lastly, students work independently to write the answers to the four questions. A new sheet of paper is given to each student.
   - The students fold their paper in half, vertically.
   - They write one of the questions at the top of each section (two questions on the front and two questions on the back of the paper).
   - Responses to each question are written in the appropriate column.
   - Students use colored pencils to illustrate the details in each answer.
It is always good to go back and visit the places you enjoyed in your youth. I am currently raising my family in the state of New York. My children are always pestering me to tell them what it was like in the days of long ago, when I was a kid. These ancient times occurred about twenty years ago. This doesn’t seem so long ago to me. You see I grew up in the mystical land known as “La Florida.” Most of my intriguing stories are based on the time my pals and I spent playing in the sinkhole in the forest. The coolest thing about a sinkhole is the fact that ecosystems change from the top of the sinkhole to the bottom. In less than five minutes a kid can watch a gopher tortoise dig a hole in the sandy soil and catch a bluegill in the lake at the bottom of the ravine.

Each adventure always begins in the Upland-Pine ecosystem. We would make our way through the longleaf pine trees. Our path was usually the same. Our feet kicked up the loose soil as we made our way to the swings we hung from the branches of the oak trees. My children often laugh at the idea of a tree being named, “Turkey Oak.” Southern red oak, live oak, and blue jack oak do not receive the same jeers as “Turkey Oak.” The names gopher apple and lead plant have left some unique pictures in the minds of my children. It was time for my offspring to see for themselves that the gopher apple is not actually some mutant breeding of a gopher and an apple.

I took my kids on an adventure to the mystical sinkhole. My children were just as excited to observe the animals in this ecosystem as I was. It is the eternal question, “How can that red-bellied woodpecker bang his beak into the wood without getting a tremendous migraine?” George and Janet were also amazed at the green tree frogs sticking to the trees like superheroes. They have heard stories of my friends and me hanging eastern fence lizards from our earlobes. We thought we had the latest in reptile jewelry. Thank goodness harassing the wildlife is not allowed anymore.
My children and I took a more civilized wooden path down the side of the sinkhole. The kid in me still wanted to go Florida sledding. I would grab a sheet of plastic and slide over the karst terrain until I got bogged down in the mud. It certainly is a benefit to the habitat to have humans stay on the designated path. There are many more ferns and mosses growing along the slide, I mean side. It is a moister, more tropical environment than the upland pine region.

As we got closer to the bottom George wanted to know where all those shells came from. I explained that was what was left of the apple snails that were the entrée for the egret’s dining experience. Janet pointed to a pretty green dragonfly. To her amazement it landed on her finger. I dazzled the kids by twisting the web of the giant orb spider into a line. I dipped the line into the cool water. A minnow was hooked instantly. “That is some sticky stuff,” said Janet. “Awesome,” said George in an amazed voice.

George and Janet were anxious to get their dip-nets into the water. They made the dip-nets using a piece of material over a stretched out wire hanger and attached it to broom handles. They eagerly dug deep down in the muck. They retrieved different types of macroinvertebrates. Snails, mussels, crayfish, and leeches were plentiful. This was an indicator of good water quality. Often pollution kills many macroinvertebrates.

We waded through the beautiful white flowered lily pads. They seemed even more beautiful through my adult eyes. I have a greater appreciation for flowers now. The purple pickerelweed along the shore is magnificent. Of course a native Floridian doesn’t travel far without a snorkel and mask. We dove into the water and were surprised at the sight of different fish. The largemouth bass made me wish I had my fishing pole. There were schools of gar, perch, and sunfish. On the bottom were many catfish.

It was great fun visiting the mysterious sink again. Times change and I can’t do the Florida sledding anymore. Even though the wooden path isn’t as thrilling as sliding down the terrain on a sheet of plastic, it appears to be an improved habitat for the creatures that live in the diverse systems of the sinkhole. I can assure you that my kids had just as much fun as I did in the ancient times of my youth. It was much easier taking the wooden walkway to the top of the sinkhole than it was to get your foot in just the right spot on the rocky ledge without slipping. A change for the better I say.

Written by Barbra Eileen Siebert
Background Information
A sinkhole contains several distinct ecosystems. The upland-pine ecosystem is in the area that surrounds the sinkhole or the land that is at the top of the sinkhole. It contains longleaf pines, varieties of oak trees such as the southern red oak, live oak, blue jack oak and the turkey oak. Other plants include gopher apple, persimmon and lead plant. Grasses are usually found in this region along with a few shrubs. Animals that typically inhabit the region are the gopher tortoise, green tree frog, eastern fence lizard, red-bellied woodpecker, cotton mouse, and fox squirrel.

The sandy soil of this area allows water to percolate rapidly into the groundwater system. These regions are known as recharge areas for the aquifer. Many of the upland pine ecosystems have been altered for housing plans, commercial businesses, agriculture, and forestry products. Many populations of naturally occurring species have declined.

The sides of the sinkhole are a rocky karst terrain. The sides are made of limestone and are very steep. The sinkhole appears more tropical on descent. Ferns, mosses, mixed grasses, shrubs and other subtropical vegetation are found in this region of the sinkhole. After heavy precipitation, a flood will provide amphibians with a temporary pond that is needed for mating.

A sinkhole lake may be at the bottom. The lake usually has a limestone base. Except for runoff this type of lake usually does not have surface inflow and outflow of water. A sinkhole lake most often is connected with the aquifer. The water appears clear and alkaline, with a high mineral content of calcium, bicarbonate, and magnesium. Species found in this ecosystem include macroinvertebrates such as: freshwater mussels, scud, crayfish, and snails. Dragonflies, stoneflies, damselflies, and caddis flies are also found here. Types of fish include but aren’t limited to: largemouth bass, gar, carp, minnow, shiner, pike, and sunfish.

Materials:
- “Sinkhole Sledding” text
- “Sinkhole Habitats” student activity sheet
- colored pencils

Directions:
1. Open a class discussion by having students state what types of plants and animals live in a sinkhole.
2. Ask students to state fun activities one can do while visiting a sinkhole. (optional: discuss dangers)
3. Have the students read the student text “Sinkhole Sledding.”
4. After reading the story, chart on the board the different types of ecosystems that can be found in and around a sinkhole.
5. Have the students complete “Sinkhole Habitats” student activity sheet.
A sinkhole contains various habitats. The top of the sinkhole usually provides a home for woodland mammals such as deer. Illustrate the various life forms found at the middle and lower portions of the sinkhole. Remember to illustrate the karst terrain. The top area of the sinkhole has been done for you.
**BMP Posters**

Teacher Information

**Materials:**

- white poster-size paper
- markers
- transparencies of “Major Sources of Nonpoint Source (NPS) Pollution and Best Management Practices (BMPs)” made from pp. 14-18
- overhead projector
- “Best Management Practices” student handout pg. 19

**Directions:**

1. Make transparencies of “Major Sources of Nonpoint Source (NPS) Pollution and Best Management Practices (BMPs).”

2. Identify and discuss sources of pollution and the best management practices utilized on each transparency. *(For orientation purposes use a sheet of paper to cover up a section of the transparency.)*

3. Divide the class into groups.

4. Each group is to make a poster identifying potential sources of pollution and best management practices in order to prevent pollution. Poster topics are BMPs for the:
   - Homeowner
   - Logger
   - Miner
   - Construction Worker
   - Painter
   - Landscaper

5. After the posters are completed, have each group share their poster and discuss the BMPs displayed.

6. Display the posters.
Public Service Announcement
Teacher Information

Materials:

- Public Service Announcement student sheet p. 28
- “Major Sources of Nonpoint Source (NPS) Pollution and Best Management Practices (BMPs)” (make transparencies from pp. 14-18)
- Best Management Practices student sheet p. 19

Directions:

1. Review “Major Sources of Nonpoint Source (NPS) Pollution and Best Management Practices (BMPs),” (transparencies)


3. Inform the students they are going to make a public service announcement.

4. The students can work in groups of three.

5. They are to develop a one-minute public service announcement. The best announcements can be aired by the school’s closed circuit television, the local cable company, or the local radio station.

Teachers may wish to ask the school’s media specialist about details concerning the contest for students offered through F.A.M.E. (Florida Association for Media in Education). Information is available at: http://www.floridamedia.org
BMP Public Service Announcement

On the lines below, write a one-minute public service script for the broadcast. Announce BMPs that will help protect the aquifer and reduce the occurrence of sinkholes caused by human activity. Practice reading the script using your announcer voice.

Name_______________________________
English

Grade Levels: 6-8

Overview: The video “Water’s Journey” tracks the arterial network of an underground waterway, both above and under ground, in real time. Throughout the video, many examples of figurative language are used (similes, metaphors, and alliteration) to convey understanding of our valuable water resources.

Concept: Students will use numerous language arts strategies to identify figurative language and to understand the power of language in communication.

Sunshine State Standards:

Language Arts

Strand A: Reading
  • Use strategies to clarify meaning, such as rereading, note taking, summarizing, outlining, and writing a grade level-appropriate report. (LA.A.1.3.4)
  • Determine the main idea or essential message in a text and identify relevant details and facts and patterns of organization. (LA.A.2.3.1)
  • Locate, organize, and interpret written information for a variety of purposes, including classroom research, collaborative decision making, and performing a school or real-world task. (LA.A.2.3.5)

Strand B: Writing
  • Write text, notes, outlines, comments, and observations that demonstrate comprehension of content and experiences from a variety of media. (LA.B.2.3.1)

Strand C: Listening, Viewing, and Speaking
  • Listen and use information gained for a variety of purposes, such as gaining information from interviews, following directions, and pursuing a personal interest. (LA.C.1.3.1)
  • Determine main concept, supporting details, stereotypes, bias, and persuasion techniques in a nonprint message. (LA.C.2.3.1)

Strand D: Language
  • Use literary devices and techniques in the comprehension and creation of written, oral, and visual communications. (LA.D.2.3.2)

*Benchmarks for other subject areas will be identified with individual activities as appropriate.
Suggested Path for Implementation: (Using the 5Es Model)

Engage:
• Literature Connection: *The Missing ‘Gator of Gumbo Limbo* (pp. 125-127) by Jean Craighead George
  o Student responses   EN p. 4

Explore:
• View the thirty-minute video, *Water’s Journey: The Hidden Rivers of Florida*, and record examples of figurative language such as simile, metaphor, and alliteration
  o Video Note-Taking Organizer   EN p. 5

Explore/Explain:
• Vocabulary Cartoons   EN p. 6
• “Human Activity Can Trigger Sinkholes” text:   EN p. 7
  o Teacher information for using Problem-Solution Guide   EN p. 8
  o Problem-Solution Guide   EN p. 9
  SC.D.2.3.2; SS.B.2.3.6; SS.B.2.3.9
• *The Lovely Bones* excerpts - Student text and responses:   EN p. 10
  o Teacher Information   EN p. 4
• *Florida Waters* “Springs” text:   EN p. 11
  o The Third Time Is A Charm   EN p. 12
• “An Essay on Florida Springs” text:   EN pp. 13-15
  o Teacher information for guided discussion   EN p. 16

Extend:
• “Underwater Photography” text:   (Appendix pp. 39-40)
  o Suggested tasks   EN p. 17
• “Vampire Sink Cleanup” text:   (Appendix pp. 37-38)
  o Suggested tasks   EN p. 17
• Biographies/Resumes:   (Appendix pp. 3-7)
  o Suggested tasks   EN p. 17
• Quotes on Florida Springs text:   EN p. 18
  o Teacher Information (suggested shoulder partner activity)   EN p. 17
  o Student response   EN p. 18
• *The Missing ‘Gator of Gumbo Limbo* - read in its entirety:
  o Teacher Cyber Guide for supplemental unit instructional activities
    [http://www.sdcoe.k12.ca.us/score/gator/gatorgtg.html](http://www.sdcoe.k12.ca.us/score/gator/gatorgtg.html)
• Taking Action:
  o Student Creation of Children’s Book   EN p. 19

Evaluate/Assess:
• Many assessments embedded throughout tasks and activities, for example:
  o *Missing ‘Gator of Gumbo Limbo* reading/writing prompts
Problem-Solution Guide for “Human Activity Can Trigger Sinkholes”

Materials

Book: The Missing ‘Gator of Gumbo Limbo by Jean Craighead George
Water’s Journey: The Hidden Rivers of Florida DVD/Video (30 minutes)
Various materials depending on chosen activities

Vocabulary - (see glossary)

Literature Connection:

- The Lovely Bones
  by Alice Siebold

Websites

Quotes About Florida Springs (includes “An Essay on Florida Springs” by Al Burt)
http://www.tfn.net/springs/Springbook/Quotes.htm

Teacher CyberGuide for The Missing ‘Gator of Gumbo Limbo
http://www.sdcoe.k12.ca.us/score/gator/gatortg.html
Short Response  (2-point rubric)

- “The sunlight was now shining brightly, and the long needles of the slash pines were a sea of silver sabers. The royal palm leaves were chiming and Gumbo Limbo Hole was clear as glass.”

  Identify an example of each of the following in the quote above:
  metaphor    simile    alliteration

- What is the author conveying to you in the following quote?
  “Green algae, I said to myself. I could hear a bell ringing but again, I couldn’t find a door to open. Green algae.”

The Lovely Bones - Teacher Information
(Excerpts from p. 52 and p. 293)

(Caution to teacher: This book contains sexual content and violence. Only the excerpts pertain to sinkholes.

Teacher Option: Assign one or both of the writing response tasks to students.

Writing Response  (6-point rubric)

- First Excerpt: The Lovely Bones, p. 52
  Property owners have certain rights. Think about the potentially harmful practices of the Flanagans. Do you think property owners’ rights are more important than the rights of others in the surrounding area? Use information from this excerpt, previous readings, and the video, to explain your position and tell why you feel the way you do.

- Second Excerpt: The Lovely Bones, p. 293
  Ruth and Ray were heading to the sinkhole, and Ray was a bit nervous about being in the area. Keep in mind the physical description of the sinkhole location given in this excerpt. Now write about the adventures of a day you spent exploring a sinkhole.
Video Note-Taking Organizer

As you view and listen to the video, use this organizer to record examples of figurative language devices such as simile, metaphor, and alliteration. If you have an example you are not sure which category it belongs in, place it in the “I’m not sure” column until you can identify where it goes.

<table>
<thead>
<tr>
<th>Simile</th>
<th>Metaphor</th>
<th>Alliteration</th>
<th>I’m Not Sure</th>
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Vocabulary Cartoons

Purpose: Use cartoons as a mnemonic device to learn and remember vocabulary.

Materials:
- pencil
- paper
- vocabulary word

Directions:

1. Choose a vocabulary word that you might need help with in order to remember it and to use it correctly.

2. Now think of a rhyming word or other word phrase that helps you “picture” it. (For example: porous and “pour us;”)

3. Take the two words (vocabulary word and rhyming word or word phrase) and combine them into a cartoon picture.

We were partially absorbed as it began to pour us onto the porous sponge.
Sinkholes are part of the slow, natural process of erosion in Florida’s limestone terrain that occurs over thousands of years. But that doesn’t make the formation of a sinkhole any less dramatic. Sinkholes are common geologic phenomena that generally occur where the limestone is within a few hundred feet of the land surface. Though most are only 10 to 12 feet in diameter, sinkholes have been known to expand to hundreds of feet in diameter. In fact, many of Central and North Florida’s lakes actually are the result of old sinkholes. For instance, in Northeast Florida, Keystone Heights has numerous lakes that were formed by ancient sinkhole activity. However, sinkholes that occur east of Keystone Heights are generally considered to be triggered by human activity such as overwithdrawal of groundwater, diverting surface water from a large area and concentrating it to a single point, artificially creating ponds of surface water, or drilling new water wells. In urban or suburban areas, sinkholes are hazardous because they can destroy highways and buildings. Sinkholes also can cause water quality problems. During the collapse, surface waters may leak into an aquifer, our underground source of drinking water. Most natural sinkholes cannot be prevented. However, those caused by human activity may be avoided, especially those caused by over-pumping groundwater. During dry conditions, water tables drop in the limestone and cavities under Florida’s sand and clay soil. The combination of gravity, loss of buoyancy and water pressure can activate a collapse. The St. Johns River Water Management District promotes year-round water conservation to prevent water shortages and over-pumping. Heavy rains after droughts can also cause enough pressure on the ground to create sinkholes. Recent published reports say that the active 2004 hurricane season may have made Volusia County more vulnerable to sinkhole activity, due to heavy rainfall from hurricanes Charley, Frances and Jeanne. Rainfall percolating, or seeping, through the soil absorbs carbon dioxide and reacts with decaying vegetation, creating a slightly acidic water. That water moves through spaces and cracks underground, slowly dissolving the limestone and creating a network of cavities and voids. As the limestone dissolves, pores and cracks are enlarged and carry even more acidic water. Sinkholes are formed when the land surface above collapses or sinks into the cavities or when surface material is carried downward into the voids. A rapid sinkhole caused by well drilling or other sudden alterations to the terrain may not give any warning signs. Otherwise, the collapse process usually occurs gradually enough that a person may leave the affected area safely. The final breakthrough can develop over a period of a few minutes to a few hours. Some subtle warning signs of a naturally occurring sinkhole are gradual localized ground settlement, doors and windows that fail to close properly, cracks in a foundation, a circular pattern of ground cracks outlining the sinking area, vegetation stress due to a lowered water table, and turbidity in local well water due to sediment washing into the limestone’s pores. There are many other causes of localized ground settlement and vegetation stress, and depressed areas are not necessarily indications of an imminent sinkhole. The District is responsible for providing long-term protection of the water supply. While water restrictions can cause some inconvenience to residents and businesses, limiting outdoor watering is critical throughout the year, and especially during a drought. Public cooperation is vital to ensuring long-term water resource protection. For more information about water resource protection or for a copy of the District’s fact sheet on sinkhole formation, visit the District’s Web site at www.sjrwmd.com.

This article is used with permission (Beth Hickenlooper, Communications Manager, Office of Communications and Governmental Affairs, St. Johns River Water Management District).
Teacher Information for Using Problem-Solution Guide
(use with reading of “Human Activity Can Trigger Sinkholes” article)

Guide students through the reading and discussion of the article. Use the Problem-Solution Guide to assist note taking in regards to identifying problem, effect, cause, and solution.

Directions for use of Guide:

1. Have students skim the article for their prediction of what the article is about and what the problem might be.

2. Read the article orally with the class.

3. Guide students to identify the problem stated in the article. Instruct them to write the problem statement in the right-hand column opposite of the question, “What is the problem?”

4. Lead a discussion of possible effects, causes, and solutions to the identified problem. Students should record answers to questions 2-4 in the appropriate right-hand column.

Tips:

Suggest that as the article is read, students underline, highlight, use post-its, or write with pencil in the margins of the article as they find possible effects, causes, and solutions to the problem. This will give them a purpose for reading and will also assist them in filling out their problem-solution guide.
### Problem-Solution Guide

Read each of the questions below on the chart. As you read through the text, look for the problem, cause(s), effect(s), and solution(s). Write your response statements in the right-hand column opposite of the appropriate question.

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<td>1. What is the <strong>problem</strong>?</td>
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<td>2. What are the <strong>causes</strong>?</td>
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<td>3. What are the <strong>effects</strong>?</td>
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<td>4. What are the <strong>solutions</strong>?</td>
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Read these excerpts from *The Lovely Bones* written by Alice Sebold.

... “It was late when he got there, and he left the safe in his Wagoneer while he approached the house of the Flanagans, who lived on the property where the sinkhole was. The Flanagans made their living by charging people to dump their appliances [in the sinkhole].”

Excerpt: *The Lovely Bones*, p. 52

“Then she turned toward the lot. They were quiet. Ruth moved in ever-diminishing circles, with the hole and its vague edge as their goal. Ray trailed just behind Ruth as she led the way. If you saw it from a distance, the sinkhole seemed innocuous—like an overgrown mud puddle just starting to dry out. There were spots of grass and weeds surrounding it and then, if you looked close enough, it was as if the earth stopped and a light cocoa-colored flesh began. It was soft and convex, and it drew in items placed on top of it.

“How do you know it won’t swallow us?” Ray asked.

“We’re not heavy enough,” Ruth said.

“Stop if you feel yourself sinking.”

Watching them I remembered holding on to Buckley’s hand the day we went to bury the refrigerator. While my father was talking to Mr. Flanagan, Buckley and I walked up to the point where the earth sloped down and softened, and I swore I felt it give ever so slightly beneath my feet. It had been the same sensation as walking in the graveyard of our church and suddenly sinking into the hollow tunnels that the moles had dug among the headstones.”

Excerpt: *The Lovely Bones*, p. 293

**Writing Responses** (6-point rubric)

- **First Excerpt: The Lovely Bones, p. 52**

  Property owners have certain rights. Think about the potentially harmful practices of the Flanagans. Do you think property owners’ rights are more important than the rights of others in the surrounding area? Use information from this excerpt, previous readings, and the video, to explain your position and tell why you feel the way you do.

- **Second Excerpt: The Lovely Bones, p. 293**

  Ruth and Ray were heading to the sinkhole, and Ray was a bit nervous about being in the area. Keep in mind the physical description of the sinkhole location given in this excerpt. Now write about the adventures of a day you spent exploring a sinkhole.
“Springs”

Springs are a “window” into the aquifer from which they flow. Cool in the summer and warm in the winter, they are among the most sought-after of all the state’s natural and scenic resources. Most of Florida’s springs are found in the northern half of the state and flow from the Floridan aquifer. As rainwater enters and recharges the aquifer, pressure is exerted on the water already in the aquifer. This pressure causes the water to move through cracks and tunnels in the aquifer. Sometimes this water flows out naturally to the land surface at places called springs. When the openings are large, spring flow may become the source of rivers. The Ichetucknee is an example of a river created by a spring. Springs also make substantial contributions to the flow of other rivers. Manatee, Fanning, Troy and Blue springs contribute nearly 368 million gallons each day to the Suwannee River.

For thousands of years, Native American settled near springs and fished in spring-fed streams. Spanish explorer Ponce de Leon came to Florida seeking a Fountain of Youth, as well as gold and other treasures. Traveling in Florida in 1774, botanist William Bartram described water issuing from one of the springs along the St. Johns River as “perfectly diaphanous,” with fish appearing “as plain as lying on a table before your eyes, although many feet deep in water” (Van Doren 1955:135). Today, springs are popular with both tourists and residents. Many of Florida’s largest springs have been incorporated into state parks, including Manatee, Homosassa, Silver, Wakulla, and Ichetucknee. Wakulla and Silver springs have been popular locations for movies. Marjorie Kinnan Rawlings’ *The Yearling*, as well as more than 100 episodes of the popular TV series *Sea Hunt*, was filmed at Silver Springs. The *Creature From the Black Lagoon* and some of the Tarzan movies were shot at Wakulla Springs.

Rain falling onto nearby recharge areas and entering the aquifer is the source of most of Florida’s ground water, including water that flows from springs. Contrary to popular belief, underground rivers do not carry water into Florida from other states (Spechler and Schiffer 1995). Caverns in the aquifer are sometimes large and interconnected and may transmit water underground for several miles, but there are no underground rivers. The 320 known springs in the state discharge nearly 8 billion gallons of water each day, more than all the fresh water used in the state each day (Spechler and Schiffer 1995).

Large withdrawals of water from wells near a spring can cause the flow of the spring to stop. Silt or sediments building up in the spring can also cause loss of flow. The only large spring in Florida known to have ceased flowing is Kissengen Spring, about 4 miles southeast of Bartow (Berndt et al. 1998). The spring stopped flowing in 1950 (Rosenau et al. 1976).

Text is from *Florida Waters – A Water Resources Manual from Florida’s Water Management Districts*
You will read the text once, and then record what you know in the left column. Read the text second time and record additional information you learned in the middle column. After reading the text the third and final time, record any other information you learned in the right-hand column.

<table>
<thead>
<tr>
<th>What I know after reading it once</th>
<th>Something else I know after reading it twice</th>
<th>What I finally know after reading it thrice</th>
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Name ___________________
Springs have a way of getting into your mind and staying there. My first spring was a small one, a goblet hollowed out of the earth, but I have never forgotten it.

To drink, you got down on your hands and knees and put your face into it. On the bottom—maybe two feet down—was a crayfish, wriggling a bit in the sand boils. Above, a snake curled around the limb of a tree. It did not matter. I leaned over and lapped up that sweet water anyway—and the mystique of springs was forever imprinted on me.

Since then, there have been many springs, most of them larger and more powerful, springs you could swim in, some with ‘gators lounging on the banks of the far side. Sometimes it was like swimming in Tarzan’s water cooler.

That mystique always was there. Always, there was a freshening and cleansing by water that poured out of the ground like an incredible gift, like a process of rebirth. It was something that seemed too large for simple gratitude and appreciation.

Geologists and water managers can break down the springs into numbers and explain how and why they came to be, but the mystique of the springs leaps far beyond exact measurement into the imagination. What I saw happening—while traveling this state and writing about it for a quarter century changed me. It turned me into one of those common folk who want Florida to remain Florida, to remain a real place, not to become a chintzy imitation of itself.

We common folk see Florida as a place struggling to stay true to itself—struggling to maintain an honest identity. We are people who find significance not only in headlines, and beauty not only in colorful horizons, but also in the small things of Florida—the sights and sounds of home that were blooded and boned into our beings as we grew up. These represent heritage and affirming identity. For us, they are the true things of Florida.

High among them are Florida’s springs. The beaches and the oceans are the marvels that attract the tourists. The springs are the marvels that attract Floridians who have a larger sense of this unusual state. Like nothing else, they add a melody to our measled land.

“Measled” was Archie Carr’s description. Florida’s great poet-scientist used words with clinical precision as well as lyrical imagery. Looking around at Florida in 1964, he said, “The world is all broken out with man.” He made it sound as though Florida had come down with a case of the measles. He saw the over development of Florida as “the partly aimless, partly avaricious ruin of unequalled natural riches.”
Now, you do not have to be an Archie Carr to know. You can see it for yourself. Look around you in Florida at all the self-inflicted injuries and take stock. All Floridians can see and mourn.

In the opening pages of The Yearling, Marjorie Kinnan Rawlings’ wonderful book about Florida past, the boy Jody goes rambling from his home in the Big Scrub. “He went down to the spring…a secret and lovely place…” Rawlings wrote. “Water bubbled up from nowhere…(it) cut itself a channel through white limestone and began to run rapidly downhill to make a creek. The creek joined Lake George…part of the St. Johns River…the great river flowed northward and into the sea…the beginning of the ocean…The bubbling spring would rise forever from the earth…When he was an old man, as old as this father, it would continue.”

Today, Jody could not be so sure about that. If he looked at the diminishing volumes of the springs and the dry or dwindling lake bed, he would have second thoughts about whether his bubbling spring would last forever.

Rawlings’ words lift a small spring into the formation of an ocean. She reveals this everyday piece of Florida as significant to a vision of the world. She tells it the way Floridians want to believe it.

Springs deliver messages to all of us. Somehow they reach and salve hungers that transcend our conscious appetites. With their mystique, they become “watering holes of the spirit” where we can refill our imaginations with hope, where there is a pool of inspiration to revive our jaded views of the world.

Springs nourish clues to our natural past, and they encourage us to recognize that what we have left is too precious to squander on hucksters who never sipped from a spring while keeping an eye on a crawfish at the bottom, or on a snake hanging off a tree limb overhead.

Whatever the distractions and distortions around them—however strip-zoned and ugly the road might be, and however concreted and constrained those once sandy banks might have become—springs still can deliver a living piece of Florida that performs much the same way it did during our childhood, and even before that.

In our parks, the springs still set a scene that lets you imagine with some accuracy how it must have been before your memories started, what it was like before there were interstates and jets and skyscrapers, when Native Americans or Spanish conquistadors knelt and drank from waters that looked very much like this. Except that, in some of them, the color might be clouded a bit and have a suggestion of salt or a chemical bite, or even the faint flavor of cement dust. And now, if you drink carelessly, you might discover that lovely water was not as virginal as it looked. Yet, our springs still have magic. They still offer experiences that we can find nowhere else, and out of those can come a sense of connection with how Florida evolved and what Florida really is.
We go there for a swim or a float or just a gawk, and there comes a nudge toward historic understanding. Despite wars and freezes, Democrats and Republicans, incredibly the springs still keep bubbling, and they still keep promising that in Florida there remain these lovely and inspirational gifts that are irreplaceable—beyond dollar value—easily enjoyed if left natural, easily destroyed if too closely captured.

Those old Spanish conquistadors who came here in the 16th century looking for the fountain of youth found one, but they were looking for the wrong thing. Though they never understood it, this really was a place of rejuvenation, but it was not located in a single magical spring as they had hoped. Instead, it was in the nature of this place. Rather than one spring that restored youth, there was a dazzling array of natural gifts—many springs, rivers, and lakes, and an extraordinary range of geography, climate, plant and animal life. Springs that were then—and still are today—watering holes for the spirit where every minute, every hour, every day is created new beginnings and new capacities for life.

This essay is used with permission of the author, Al Burt. It is from an editorial in the Tallahassee Democrat, April 27, 2003.
Teacher Information for Guided Discussion Strategy  

to be used with  

“An Essay on Florida Springs”

Students often have difficulty unlocking meaning from text. The purpose of this guided discussion with use of sticky notes is to model for students, and also to create opportunities for students to inquire and to respond to one another. This will help students build their comprehension of text.

Materials:

- Copies of the text
- Sticky notes (post-its)
- Highlighter or pencil

The following suggestions for a teacher-led discussion are to be used in a flexible manner (the teacher can add to, or delete, as desired). You may choose to have students work in small groups, if that is already an established practice in your class.

Directions:

1. Instruct students to mark text with sticky notes for any of the following:
   - questions they have
   - sections they really like or want to discuss
   - interesting or vivid descriptions
   - teacher-directed skill/concept identification
   - unknown vocabulary
   - connections to other text/to self/to world

2. Read chunks of text orally (a single to a few short paragraphs). **Prior to reading aloud, choose your stopping points.**

3. Occasionally, stop and instruct students to “Say Something” to another student seated nearby. This “something” could be a reaction, a comment, a question, a prediction, or an opinion. Both partners share. Allow a minute for this exchange.

   (The first time you try this, you might need to give extra wait time…some students are not used to a teacher telling them to talk to one another. After a short time, meaningful discussion will occur naturally.)

   To generate initial conversation among students, you might ask a question or direct student responses in connection to a current instructional focus (for example, figurative language or descriptive writing).

Natural outcomes of reading and discussing this text might involve the reading of *The Yearling*, further research on springs or current environmental issues, or author studies.
“Underwater Photography”  
(Text – Appendix pp 39-40)  
Student Response

Suggested Tasks:

- In “Underwater Photography,” what writing conventions does the author use to convey emotion?

“Vampire Sink Cleanup”  
(Text – Appendix pp 37-38)  
Student Response

Suggested Tasks:

- Create a poem about one of the following:
  - the condition of the sinkhole as the divers found it
  - the community cleanup effort
  - the change in the health of the sinkhole over time (from its early natural state, to garbage dump and restored health in the twenty-first century)
  - your reaction as you read the article

Biographies and Resumes  
(Text – Appendix pp. 3-7)  
Student Response

Suggested Tasks:

- Read and study the biographies and resumes of Wes Skiles and Jill Heinerth. Write a letter to the principal of your school convincing him or her why _____________ (Mr. Skiles or Ms. Heinerth) should be the special speaker for _____________ (graduation, career day, the first day of school assembly - choose one).

Quotes About Florida Springs  
(Text – English p. 18)  
Teacher Information for Student Response

Teacher:
Instruct students to individually read the quotes and choose one that makes an impression on him or her. Then have them turn to a shoulder partner (a classmate that sits next to them) and share the quote and their reason for choosing it.
Quotes About Florida Springs
Student Text and Response

“These superb fountains are a unique natural asset of Florida.” (Archie Carr)

“…a secret and lovely place.” (Marjory Kinnan Rawlings)

“…bowls of liquid light.” (Marjorie Stoneman Douglas)

“…each is a little ecologic jewel in which geology and biology have created a masterwork of natural art.” (Archie Carr)

Florida springs are a ”crystal flood,” “almost as transparent as the air we breathe,” “so extremely clear as to be absolutely diaphanous or transparent as the ether,” an “enchanting and amazing crystal fountain,” “the blue ether of another world,” “a silvery bed...,” (William Bartram)

“Springs add a melody to the land.” (Al Burt)

“…an emerald bigger than your house,” a “crystal ball of water.” (Joe Clark)

“…you saw the spring boil tumbling up out of its deep birthplace and roiling the surface with little prisms that sprayed color from the slanting light of the morning sun…” (Archie Carr)

“…entering into a spring is like passing though a mystical gate…like diving into the liquid heart of a palm.” (Bill Belleville-writer)

“There is nothing on earth comparable to it.” (Harriet Beecher Stowe, commenting on Silver Springs)

“It is not strange that they should be deemed to possess a renovating elixir, an to promise, to those who would dwell by their banks and disport in their waters, a restoration of youthful vigor and energy.” (George Rainsford Fairbanks, in History of Florida)

“Florida springs will not protect themselves, those who know and love them must protect them.” (Jim Stevenson, Florida Department of Environmental Protection)

Student Response:

Choose one of the quotes above that made an impression on you. With a shoulder partner, discuss its meaning and why you chose it.

Note: A shoulder partner is a classmate who sits beside you.
Student Creation of Children’s Book

Suggestions for the Teacher:

As a culminating activity, assign students to write a fictional book for K-3 students (ages 5-8) that deal with the aquifer, springs, or sinkholes. They should include facts they have learned, and perhaps some of the descriptive language they identified in the video and in various texts they have been exposed to.

Gather some Magic School Bus books (*The Magic School Bus At the Waterworks*, *The Magic School Bus - Wet All Over*, etc.) and share with students to give them the idea of how to incorporate science concepts into literature. Students might choose to write a story based on a familiar one they know from childhood (*Goldilocks and the Three Bears*, *Cinderella*, *Little Red Riding Hood*, etc.).

Encourage students to pair up as writers and illustrators, or to add graphics from the computer. When completed, arrange for students to buddy-read with younger students at a nearby school. Copies of these books could be placed in elementary school libraries, the public library, or dentist and doctor offices.
Social Studies

Grade Levels – 6-8

Overview: The video *Water's Journey: The Hidden Rivers of Florida* tracks the arterial network of an underground waterway, both above and under ground, in real time. Throughout the video, problem solving, data collection, and mapping skills are employed. Numerous examples of human impact on the environment are visible.

Concept: Students will engage in studies and activities that promote understanding of how the interactions of people and their physical environment have consequences for present as well as future generations.

Sunshine State Standards:

**Social Studies**

**Strand A: Time, Continuity, and Change (History)**
- Know how the environment of Florida has been modified by the values, traditions, and actions of various groups who have inhabited the state. (SS.A.6.3.3)
- Understand how Florida has allocated and used resources and the consequences of those economic decisions. (SS.A.6.3.5)

**Strand B: People, Places, and Environments (Geography)**
- Understand how the interaction between physical and human systems affects current conditions on Earth. (SS.B.2.3.9)

*Benchmarks for other subject areas will be identified with individual activities as appropriate.*

Suggested Path for Implementation: *(Using the 5Es Model)*

**Engage:**
  - Reading and writing responses SS p. 4 LA.A.2.3.1; LA.A.2.3.5
- View the six-minute video, *Protecting Springs*
  - Student Note-Taking Sheet SS p. 5 LA.B.2.3.1; LA.B.2.3.2
Explore:
- View the thirty-minute video noting the various ways in which the watershed has been affected by human activity
  - T-chart response SS p. 6
  - Student response SS p. 4
LA.B.2.3.2

Explore/Explain:
- Vocabulary Match Game SS p. 7
  - Vocabulary cards pp. SS 8-17
  - Vocabulary quiz and answer key SS pp. 18-20
- The Florida Waters “Sinkhole Phenomenon” text and debate scenario: SS p. 21
  - Teacher information for student debate SS p. 22
- It’s Not My Problem…Is It?? – aquifer activity: SS p. 23
  - Student Response Sheet SS p. 24
SC.D.2.3.2
- Mapping Florida’s Springs – activity SS p. 25
  - Student responses SS p. 27
- Springs Refuge text and student response SS p. 28

Extend:
- “Underwater Photography” text: (Appendix pp. 39-40)
  - Suggested tasks SS p. 29
- “Vampire Sink Cleanup” text: (Appendix pp. 37-38)
  - Suggested tasks SS p. 29
- Biographies/Resumes text: (Appendix pp. 3-7)
  - Suggested tasks SS p. 29
- Taking Action:
  - Water Board Game SS p. 30

Evaluate/Assess:
- Many assessments embedded throughout tasks and activities, for example:
  - Missing ‘Gator of Gumbo Limbo reading/writing prompts
  - Vocabulary quiz
  - It’s Not My Problem…Is It???

Materials
- Book: The Missing ‘Gator of Gumbo Limbo by Jean Craighead George
- Water’s Journey: The Hidden Rivers of Florida DVD/Video (30 minutes)
- Various materials depending on chosen activities
**Vocabulary** – see glossary and below:

*additional vocabulary specific for this strand

  *irrigation
  *radio-location telemetry

**Articles:**

“Unlocking the Labyrinth of North Florida Springs” (March, 1999 issue of *National Geographic*) by Ken Ringle, photographs by Wes Skiles

**Project Wet Activities:**

- *A Grave Mistake*
- *Dilemma Derby*
- *Poison Pump*
- *Water Bill of Rights*

**Websites:**

Department of Environmental Protection - springs information
http://www.dep.state.fl.us/geology/geologictopics/springs.htm

Department of Environmental Protection - springs information
http://www.dep.state.fl.us/geology/geologictopics/springs/bulletin66.htm

Department of Environmental Protection - sinkhole information
http://www.dep.state.fl.us/geology/geologictopics/sinkhole.htm
**The Missing ‘Gator of Gumbo Limbo**

Student Responses

(Excerpt pp. 79-86)

**Extended Response** (4-point rubric)

- “Florida’s vast network of waterways affects many special interests, like housing, farming, tourism, and wildlife.” Use details and information from the text to explain how the change in a waterway may affect these special interests.

- The Army Corps of Engineers was hired to drain the land south of Lake Okeechobee. Use facts and information from the text to create a flow chart to show the process they used to accomplish this task.

**Writing Prompt** 6-point rubric

- “Water is a big issue in this town—the environmentalists are fighting the developers, the developers are trying to get around the environmentalists, and the politicians are hopping from one side to another.”

Choose one of the occupations—environmentalist, developer, or politician—and persuade the reader to use that person’s point of view for addressing the saltwater intrusion issue.

**Water’s Journey**

Student Responses to Video

**Extended Response** (4-point rubric)

- The video states that the population growth has quadrupled in the last 40 years. Think about how the run-off from various human activities has affected our water supply. Use details from the video to tell what humans can do to reduce the negative impact of a growing population.

**Teacher Information For 6-Minute Video (Protecting Springs)**

- Inform students they will watch the 6-minute video twice. The first time they will take general notes about the subtopics aquifer, sinkhole and spring. They record notes in the “first viewing” section for each subtopic on their note-taking sheet. Before viewing the second time, assign each student a perspective (homeowner, elected official, or land developer). The students will then take notes from their assigned perspective as they view the second time. These notes are recorded in the “second viewing” section for each subtopic. Then have students form groups of three (one from each perspective) to share out.
Water’s Journey *Protecting Springs* Video
Note-Taking Sheet

First viewing of six-minute video: Write a few words or details for each subtopic that you hear or see in the video.

Second viewing: Write information that would be important from your assigned perspective (*homeowner, elected official, land developer*). Underline your perspective.

<table>
<thead>
<tr>
<th>Subtopic</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>aquifer</strong></td>
<td></td>
</tr>
<tr>
<td><em>first viewing</em></td>
<td></td>
</tr>
<tr>
<td><strong>aquifer</strong></td>
<td></td>
</tr>
<tr>
<td><em>second viewing</em></td>
<td></td>
</tr>
<tr>
<td><strong>springshed</strong></td>
<td></td>
</tr>
<tr>
<td><em>first viewing</em></td>
<td></td>
</tr>
<tr>
<td><strong>springshed</strong></td>
<td></td>
</tr>
<tr>
<td><em>second viewing</em></td>
<td></td>
</tr>
<tr>
<td><strong>spring</strong></td>
<td></td>
</tr>
<tr>
<td><em>first viewing</em></td>
<td></td>
</tr>
<tr>
<td><strong>spring</strong></td>
<td></td>
</tr>
<tr>
<td><em>second viewing</em></td>
<td></td>
</tr>
</tbody>
</table>
T-Chart
(for use with 30-minute video)

Use this graphic organizer to demonstrate your understanding of cause and effect.

Example:

<table>
<thead>
<tr>
<th>Cause</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>raking leaves for 2 hours</td>
<td>blisters on hands</td>
</tr>
</tbody>
</table>
Vocabulary Match Game

Materials:

- Terms and definitions cards (cut out and laminate for student use)
  (Terms and definition cards are provided on pp. 8-17)

Directions:

1. Shuffle cards and place face-down on table surface.

2. Players take turns turning over one card and then another card in an attempt to match the term to its definition.

3. When a match is made, the player picks up the pair and places it in his/her own pile. Another turn is allowed when a match is made.

4. When a match is not made, the cards are turned upside-down again and the next player takes his or her turn.

5. Play continues until all cards have been paired up.

6. Player with the most matched pairs is the winner.

aquifer

matched pair

-an underground layer of sand, gravel, or rock that stores and carries water
<table>
<thead>
<tr>
<th>karst</th>
<th>groundwater</th>
</tr>
</thead>
<tbody>
<tr>
<td>limestone</td>
<td>aquifer</td>
</tr>
<tr>
<td>conduit</td>
<td>sinkhole</td>
</tr>
<tr>
<td>recycling</td>
<td>saturation</td>
</tr>
<tr>
<td>acidic</td>
<td>reclamation</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>electromagnetic</td>
<td>drought</td>
</tr>
<tr>
<td>wastewater treatment</td>
<td>swallet hole</td>
</tr>
<tr>
<td>watershed</td>
<td>runoff</td>
</tr>
<tr>
<td>pollution</td>
<td>water cycle</td>
</tr>
<tr>
<td>------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>surface water</td>
<td>renewable resource</td>
</tr>
<tr>
<td>escarpment</td>
<td>labyrinth</td>
</tr>
<tr>
<td>leach</td>
<td>percolation</td>
</tr>
<tr>
<td>porous</td>
<td>by-products</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
</tr>
<tr>
<td>BMP (Best Management Practice)</td>
<td>culvert</td>
</tr>
<tr>
<td>drought-tolerant</td>
<td>erosion</td>
</tr>
<tr>
<td>springshed</td>
<td>land acquisition</td>
</tr>
<tr>
<td>nitrate%es</td>
<td>water quality</td>
</tr>
<tr>
<td>-----------</td>
<td>---------------</td>
</tr>
<tr>
<td>well</td>
<td>irrigation</td>
</tr>
<tr>
<td>radio-location telemetry</td>
<td></td>
</tr>
<tr>
<td>having a pH value of less than 7; acidic liquids are corrosive and sour</td>
<td>an underground layer of sand, gravel, or rock that stores and carries water</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>methods that have been determined to be the most effective, practical means of preventing or reducing pollution from various sources of water run-off</td>
<td>materials that are not one of the intended products of a production process. It is a catch-all term and includes most wastes that are not spent materials or sludges.</td>
</tr>
<tr>
<td>a pipe, canal, channel, or passage for conveying water or fluid</td>
<td>a sewer or drain crossing under a road or embankment</td>
</tr>
<tr>
<td>a long period of time with little or no rain that results in a shortage of water</td>
<td>plants that use less water to grow</td>
</tr>
<tr>
<td><strong>-the relation of magnetism and electricity</strong></td>
<td><strong>-the wearing away of the top layer of the Earth (such as soil, sand or rock) by wind, water, or glaciers</strong></td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>-a steep sloping bank</strong></td>
<td><strong>-water below the ground usually found in aquifers</strong></td>
</tr>
<tr>
<td><strong>-a type of terrain underlain by limestone and characterized by caves, sinkholes and disappearing streams</strong></td>
<td><strong>-interconnecting passages through which it is difficult to find one’s way: a maze</strong></td>
</tr>
<tr>
<td><strong>-purchasing land, as for conservation</strong></td>
<td><strong>-to remove soluble or other substances from, by the action of a percolating liquid</strong></td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Highly porous rock formed over millions of years from shells and bones of sea animals</td>
<td>- Highly porous rock formed over millions of years from shells and bones of sea animals. These porous rocks, known as limestones, are formed by the accumulation of marine organisms' remains, primarily shells and bones, which are slowly transformed over millions of years into solid rock. They are highly valued for their aesthetic qualities and durability, making them ideal for construction and decorative purposes.</td>
</tr>
<tr>
<td>Nitric acid; nitrates</td>
<td>- A salt of nitric acid; nitrates are compounds in the environment containing nitrogen. These compounds are found in animal wastes, fertilizers, septic tanks, and in untreated municipal sewage (can cause &quot;blue baby&quot; syndrome).</td>
</tr>
<tr>
<td>Movement of water through the soil</td>
<td>- The process where water moves through the soil.</td>
</tr>
<tr>
<td>Contamination of water or air by harmful chemicals or waste materials</td>
<td>- Contamination of water or air by harmful chemicals or waste materials.</td>
</tr>
<tr>
<td>Material that contains small holes</td>
<td>- A material that contains small holes.</td>
</tr>
<tr>
<td>Water that has been used, collected, and then treated or cleansed so it is safe to be used for irrigation, etc., but remains undrinkable</td>
<td>- Water that has been used, collected, and then treated or cleansed so it is safe to be used for irrigation, etc., but remains undrinkable.</td>
</tr>
<tr>
<td>To use more than once</td>
<td>- To use more than once.</td>
</tr>
<tr>
<td>Materials that may be replenished through human or natural activities. These materials are continually being renewed or restored.</td>
<td>- Materials that may be replenished through human or natural activities. These materials are continually being renewed or restored.</td>
</tr>
<tr>
<td>Definitions</td>
<td>Definitions</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>-water from rain or irrigation that doesn't soak into the ground, but</td>
<td>-having absorbed all the liquid that is possible</td>
</tr>
<tr>
<td>flows into the nearest body of water</td>
<td></td>
</tr>
<tr>
<td>-a hole or depression in the ground caused by erosion of underground</td>
<td>-the total land area that contributes rainfall and runoff to a spring or</td>
</tr>
<tr>
<td>limestone</td>
<td>series of connected springs</td>
</tr>
<tr>
<td>-water that is found on the surface of the Earth such as oceans, rivers,</td>
<td>-a hole in the land through which a stream delivers surface water to the</td>
</tr>
<tr>
<td>lakes, ponds, wetlands, streams, or seas</td>
<td>aquifer (considered the opposite of a spring)</td>
</tr>
<tr>
<td>-a method of cleaning water for a specific purpose. The water may then be</td>
<td>-the continuous movement of water from the Earth into the atmosphere and</td>
</tr>
<tr>
<td>reused or returned to the environment.</td>
<td>back to Earth again</td>
</tr>
<tr>
<td>Definition</td>
<td>Definition</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>-the condition of water with respect to its content of contaminants</td>
<td>-the land and water areas that water moves over, through, and drains into</td>
</tr>
<tr>
<td>-a hole or shaft drilled into the earth where water, other liquids, and gases are pumped to the surface</td>
<td>-the application of water to an area</td>
</tr>
<tr>
<td>-a method of transmitting sub-surface communication using low frequency radio</td>
<td></td>
</tr>
</tbody>
</table>
Match the term to its definition by writing the corresponding letter on the line.

(Use the definition sheet you are provided to determine your answers.)

_____ 1. karst
_____ 2. groundwater
_____ 3. aquifer
_____ 4. conduit
_____ 5. sinkhole
_____ 6. saturation
_____ 7. reclamation
_____ 8. wastewater treatment
_____ 9. swallet hole
_____ 10. watershed
_____ 11. runoff
_____ 12. pollution
_____ 13. radio-location telemetry
_____ 14. surface water
_____ 15. escarpment
_____ 16. labyrinth
_____ 17. leach
_____ 18. percolation
_____ 19. BMPs
_____ 20. erosion
Vocabulary Quiz
Definitions Page

Use this page to determine your answers. Write your answers on the Answer Sheet.

A. A pipe, canal, channel, or passage for conveying water or fluid
B. Water from rain or irrigation that doesn’t soak into the ground, but flows into the nearest body of water
C. The process where water moves through the soil
D. A steep sloping bank
E. An underground layer of sand, gravel, or rock that stores and carries water
F. The land and water areas that water moves over, through, and drains into
G. A hole in the land through which a stream delivers surface water to the aquifer (considered the opposite of a spring)
H. The wearing away of the top layer of the earth (such as soil, sand or rock) by wind, water, or glaciers
I. Methods that have been determined to be the most effective, practical means of preventing or reducing pollution from various sources of water run-off
J. Type of terrain underlain by limestone and characterized by caves, sinkholes and disappearing streams
K. A hole or depression in the ground caused by erosion of underground limestone
L. Water that is found on the surface of the Earth such as oceans, rivers, lakes, ponds, wetlands, streams, or seas
M. To remove soluble or other substances from, by the action of a percolating liquid
N. Interconnecting passages through which it is difficult to find one’s way; a maze
O. Having absorbed all the liquid that is possible
P. Water below the ground usually found in aquifers
Q. Water that has been used, collected, and then treated or cleansed so it is safe to be used for irrigation, etc., but remains undrinkable
R. A method of transmitting sub-surface communication using low frequency radio
S. A method of cleaning water for a specific purpose. The water may then be reused or returned to the environment.
T. Contamination of water or air by harmful chemicals or waste materials
Answer Key for Vocabulary Quiz

1. J
2. P
3. E
4. A
5. K
6. O
7. Q
8. S
9. G
10. F
11. B
12. T
13. R
14. L
15. D
16. N
17. M
18. C
19. I
20. H
In early March 1998, as a drilling company was drilling an irrigation well for a future golf course in western Pasco County, a massive sinkhole opened up and threatened to swallow the entire drilling rig. Although the driver got the rig out in time, a crane had to retrieve a truck from the 150-foot-deep sinkhole. Shortly after this event, nearly 700 sinkholes, most only a few feet wide, appeared in the surrounding area.

While sinkholes are common in the area, “this event was unique,” according to Mark Steward, chairman of the Geology Department at the University of South Florida. “I know of no other recent event in Florida that opened so many sinkholes in one small area.”

According to Tony Gilboy, hydrologist for the Southwest Florida Water Management District, the phenomenon began when the contractor drilled a hole into the Florida aquifer for an irrigation well. As he cleaned out the hole using compressed air, a common development practice, a large underground cavity collapsed, resulting in the large sinkhole near the drill rig. The force of several tons of dirt falling into the cavity caused a massive pressure wave through the aquifer, producing the nearly 700 smaller sinkholes on the surrounding property. Heavy rains, which the area had been experiencing, may also have contributed by putting pressure on the underground cavities, causing them to collapse.

Text from Florida Waters - A Water Resources Manual from Florida’s Water Management Districts

The text states that developers have a common practice of using compressed air to clean out holes that are dug into the aquifer for wells. As a developer, you believe this is a safe practice you should be allowed to continue. As a property owner in the surrounding area, you think this practice should be disallowed. As a town council member who is trying to bring in additional tourism dollars to your area, you think this event was rare and probably won’t happen again, but you have the interests of your constituents to consider.

Debate Scenario:
Students are each assigned to represent one of the following groups: developer, property owner, or town council member. The council member must listen to the arguments put forth by the developers and the property owners in order to make a decision as to whether this practice will be allowed in their county.
Teacher Information for Student Debate
“Sinkhole Phenomenon”

Overview of Debate Scenario:

Students are each assigned to represent one of the following groups: developer, property owner, or town council member. The council member must listen to the arguments put forth by the developers and the property owners in order to make a decision as to whether this practice will be allowed in their county.

The following information is on the student sheet with the “Sinkhole Phenomenon.”

- The text states that developers have a common practice of using compressed air to clean out holes that are dug into the aquifer for wells. As a developer, you believe this is a safe practice you should be allowed to continue. As a property owner in the surrounding area, you think this practice should be disallowed. As a town council member who is trying to bring in additional tourism dollars to your area, you think this event was rare and probably won’t happen again, but you have the interests of your constituents to consider.

Teacher Directions:

1. Count off students: 1, 2, 3, 1, 2, 3, …

2. Assign each number a group to represent.
   (i.e., all 1s are developers, all 2s are town council members, and all 3s are property owners)

3. Instruct students to form groups of three with representation for each number 1-3
   (i.e., 1 each: developer, town council member, property owner).

4. As students read the text, they should highlight points that are of interest to the assigned group they are representing.

5. Students representing developers or property owners should then present their case, for or against the practice of using compressed air to clean out holes that are dug into the aquifer for wells, to the town council member.

6. Once presentations have been made, the town council member will “vote” in support of one or the other, based on information presented to him or her by the developer and homeowner. He or she will also have to weigh the tourism dollar issue in the decision.

7. Have the town council member from each group of three students present his or her decision to the class and give reasons why that decision was made.
It’s Not My Problem…Is It???

Purpose: Work in small groups to learn how untreated wastewater can pollute the aquifer.

Materials:
Per Group:
- small pitcher of water
- 1 - 8 ounce cup of tea, coffee, juice, or similar liquid
- rectangular or oval pan, about 3” deep (9”x13” works)
- coarse sand – enough to fill the pan 1/3 to 1/2 full

Per Student:
- 1 3-5 ounce paper cup
- flexible straw
- dropper
- pen or marker
- scissors

Procedures:
1. Get into groups and gather materials.
2. Use scissors to cut the bottom out of your paper cup. Then, with a pen or marker, draw some house identifying marks on your own cup.
3. Pour enough sand into the pan to form a land area surrounding a lake (leave a good-sized hole in the middle).
4. Bend your straw into an “L” shape to represent a wastewater pipe that comes from your house. Pick a location around the lake for your “property.” Then push the straw into the sand with the long end extending out into the hole and the short, flexible end sticking up out of the sand, at least a couple of inches from the “shoreline.”
5. Place your house (paper cup) topside down over your straw. Your group should now have their homes all located around the hole.
6. Fill the hole with water, using the water in your pitcher.
7. **Take turns with your group members on this step.** To simulate untreated wastewater from drains (kitchen, bathrooms, etc.) in your house running into the lake, fill your dropper with the liquid (tea, coffee, or juice) and put 6-8 drops into the straw end protruding up inside your house.
8. Observe what occurs from your action, and record your observations on the recording sheet.
9. Repeat step 7 a couple more times to show the cumulative effects of flushing toilets and pouring items down the drains.
It’s Not My Problem…Is It???
Student Response Sheet

Illustrate and describe what you observe in Step 7.

If every home continues this method of getting rid of wastewater for a long period of time, how will this affect the aquifer?

People also use various chemicals on their yards such as fertilizers, pesticides, etc. What could homeowners do to lessen the harmful effect on the aquifer?

Think About It: Many older homes were built when the normal practice was to pipe wastewater directly into lakes and rivers. Now we know water pollution occurs as a result of this practice, and we have regulations that govern wastewater disposal and treatment.
Mapping Florida’s Springs

Materials:

- map of Florida
- pushpins, yarn, springs name cards
- computer Internet access
  
  http://www.dep.state.fl.us/geology/geologictopics/springs/bulletin66.htm
- markers, pencils, etc.
- resource materials – anything about Florida Springs

Directions:

1. Look carefully at a map of Florida. Notice how towns and cities tend to be located next to rivers. Rivers provide water for the essential needs of both tiny towns and huge cities. Most people do not realize that rivers and streams are also found beneath the ground. In fact, the water you drink may come from water stored underground in springs.

2. Florida has approximately 750 springs. Use the following website or other available resources to find out more information about the location of these springs:

   http://www.dep.state.fl.us/geology/geologictopics/springs/bulletin66.htm

3. Research at least ten (10) of these springs to find their Florida map coordinates.

4. Use a Florida map (with coordinates) to mark the exact location of at least ten Florida springs. (You might want to assign students to research certain springs in order to find the location of most of the springs.)

5. Optional: Post a large Florida map on the wall showing the location of each spring. Use pushpins and yarn to link location and springs name cards.

(Source: Florida Department of Environmental Protection – Florida Geological Survey (FGS) Bulletin #66)
New Technology Maps Underground Springs

by Victoria Langley
Tuesday December 24th, 2002
Capitol News Service

Some high-tech tools could hold the key to preserving and protecting Florida's water supply. This fall the state used radio-location telemetry for the first time ever to explore the underwater cave system of Wakulla Springs, in North Florida. The research could help protect your drinking water, and even save your life.

Florida has 600 freshwater springs - more than anywhere else in the world. Researchers recently made history when they used 2-way radio technology to talk with and track the progress of a diver 300 feet below ground, as she explored one of the underwater caves connecting the springs.

State Environmental Secretary David Struhs calls it an exciting breakthrough. "It's one thing to look in a textbook," Struhs said. "It's another thing to actually be running through the woods and across the lawn and through the lobby of a hotel knowing that all the while, these divers are swimming below our feet." Struhs says radio-tracking divers will help bolster the state's argument for purchasing and preserving land miles from a spring.

The new technology could also help save lives. Cave-diving is a popular but dangerous sport in Florida. Two to four cave-divers a year die when they get lost underground. Diver Erik Anderson, an underwater archaeology student at Florida State, had a close call when he got trapped in an underwater cave and nearly ran out of air. He says it's easy to lose your bearings. "Oh, definitely, definitely. Especially when you're dealing with low visibility situations and ledges and water that's like night-time," Anderson said.

The state hopes radio-tracking will lead to safer exploration, and help save Florida's springs for future generations. The state spent nearly 8 million dollars last year purchasing 48-hundred acres to protect Wakulla Springs. For more information on the Florida springs initiative, log on to www.floridasprings.com

Permission for use granted by Mike Vasilinda, Productions/Capitol News Service
“New Technology Maps Underground Springs”
Student Responses

Short Response  (2-point rubric)

- In 2001, the state purchased 4,800 acres to protect Wakulla Springs at a cost of nearly eight million dollars. State Environmental Secretary David Struhs says “radio-tracking divers will help bolster the state’s argument for purchasing and preserving land miles from a spring.” Use details and information from the text to explain why he believes this to be true.

Extended Response  (4-point rubric)

- History was made in the fall of 2002 when radio-location telemetry was used for the first time to explore the underwater cave system of Wakulla Springs. Imagine that you are requesting a loan from a bank to purchase this technology. Write to persuade the loan officer that it is beneficial and potentially profitable. Be sure to use details from the text to support your position.

Writing Response  (6-point rubric)

- Cave-diving is a popular but dangerous sport. Think about the excitement and risk associated with underwater exploration of caves and springs. Now write a story about the day in the life of a person tracking (above ground) a diver exploring a springs system.

Questions for Consideration:

1. What was the author’s purpose in writing “New Technology Maps Underground Springs”?

2. Should private lands be purchased by the state and set aside for preservation purposes? Why, or why not?

3. If the state purchases land for public use such as parks and fishing areas, should users be charged a fee? If so, why? If not, who would help pay for the maintenance?

4. What other information might you want to know about Florida’s springs?
Springs have provided refuge for people throughout time, including during various conflicts such as the Civil War that is the setting for this story. Use information from the text above to explain what the author means by this statement:

“*These special places remind us that regardless of our differences, we are all connected through water.*”

---

Winston looked around at the lush green landscape. It was springtime and, in spite of the terrible things he had seen and experienced, his heart was light. He was going home.

He and his small command of soldiers had stopped at this wooded spring to fill their canteens with its sweet waters and to rest before they began their journey home. The soldiers were pleasantly surprised when women from the farmhouse on the property of the spring brought them warm loaves of homemade bread from the farm ovens.

Winston sat alone by the spring, marveling at the clear waters. As he tipped his head back and drank from the canteen, he thought he had never tasted anything better in his whole life. He hoped that he would hang on to this one thing the war had taught him---to be grateful for the small gifts that come our way: a refreshing drink of water, warm bread, the laughter of friends, a letter from home.

Winston watched the stars come out in the night sky and studied their reflection in the clear waters of the spring. He felt in his pocket for his harmonica and began to play a soothing tune. Suddenly, he heard the distant sound of another harmonica, like a familiar voice. Had he fallen asleep at his post and entered a dream? No, he was wide-awake, for the full moon had risen and was now reflected in the pool of the spring.

Soon the music came from behind his left shoulder. In the pool, Winston saw the reflection of a man’s face, similar to his own, only thinner and sadder. Winston sat very still in the night quiet and studied his twin’s reflection….
“Underwater Photography”  
(Text - Appendix pp. 39-40)  
Student Responses

Suggested Tasks:

- Wes Skiles is a world-renowned underwater photographer. What does he have in common with Neil Armstrong and John Muir? Use a graphic organizer to display your information.

- Why must exploration be encouraged and supported in today’s world? Think of some real-life opportunities we have for exploring and searching for answers to questions people have. In a small group, discuss your answers to the above question.

“Vampire Sink Cleanup”  
(Text – Appendix pp. 37-38)  
Student Responses

Suggested Tasks:

According to the author, most people do not know that sinkholes are direct openings to our drinking water supply. As suggested in this article, when people become aware, they want to be a part of the solution rather than the problem.

- Design a plan by which you could help people in your community become aware of the importance of protecting the health of the aquifer. Then, with help from your teacher or others in the community, put your plan into action. (Possible ideas: posters, public service announcement at school or on local TV, organize cleanup days in your community, ask service groups such as scouts to assist you in some way, or give a speech to various community groups.)

Biographies and Resumes  
(Text – Appendix pp. 3-7)  
Student Responses

Suggested Tasks:

- Read the biographies and resumes for Wes Skiles and Jill Heinerth. Consider which one would be the best person for the job of an expedition leader.

Support your choice by including at least three of the person’s accomplishments or experiences that qualify him or her for the job. With a partner, share your choice and your reasons why you think that person is the best for the job.
Water Board Game

This activity will enable students to share their knowledge of springs, aquifers, sinkholes, and the origin of our drinking water with those living at home and within their community by creating a water board game.

Materials:

- box (or container) with lid to hold completed game
- cardboard or heavy poster board (science display board also works well)
- markers, crayons, paints, etc.
- cards containing facts about springs, aquifers, and sinkholes
- individual game piece for each player

Directions:

1. Create an original board game using facts you have learned about aquifers, springs, and sinkholes.

2. The game must include at least thirty student-created factual question cards with an answer key provided.

3. A colorful game board with all necessary game pieces must be included.

4. Include detailed written (or typed) directions that are easy to follow and have been tested prior to the project due date.

5. All parts of the game must be stored in a box or container (with a lid) that is:
   a. labeled with the name of the game.
   b. appropriately decorated.

6. Share the game with others.
Mathematics

Grade Levels 6-8

Overview: The video, *Water's Journey: The Hidden Rivers of Florida*, tracks the arterial network of an underground waterway, both above and under ground, in real time. Throughout the video, problem solving, data collection, and mapping skills are essential.

Concept: Students will understand how various mathematical skills are used in real life as they participate in numerous problem-solving activities, including data collection, graphing, scaled drawings, estimation, charts, and tables.

Sunshine State Standards

Mathematics:

**Strand A: Number Sense, Concepts, and Operations**
- Understands the relative size of integers, fractions, and decimals; numbers expressed as percents; numbers with exponents; numbers in scientific notation; radicals; absolute value; and ratios. (MA.A.1.3.2)
- Understands concrete and symbolic representations of rational numbers and irrational numbers in real-world situations. (MA.A.1.3.3)
- Understands and uses exponential and scientific notation. (MA.A.2.3.1)
  Adds, subtracts, multiplies, and divides whole numbers, decimals, and fractions, including mixed numbers, to solve real-world problems, using appropriate methods of computing, such as mental mathematics, paper and pencil, and calculator. (MA.A.3.3.3)
- Uses estimation strategies to predict results and to check the reasonableness of results. (MA.A.4.3.1)

**Strand B: Measurement**
- Uses concrete and graphic models to drive formulas for finding rates, distance, time, and angle measures. (MA.B.1.3.2)
- Constructs, interprets, and uses scale drawings such as those based on number lines and maps to solve real-world problems. (MA.B.1.3.4)
- Solves real-world and mathematical problems involving estimates of measurements including length, time, weight/mass, temperature, money, perimeter, area, and volume, in either customary or metric units. (MA.B.3.3.1)

**Strand C: Geometry and Spatial Sense**
- Represents and applies geometric properties and relationships to solve real-world and mathematical problems. (MA.C.3.3.1)
**Strand D: Algebraic Thinking**
- Describes a wide variety of patterns, relationships, and functions through models, such as manipulatives, tables, graphs, expressions, equations, and inequalities. (MA.D.1.3.1)
- Creates and interprets tables, graphs, equations, and verbal descriptions to explain cause and effect relationships. (MA.D.1.3.2)
- Uses algebraic problem-solving strategies to solve real-world problems involving linear equations and inequalities. (MA.D.2.3.2)

**Strand E: Data Analysis and Probability**
- Collects, organizes, and displays data in a variety of forms, including tables, line graphs, charts, bar graphs, to determine how different ways of presenting data can lead to different interpretations. (MA.E.1.3.1)
- Understands and applies the concepts of range and central tendency (mean, median, and mode). (MA.E.1.3.2)

*Benchmarks for other subject areas will be identified with individual activities as appropriate.*

**Suggested Path for Implementation: (Using the 5Es Model)**

**Engage:**
- Literature Connection: *The Missing ‘Gator of Gumbo Limbo* (p. 17) by Jean Craighead George
  - Scaled Drawing of a Sinkhole MA pp. 5-6 (LA.C.1.3.1)

**Explore:**
- View the thirty-minute video, *Water’s Journey: The Hidden Rivers of Florida* focusing on ways that mathematics is used in real-world activities
  - Student responses MA pp. 6-7 (L.A.B.2.3.1 L.A.C.1.3.1 SC.D.2.3.2)

**Explore/Explain:**
- Applying Water Vocabulary in Mathematics:
  - Student responses MA pp. 8-9
- Read “Vampire Sink Cleanup” (Appendix pp. 37-38)
  - Student responses MA p. 10-11 (L.A.A.2.3.2 L.A.A.2.3.5 SC.D.2.3.2)
- Create a Sinkhole – activity:
  - Student responses MA p. 12 (SC.A.1.3.1 SC.D.1.3.1 SC.H.2.3.1)
• Magnitude of Florida’s Springs text
  o Student responses MA pp. 13-17
    (L.A.A.2.3.5 SC.C.1.3.1 SC.C.2.3.1)
• Build an Aquifer – activity:
  o Student responses MA pp. 18-22
    (SC.A.1.3.1 SC.H.1.3.4 SC.H.1.3.7)
• Tri-Tab Fact Book about Aquifers, Sinkholes, and Springs MA p. 23

Extend:
• View of an Aquifer – activity (Mapping Coordinates) MA pp. 24-25
  (SS.B.1.3.1)
• America’s Water Usage:
  o Student responses MA pp. 26-27
• Protecting Our Water:
  o Student responses MA pp. 28-30
• Taking Action:
  o Mathematical Water Trivia Display (share with high school club, class, or other groups and/or display in media center, hallway, or other locations) MA p. 31
    (SC.G.2.3.4)
  o Jeopardy Game – Mathematical facts and trivia for Home/Community Connection MA p. 32
    (SC.G.2.3.4)

Evaluate/Assess:
• Many assessments embedded throughout tasks and activities, for example:
  o “Vampire Sink Cleanup” - Student responses
  o Create a Sinkhole – Student responses
  o Magnitude of Florida’s Springs – Student responses

Materials

Book: The Missing ‘Gator of Gumbo Limbo by Jean Craighead George
Water’s Journey: The Hidden Rivers of Florida DVD/Video (30 minutes)
Various materials depending on chosen activities

Vocabulary – (see glossary)
Project WET Activities:

- *A Grave Mistake*
- *Get the Groundwater Picture*

Websites

United States Geological Survey (USGS) – (water use maps)
http://ga.water.usgs.gov/edu/mapgallery.html

Florida Springs Database (Florida Springs Flyer – Interactive GIS Viewer)
http://www.thiswaytothe.net/gis/

Florida Department of Environmental Protection (springs locater)
http://www.dep.state.fl.us/springs/locator/Firstmagmap.htm

Florida Department of Environmental Protection (sinkhole information)
http://www.dep.state.fl.us/geology/geologictopics/sinkhole.htm

Florida Department of Environmental Protection (Florida Sinkhole Database)
http://www.dep.state.fl.us/geology/gisdatamaps/sinkhole_database.htm

Florida Department of Environmental Protection (Springs of Florida- downloadable)
http://www.dep.state.fl.us/geology/geologictopics/springs/bulletin66.htm
Engage students by reading page 17 (first paragraph) of *The Missing ‘Gator of Gumbo Limbo* written by Jean Craighead George.

“\[I \text{ liked the idea of Dajun in our solution pit. Solution pits are peculiar to limestone country, particularly in Florida. They are sinkholes that can be a few feet across or a hundred. Some are shallow and dry up in the winter dry season; others are very deep, with steep limestone walls. James James says they are made by the acid from decaying plants eating into Florida’s limestone bedrock. The pit in Gumbo Limbo Hammock is about twenty feet across---a big one---and James James doesn’t know how deep. It is back among the mahogany trees and surrounded by wax myrtle, water oak, and spackleberry. In the rainy season of summer it fills to within one foot of the rim. During the dry season it falls three or four feet.}\]

Excerpt: *The Missing ‘Gator of Gumbo Limbo*, page 17

**Student Activity:** Create a scaled drawing of the sinkhole referred to in the text above.

**Materials:**
- graph paper
- pencils
- ruler

**Directions:**
1. After reading the text, use graph paper to create a scaled drawing of this sinkhole.
2. Based on the information given, you will need to determine your own dimensions related to the depth of the sinkhole and the slope of the sides.
3. Determine the mathematical scale you will use to create the drawing. (Be sure to explain your reasons for using this scale.)
4. Draw your sinkhole to scale. Be sure to note the scale used as well as the true dimensions of the sinkhole.
5. Add other features from the text to complete your scaled drawing.
Extended Responses (4-point rubric)

- The video states that this 10-mile adventure through the Floridan Aquifer often changes from shallow depths to those of 182 feet below ground. This is depicted in the video using a cross-section of the underground waterway. Calculate the average descent per mile if the depth of 182 feet was at the midpoint of the waterway and explain how you arrived at your answer. Then create a line graph showing both the descent and ascent in this given situation.

- According to the video, 450 acres of land per day is lost to development. This land development is destroying the recharge areas for our aquifers. If land development is reduced by 10 acres of land per day, how many acres of land would be lost to development in one year? Explain how you got your answer.

- The video states that eight billion gallons of water per day bursts forth from Florida springs. Write the numeral “eight billion” in four other ways.

Notes for teacher concerning spring magnitudes – The amount of water that flows from a spring in a given time determines its magnitude. There are eight categories of spring magnitudes with first-magnitude springs have the highest flow rate. A spring’s magnitude can be determined from one discharge measurement. However, springs have dynamic flows. A spring categorized as being a first-magnitude spring at one moment in time may not remain in the same category over time. Therefore, the magnitude of the spring is based on the median value of all discharge measurements for the period of record.
1. The answers are:

36.4 feet per mile

182 ÷ 5 = 36.4 feet per mile where 5 is the midpoint

2. The answers are:

160,600 acres during a regular year

OR

161,040 acres during a leap year

AND

(450 – 10) x 365 = 160,600 acres

OR

(450 – 10) x 366 = 161,040 acres

3. Accept all correct answers.
Applying Water Vocabulary in Mathematics
Student Response Sheet

Short Responses (2-point rubric)

1. The average yearly rainfall for the state of Florida is 54 inches. Suppose that out of this amount of rain, an average amount of 32 inches per year soaks into the ground, 6 inches evaporate, and 16 inches remain above ground. (Round to the nearest percent.)
   a. What percentage becomes **groundwater**? ________________
   b. What percentage remains **surface water**? ________________

2. The divers collected several water samples at various points during their underwater journey through the Floridan Aquifer. Suppose that each of their cylinder-shaped containers had a diameter of one inch and a height of three inches.
   a. The divers were testing nitrate levels in various areas of the aquifer to determine ____________ ____________.
   b. What volume of water was collected if each bottle was completely filled? (Hint: Volume of a cylinder $\pi r^2 h$) ________________

Extended Response (4-point rubric)

3. While in an underground cave, suppose a diver noticed there were three conduits to choose from to continue his journey. The openings for each are described below:
   - Conduit #1 – oval-shaped with a diameter at its widest points measuring 20 mm horizontally x 80 mm vertically
   - Conduit #2 – hexagon-shaped with the equal sides measuring 12 inches
   - Conduit #3 – parallelogram having an obtuse angle of 135° with lengths measuring 35mm x 100 mm

Which **conduit** opening would be the easiest to maneuver through? Explain your answer.

__________________________________________________________________________________________________________

__________________________________________________________________________________________________________

__________________________________________________________________________________________________________

__________________________________________________________________________________________________________

__________________________________________________________________________________________________________
Using Water Vocabulary
Answers to Student Responses

1. a. 59% becomes groundwater
   b. 30% remains surface water

2. a. water quality
   b. 2.36 cubic inches

3.  
   Conduit #2 would be the easiest to maneuver through. A hexagon is made up of 6 equilateral triangles. That means all sides of the triangles measure 12 inches. Therefore the hexagon shaped conduit would have a diameter of 24 inches at each of its points making it large enough for a human to get through. Conduit #1’s widest vertical diameter is only 20 mm which is approximately 7 inches wide. It would be very difficult to squeeze through an opening that size. Even though Conduit #3 is 100 mm wide, the 25 mm vertical opening would appear smaller due to the outside angles or the lean of the parallelogram.
“Vampire Sink Cleanup”  
(Text - Appendix pp. 37-38)  
Student Responses

Short Responses (2-point rubric)

1. The article states that a dumpster was placed at the sink cleanup site where it was overflowing when the cleanup was completed. If the debris in the dumpster was then fully compacted to fit inside the dumpster, what would be the amount of debris that was collected from the sink area? Use the information from the text to explain your answer.

2. Upon arriving at the sinkhole, Brian and Wes had to carefully navigate the entire area until they were able to find a safe but very steep, sloping footpath to the bottom. Draw a diagram of the slope having an angle of 120°.

3. Due to the vertical drop at the sinkhole, the team had a difficult time removing some of the heavy objects. The team devised a hauling system known as the “Single Rope Technique” to reduce the heavy items to a 2:1 ratio. Explain what is meant by a 2:1 ratio.

4. As the tub was pulled out of the water, 1/6 of the tub’s water capacity remained inside. Use the following information to determine the weight being pulled from the sinkhole.”

   - The empty iron bathtub weighed 235 pounds.
   - The holding portion of the tub holds 11.25 cubic feet of water.
   - Water weighs approximately 62.4 pounds per cubic foot.
1. The dumpster measured 20 x 8 x 5 feet. If all the debris is compacted inside the dumpster, the dumpster would hold its volume in trash. The volume of the dumpster is 800 cubic feet. Therefore, the dumpster holds 800 cubic feet of debris if compacted.

2. The slope having an angle of 120° should look similar to:

3. We use ratios to make comparisons between two things. Here we are comparing the mass of one object (the tub) to the amount of force needed on the other end. The force needed to lift the object would need to be twice that of the object. Therefore, the ratio of the force needed for removal to the mass of the tub is two to one.

4. If the tub holds 11.25 cubic feet of water and water weighs approximately 62.4 pounds per cubic foot, then the water in the full tub would weigh approximately 702 pounds. Since it is only 1/6 filled after it is out of the water, then the water would weigh about 117 pounds. The empty tub weighs about 235 pounds. Therefore, 117 + 235 = approximately 352 pounds.

\[
\begin{align*}
11.25 \times 62.4 &= 702 \text{ pounds} \\
1/6 \text{ of 702} &= 117 \text{ pounds} \\
117 + 235 &= 352 \text{ pounds}
\end{align*}
\]
Create a Sinkhole

A sinkhole is a collapsed underground space caused when bedrock erodes and dissolves from acidic water.

Materials:

- plastic box, aquarium or other waterproof container
- small balloon
- sand or dirt
- spray bottle with water
- straight pin
- miniature homes, trees, farm animals, etc.

Directions:

1. Fill the bottom of the container with a few inches of dirt or sand.
2. Blow up the balloon. Determine the size of the balloon filled with air.
3. Lay the balloon on the surface of the dirt and completely cover the balloon with damp dirt or sand. (Make the surface as level as desired.)
4. Place the miniature homes and other pieces on the surface to create an established home area.
5. Dampen the surface by spraying water on it.
6. Cause a sinkhole to develop by popping the balloon with the straight pin.
7. Observe the results.

Student Responses

Short Response (2-point rubric)

1. Based on the activity, determine the circumference of the sinkhole. Explain how you arrived at your answer.

Extended Responses (4-point rubric)

1. Use graph paper to draw a scaled, two-dimensional cross-section (side view) of the sinkhole you created in the activity. Create a map of coordinate points so that other students might recreate your sinkhole cross-section.

2. *Based on the activity, what is the volume of the sinkhole you created? Explain how you determined the volume of your sinkhole.
   Hint: Volume of a hemisphere = \( \frac{2}{3} \pi r^3 \)

* Enriched activity
Magnitude of Florida Springs
Student Text

Information from The Florida Geological Survey, Division of Resource Assessment and Management, Department of Environmental Protection – Special Publication No. 52, Florida Spring Classification System and Spring Glossary, compiled by Rick Copeland.

The classification of a spring is based on the amount of water that flows from the spring during a given period of time. The largest springs (those with the greatest volume of flow) are known as first magnitude springs. These springs have a water discharge rate of greater than or equal to 100 cubic feet per second or greater than or equal to 4.6 million gallons per day. The table below shows the eight magnitude categories.

### Spring Magnitudes

<table>
<thead>
<tr>
<th>Magnitude</th>
<th>Standard Units</th>
<th>Metric Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No current flow</td>
<td>No current flow</td>
</tr>
<tr>
<td>1st</td>
<td>≥ 100 cfs (≥ 64.6 gpm)</td>
<td>≥ 2.832 cms</td>
</tr>
<tr>
<td>2nd</td>
<td>≥ 10-100 cfs (≥ 6.46-64.6 gpm)</td>
<td>≥ 0.283-2.832 cms</td>
</tr>
<tr>
<td>3rd</td>
<td>≥ 1-10 cfs (≥ 0.646-6.46 gpm)</td>
<td>≥ 0.028-0.283 cms</td>
</tr>
<tr>
<td>4th</td>
<td>≥ 100 gpm - 1 cfs (≥ 100-448 gpm)</td>
<td>≥ 0.0063-0.028 cms</td>
</tr>
<tr>
<td>5th</td>
<td>≥ 10–100 gpm</td>
<td>≥ 0.631-6.308 lps</td>
</tr>
<tr>
<td>6th</td>
<td>≥ 1-10 gpm</td>
<td>≥ 0.063-0.631 lps</td>
</tr>
<tr>
<td>7th</td>
<td>≥ 1 pint/min - 1 gpm</td>
<td>≥ 0.473-3.785 lpm</td>
</tr>
<tr>
<td>8th</td>
<td>≤ 1 pint/min</td>
<td>≤ 0.473 lpm</td>
</tr>
</tbody>
</table>

### Key

<table>
<thead>
<tr>
<th>Standard Units</th>
<th>Metric Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>cfs – cubic feet per second</td>
<td>cms – cubic meters per second</td>
</tr>
<tr>
<td>mgd – million of gallons per day</td>
<td>lps – liters per second</td>
</tr>
<tr>
<td>gpm – gallons per minute</td>
<td>lpm – liters per minute</td>
</tr>
<tr>
<td>pint/min – pints per minute</td>
<td></td>
</tr>
</tbody>
</table>

Notes regarding magnitude – One discharge measurement is enough to place a spring into one of the eight magnitude categories. However, springs have dynamic flows. A spring categorized as being a first-magnitude spring at one moment in time may not continue to remain in the same category. Therefore, the magnitude of the spring is to be based on the median value of all discharge measurements for the period of record (FSNC, 2003). The median of a set of scores is the middle value when the scores are arranged in increasing (or decreasing) order (Modified from Triola, 1998).
Spring Magnitudes (Continued)

It is recognized that, historically, many springs in Florida have kept one magnitude category, even though the discharge may have changed considerably from when it was first assigned a magnitude. For this reason, a historical category is acceptable in the Florida Springs Classification System. For example, the discharge of a spring may have been taken in 1946. At that time it was classified as a first-magnitude spring. No other measurement was taken until 2001. During that year, three discharge measurements were taken. The median value of all four measurements reveals that the spring should be reclassified to a second-magnitude spring in 2001. Nevertheless, it can still be considered a historical first-magnitude spring. The term “historical” refers to the period of time prior to the adoption of the Florida Springs Classification System (2003).

The location of a discharge measurement is critical for defining the magnitude of a spring. Whenever possible, a discharge measurement should be restricted to a vent or seep. However, this is often impractical. For example, the only place to take a measurement may be in a spring run downstream where multiple springs have discharged into the run. For this reason, whenever a discharge measurement or water sample is taken, the springs (vents or seeps) included in the measurement need to be reported. The exact location of the discharge measurement (using a Global Positioning System - GPS - with approved locational specifications) and a standardized locational reference point for each measurement is encouraged.
Based on the information in the student text, *Magnitudes of Florida’s Springs*, use the table below to determine the magnitude of each given spring. Then use the data to answer the questions that follow.

<table>
<thead>
<tr>
<th>Name of Spring</th>
<th>Dates of Measure</th>
<th>*Discharge Rate (cfs)</th>
<th>*Median Discharge Rate</th>
<th>Magnitude of Spring</th>
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<tbody>
<tr>
<td>Hart Spring</td>
<td>March 14, 1932</td>
<td>40</td>
<td>62.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>May 12, 1932</td>
<td></td>
<td>58.6</td>
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</tr>
<tr>
<td></td>
<td>July 24, 1946</td>
<td></td>
<td>58.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>April 27, 1956</td>
<td></td>
<td>152</td>
<td></td>
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<tr>
<td></td>
<td>November 23, 1960</td>
<td></td>
<td>79.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>November 1, 1972</td>
<td></td>
<td>51.28</td>
<td></td>
</tr>
<tr>
<td></td>
<td>June 26, 1997</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turtle Spring</td>
<td>November 3, 1972</td>
<td>40.8</td>
<td>36.39</td>
<td></td>
</tr>
<tr>
<td></td>
<td>September 22, 1997</td>
<td></td>
<td>11.43</td>
<td></td>
</tr>
<tr>
<td></td>
<td>July 17, 2002</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manatee Spring</td>
<td>March 14, 1932</td>
<td>149</td>
<td>218</td>
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<tr>
<td></td>
<td>December 17, 1942</td>
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<td></td>
<td>April 27, 1956</td>
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<td></td>
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<td>145</td>
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<td></td>
<td>May 28, 1963</td>
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<td></td>
<td>April 19, 1972</td>
<td></td>
<td>210</td>
<td></td>
</tr>
<tr>
<td></td>
<td>April 25, 1972</td>
<td></td>
<td>203</td>
<td></td>
</tr>
<tr>
<td></td>
<td>July 31, 1973</td>
<td></td>
<td>154</td>
<td></td>
</tr>
<tr>
<td></td>
<td>October 23, 2001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ichetucknee Springs</td>
<td>May 17, 1946</td>
<td>197.2</td>
<td>186</td>
<td></td>
</tr>
<tr>
<td></td>
<td>October 3, 2001</td>
<td></td>
<td></td>
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<tr>
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<td>February 12, 1929</td>
<td>5.4</td>
<td>4.42</td>
<td></td>
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<tr>
<td></td>
<td>April 18, 1946</td>
<td></td>
<td>4.15</td>
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<td></td>
<td>November 4, 1950</td>
<td></td>
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<td></td>
<td>June 18, 1954</td>
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<td></td>
<td>October 19, 1960</td>
<td></td>
<td>3.03</td>
<td></td>
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<tr>
<td></td>
<td>March 8, 1972</td>
<td></td>
<td>2.79</td>
<td></td>
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<td></td>
<td>January 8, 2003</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Owens Spring</td>
<td>September 10, 1973</td>
<td>51.2</td>
<td>90 (est.)</td>
<td></td>
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<td></td>
<td>June 2, 1998</td>
<td></td>
<td>0.89</td>
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<td></td>
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</tr>
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</table>

*All rates given in cubic feet per second (cfs)
Information taken from Florida DEP, Bulletin 66

Name ____________________
Magnitudes of Florida’s Springs Student Response – page 2

Using the data from your chart, construct a bar graph that illustrates the magnitudes of these springs. Be sure to:

- Title the graph
- Label each axis
- Use a consistent scale
- Record your information accurately
## Magnitudes of Florida’s Springs

### Answers to chart

<table>
<thead>
<tr>
<th>Name of Spring</th>
<th>*Median Discharge Rate</th>
<th>Magnitude of Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hart Spring</td>
<td>58.6</td>
<td>2nd</td>
</tr>
<tr>
<td>Turtle Spring</td>
<td>36.39</td>
<td>2nd</td>
</tr>
<tr>
<td>Manatee Spring</td>
<td>203-210</td>
<td>1st</td>
</tr>
<tr>
<td>Ichetucknee Springs</td>
<td>186-197.2</td>
<td>1st</td>
</tr>
<tr>
<td>Green Cove Springs</td>
<td>3.03-3.52</td>
<td>3rd</td>
</tr>
<tr>
<td>Owens Spring</td>
<td>51.2</td>
<td>2nd</td>
</tr>
</tbody>
</table>

*All rates given in cubic feet per second (cfs)*

Information taken from Florida DEP, Bulletin 66
Surface water is able to seep into the ground and become part of our groundwater based on the permeability of the soil and rock materials it must move through. Permeability refers to the rate at which soil and rock materials allow water to move through it. Permeable materials are made of particles having connected spaces that water can easily move through. Impermeable materials have fine particles that fit tightly together and do not allow water to easily move through it.

Work in small groups to create a water permeability system to show how surface water becomes part of our aquifer.

**Materials:**
- 4 clear plastic cups per group
- sand
- aquarium gravel
- clay
- 3 coffee filters per group
- 2 measuring cups per group
- large container of water
- stopwatch per group

**Directions:**
1. Cut the bottoms out of 3 cups and insert coffee filters into the cups.
2. In individual cups, put 250 mL of each dry soil type (clay, sand, and gravel).
3. Place one of the soil cups over an empty measuring cup and slowly, but continuously, pour 250 mL of water over the soil. Use a stopwatch to record the time it takes the water to flow or permeate through the soil. Then measure the amount of water that flowed through the soil. Record your data in the data chart below. Repeat the procedure for each soil type.

**Permeability Chart**

<table>
<thead>
<tr>
<th>Type of Soil Material</th>
<th>Beginning Water Amount</th>
<th>Rate of Water Flow</th>
<th>Water Amount that Flowed Through Soil</th>
<th>Amount of Water Retained in Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>sand</td>
<td>250 mL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>gravel</td>
<td>250 mL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>clay</td>
<td>250 mL</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. Does the water seem to move faster through the sand, gravel, or clay? Record other observations on your Aquifer Observations data form.

<table>
<thead>
<tr>
<th>Aquifer Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
</tr>
</tbody>
</table>

5. In the fourth cup, place alternating layers of clay, sand, and gravel filling the cup about ¾ full.

   Note that in the real world, water that is above the ground, like rivers and lakes, is called surface water. Below the surface, water is known as groundwater.

6. Slowly pour water into the fourth cup filling it to one inch below the top of the clay, sand, and gravel. Look at the top of the water. (This line is known as the water table.) The area below the water table is called the saturation zone.

7. Now pretend the large container of water is a rain cloud. Sprinkle a little more water into your aquifer (cup 4) until the water table is about ½ inch below the surface of the water. You have just recharged your groundwater supply. That is what happens when it precipitates and water sinks into the ground.

8. After each group’s permeability chart is complete, use the student data to obtain the median score for the “rate of flow” and the “water amount that flowed through the soil.” Students will use this information to complete the student activity form. Explain to students that scientists always perform multiple trials in order to obtain a more accurate test.
Build an Aquifer
Student Response Sheet

1. Use the chart below to record your class data from the *Build an Aquifer* activity.

**Permeability Chart**

<table>
<thead>
<tr>
<th>Type of Soil Material</th>
<th>Beginning Water Amount</th>
<th>Rate of Water Flow</th>
<th>Water Amount that Flowed Through Soil</th>
<th>Amount of Water Retained in Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>sand</td>
<td>250 mL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>gravel</td>
<td>250 mL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>clay</td>
<td>250 mL</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Use your data from above to construct a bar graph on the grid below showing the rate of water flow through the different materials. Be sure to title the graph, label each axis, use an appropriate and consistent scale, and graph the data accurately.
3. Ben determined that the water table in his area is located 232 feet underground. The top confining layer of soil lies 348 feet underground. What fraction of the distance from the surface to the top confining layer contains ground water?

4. Charles studied the watershed in his area and found that after the previous rainstorm the amount of surface runoff water was 6,840,000 m³. Which of the following represents this amount of water runoff in scientific notation?

   A. 68.4 x 10⁶ m³
   B. 6.84 x 10⁶ m³
   C. 684 x 10⁵ m³
   D. 684 x 10⁵ m³

5. The average yearly rainfall for the state of Florida is 54 inches. Suppose that out of this amount of rain, an average of 32 inches per year becomes groundwater. What percent of the yearly rainfall becomes groundwater? (round to the nearest percent)

   The percent of yearly rainfall that becomes groundwater is ____________
Build an Aquifer
Answers - Student Responses

1. Answers will vary based on results of activity.

2. Bar graphs will vary based on activity results.

3. Gridded Response:
   
   \[348 \text{ feet} - 232 \text{ feet} = 116\]
   
   therefore; the answer is
   
   \[\frac{116}{348} \quad \text{or} \quad \frac{58}{174} \quad \text{or} \quad \frac{29}{87} \quad \text{or} \quad \frac{1}{3}\]

4. B. \(6.84 \times 10^6 \text{ m}^3\)

5. \(\frac{32}{54} = 32 \div 54 = 0.592 = 59\%\)
Tri-Tab Fact Book

Materials:

- two (2) 8-1/2 x 11” pieces of paper per student
- scissors
- markers or pencils
- ruler (optional)

Directions:

- Fold papers in half lengthwise (hotdog style).
- Divide folded pages into three equal sections and cut each section on the top pages of the fold. Do not cut the bottom page (see below).
- Label each section as shown below and draw a picture illustrating the label on each.
- Under each flap write mathematical facts and other information you have learned about each topic.
View of an Aquifer
Student Response Activity (Mapping Coordinates)

Materials:

- graph paper
- pencil
- ruler (optional)

Directions:

Many groundwater caves are comprised of a network of conduits. Use the information below to draw an aerial view showing the paths of the underground waterways through the aquifer.

Use the following details in creating your plot:
Scale: ___ = .2 km
The coordinates for point S are 4,18

Information for Conduits:

- The largest conduit (#1) moves southeast from point S (spring entrance) for 3.6 km. (The location of point S is 4,18)

- There are three secondary conduits (#2, #3, #4) that intersect the larger conduit.

- Conduit #2, having a length of 1.2 km, intersects conduit #1 eight-tenths of a km from the spring entrance as it flows south.

- Conduit #3, measuring 1.8 km in length and flowing east, intersects conduit #1 1.4 km from the spring entrance. This conduit has an ending point (C) where it intersects conduit #2.

- Conduit #4 is 1600 m in length as it flows west and intersects conduit #1 at point D that is 2.8 km from point S. Its ending point is 1.2 km south of point B.

- Conduit #5 measuring 800 m in length flows southwest from its starting point (E) where it connects with Conduit #3 and intersects Conduit #1 at point F.
View of an Aquifer
Answer to Student Response

Key

Mapping Coordinates
Point A (8, 14)
Point B (11, 11)
Point C (8, 11)
Point D (18, 11)
Point E (16, 11)
Point F (13.5, 8.5)
Point S (4, 18)
America’s Water Usage (2000)
Student Response Sheet

In the year 2000, Americans used about 346,000 million gallons of water each day from surface and ground water sources. Here is an estimated breakdown of uses:

America’s Usage of Groundwater and Surface Water
(Information Source - USGS)

<table>
<thead>
<tr>
<th>Use</th>
<th>Amount (mgd) (million of gallons per day)</th>
<th>Percent of Water Used in 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation</td>
<td>138,400</td>
<td></td>
</tr>
<tr>
<td>Thermoelectric Power</td>
<td>134,940</td>
<td></td>
</tr>
<tr>
<td>Public Supply</td>
<td>44,980</td>
<td></td>
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<tr>
<td>Industry</td>
<td>17,300</td>
<td></td>
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<tr>
<td>Livestock, Aquaculture</td>
<td>3,420</td>
<td></td>
</tr>
<tr>
<td>Domestic</td>
<td>3,480</td>
<td></td>
</tr>
<tr>
<td>Mining</td>
<td>3,480</td>
<td></td>
</tr>
</tbody>
</table>

Find the estimated percentage of water used during 2000 for each category. Use the data to construct a circle graph showing the water withdrawals of Americans in 2000. Be sure to title and label the graph appropriately.

Show your work or explain in words how you got information to construct your graph.

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________
America’s Water Usage (2000)
Answers to Student Responses

America’s Usage of Ground Water and Surface Water
(Information Source - USGS)

<table>
<thead>
<tr>
<th>Use</th>
<th>Amount (mgd) (million of gallons per day)</th>
<th>Percent of Water Used in 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation</td>
<td>138,400</td>
<td>40%</td>
</tr>
<tr>
<td>Thermoelectric Power</td>
<td>134,940</td>
<td>39%</td>
</tr>
<tr>
<td>Public Supply</td>
<td>44,980</td>
<td>13%</td>
</tr>
<tr>
<td>Industry</td>
<td>17,300</td>
<td>5%</td>
</tr>
<tr>
<td>Livestock, aquaculture</td>
<td>3,420</td>
<td>&lt; 1%</td>
</tr>
<tr>
<td>Domestic</td>
<td>3,480</td>
<td>1%</td>
</tr>
<tr>
<td>Mining</td>
<td>3,480</td>
<td>1%</td>
</tr>
</tbody>
</table>

In order to get the information needed for the graph, the water amount (mgd) for each specific use is divided by the estimated total of water (mgd) used by Americans. Since the total water used in 2000 was 346,000 million gallons, each specific amount as given in the chart was divided by 346,000 to determine the percent of water used.

America’s Water Usage (2000)
Protecting Our Water
Student Response Sheet

1. Derek worked with the local water management office to conduct nitrate tests on rivers and creeks in his community. After completing his tests, Derek created this circle graph indicating his outcomes.

Out of the 160 bodies of water tested for nitrates, how many did Derek find to be of poor quality?

a. 800 bodies of water  
   b. 8 bodies of water  
   c. 32 bodies of water  
   d. 100 bodies of water

2. Treeland Paper Company uses 90 million gallons of water a day to process trees in its pulp mill. Thirty-five percent of the water used in this process is fresh water that is piped to the plant from a local stream. The stream’s depth is monitored regularly, especially during a drought, to ensure that the pulp mill receives a constant supply of water. If the water level recedes to a certain depth, the stream’s piping system cannot get the needed amount of water to the plant. Therefore, when the water depth drops steadily, the artesian wells built on company property are used to pump ground water back into the stream.

Suppose the summer drought caused the stream’s water level to drop significantly and the company started pumping water from the wells. If one artesian well pumps 43,620 gallons of water an hour into the stream, how many artesian wells must be used to resupply the stream with the needed amount of water to maintain productivity at the pulp mill each day?

Which of the following CANNOT be used to solve this problem if \( x \) represents the number of artesian wells needed?

a. \[
\frac{.35(90 \times 10^6)}{43,620 \times 24} - x
\]

b. \[(43,620 \times 24)x - 90,000,000 \times .35\]

c. \[90,000,000 \times .35x - 43,620\]

d. \[\frac{35}{100} \times 90,000,000 - (24 \times 43,620)x\]
3. The population of the United States is about 275 million. If Americans use an average of 450 billion gallons of water per day, estimate the amount of water that could be saved in a year if each person in the United States uses one less gallon of water per day.

Amount of water saved in a year: _________________________________

Explain your answer:

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________
1. B. 8 bodies of water

2. C. 90,000,000 x .35x - 43,620

3. Amount saved is about 275 million gallons of water

If there are about 275 million people living in the world and each person saved one gallon of water a day, it would equal 275 million gallons of water.
Mathematical Water Trivia Display

Materials:

- trivia resources
- poster board
- markers, paints, etc.

Directions:

1. Review mathematical trivia students have learned about water.

2. Using the materials above, ask students to design posters or displays that reveal mathematical trivia about our water.

3. Focus on the protection and conservation of our natural ground water.

4. Share the posters/displays with other school groups, classes, and students by displaying them in the media center, cafeteria, or hallways.
Jeopardy Game

This activity will enable students to share their mathematical knowledge of springs, aquifers, sinkholes, and our drinking water to those living at home and within the community.

Materials:

- poster board
- pocket sleeves
- index cards
- mathematical facts and trivia

Directions:

- Stick pocket sleeves onto poster board setting up similar to a Jeopardy board having four columns and six rows.

- Number the sleeves in numerical order down each column with the first sleeve in each column starting with “1.”

- Label each column with its category name. Use the following headings “Sinkholes,” “Aquifers,” “Springs,” and “Protecting our Water.”

- Think about mathematical facts and trivia you have learned pertaining to the four categories above: sinkholes, aquifers, springs, and protecting our water. Create questions you might ask.

- On individual index cards, write the answers to your questions based on mathematical facts and trivia. Write the question for each in parentheses underneath the answer. (Remember this is Jeopardy.)

- Place the index card in each pocket with the written side facedown the backside of the poster.

- One student will be the game host and pull the card as identified by the player of one team. The host will give the answer only and the player must answer with the questions, “What is …” just as in Jeopardy.

- Each player or team will take turns. The player or team with the most correct answers wins.
### Appendix

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<th>Page</th>
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<td>3-4</td>
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<tr>
<td>Jill Heinerth</td>
<td>5-7</td>
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<td>Vocabulary Book</td>
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<td>KWL &amp; KWL(OIR) Directions</td>
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<td>Third Time is a Charm *</td>
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<th>Resources to use with <em>Water’s Journey: The Hidden Rivers of Florida:</em></th>
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<tr>
<td>Books</td>
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<tr>
<td>Writing Rubric (6-point)</td>
<td>31-32</td>
</tr>
<tr>
<td>Math Rubric (2-point)</td>
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<tr>
<td>Math Rubric (4-point)</td>
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<tr>
<td>Science Rubric (2-point)</td>
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<tr>
<td>Science Rubric (4-point)</td>
<td>36</td>
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</table>

<table>
<thead>
<tr>
<th>Texts:</th>
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<tbody>
<tr>
<td>“Vampire Sink Cleanup” by Wes Skiles</td>
<td>37-38</td>
</tr>
<tr>
<td>“Underwater Photography” by Wes Skiles</td>
<td>39-40</td>
</tr>
<tr>
<td>“How Sinkholes Form “(St. Johns River Water Management District)</td>
<td>41</td>
</tr>
</tbody>
</table>
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*Includes Blackline Master

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Student Pre/Post Assessment and Rubric*

Participant Feedback Forms
Biographies

Biography for Wes Skiles

Wes Skiles is best known for his work in educational adventure science films. Over the past 15 years he has created and produced over a dozen films for major networks including PBS. Recently, he directed the IMAX film, “Journey into Amazing Caves,” and led a major National Geographic expedition to Antarctica to film the largest iceberg in recorded history. His primary goal is to continue work in the realm of entertaining educational films focused on the earth’s most important resource, water.

Over the past decade Wes has successfully filmed where no one has before. His unstoppable spirit of adventure has led him to exotic destinations and fantastic voyages. At ease with both motion and still photography, he divides his time working on assignment for National Geographic Magazine and with television’s top producers of science, adventure and natural history programming.

As evidenced by his feature in the National Geographic Magazine on the North Florida Springs and his award-winning film for A&E New Explorers program, “Polluting the Fountain of Youth,” Wes is able to utilize stunning visual imagery to convey the subtle beauty of Florida’s landscape. His enthusiastic story-telling style makes science exciting and accessible and always provides the audience with an intimate perspective and understanding of the subjects he films.

Outside of the world of film-making, Wes is deeply involved as a volunteer protecting the environmental resources of his Florida home. He was appointed by Florida’s governor to serve on the Florida Springs Task Force. He leads field trips for citizens and government officials to learn about Florida springs and spends a lot of time in local schools teaching kids about how they can protect water resources. His passion for the environment permeates his life from his occupation to his avocation.

Wes has presented his work in many international forums. He has spoken on topics as diverse as risk management, spring’s protection and hydrogeology.
Wes Skiles
Director of Photography

KARST PRODUCTIONS INC.
5779 NE County Road 340
High Springs, Florida USA 32643
Tel 386-454-2376 • Fax 386-454-3541
Wesskiles@alltel.net • www.wesskiles.com

Wes Skiles leads a highly experienced team that specializes in hi-definition multi-camera projects. He has a reputation for delivering the highest quality product in the most challenging locations - from conception to completion.

As a modern day explorer, his work has spanned the globe from the deepest caves to the polar climes to the wilds of the African Savanna. As an executive producer, director and cameraman, his work appears on major networks both in the U.S. and around the world.

RECENT FILM AND TELEVISION CREDITS

Work in Progress
A Well in Time - Executive Producer, Director
Water's Journey - Executive Producer, Director - PBS
Spirit of the Ichetucknee - Executive Producer, Director
The River Returns - Executive Producer, Director - PBS

Recent Projects
PBS New Explorers “Sounds of Discovery” Documenting the first real time tracking of deep dives performed on sperm whales, the largest toothed mammal on earth. Producer/Cameraman
PBS New Explorers “Most Dangerous Science” Documenting the life of scientist and explorers on a quest to unravel the mysteries of the world’s longest underwater cave. Producer/Cameraman
PBS New Explorers “Walking Among the Sharks” Documenting science in the extreme depths of the world’s oceans. Producer/Cameraman
PBS New Explorers “Polluting the Fountain of Youth” Documenting the study and exploration of the springs of North Florida. Producer/Cameraman.
PBS New Explorers “Inside the Central Nervous System” A detail look into the search for a cure to paralysis Director/Cameraman
PBS New Explorers “Miracle of Flight” Documenting the trans-gulf migration of neo tropical songbirds from South America to the US. Director/Cameraman
PBS New Explorers “Exploring the Labyrinth” Documenting the discovery of new life forms within the islands of the Bahamas. Director/Cameraman.
PBS/WQED “Mysteries Underground” Exploring the great caves of the World, Cameraman
PBS/WRAL “Taste of Adventure” Exploring Georgia and Florida’s best parks and cuisine. Cameraman
PBS/WCEU “For the Love of Manatees” Underwater Camera for special on the life and plight of the West Indian Manatee
PBS/KCTS Underwater Cameraman for Ocean Seriesice Island - Expedition Leader, Executive Producer, Director of Photography - National Geographic Society
Protecting Florida’s Springs - Executive Producer, Director
Journey to Amazing Caves - Director, Director of Photography - MacGillvray Freeman / IMAX®
Ripley's Believe It or Not - Creative Consultant, Director of Photography - TBS / Columbia TriStar
National Geographic Explorer and Specials: Producer, Cameraman - Mapping the Labyrinth, Mysteries Underground, Return to Paradise - National Geographic Television
The Searchers segment - CBS Special
Hidden Rivers of the Maya - Creator, Producer, Cameraman - Executive Producer: LMNO Productions
Deep Probe Series (3 episodes) - Co-Creator, Writer, Director of Photography - Predators of the North, Windows to a Hidden World, Nullabor Dreaming - Discovery Channel
Biography for Jill Heinerth

Jill and Paul recently returned from the challenging Ice Island Expedition in Antarctica. Together with veteran cinematographer Wes Skiles, they explored the inner reaches and underbellies of icebergs using cave diving techniques. They were the first people to use closed-circuit rebreathers in this environment and the first to cave dive inside an iceberg. Their two-month adventure yielded a television special and is chronicled in National Geographic magazine’s December 2001 issue. Jill was also featured in Sports Illustrated for Women and other magazines for her cutting edge exploration work. Jill Heinerth’s love of the underwater world began in her Canadian homeland where she also ran a successful graphic design firm.

In 1992, Jill did her last chilly dive in Tobermory, Canada and relocated to the Cayman Islands to pursue a full time career in diving. Working at the Cayman Diving Lodge on the East End of Grand Cayman, she had the opportunity to dive, teach and photograph full time. In Cayman she became involved with the Cayman Islands Watersports Operators Association. As an executive member, she was responsible for the Cayman representation at the diving industry’s international trade show DEMA. She initiated a fund raising program to benefit Reef Preservation and Education programs on the island and protect the ever-dwindling natural resources. In off-hours she began a quest to find diveable caves in the interior of Cayman. Through those efforts she met her husband Paul Heinerth.

Jill’s diving career has always been a “right place at the right time” sort of story. In 1995 she moved to Florida after Paul swept her off her feet! In May 1995 they participated in the U.S Deep Caving Team Expedition to Huautla, Mexico with Dr. Bill Stone. Through late 1995 and 1996 Jill became involved in further exploration in Mexico as U.S Director for the Ejido Jacinto Pat Expedition in Akumal.

In 1998, she and her husband Paul were selected as lead divers for the United States Deep Caving Team exploration of Wakulla Springs. During this project Jill completed a mission that took her deeper into a cave at extreme depths than any woman in history. Her 21-hour mission including five hours at 300 feet of depth was featured in a National Geographic Explorer Television program. This landmark project of the United States Deep Caving Team has brought technical diving into the next century with the use of rebreathers and revolutionary sonar mapping devices.

In 2000, Jill was inducted into the international Women Divers Hall of Fame at the Beneath the Sea Dive symposium in Secaucus, New Jersey and was recognized as Canadian Technical Diver of the Year. In 2001, Jill was inducted as a Fellow of the National Speleological Society.

In addition to teaching and exploration, Jill produces adventure television programs and documentaries. From under the ice in Antarctica, to the jungles of the Yucatan to a swimming pool with a live alligator, her film assignments have taken her to some unusual locations. A recent project involved rappelling down through an ancient well into a magical underwater world full of Mayan cultural artifacts and human bones. She produced Ice Island, which was recently recognized by the Explorer’s Club as the year’s best exploration film.

Jill has presented workshops and symposiums in France, England and all over North America. Jill is a Master Instructor for the Professional Association of Diving Instructors (PADI) and a Mixed Gas
and Technical Cave Instructor for the International Association of Nitrox and Technical Divers (IANTD) and a Cave Diving Instructor for the National Speleological Society Cave Diving Section (NSS-CDS). She volunteers as a technical advisor to several diving training organizations. She is currently supporting and teaching a number of women’s dive training programs and hopes to continue to develop further programs that entice the participation of women in all areas of diving.
Jill Heinerth is likely the most active female cave explorer on the planet, and her athleticism and technical skill is complemented with an extensive creative background. Her experience with high technology underwater has earned her key positions in expeditions that explore uncharted regions of our world. Her work has taken her from the deep caves of Mexico to the inside of Antarctic icebergs. Her educational background in Fine Arts and Design has served her well as a producer and writer in film and print media.

BACKGROUND

Film & Television Work in Progress
A Well in Time - Producer, Writer
Water’s Journey - Producer, Writer - PBS (national fall 2003)
Spirit of the Ichetucknee - Producer, Writer
The River Returns - Producer, Writer - planned for PBS

Recent Projects
Ice Island - Producer, Exploration Diver, Safety Director - National Geographic Society
Protecting Florida’s Springs - Producer
National Geographic Explorer - Exploration Diver, Project Organizer, Underwater Camera - Mapping the Labyrinth - National Geographic Television
Surviving the Worst - Segment Producer - Alligator Attack, Shark Attack - Fox Television
Dreamchasers - Associate Producer, Underwater Lighting - Cave Diving Episode - Diplomatic TV - A&E
Green Umbrella Productions - Cave Diving Science Episode - Underwater Lighting, Location Producer - Discovery Channel

Publications
Underwater photographs and stories have been published in Skin Diver, Southern Diver, Rodale’s Scuba Diving, Immersed, Nitrox Diver, National Geographic, Underwater Speleology, Asian Diver, Dive Girl, Advanced Diver, Undersea Journal, Dykking, Tauchen, and many other magazines and periodicals.

Professional Credentials & Activities
Master Instructor (Professional Association of Diving Instructors)
Medic First Aid Instructor
Technical Rebreather Instructor (IANTD - International Association of Nitrox and Technical Divers)
Technical Cave & Mixed Gas Instructor (IANTD)
Honors Bachelor of Fine Arts - York University, Canada
Member of the B.O.D. of the U.S. Deep Caving Team
Member of the International Board of Advisors of the International Association of Nitrox and Technical Divers
Consultant to Diving Science and Technology (DSAT) Technical Diving Programs
Consultant to NOAA on use of rebreather technology

Awards and Honors
Explorer’s Club Film Festival- Best Exploration Film 2002
Fellow of the National Speleological Society (NSS) 2000
Inducted into the Women Divers Hall of Fame 2000
Canadian Technical Diver of the Year 2000
1998 Women’s record for deep cave penetration
1988 Murray G. Ross Award – the highest honor bestowed on a York University graduate
1988 Emily Stowe Award for Academic Excellence
1986 Alumni Silver Jubilee Scholarship
1985 Prize for Most Outstanding Contribution to College Life
1984 Collegiate Athlete of the Year
1983 Principal’s Award for Most Outstanding Student
Foldable Activities
Vocabulary Book

Directions:

1. Fold a sheet of notebook paper in half lengthwise (hotdog fold).
2. Open the fold and on one side of the fold, cut every third line across. This will normally give you ten tabs.
3. Label the tabs with the vocabulary word.
4. Write the definition of the vocabulary words directly under the labeled tab.

*If you leave the holes of the paper uncovered, students can store the paper in their binders.

This booklet may also be used for:
- Taking notes and recording information
- Questions and answers

| karst |
| escarpment |
| percolation |
| reclamation |
Layer Book

Directions:

1. Stack three sheets of paper (8 ½” x 11”) so that the back sheet is one inch higher than the next sheet, and the front sheet is one inch higher than the middle sheet.

2. Bring the bottom of all sheets upward and align the edges so that all of the layers are the same distance apart.

3. When all tabs are an equal distance apart, fold the papers and crease well. Slip the pages inside of each other to form a “book” with overlapping tabs.

4. Open the papers and glue them together along the inner centerfold or staple them along the outside fold.

5. Position your book so that the tabs open either up or down.
Tri-Tab Fact Book

Materials:

- 8-1/2” x 11” paper per student
- Scissors
- Markers or crayons

Directions:

- Fold paper in half lengthwise (hotdog style).
- Divide folded paper into three equal sections and cut each section only on the top half of the fold (see below).
- Label each section with a concept/topic as shown below (draw a picture illustrating the concept/topic – optional).
- Under each flap write facts you have learned about that concept/topic.

* This foldable booklet can easily be made into four sections and can be used for any categories that meet your needs.
Reading Strategies (Before, During, and After)

**Before Reading**

Set a purpose
Make predictions
Activate prior knowledge

**Strategies To Use Before Reading:**

- Venn Diagram *
- Anticipation/Reaction Guide *
- KWL *
- Quick Writes
  - Students are given 2-3 minutes to write whatever they know about topic.
- Wordsplash
  - Teacher selects key words from text and displays in a graphic arrangement for students to create complete statements about each term.

**During Reading**

Revise or confirm predictions
Make connections (text to self, text to text, text to world)
Combine new information with background knowledge

**Strategies to Use During Reading:**

- Stickies to Code the Text
  - Use stickies with m.i. for main idea, + for supporting detail, ! for interesting fact, and ? for question or lack of understanding
- Highlighting
• Think, Pair, Share
  o Think about a posed question or prompt, Pair up to compare individual responses or thoughts, Share thoughts or answers with the class or whole group.

• 2-Column Notes (Double-Entry Diaries)
  o Fold notebook paper in hot-dog or vertical fold. Record facts, quotes, or important ideas in left-hand column and supporting details, responses, or proofs in right-hand column.

---

**After Reading**

Summarize
Reflect and Analyze
Synthesize
Draw logical conclusions
Sequence

---

**Strategies to Use After Reading:**

• Journal Response

• T-Chart
  o Use this two-column chart format to record fact/opinion, problem/solution, compare/contrast, or cause/effect responses.

• Fact Frame
  o Write a fact in the center box and supporting details in the outer box.

• Exit Cards
  o At the end of a selection or lesson, the student writes something they have learned or a question they still have on a 3” x 5” index card and gives it to the teacher.

• Star Connections
  o Draw a large star on a regular-size sheet of paper. Write the topic in the middle and key facts on each point of the star.

• 3-2-1 *

* Blackline Master included in this section
**K W L Chart**

K – what you already know  
W – what you wonder  
L – what you have learned

Before beginning your study on this concept, create a KWL chart filling in the “K” and “W” columns. In the “K” column write things you already know about the topic and in the “W” column create a list of questions you wonder about the topic. At completion of the study, go back and fill in the “L” column with information you have learned.

<table>
<thead>
<tr>
<th>K (know)</th>
<th>W (wonder)</th>
<th>L (learned)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KWL Chart</td>
<td></td>
<td></td>
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<tr>
<td>-----------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What I Wonder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What I Learned</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What I Know</td>
<td></td>
<td></td>
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</tbody>
</table>
Before beginning your study on this concept, create a KWL chart filling in the “K” and “W” columns. In the “K” column write things you already know about the topic and in the “W” column create a list of questions you wonder about the topic. After completing the “W” column, place a check mark in one or more of the O I R columns to show what you can do to find the answer. At completion of the study, go back and fill in the “L” column with information you have learned.

<table>
<thead>
<tr>
<th>K (know)</th>
<th>W (wonder)</th>
<th>O</th>
<th>I</th>
<th>R</th>
<th>L (learned)</th>
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# KWL Chart
(OIR Version)

<table>
<thead>
<tr>
<th>What I Know</th>
<th>What I Wonder</th>
<th>O</th>
<th>I</th>
<th>R</th>
<th>What I Learned</th>
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O – Observe
I – Investigate
R - Research
Anticipation/Reaction Guide

Anticipation/Reaction Guide: True/False statements, yes/no predictions of vocabulary terms one could expect to find in the upcoming text selection, or Agree/Disagree statements can be designed by the teacher and given to students for individual responses prior to reading text. After reading the text, the student revisits prior responses to confirm or revise their prior understanding of the vocabulary word, topic, or concept being taught.

Procedures:

1. Teacher should analyze the material to be read, then select vocabulary words or major ideas with which students will interact.

2. Write the ideas in short, clear statements, avoiding distractions. (If using this strategy for selected vocabulary words, students place a check in the “yes” or “no” column both “Before Reading” and “After Reading.”)

3. Put statements in a format that will elicit prediction and anticipation for reading text.

4. Have students individually complete the task, and then discuss student responses prior to reading the text. Avoid making any type of judgment of student responses.

5. After reading, have students evaluate their responses relative to the material they read.

6. Students should then complete the chart by giving their “After Reading” responses.

Anticipation/Reaction Guide

<table>
<thead>
<tr>
<th>Before Reading</th>
<th>Statements (or vocabulary word)</th>
<th>After Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Agree</td>
<td>(Yes)</td>
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<tr>
<td>No</td>
<td>Disagree</td>
<td>(No)</td>
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VENN Diagram

A VENN Diagram is a graphic organizer that is used to compare and contrast different ideas, objects, characters, etc. A graphic organizer may be used with either two or three overlapping circles.

Directions:

1. Create a double or triple VENN diagram depending on the number of things you want to compare and contrast.
2. Identify each major circle with a heading.
3. List characteristics of each heading in the correct circle. Note that overlapping circles indicate that the characteristic is true of both headings. (or with a triple VENN, all three, or two of the three depending on where the characteristic goes)
4. After completing the VENN, students will have an easy visual to see characteristics that are the same and different.

**Double VENN Diagram**

![Double VENN Diagram]

**Triple VENN Diagram**

![Triple VENN Diagram]
## Compare/Contrast Matrix

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Object 1</th>
<th>Object 2</th>
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</table>

## Compare/Contrast Similarities and Differences Chart

<table>
<thead>
<tr>
<th>Object 1</th>
<th>Object 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Similarities</td>
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<tr>
<td>Differences</td>
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</tbody>
</table>
# 3 – 2 – 1 Strategy

<table>
<thead>
<tr>
<th>Three Things I Found Out or Learned</th>
<th>Two Interesting Facts, Ideas, or Thoughts</th>
<th>One Question I Still Have</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2</td>
<td>1</td>
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</table>

Name __________________________
The Third Time Is A Charm

<table>
<thead>
<tr>
<th>What I know after reading it once</th>
<th>Something else I know after reading it twice</th>
<th>What I finally know after reading it thrice</th>
</tr>
</thead>
<tbody>
<tr>
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</table>

Name ___________________________
Appendix

T-Chart

Use this graphic organizer to demonstrate your understanding of cause and effect.

Example:
- *raking leaves for 2 hours*
- *blisters on hands*

<table>
<thead>
<tr>
<th>Cause</th>
<th>Effect</th>
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</table>
Resources

**Literature Connections**

*Spring Waters: Gathering Places*
b by Sandra Chisholm DeYonge

Early people thought that springs were a gift from the earth. Beautifully illustrated stories and myths chronicle the use of spring waters through time. Games and investigations lead readers to an understanding of ground water, springs, and the importance of healthy water for healthy people everywhere.

*The Missing ‘Gator of Gumbo Limbo*
b by Jean Craighead George

A homeless mother, her daughter, Liza, and a 12-foot alligator live in a secluded part of the Florida Everglades. A few other down-on-their-luck individuals also share this lovely, undisturbed ecological habitat—until the big, harmless gator named Dajun begins giving shivers to condominium dwellers nearby. A government agent is sent to the hammock to dispatch Dajun. Liza and her wooded band hope to find him first to provide a hidden sanctuary. The quiet clues that Liza uses to locate Dajun, wins over nature-loving readers (Ages 9-12)

**Non-fiction Books**

*Sinkholes*
b by Sandra Friend

Learn all about the unique formations known as sinkholes. Discover why they are an important part of our natural environment. They can appear anywhere in the world where rock dissolves allowing the ground above it to sink – from valleys in the mountains to the depths of the deepest seas, from the crystal clear springs of Florida to the deserts of Arabia. Color photographs are included. (ages 12 and up)

b By Joe Follman and Richard Buchanan

*The Florida Water Story – From Raindrops to the Sea*
b By Peggy Sias Lantz and Wendy A. Hale

This book follows the water cycle through four major Florida habitats, wetlands, oceans, coastlines, and coral reefs.

*The Science of a Spring*
b John Stringer

Find out why springs act the way they do, based on elementary concepts of physics.
The Springs of Florida
by Doug Stamm

This book is a guided tour of Florida's magnificent springs. You will learn how the springs emerged from the limestone aquifers and the forces that make the springs of Florida a unique ecosystem. You will observe the colorful wildlife in underwater photographs that document the natural history of Florida's springs and their inhabitants. Maps and charts are included giving detailed descriptions of Florida’s major spring parks and the opportunities for learning about them and enjoying their natural beauty.

The Young Naturalist's Guide to Florida
Peggy Sias Lantz, Wendy A. Hale
Florida has many special places that are unlike any others. Find about many of Florida’s special places such as sinkholes, caves and waterfalls and ways to help protect these unique places.

Website Resources

Florida’s Water Management Districts

Northwest Florida Water Management District (Publications and information)
http://www.state.fl.us/nfwmd/pubs/publist.htm

St. Johns River Water Management District (Publications Available)

St. Johns River Water Management District (Water Education Resources)

St. Johns River Water Management District - Streamlines Feature Story (The Aquifer)
http://sjr.state.fl.us/programs/outreach/pubs/streamln/96fall/fa96sln2.html

St. Johns River Water Management District – Article (How Sinkholes Form)
http://sjr.state.fl.us/programs/outreach/pubs/order/pdfs/fs_sinkhole.pdf

South Florida Water Management District (Education Resource List)
http://www.sfwmd.gov/stude/ed_list.html

Southwest Florida Water Management District (Youth Education Publications)
http://www.swfwmd.state.fl.us/infoed/educators/inschoolpubs.htm
Southwest Florida Water Management District – Articles:
  * Groundwater – What Do We Know About it?
  * Florida’s Aquifers
  * Florida’s Karst Terrain
  * It’s Your Turn Don’t Be a Groundwater Polluter!
  http://www.swfwmd.state.fl.us/education/waterweb/wwgroundwater.pdf

Southwest Florida Water Management District (Watersheds and water quality)
http://www.swfwmd.state.fl.us/education/waterweb/waterwebwatersheds.pdf

Suwannee River Water Management District (springs)
http://www.mysuwanneeriver.com/water+data/springs/default1.htm

**Other Agencies**

Environmental Systems Research Institute - Predicting Areas of Public Water Supply Problems – Floridan Aquifer
http://gis.esri.com/library/userconf/proc95/to100/p088.html

Florida Department of Environmental Protection (*Florida’s Springs – Protecting Nature’s Gems*)
http://www.floridasprings.org/

Florida Department of Environmental Protection (springs locator)
http://www.dep.state.fl.us/springs/locator/Firstmagmap.htm

Florida Department of Environmental Protection (sinkhole information)
http://www.dep.state.fl.us/geology/geologictopics/sinkhole.htm

Florida Department of Environmental Protection (hydrogeology information and online posters)
http://www.dep.state.fl.us/geology/geologictopics/hydrogeo.htm

Florida Department of Environmental Protection (*Florida Spring Classification System and Spring Glossary*)
http://www.dep.state.fl.us/geology/geologictopics/springs/sp_52.pdf

Florida Department of Environmental Protection (Information and photos of Lake Jackson sinkhole)
http://www.dep.state.fl.us/geology/geologictopics/jacksonsink.htm

Florida Department of Environmental Protection (Sinkhole Database with Excel spreadsheet of Florida sinkholes)
http://www.dep.state.fl.us/geology/gisdatamaps/sinkhole_database.htm
Florida Department of Environmental Protection (springs reports and publications)
http://www.dep.state.fl.us/springs/reports/index.htm

Florida Department of Environmental Protection (Springs of Florida- downloadable document)
http://www.dep.state.fl.us/geology/geologictopics/springs/bulletin66.htm

Florida Geological Survey (Florida Springs)
http://www.flmnh.ufl.edu/springs_of_florida/

Florida Geological Survey Bulletin No. 31 – “Springs of Florida” (distribution of Florida springs)
http://www.flmnh.ufl.edu/springs_of_florida/distribu.html

Florida Springs Database (Florida Springs Flyer – Interactive GIS Viewer)
http://www.thiswaytothe.net/gis/

Florida Springs Database (Search by county, compared by size or magnitude)
http://www.floridaspringsguide.com

Florida Springs.org - “The Journey of Water – Going to the Source of Springs”
http://www.floridasprings.org/anatomy/jow

Florida State University (Floridan Aquifer)
http://fga.freac.fsu.edu/gaw/resources/waterpdf/floridan_aquifer_system.pdf

Groundwater Foundation
www.groundwater.org/kc/whatis.html

Karst Waters Institute (teacher resources)
http://karstwaters.org/educationlinks/teachers.htm

Quotes About Florida Springs
http://www.tfn.net/springs/Springbook/Quotes.htm

Sinkhole Development (several pages showing the development of sinkholes)
http://www.sinkhole.org/facts1.htm

Springs Fever: A Field & Recreation Guide to 500+ Florida Springs
http://www.tfn.net/springs/

Springs Fever: A Field & Recreation Guide to 500+ Florida Springs (Florida Springs – information and photos)
http://tfn.net/Springs/Springbook/FirstMagnitude.htm (First Magnitude Springs)

Texas Natural Resource Conservation Commission (aquifer activity)
United States Geological Survey (USGS) – (water use maps)
http://ga.water.usgs.gov/edu/mapgallery.html

United States Geological Survey (USGS) (Karst topography - paper models)
AND teacher guide

University of Florida (aquifers)
http://aquat1.ifas.ufl.edu/guide/aquifers.html

University of South Florida - Karst Research Group (Florida karst)
http://uweb.cas.usf.edu/~vacher/FloridaKarst/FloridaKarstI.htm

Others

Cave Diver’s Forum (Great pictures of springs)
http://www.cavediver.net/pictures/wingman/

Florida News - “New Technology Maps Underground Springs” (archived article)

Florida Travel Magazine – “Florida Spring – A Natural, Freshwater Supply“ article
(September/October 2004) – information on several springs and gives additional websites
http://www.floridatravelusa.com/articlesnew/springsep04p110.html

Orlando Sentinel – Article: FLORIDA’S WATER CRISIS: Wither the Springs
http://www.orlandosentinel.com/news/local/orl-water05050502may05.story?coll=orl%2Dnews%2Dheadlines

Other Resources

Florida’s Aquifer Adventure (DVD) available from Florida Geological Survey
Scoring for Performance Task Items

Two types of performance tasks are included, short-response tasks and extended-response tasks. For each performance task, student responses will be scored using rubrics.

**Short-Response (SR) Tasks** (2-point rubric)

Short-response tasks are worth 0, 1, or 2 points. They should take approximately 3-5 minutes per item to complete.

**Extended-Response (ER) Tasks** (4-point rubric)

Extended-response tasks are worth 0, 1, 2, 3, or 4 points. They should take approximately 5-10 minutes per item to complete. These tasks normally include multiple, related steps.
FCAT Reading Scoring Rubrics

**Short-Response Tasks (2-point rubric)**

**2 points**  The response indicates that the student has a complete understanding of the reading concept embodied in the task. The student has provided a response that is accurate, complete, and fulfills all the requirements of the task. Necessary support and/or examples are included, and the information given is clearly text-based.

**1 point**  The response indicates that the student has a partial understanding of the reading concept embodied in the task. The student has provided a response that includes information that is essentially correct and text-based, but the information is too general or too simplistic. Some of the support and/or examples may be incomplete or omitted.

**0 points**  The response is inaccurate, confused, and/or irrelevant, or the student has failed to respond to the task.

**Extended-Response Tasks (4-point rubric)**

**4 points**  The response indicates that the student has a thorough understanding of the reading concept embodied in the task. The student has provided a response that is accurate, complete, and fulfills all the requirements of the task. Necessary support and/or examples are included, and the information given is clearly text-based.

**3 points**  The response indicates that the student has an understanding of the reading concept embodied in the task. The student has provided a response that is accurate and fulfills all the requirements of the task, but the required support and/or details are not complete or clearly text-based.

**2 points**  The response indicates that the student has a partial understanding of the reading concept embodied in the task. The student has provided a response that includes information that is essentially correct and text-based, but the information is too general or too simplistic. Some of the support and/or examples and requirements of the task may be incomplete or omitted.

**1 point**  The response indicates that the student has very limited understanding of the reading concept embodied in the task. The response is incomplete, may exhibit many flaws, and may not address all the requirements of the task.

**0 points**  The response is inaccurate, confused, and/or irrelevant, or the student has failed to respond to the task.
FCAT Writing Rubric
6-Point Rubric

6 points:
- writing focused on topic
- logical organizational pattern (beginning, middle, conclusion, and transitions)
- ample development of supporting ideas
- sense of wholeness or completeness
- demonstrates mature command of language
- precision of word choice
- subject/verb and verb/noun form agreement generally correct
- sentences complete with few exceptions (fragments used purposely)
- various sentence structures used

5 points:
- writing focused on topic
- adequate development of supporting ideas
- organization pattern exists, with few lapses
- demonstrates sense of completeness or wholeness
- word choice adequate, but may lack precision
- most sentences complete, some fragments
- occasional errors in subject/verb agreement and in standard forms of verbs and nouns don’t impede communication
- conventions in punctuation, capitalization, and spelling generally followed
- various sentence structures used

4 points:
- writing generally focused on topic, but many contain some extraneous or loosely related information
- demonstrates sense of wholeness or completeness
- some pars of response may contain specifics and details, while supporting ideas or other areas may not be developed
- word choice generally adequate
- knowledge of conventions of punctuation and capitalization is demonstrated
- commonly used words spelled correctly
- attempt made to use variety of sentence structure, but most are simple constructions
FCAT Writing Scoring Rubric – page 2

3 points:
• writing generally focused, but may contain extraneous or loosely related information
• organizational pattern has been attempted and some transitional devices used, but lapses may occur
• lacks a sense of completeness or wholeness
• some supporting ideas may not be developed with specifics and details
• word choice is adequate but limited, predictable, and occasionally vague
• knowledge of conventions of punctuation and capitalization is demonstrated
• commonly used words are usually spelled correctly
• attempt to use variety of sentence structures although most are simple constructions

2 points:
• writing may be slightly related to topic or may offer little relevant information and few supporting ideas or examples
• writing that is relevant to topic exhibits little evidence or an organizational pattern or use of transition devices
• development of supporting ideas may be inadequate or illogical
• word choice may be limited or immature
• frequent errors occur in basic punctuation and capitalization
• commonly used words frequently misspelled
• sentence structure limited to simple constructions.

1 point:
• writing only minimally addresses topic because there is limited, if any, development of support ideas, and unrelated information is included
• writing that is relevant does not exhibit an organizational pattern
• few, if any transitional devices are used to signal movement through the text
• supporting ideas may be sparse, and are usually provided through lists or clichés
• limited or immature word choice
• frequent errors in spelling, capitalization, punctuation, and sentence structure may impede communication
• sentence structure may be limited to simple constructions

Unscorable:
• response is not related to what the prompt requested
• response is simply a rewording of the prompt
• response is a copy of a published work
• student refused to write
• response is illegible
• response is incomprehensible (no meaning is conveyed)
• response contains an insufficient amount of writing to determine if the student was attempting to address the prompt
FCAT Mathematics Scoring Rubrics

Short-Response Tasks (2-point rubric)

2 points  A score of two indicates that the student has demonstrated a thorough understanding of the mathematics concepts and/or procedures embodied in the task. The student has completed the task correctly, in a mathematically sound manner. When required, student explanations and/or interpretations are clear and complete.

1 point  A score of one indicates that the student has provided a response that is only partially correct. For example, the student may provide a correct solution, but may demonstrate some misunderstanding of the underlying mathematical concepts or procedures. Conversely, a student may provide a computationally incorrect solution but could have applied appropriate and mathematically sound procedures or the student’s explanation could indicate an understanding of the task, even in light of the error.

0 points  A score of zero indicates that the student has provided a completely incorrect or uninterpretable response, or no response at all.
Extended-Response Tasks  (4-point rubric)

4 points  A score of four is a response in which the student demonstrates a thorough understanding of the mathematics concepts and/or procedures embodied in the task. The student has responded correctly to the task, used mathematically sound procedures, and provided clear and complete explanations and interpretations. This response may contain minor errors that do not detract from the demonstration of a thorough understanding.

3 points  A score of three is a response in which the student demonstrates an understanding of the mathematics concepts and/or procedures embodied in the task. The student’s response to the task is essentially correct with the mathematical procedures used and the explanations and interpretations provided demonstrating an essential but less than thorough understanding. The response may contain minor flaws that reflect inattentive execution of mathematical procedures or indications of some misunderstanding of the underlying mathematics concepts and/or procedures.

2 points  A score of two indicates that the student has demonstrated only a partial understanding of the mathematics concepts and/or procedures embodied in the task. Although the student may have used the correct approach to obtaining a solution or may have provided a correct solution, the student’s work lacks an essential understanding of the underlying mathematical concepts.

The response contains errors related to misunderstanding important aspects of the task, misuse of mathematical procedures, or faulty interpretations of results.

1 point  A score of one indicates that the student has demonstrated a very limited understanding of the mathematics concepts and/or procedures embodied in the task. The student’s response is incomplete and exhibits many flaws. Although the student’s response has addressed some of the conditions of the task, the student reached an inadequate conclusion and/or provided reasoning that was faulty or incomplete.

The response exhibits many flaws or may be incomplete.

0 points  A score of zero indicates that the student has provided a completely incorrect or uninterpretable response, or no response at all.
FCAT Science Scoring Rubrics

Short-Response Tasks (2-point rubric)

2 points A score of two indicates that the student has demonstrated a thorough understanding of the scientific concepts and/or procedures embodied in the task. The student has completed the task correctly, in a scientifically sound manner. When required, student explanations and/or interpretations are clear and complete. The response may contain minor flaws that do not detract from demonstration of a thorough understanding.

1 point A score of one indicates that the student has provided a response that is only partially correct. For example, the student may arrive at an acceptable conclusion or provide an adequate interpretation, but may demonstrate some misunderstanding of the underlying scientific concepts and/or procedures. Conversely, a student may arrive at an unacceptable conclusion or provide a faulty interpretation, but could have applied appropriate and scientifically sound concepts and/or procedures.

0 points A score of zero indicates that the student has provided a response that demonstrates no understanding of the science embodied in the task. The student explanation may be incorrect, uninterpretable, or contain clear misunderstanding of the underlying scientific concepts and/or problems.
**FCAT Science Scoring Rubrics – page 2**

**Extended-Response Tasks (4-point rubric)**

**4 points** A score of four indicates that the student has demonstrated a thorough understanding of the scientific concepts and/or procedures embodied in the task. The student has completed the task correctly, used scientifically sound procedures, and provided clear and complete explanations and interpretations.

The response may contain minor flaws that do not detract form a demonstration of a thorough understanding.

**3 points** A score of three indicates that the student has demonstrated an understanding of the scientific concepts and/or procedures embodied in the task. The student’s response to the task is essentially correct, but the scientific procedures, explanations, and/or interpretations provided are not thorough.

The response may contain minor flaws that reflect inattentiveness or indicate some misunderstanding of the underlying scientific concepts and/or procedures.

**2 points** A score of two indicates that the student has demonstrated only a partial understanding of the scientific concepts and/or procedures embodied in the task. Although the student may have arrived at an acceptable conclusion or provided an adequate interpretation of the task, the student’s work lacks an essential understanding of the underlying scientific concepts and/or procedures.

The response may contain errors related to misunderstanding important aspects of the task, misuse of scientific procedures/processes, or faulty interpretations of results.

**1 point** A score of one indicates that the student has demonstrated a very limited understanding of the scientific concepts and/or procedures embodied in the task. The student’s response is incomplete and exhibits many flaws. Although the student’s response has addressed some of the conditions of the task, the student has reached an inadequate conclusion and/or provided reasoning that is faulty or incomplete.

The response exhibits many flaws or may be incomplete.

**0 points** A score of zero indicates that the student has provided a response that demonstrates no understanding of the science embodied in the task. The student explanation may be incorrect, uninterpretable, or contain clear misunderstanding of the underlying scientific concepts and/or procedures.
“Vampire Sink Cleanup”  
by Wes Skiles

During the exploration of the Floridan Aquifer while filming for Water’s Journey, we came upon a large, deep sinkhole. Scientists call these vertical solution pipes and they give us access both from the surface and underground. Following our dive team using the ELF, or Extreme Low Frequency radio locator, Brian Pease and I were able to track them as they swam deep underground beneath highways and buildings to this unusual site. Upon arriving, Brian and I had to carefully navigate around the entire sinkhole until we were able to find a safe but very steep, sloping footpath to the bottom.

As we arrived at the bottom we discovered hideous quantities of garbage and trash that had been carelessly thrown into the sink. People often think that sinkholes are a good place to get rid of their garbage – a hole in the ground that they think is a perfect place to throw their personal trash. What most people don’t know is that these are direct openings to our drinking water!

Among the things we found were containers of used motor oil, antifreeze, paint, roofing tar, and refuse from someone’s remodeling project in which some individual discarded his or her bathtub, toilet and sinks! As we neared the water in the bottom of the sink we could smell both petroleum products and hydrogen sulfide. Petroleum, which is lighter than water, floats at the surface and an oily sheen could be seen amongst other trash and debris. Hydrogen sulfide is a gas produced from the decomposition of organic material and is quite common in many of our sinkholes in north Florida.

Shortly after we arrived the team surfaced, much to their disgust! And they told us it was no better below the water than above. On the slope down into the cave and on the floor of the cave they encountered a lawn mower, tires, a BBQ grill, an oil drum and a plethora of other waste products of society, none of which belong in our drinking water! The water on the surface actually burned the skin of the divers and made them very uncomfortable, not to the mention the horrific smells of the natural and unnatural contaminants.

We took out all that we could carry ourselves but there was much more work to be done. That day we decided that thoroughly cleaning the sinkhole must be a priority.

Later, during the screening of the film in the local community where the sink is located, we announced our intentions for a cleanup of the site in hopes of helping return it to its natural state. The response from the audience was overwhelming. People were really excited to know that they could be a part of cleaning up their local environment.

With cooperation from the City of High Springs, Florida and a local waste management company, we were able to arrange for a 20’x8’x5’ dumpster that we could use to dispose of the trash. On the day of the cleanup, the dumpster was in place and over 60 volunteers showed up including certified cave divers. A large portion of the group was comprised of members of a chapter (called a “grotto”) of an organization called the Florida Speleological Society. These grottos are members of...
a larger, international organization called the National Speleological Society whose members are dedicated to the exploration, conservation, and protection of cave environments.

The many local residents and children of all ages who participated that day were very enthusiastic with seemingly endless energy and left knowing they had contributed to the long-term health of the aquifer. The tons of garbage and debris reflecting the decades of abuse had finally been removed.

But some of the trash turned out to be treasure as bottles that were discovered buried beneath the detritus (decomposing organic matter) dated back as far as 50 years, making them collector’s items!

Underwater, divers faced a much more difficult task to remove the lawn mower and other items our team had discovered because of the depth – 40’ vertically! Members of the speleological group rigged a special hauling system called “Single Rope Technique” and incorporated a 2:1 mechanical advantage which allowed them to haul out heavy objects at half their weight. The iron bathtub proved to be the biggest lifting challenge.

It was a long, tiring day but six hours later, the dumpster was overflowing and the sink, once again, appeared to be in a state that the Timucua Indians may have seen hundreds of years ago.
“Underwater Photography”  
by Wes Skiles

Underwater photography is one of the most fun and exciting areas to explore in photography. As a professional in underwater photography, you have the opportunity to photograph or film whales, sharks, wrecks, caves, and even under the ice in places like Antarctica. It’s a very demanding and challenging pursuit, however. It requires you to be an expert in every aspect of diving before you can even think about taking the camera with you. Imagine making a living riding a bike while having to carry a camera, focus it, and adjust the aperture, all while constantly pressing various other buttons…! We call this task loading which is the challenge of doing many different tasks at the same time. Because diving can be dangerous, it is extremely important to be well trained and to have some experience before adding the additional task loading of photography or filming.

Another consideration as you explore the possibilities of underwater photography is whether you would choose to shoot still photography or moving footage. As a still photographer, you would most often be doing this as a single individual and the task loading would be less than that of shooting moving footage. Whether shooting film or video, capturing moving images is a coordinated team effort that requires people to hold lights, assist with camera cables, and sometimes be in the movie too!

Equipment is the next really big issue in underwater photography. There are special amphibious cameras that look very similar to a normal camera but are designed to go underwater. Because of their design and the materials of which they are constructed, there are limits to how deep you can take them. Then there are housed cameras for both still and motion pictures that can be used in deeper conditions. To better understand pressure you need to be able to measure it. Right now you are at what we call 1 atmosphere (absolute), which is approximately 14.7 pounds of pressure. Every 33 feet an additional 14.7 pounds of pressure per square inch is exerted on the housing and seals. All of these cameras and housings must hold out a tremendous amount of pressure by using seals called “O-Rings” that are made of a hard pliable rubber and located at all interfaces to the camera. If the camera were to be flooded, it would be destroyed so water pressure and proper sealing is a VERY big concern to any photographer! Careful preparation is necessary to make sure the camera stays sealed and dry during any given dive.

My career has been based on following the journeys and expeditions of explorers and scientists as they go to the ends of the earth pursuing the answers to many of life’s scientific mysteries. On one trip I got to film a group of esteemed scientists as they tagged the first sperm whale with a radio locating device to tell us how and where the great whales migrate and travel. I have traveled with Dr. Bill Stone to the depths of the deepest caves of the world to take images for National Geographic – 1453 meters! Recently, I went to Antarctica, to film the largest moving object ever recorded on earth, a giant Iceberg called B-15. While we were there, we dove and filmed inside of underwater ice caves of this great iceberg where no humans have been before to study rare life forms and the nature of these ice structures.

In my job the biggest challenge is easily the fact that I really have two jobs simultaneously. I am right there, oftentimes ahead of the people being the first to be there. If you have ever seen a movie
showing people proclaiming to be the first to arrive somewhere, it’s truly the cameraman who was there first! We are not there for fortune and glory; we’re there to tell stories.

A great example is in Water’s Journey where we encountered an extremely high-flow sand restriction in the cave. No one could get through so I decided to try without my camera. There was a tremendous force of water and sand coming through this very small opening. I grabbed the walls, pressed my heels against the ceiling of the cave and used one hand to cause a small avalanche of sand to make the opening a little bigger. I then was able to push and pull my body through this high-flow, dangerous restriction. When I finally made it through, I decided that it was probably too extreme and dangerous for the team and it wasn’t right to expect them to take these sorts of risks. When I turned to exit, the camera had already been pushed through the restriction and handed to me by Jill Heinerth who you see throughout the film. At that point, your natural instinct to film and document takes over. That day we ended up capturing one of the most extreme cave diving shots ever captured underwater!
How sinkholes form

Removing too much groundwater can leave underground holes, leading to sinkholes

What is a sinkhole?
Sinkholes are part of the slow, natural process of erosion in Florida's limestone terrain that occur over thousands of years. These common geologic phenomena generally occur where the limestone is within a few hundred feet of the land's surface.

Though most are only 10 to 12 feet in diameter, sinkholes have been known to expand to hundreds of feet in diameter. Many of central and north Florida’s lakes actually are the result of old sinkholes.

How do sinkholes form?
Rainfall percolating, or seeping, through the soil absorbs carbon dioxide and reacts with decaying vegetation, creating a slightly acidic water. That water moves through spaces and cracks underground, slowly dissolving limestone and creating a network of cavities and voids. As the limestone dissolves, pores and cracks are enlarged and carry even more acidic water. Sinkholes are formed when the land surface above collapses or sinks into the cavities or when surface material is carried downward into the voids.

Drought, along with resulting high groundwater withdrawals, can make conditions favorable for sinkholes to form. Also, heavy rains after droughts often cause enough pressure on the ground to create sinkholes.

Sinkholes can be triggered by human activities such as:
- Overwithdrawal of groundwater
- Diverting surface water from a large area and concentrating it in a single point
- Artificially creating ponds of surface water
- Drilling new water wells

In urban or suburban areas, sinkholes are hazardous because they can destroy highways and buildings. Sinkholes also can cause water quality problems. During a collapse, surface waters may leak into the aquifer, our underground source of drinking water.

Can sinkholes be prevented?
Many natural sinkholes cannot be prevented. However, those caused by human activity may be avoided, especially those caused by over-pumping groundwater. During dry conditions, water tables drop in the limestone and cavities under Florida’s sand and clay soil. The combination of gravity, loss of buoyancy and water pressure can activate a collapse.

By keeping water tables high, water conservation rules and drought restrictions are tools to help prevent sinkholes from occurring. The St. Johns River Water Management District promotes year-round water conservation and issues water restrictions to prevent water shortages and over-pumping during Florida’s inevitable times of drought.

The District is responsible for providing long-term protection of the water supply. While water restrictions can cause some inconvenience to residents and businesses, limiting outdoor watering is critical throughout the year, and especially during a drought. Public cooperation is vital to ensuring long-term water resource protection.

Warning signs
A rapid sinkhole caused by well drilling or other sudden alterations to the terrain may not give any warning signs. Otherwise, the collapse process usually occurs gradually enough that a person may leave the affected area safely. The final breakthrough can develop over a period of a few minutes to a few hours.

Some warning signs of a naturally occurring sinkhole include:
- Gradual localized ground settlement
- Doors and windows fail to close properly
- Cracks in a foundation
- A circular pattern of ground cracks outlining the sinking area
- Vegetation stress due to a lowered water table
- Turbidity in local well water due to sediment washing into the limestone’s pores

There are many other causes of localized ground settlement and vegetation stress, and depressed areas are not necessarily indications of an imminent sinkhole.
Trivia for Water’s Journey

- Florida has 40 rivers and 740 springs. *(FGS Bulletin #66)*

- One gram of PCBs can make up to one billion liters of water unsuitable for freshwater aquatic life. *(University of Florida, IFAS)*

- One drop of oil can render up to 25 liters of water unfit for drinking. *(University of Florida, IFAS)*

- In developing nations, 80% of diseases are water related. *(University of Florida, IFAS)*

- It would take 219 million gallons of water to cover one square mile with one foot of water. *(University of Florida, IFAS)*

- The Floridan Aquifer stretches 82,000 square miles beneath Florida and parts of Alabama, Georgia, and South Carolina. *(Southwest Florida Water Management District)*

- The deepest aquifer in Florida is the Floridan Aquifer. Its average thickness is 1,000 feet, but parts located in southwest Florida are known to be 3,500 feet thick. *(Southwest Florida Water Management District)*

- Scientists believe water was deposited in the Floridan aquifer through rain 30,000 to 50,000 years ago. *(Southwest Florida Water Management District)*

- The Floridan aquifer contains an estimated 1 quadrillion (1,000,000,000,000,000) gallons of fresh water. *(Southwest Florida Water Management District)*

- Limestone rock that makes up the aquifer is easily dissolved by acidic rainwater that can cause cave systems and sinkholes to form. *(Southwest Florida Water Management District)*

- Almost no water is as pure as the two hydrogen atoms bonded to one oxygen atom because pollutants attach themselves to water molecules affecting the water’s purity. *(Southwest Florida Water Management District)*

- The Sunshine State uses more water per capita than any other state, except California. *(Adopt a River)*

- Water is part of a deeply interconnected system. What we pour on the ground ends up in our water, and what we spew into the sky ends up in our water. *(EPA)*

- A person should consume at least 2-1/2 quarts of water per day (from all sources of water, food, etc.) to maintain health. *(American Water Works Association)*
• One inch of rainfall drops about 7,000 gallons on a 60’ x 180’ piece of land. *(American Water Works Association)*

• Groundwater can contain items that you can’t see such as hydrogen sulfide or other naturally occurring chemicals. Groundwater also may contain petroleum, organic compounds, or other chemicals introduced by humans’ activities. *(USGS)*

• In 2000, about 346,000 million gallons per day of fresh water was withdrawn from our surface and groundwater sources. Here’s the breakdown by water-use category: *(USGS)*
  
  o **Irrigation:** 40 percent  
  o **Thermoelectric power:** 39 percent  
  o **Public Supply:** 13 percent  
  o **Industry:** 5 percent  
  o **Livestock, aquaculture:** less than 1 percent  
  o **Domestic:** (self-supplied): 1 percent  
  o **Mining:** 1 percent

• Contaminated groundwater can occur if the well is located near land that is used for farming where certain kinds of chemicals are applied to crops, or near a gas station that has a leaking storage tank. Leakage from septic tanks and/or waste-disposal sites also can contaminate groundwater. A septic tank can introduce bacteria to the water, and pesticides and fertilizers that seep into farmed soil can eventually end up in water drawn from a well. *(USGS)*

• Water levels in wells are constantly changing. Just pumping water out of the well for use can lower water levels. Also, a well may be pumped so much as to cause the water level in nearby wells to be lowered, too. It all depends on how fast the aquifer that the well uses is recharged with water from the surface or from the area surrounding it. In some places people have withdrawn water from their wells faster than water replenishes the aquifer, and the wells have stopped producing water. *(USGS)*

• An aquifer can only contain water if there is water coming into it, usually from rainwater seeping down from the surface. In a severe drought, water levels in wells can significantly decline. *(USGS)*

• More than 13 million households get their water from their own private wells and are responsible for treating and pumping the water themselves. *(American Water Works Association)*

• Most of the water we use comes from aquifers deep underground, with about 90% of all households depending on this supply, called groundwater, for drinking, bathing, and everyday use. *(The Young Naturalist’s Guide to Florida)*

• In towns and cities, the major cause of pollution of drinking water sources is stormwater runoff. *(Plain Talk About Drinking Water)*
• Four quarts of oil can cause an eight-acre oil slick if dumped down a storm drain.

• Scientists estimate North America has enough groundwater to cover the continent with a sheet of water almost 100 feet thick.

• If all the world’s water fit into a gallon jug, the fresh water available for us to use would equal only about one tablespoon. *(National Wild and scenic Rivers Systems)*

• 1.2 billion people are at risk from drinking contaminated water.

• Safety Harbor is home of the historic Espiritu Santo Springs. The Spanish explorer Hernando de Soto gave this name in 1539 when he was searching for the legendary Fountain of Youth. The natural springs have attracted attention worldwide for their curative powers. *(50 states.com)*

• A swamp such as the Fakahatchee Strand in the Everglades functions in three major ways. First, its vegetation serves as a filter to clean the water as it makes its slow journey southward. Secondly, it’s a major habitat for wildlife and plant life. Finally, it actually prevents flooding by slowing down the flow of water after heavy rains. *(50 states.com)*

• Sinkholes vary in size from 1 meter (3 feet) to 18 meters (50 feet) or more in diameter, and 1 meter to 18 meters or more deep. In 1981, a sinkhole in Winter Park swallowed cars, a house, and most of a large community swimming pool. *(The Young Naturalist’s Guide to Florida)*

• The amount of water on Earth hasn’t changed since the Earth was first formed. We’ve been using the same water over and over again! *(Give Water a Hand Action Guide)*

• Americans drink more than one billion glasses of water a day! *(Give Water a Hand Action Guide)*

• Florida has more springs with flowing water, 320 known springs, than any other state. *(The Young Naturalist’s Guide to Florida)*

• A sinkhole known as Squirrel Chimney Cave, located on private land, is the only place in the world that the Squirrel Chimney Cave Shrimp is known to live. It is a 1-inch long transparent shrimp that lives in the water at the bottom of the sinkhole. *(The Young Naturalist’s Guide to Florida)*

• The water temperature in Florida’s springs stay at about 72 degrees F (22.2 degrees C) all year long. That is because it comes from deep in the ground where the air temperature does not affect it. *(The Young Naturalist’s Guide to Florida)*

• Each year industries legally dump more than 500 million pounds of toxic chemicals directly into surface water. *(NWF Water Pollution Fact Sheet)*
Suggestions for Using Trivia

*It is important that the trivia you use in your classroom be based on true facts and has real life connections for student understanding.*

- Trivia Fact of the Day
- Create “Did You Know” trivia books
- Create alphabet water trivia books
- Student research to find and compare trivia
- Create trivia word puzzles
- Create trivia word games
- Bingo Trivia
**Vocabulary (Instructional Strategies)**

**Vocabulary Flash Cards**

**Materials:**  
Index Cards  
Markers

**Directions:**  
- Prepare word cards with a vocabulary word on the front and the definition on the back.  
- Initiate an individual or team game with students giving the meaning of the word shown on the card.

**Student Dictionaries**

**Materials:**  
Stapled paper booklets or composition books  
Pencils

**Directions:**  
- Students create their own alphabetical water dictionary as they learn new vocabulary words.

**Vocabulary Jeopardy**

**Materials:**  
Poster Board  
Pocket Sleeves  
Index cards

**Directions:**  
- Stick pocket sleeves onto poster board setting up similar to a jeopardy board (usually 5 columns and 6 rows)  
- Number the sleeves in numerical order down each column. Each column starts with 1.  
- Each column may either have a category such as “Water Cycle,” “Water Treatment,” etc. or may be labeled category A, B, C, etc.)  
- Write the meaning of a vocabulary word on individual index cards (the vocabulary word in parenthesis at the end). Place the index card in each pocket with the written side facing the backside of the poster.  
- One student will be the game host and pull the card as identified by the player of one team. The host will give the definition only and the player must answer in the form of a questions such as “What is …..” just as in Jeopardy.  
- Each team will take turns. The team with the most correct answers wins.
Vocabulary Cartoons

Students create cartoons using vocabulary words to help remember them and to show understanding of meaning.

Materials: pencil  
paper  
vocabulary words

Directions:

- The student chooses a vocabulary word that he or she might need help with in order to remember it and to use it correctly.
- The student thinks of a rhyming word or other word phrase that helps “picture” it.
- Then the two words (vocabulary word and rhyming word or word phrase) are combined and drawn as a cartoon.

Vocabulary Illustrations

Materials: Paper  
Colored pencils, crayons, or markers

Directions:

- After students have been introduced to vocabulary words, students draw an illustration of selected words that depicts the meaning of the word.

My Understanding of Words *

This chart allows students to analyze their level of understanding of a word and its meaning. Teachers can plan vocabulary instruction and practice opportunities based on this self-assessment.

Materials: Blank chart

Directions:

- Students will use the chart to answer questions about given words.
**Vocabulary Alert!**

*This can be used to make students aware of important terms prior to reading text and to help set purposes for reading.*

Materials: Vocabulary notebooks or word banks

Directions:
- The teacher selects a manageable number of words (5-8) and puts them on the board or the overhead prior to the lesson.
- Students write these in their content notebook or word banks.
- Definitions are added as they are learned. These words can be added to content word walls as well.

**Word Map** *

*This type of graphic organizer helps students visually depict their understanding of a word. A definition, example of, synonym, antonym, use in context, illustration, etc., can all be included on the map.*

Materials: Word Map Form

Directions:
- Students will fill in the various parts of the word map.
- Make changes as needed.

**Six Most Important Words** (the number can vary, depending on teacher choice of text)

Materials: Blank paper

Directions:
- Prior to reading, students are asked to list the six most important words they think will be in the text.
- After reading, this list can be revised to reflect their understanding of the concept(s) being taught.
A-B-C Chart *

Materials: ABC Chart Form

Directions:
- Students try to think of a word or phrase associated with the concept or topic for each letter of the alphabet.
- They write their words in the correct blank on the chart.

Vocabulary Match Game

Materials: Terms and definitions cards (cut out and laminate for student use)

Directions:
- Shuffle cards and place upside-down on table surface.
- Players take turns turning over a card, then turning over another card in an attempt to match the term to its definition.
- When a match is made, the player picks up the pair and places it in his/her own pile. Another turn is allowed when a match is made.
- When a match is not made, the cards are turned upside-down again and the next player takes his or her turn.
- Play continues until all cards have been paired up.
- Player with the most matched pairs is the winner.

Vocabulary Journal *

Materials: Vocabulary Journal Handout

Directions:
- Students use this sheet to record a word, what they think it means, and the context in which it is used in the text.
- Later, they can look it up in a dictionary and revise if needed

* Blackline Master included

aquifer

matched pair

-an underground layer of sand, gravel, or rock that stores and carries water

* Blackline Master included
• Word Map

Example of Word Map

litter
(synonym)
undamaged
(antonym)

debris

Remains of something that has been broken or destroyed

The debris was scattered over a large portion of the town.

Picture of hurricane damage

Vocabulary Word

(sentence)

illustration or personal clue

definition in your own words

(synonym)

(antonym)
Word Map

Vocabulary Word

Use the word in a sentence.

Draw a picture or give a personal clue.

(My Definition)

(Synonym) (Antonym)

Name _______________________

Appendix

AP 51
Concept of Definition Map

Example Concept of Definition Map

Examples

- Yoplait’s fat-free vanilla
- Breyer’s strawberry
- mixed berry
- banana

Category – What is it?

A dairy product

yogurt

What it is like?

- creamy
- smooth
- can be frozen

What it is not

Appendix
Concept of Definition Map

Examples

Category – What is it?

Concept (or word)

What it is not

Properties – What is it like?

Name

Appendix

AP 53
| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

For each letter of the alphabet, try to think of a word or phrase associated with the topic. Place in the appropriate letter box.
## Blank Vocabulary Cards

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# Vocabulary Journal

<table>
<thead>
<tr>
<th>Word and Page #</th>
<th>Context in which the word is used</th>
<th>What I think this word means</th>
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# My Understanding of Words

<table>
<thead>
<tr>
<th>Vocabulary Word</th>
<th>My Level of Understanding</th>
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<tbody>
<tr>
<td></td>
<td>I know it and can teach it to somebody</td>
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Glossary
Water’s Journey: The Hidden Rivers of Florida

*acidic* - having a pH value of less than 7; acidic liquids are corrosive and sour

*aquifer* – an underground layer of sand, gravel, or rock that stores and carries water

**Best Management Practices (BMPs)** – methods that have been determined to be the most effective, practical means of preventing or reducing pollution from various sources of water run-off

*by-products* - materials that are not one of the intended products of a production process. It is a catch-all term and includes most wastes that are not spent materials or sludges

*conduit* - a pipe, canal, channel, or passage for conveying water or fluid

*culvert* - a sewer or drain crossing under a road or embankment

*drought* – a long period of time with little or no rain that results in a shortage of water

*drought-tolerant* - plants which use less water to grow

*electromagnetic* - the relation of magnetism to electricity

*erosion* – the wearing away of the top layer of the Earth (such as soil, sand or rock) by wind, water, or glaciers.

*escarpment* - a steep sloping bank

*groundwater* – water below the ground usually found in aquifers

*karst* – type of terrain underlain by limestone and characterized by caves, sinkholes and disappearing streams

*irrigation* – the application of water to an area

*labyrinth* - interconnecting passages through which it is difficult to find one's way; a maze

*land acquisition* - purchasing land, as for conservation

*leach* - to remove soluble or other substances from by the action of a percolating liquid

*limestone* – highly porous rock formed over millions of years from shells and bones of sea animals
nitrates – a salt of nitric acid; nitrates are compounds in the environment containing nitrogen. These compounds are found in animal wastes, fertilizers, in septic tanks, and in untreated municipal sewage. Nitrates are a primary public health hazard due to the fact they cause “blue baby” syndrome

percolation – the process where water moves through the soil

pollution – contamination of water or air by harmful chemicals or waste materials

porous – a material that contains small holes

radio-location telemetry - a method of transmitting sub-surface communication using low frequency radio

reclamation – water that has been used, collected, and then treated or cleansed so it is safe to be used for irrigation, etc., but remains undrinkable

recycling – to use more than once

renewable resource – materials that may be replenished through human or natural activities. These materials are continually being renewed or restored.

runoff – water from rain or irrigation that doesn’t soak into the ground, but flows into the nearest body of water

saturation – having absorbed all the liquid that is possible

sinkhole – a hole or depression in the ground caused by erosion of underground limestone

springshed - the total land area that contributes rainfall and runoff to a spring or series of connected springs

surface water – water that is found on the surface of the Earth such as oceans, rivers, lakes, ponds, wetlands, streams, or seas

swallet hole- a hole in the land through which a stream delivers surface water to the aquifer (considered the opposite of a spring)

wastewater treatment – a method of cleaning water for a specific purpose. The water may then be reused or returned to the environment

water cycle – the continuous movement of water from the Earth into the atmosphere and back to Earth again

water quality – the condition of water with respect to its content of contaminants
**watershed** – the land and water areas that water moves over, through, and drains into

**well** – a hole or shaft drilled into the earth where water, other liquids, and gases are pumped to the surface