

Abandoned Mine Drainage (AMD) and Wetlands...

Goodbye Orange Water!



Saint Vincent Environmental Education Center

A Fun Activity Book About Abandoned Coal Mines and Improving Our Water Quality

Greetings! I'm King Coal, a black, shiny rock that produces excellent heat and energy when burned. Once upon a time I was America's main source of fuel.



And my name is Pyrite. Some people call me "Fool's Gold." I'm a mineral that glitters like a thousand tiny mirrors. And I've had fun causing water problems for years!



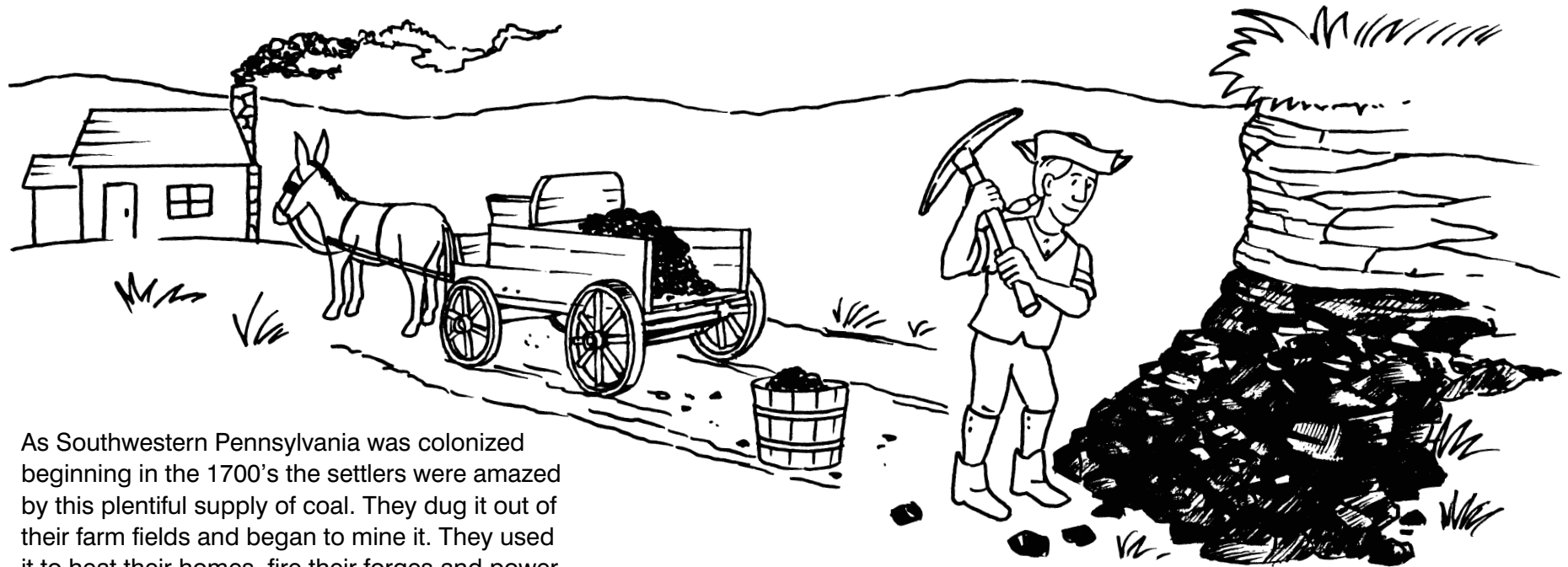
We're underground neighbors with an interesting story to tell. It's a story that follows America's growth throughout history. We've touched many people, animals and plants over the years, and changed the faces of the land, streams and rivers.

The time was right for coal!



Southwestern Pennsylvania has one of the largest coal deposits in the world. Long ago, Native American tribes who lived here, discovered coal in natural rock formations and bursting out of the surface of the ground as they planted their crops.

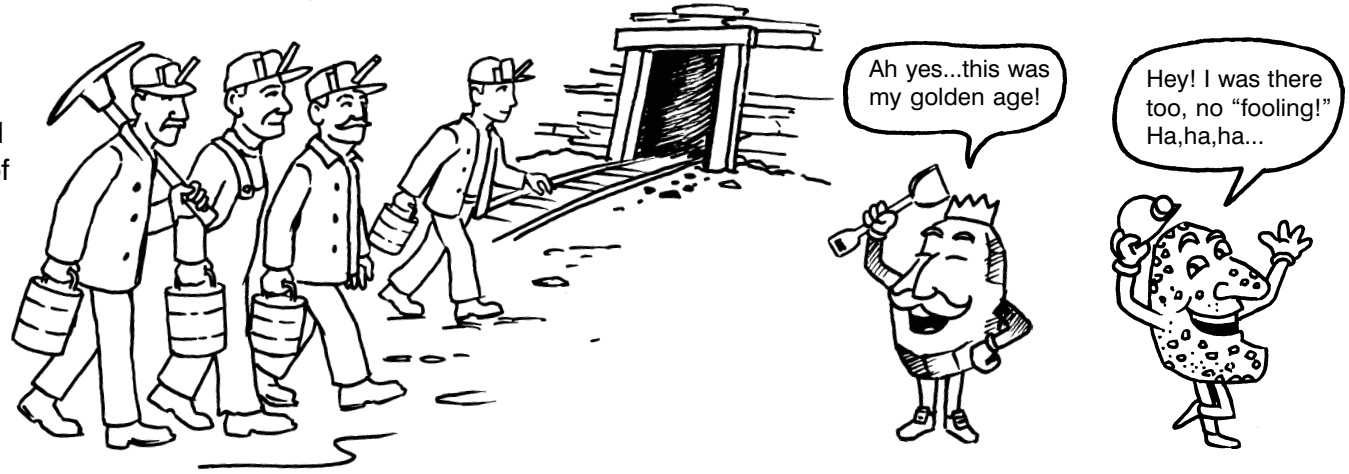
They found that the strange black rock would burn in their camp fires and stay hot for a long time.



As Southwestern Pennsylvania was colonized beginning in the 1700's the settlers were amazed by this plentiful supply of coal. They dug it out of their farm fields and began to mine it. They used it to heat their homes, fire their forges and power newly emerging industries.

Coal Energizes America...

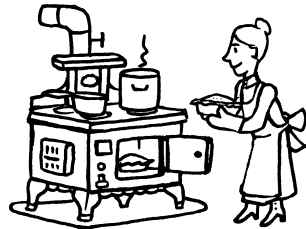
By the mid to late 1800's Southwestern Pennsylvania's underground treasure had become "King Coal", the largest source of fuel and energy in the USA. At that time people from all over the world came to America to build new lives. Thousands of them went to work in Pennsylvania's coal mines to provide for their families.



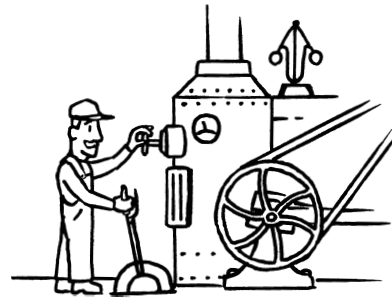
From the early 1900's to the 1960's King Coal was put to work for many uses...



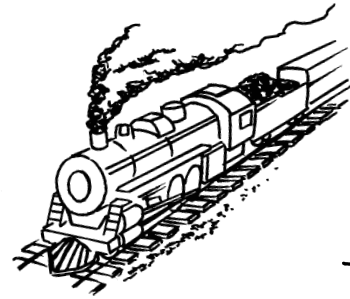
Nearly every home or building had a coal furnace for heating.



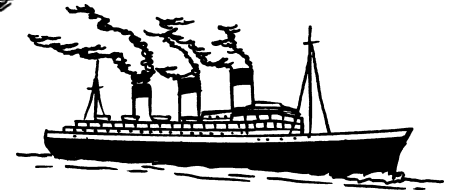
Most families cooked their meals on coal stoves.



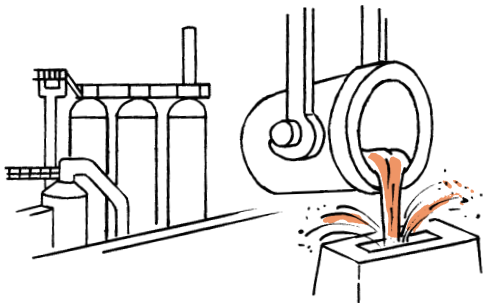
Coal powered steam engines were used in all kinds of industries from agriculture to manufacturing.



Coal powered steam locomotives drove our nations railroads.



Coal powered steam ships crossed the oceans. (When the Titanic sunk in 1912, it was carrying over 3,000 tons of coal!)



Coal heated into "coke" fired the blast furnaces of Pittsburgh steel mills where high quality steel was produced to make everything from skyscrapers and bridges to automobiles and submarines.



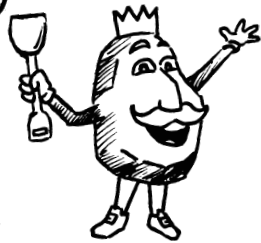
Coal powered steam generators supplied electricity to satisfy the growing demands created by America's new electronic convenience products.

I even powered the old steam engine that ran the Saint Vincent Gristmill!



How Coal Was Formed

Oh, I accomplished so much as a great and powerful King! Look at the background of my noble birth...



Hey King, aren't you a fossil fuel?



Yes! And proud of it! It's better than being a fossil fool!



Ooooooh... he's under pressure....



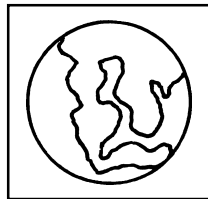
HOT FACT!

Prehistoric Pennsylvania was once located near the Earth's equator and had a hot, wet, tropical climate. The Earth is constantly changing. See how long it took for the land and water to change into what it looks like today...

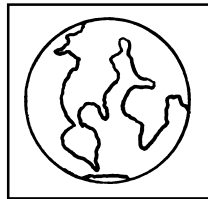
Millions of years ago Pennsylvania was a giant swamp. As the plants and animals living in this prehistoric swamp died they sank to the bottom, partially decayed and gradually accumulated into layers of rocks, minerals and natural elements.



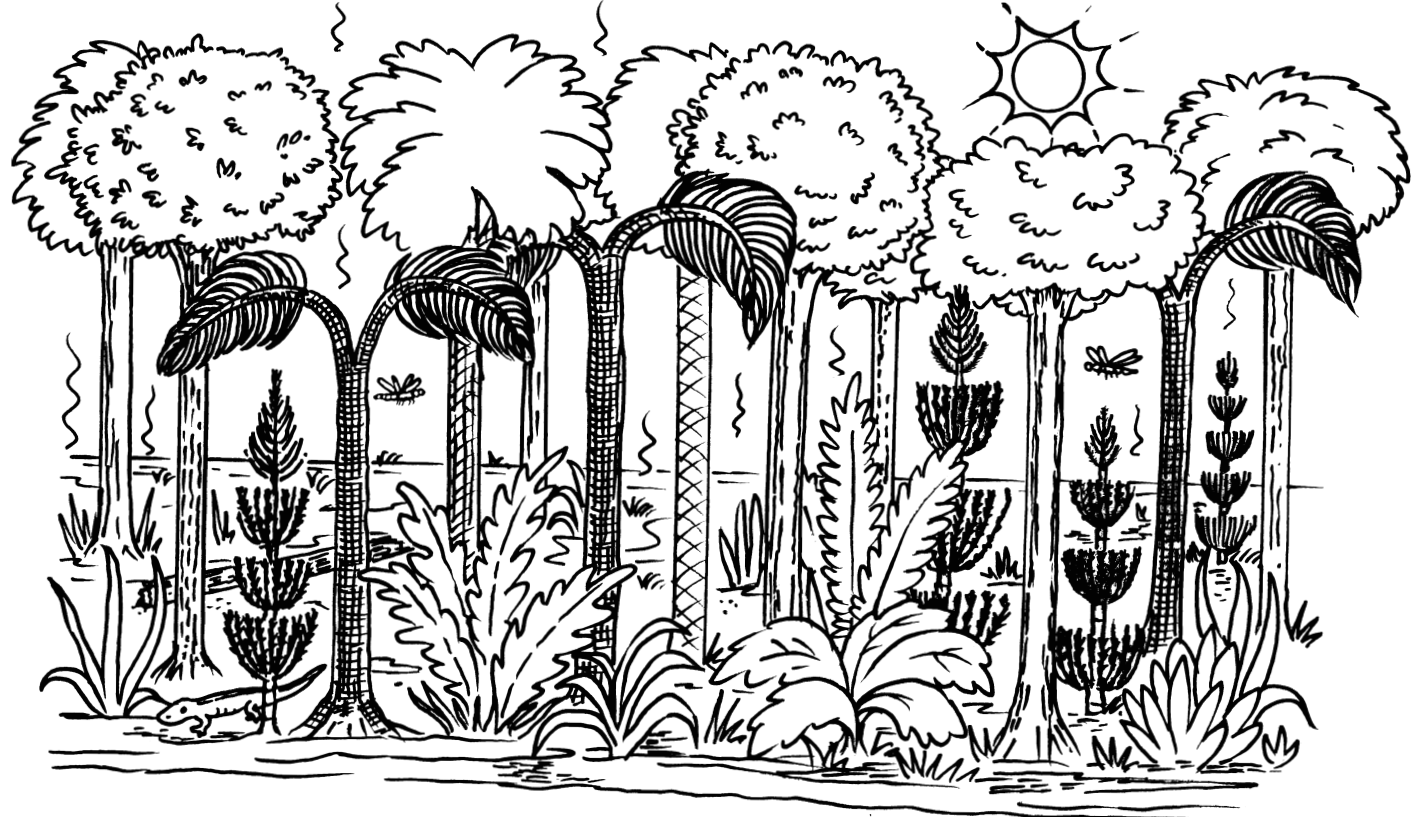
320 to 286 million years ago
Late Carboniferous Period



55 to 36 million years ago
Eocene Period



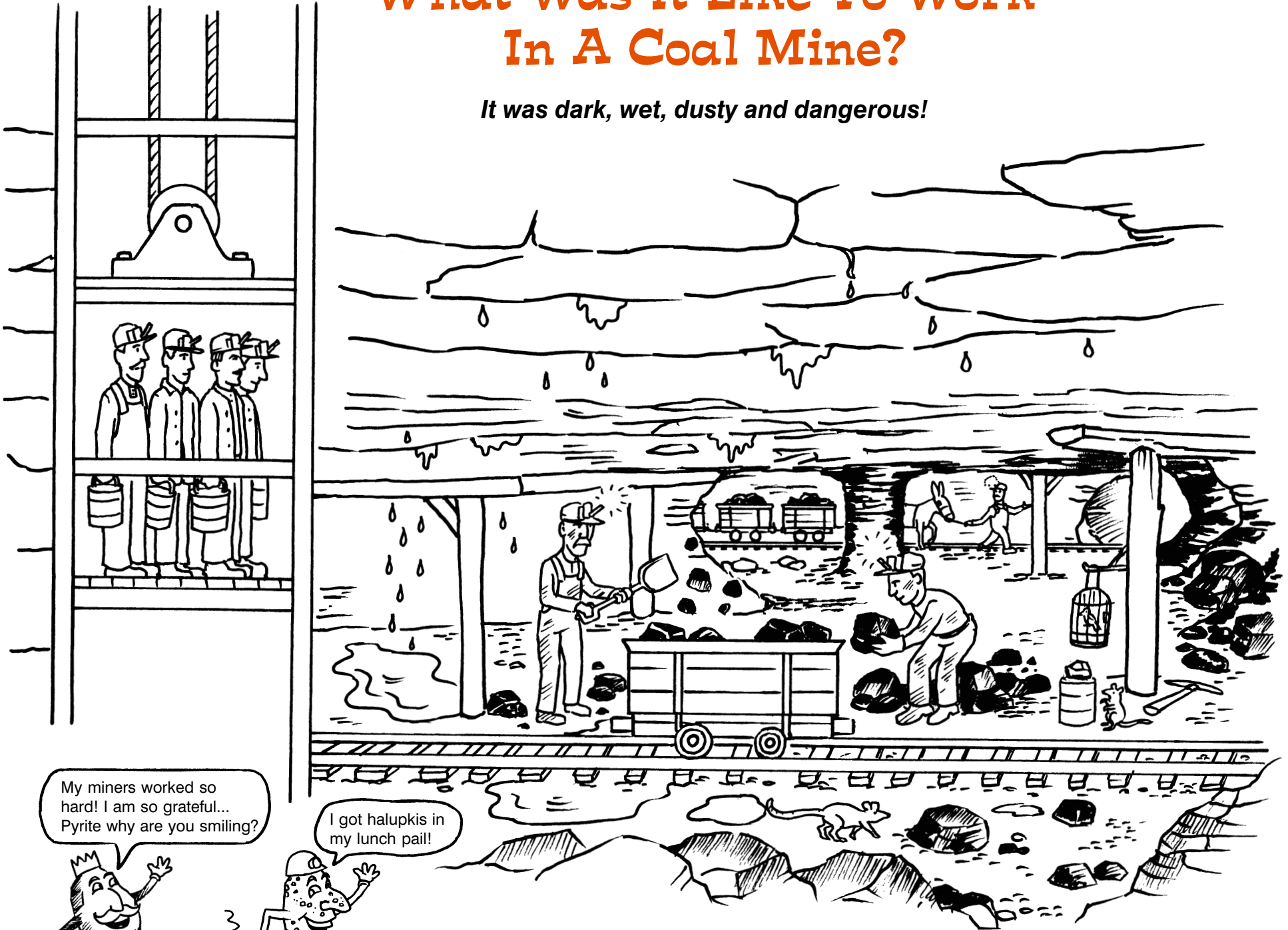
1.6 to 0.01 million years ago
Early Pleistocene Period



As the earth changed and layers built upon layers, enormous pressure, time and heat helped turn the remains of these ancient swamps into **King Coal.**

What Was It Like To Work In A Coal Mine?

It was dark, wet, dusty and dangerous!



My miners worked so hard! I am so grateful... Pyrite why are you smiling?

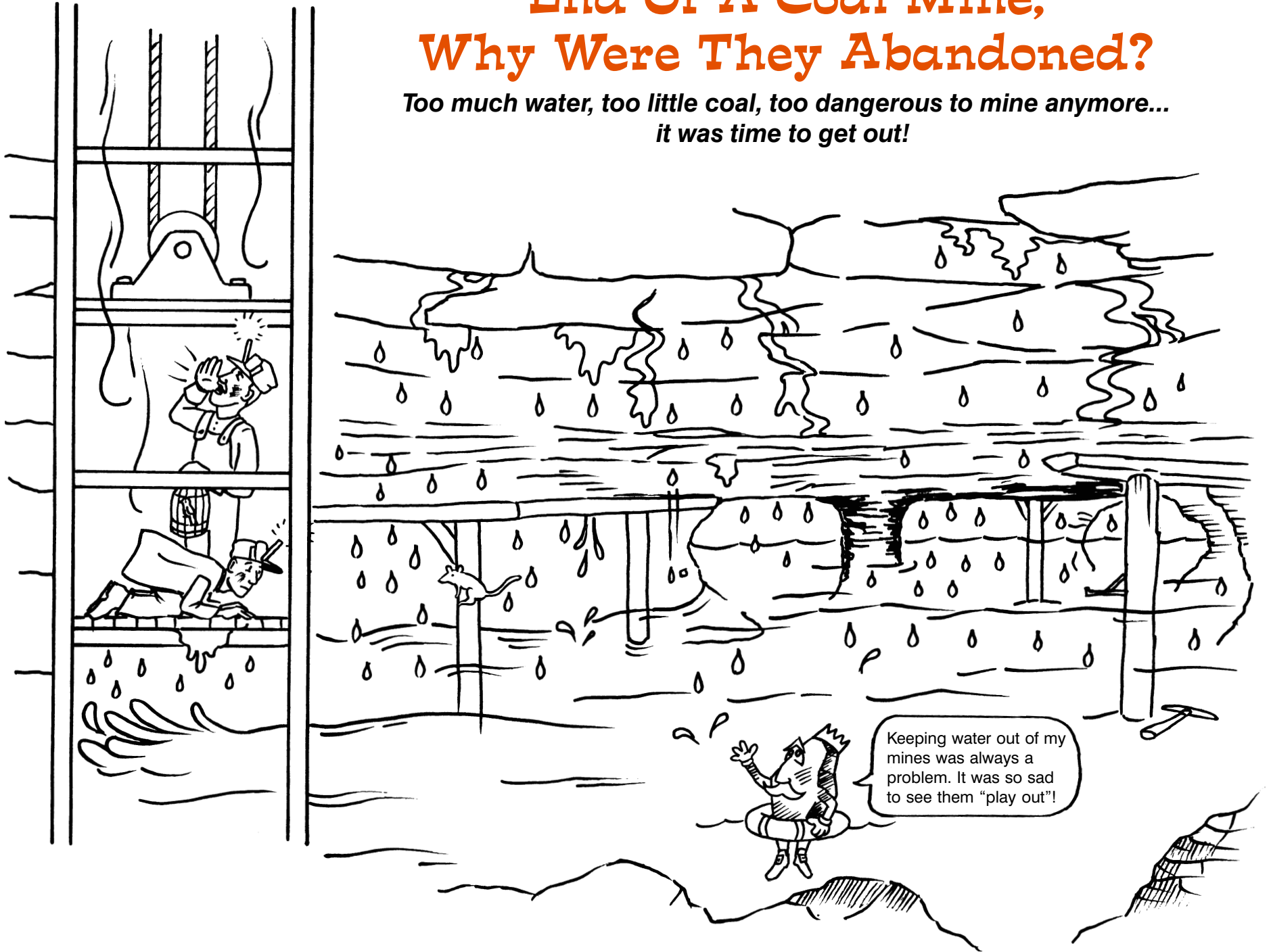


I got halupkis in my lunch pail!



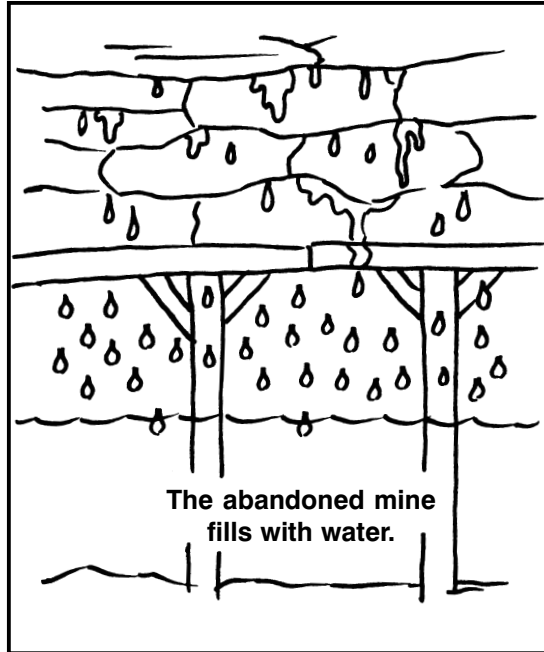
End Of A Coal Mine, Why Were They Abandoned?

*Too much water, too little coal, too dangerous to mine anymore...
it was time to get out!*

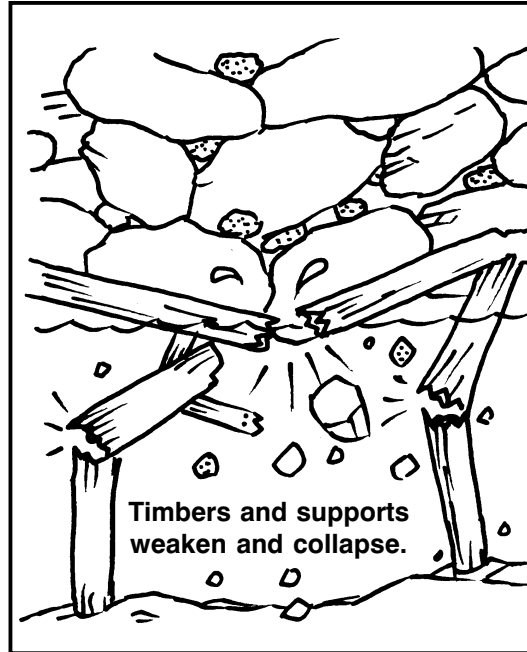


And Now Pyrite Takes Over The Abandoned Coal Mine!

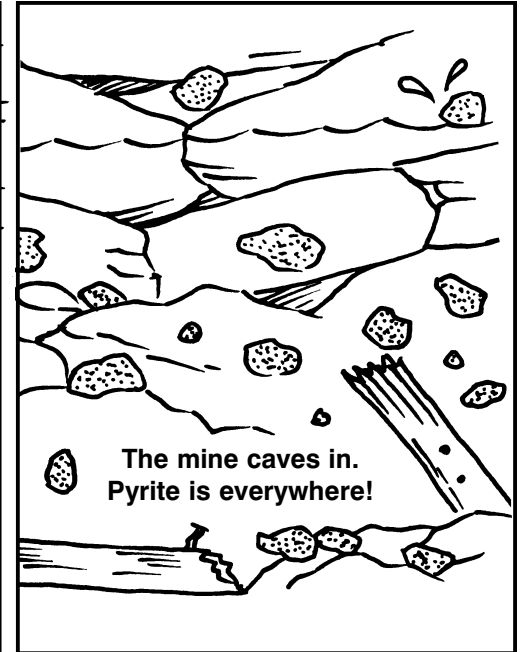
Now this old mine lets me do my stuff. I'll dissolve in the water, and then sure enough, to the earth's surface I'll wander and rise where I'll meet up with oxygen, and cause a surprise!



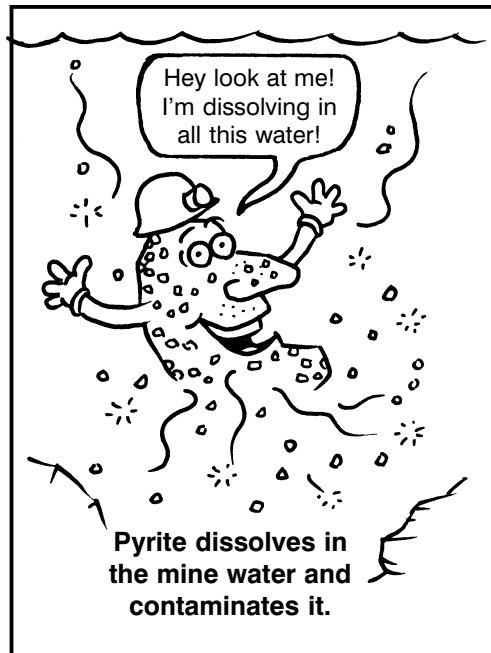
The abandoned mine fills with water.



Timbers and supports weaken and collapse.

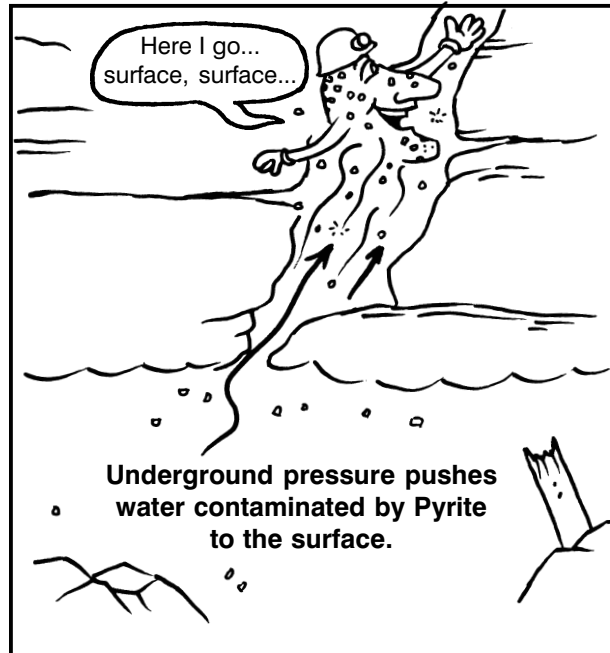


The mine caves in. Pyrite is everywhere!



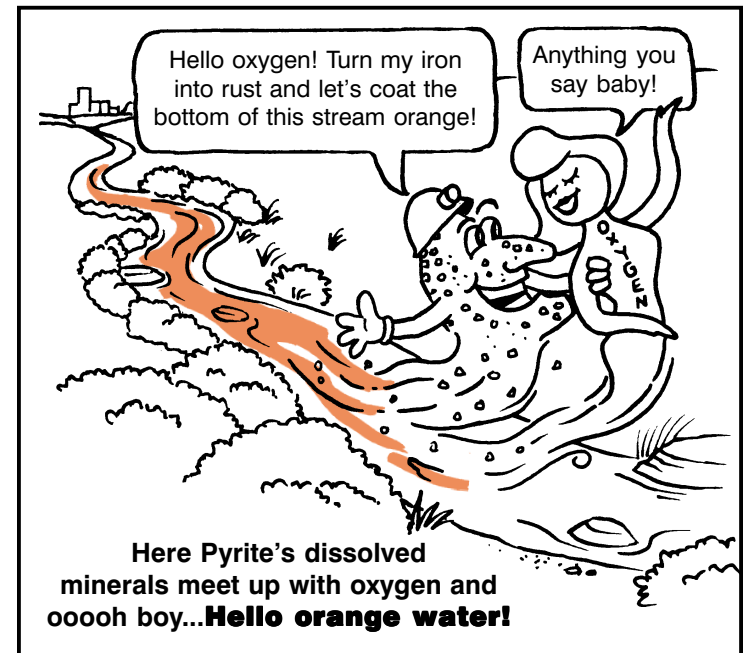
Hey look at me! I'm dissolving in all this water!

Pyrite dissolves in the mine water and contaminates it.



Here I go... surface, surface...

Underground pressure pushes water contaminated by Pyrite to the surface.



Hello oxygen! Turn my iron into rust and let's coat the bottom of this stream orange!

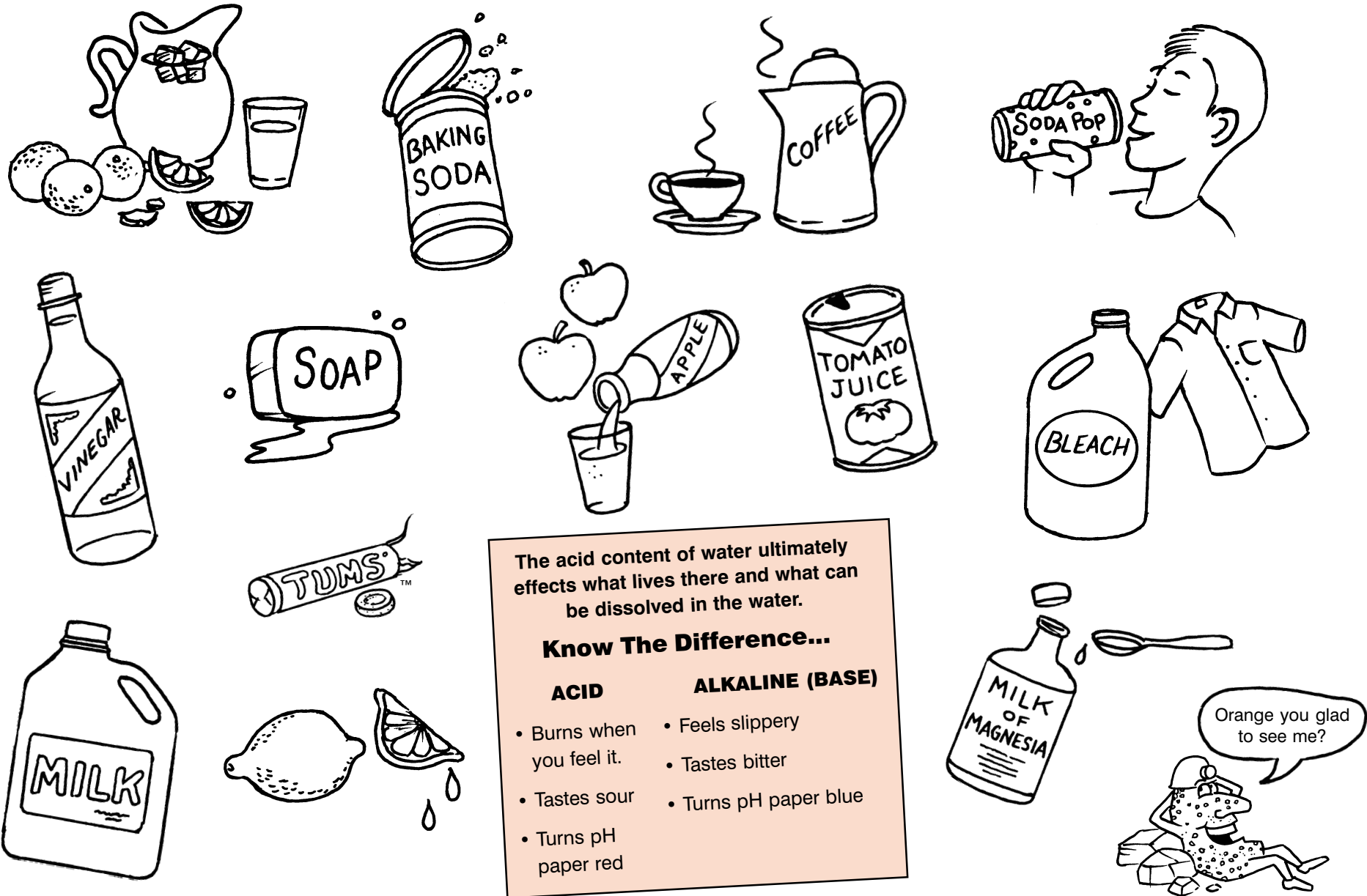
Anything you say baby!

Here Pyrite's dissolved minerals meet up with oxygen and ooooh boy...**Hello orange water!**

Learn Some Abandoned Mine Chemistry

AMD means Abandoned Mine Drainage. When water contaminated in an abandoned underground coal mine reaches the surface it can be acidic or alkaline (base) and contain other dissolved minerals.

Circle acidic things in red and basic things in blue.



The acid content of water ultimately effects what lives there and what can be dissolved in the water.

Know The Difference...

ACID

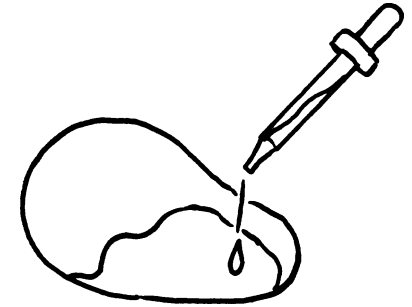
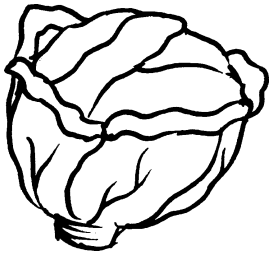
- Burns when you feel it.
- Tastes sour
- Turns pH paper red

ALKALINE (BASE)

- Feels slippery
- Tastes bitter
- Turns pH paper blue

Test The pH Of A Local Stream

Make your own pH paper with the help of an adult.



Time: 30 minutes

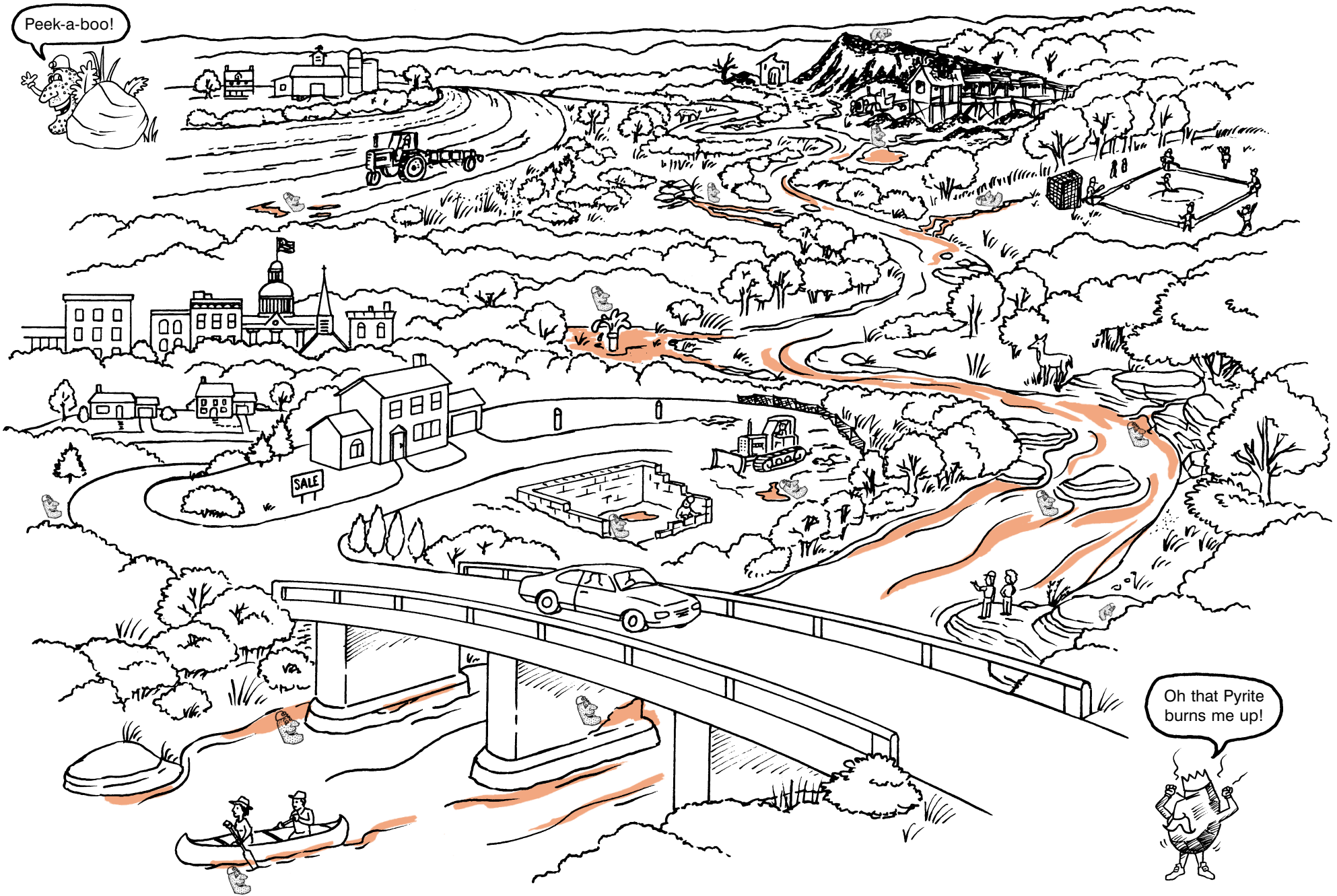
Materials:

1 head of purple cabbage, water, filter paper/heavy paper/coffee filters, various household products-lemon juice, vinegar, clear soda-pop, baking soda, black tea, antacid, ammonia, detergents, stream water


Procedure:

1. Cutouts of some shape, it can be a bunny, a flower, a house...from the filter paper or coffee filters or 22# or higher paper.
2. Preparation of the pH indicator: (Best if prepared the same day as used)
 - a. Grate (as you would for coleslaw), about half a head of cabbage and place into a bowl and add about 1/2 cup of water, make sure the cabbage is covered (warm/hot water works best).
 - b. Mix the solution. It should be a dark purple color.
 - c. Strain the juice through a kitchen strainer.
3. Dip the cutouts into the juice for about 20 seconds and allow to dry, you can use a hair dryer if necessary.
4. Place each of the household products into a reusable cup and place a dropper in each.
5. Label sections of your cutout with the name of each household product you plan to use.
6. Place 2-3 drops onto each labeled section of the paper.
7. The end product should be a very colorful design.
8. Determine the color of each pH by using the scale below and your design.
9. Determine the pH of the stream water by comparing the color of it's section to the other sections.

ACID						NEUTRAL	BASE						
pH 1	pH 2	pH 3	pH 4	pH 5	pH 6	pH 7	pH 8	pH 9	pH 10	pH 11	pH 12	pH 13	pH 14
	Stomach Acid/ Lemon Juice	Apple Juice/ Vinegar	Tomato Juice	Black Coffee	Milk	Pure Water	Baking Soda	Antacid	Hand Soap	Ammonia			Lye



Can You Find The Mine Drainage?

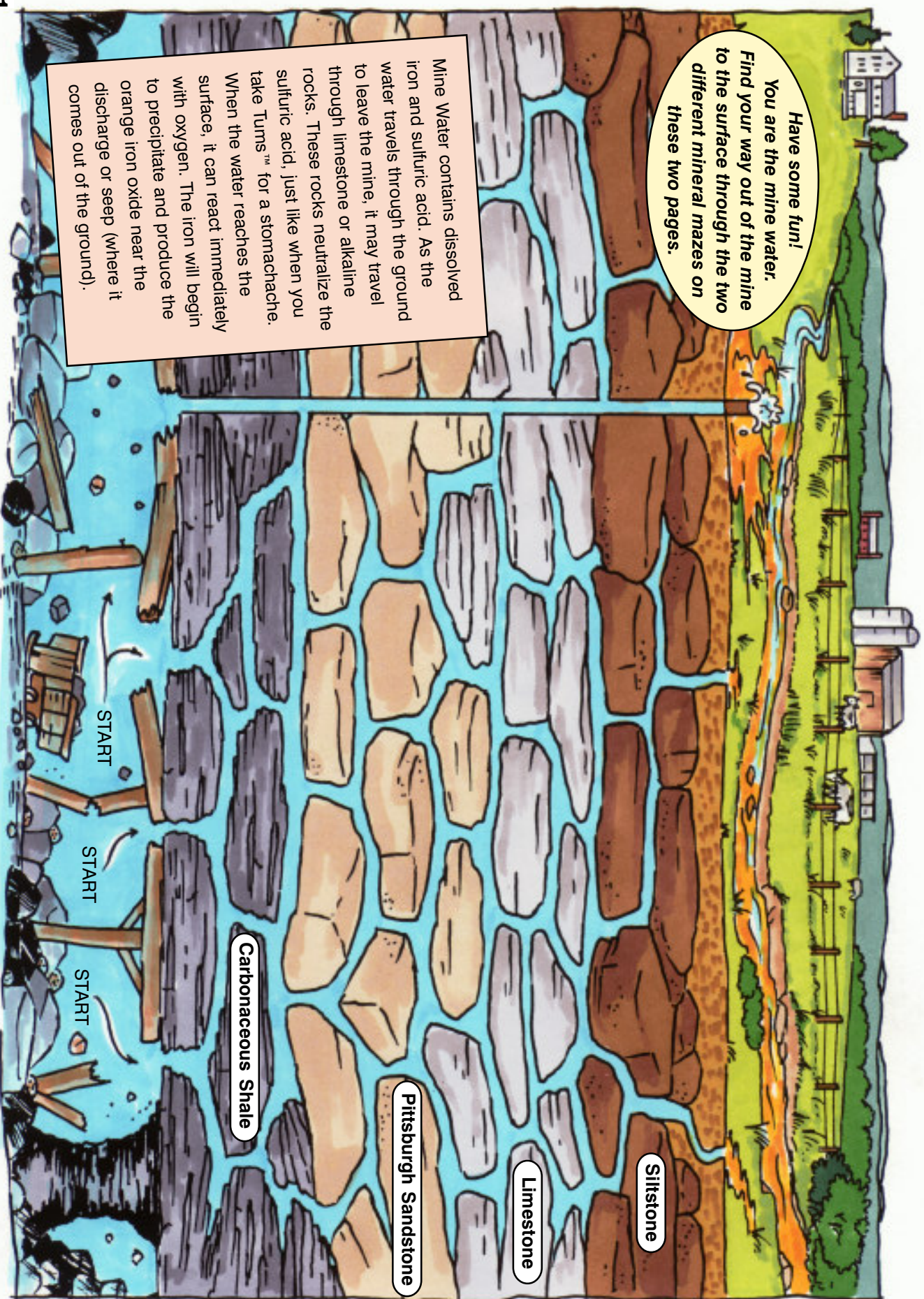
Hint: Where is Pyrite Hiding?  Circle all the places you find him in the picture above.

When the pyrite in a mine is dissolved by groundwater, iron and sulfuric acid are produced...

What happens to contaminated water

Have some fun!
You are the mine water.
Find your way out of the mine
to the surface through the two
different mineral mazes on
these two pages.

Mine Water contains dissolved iron and sulfuric acid. As the water travels through the ground to leave the mine, it may travel through limestone or alkaline rocks. These rocks neutralize the sulfuric acid, just like when you take Turns™ for a stomachache. When the water reaches the surface, it can react immediately with oxygen. The iron will begin to precipitate and produce the orange iron oxide near the discharge or seep (where it comes out of the ground).



Siltstone

Limestone

Pittsburgh Sandstone

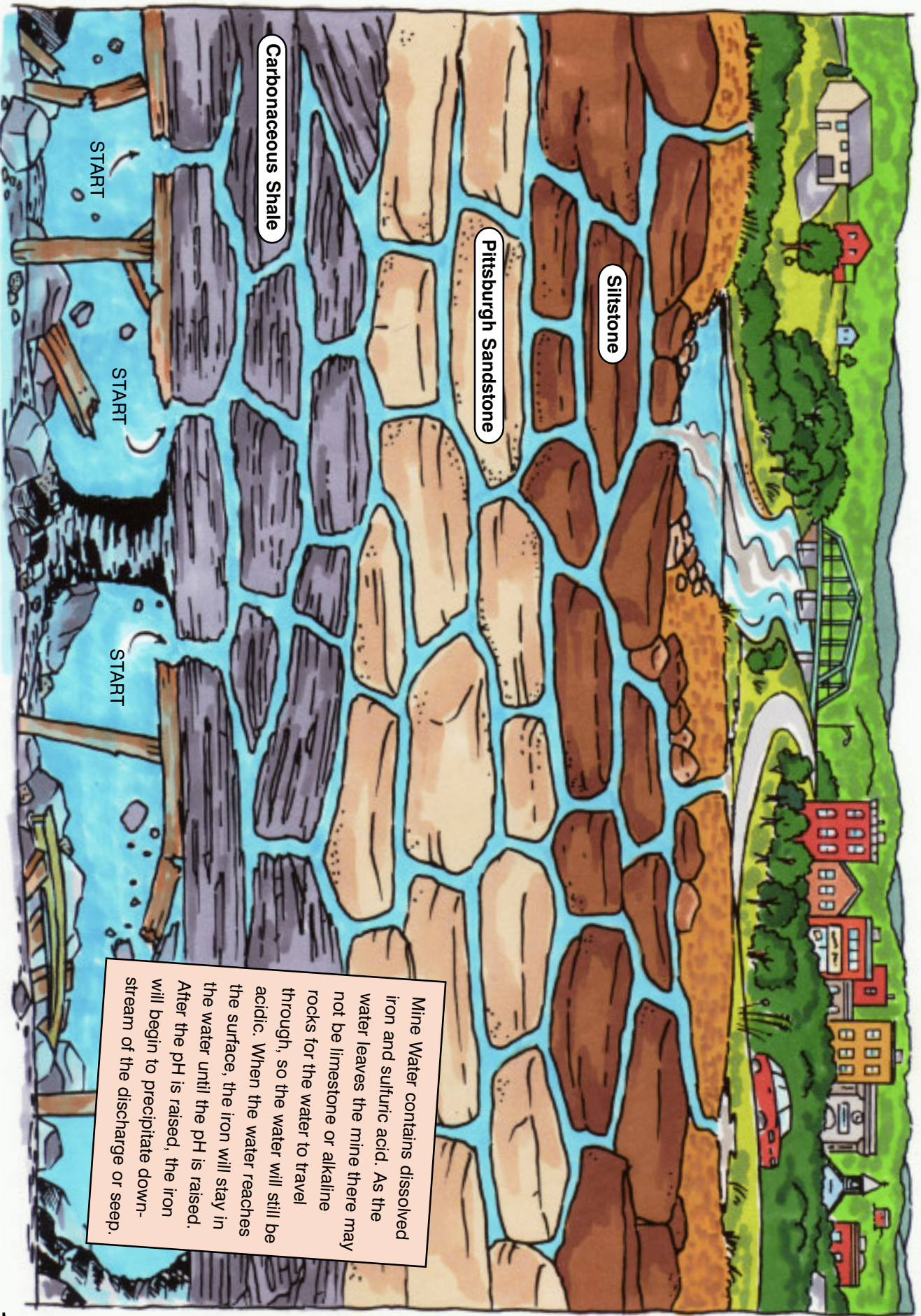
Carbonaceous Shale

START

START

START

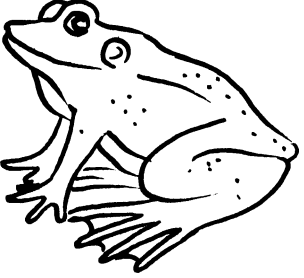
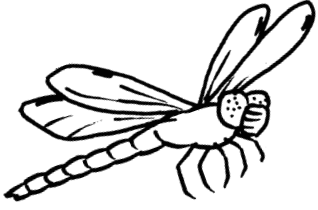
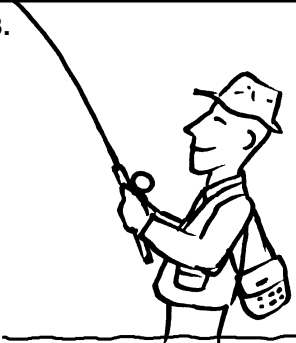
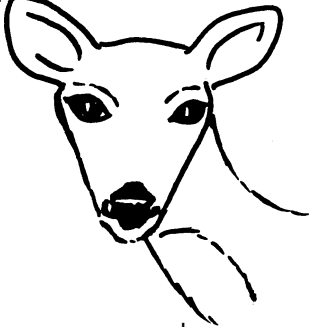

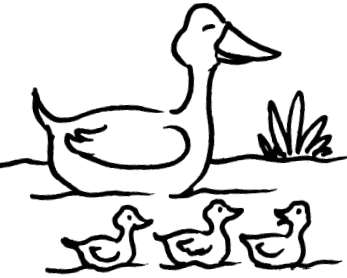



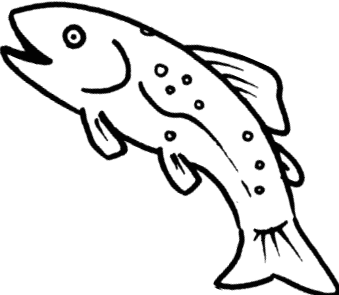


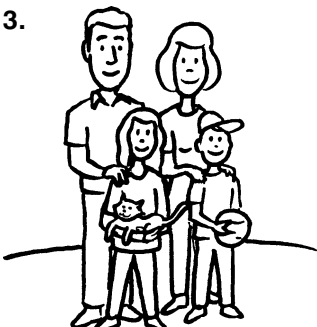

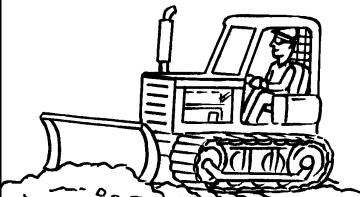
How does acid mine drainage get on its way out of an abandoned mine?

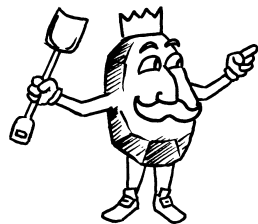


Mine Water contains dissolved iron and sulfuric acid. As the water leaves the mine there may not be limestone or alkaline rocks for the water to travel through, so the water will still be acidic. When the water reaches the surface, the iron will stay in the water until the pH is raised. After the pH is raised, the iron will begin to precipitate down-stream of the discharge or seep.

Who Does AMD Effect?

Unscramble the words and color the pictures!

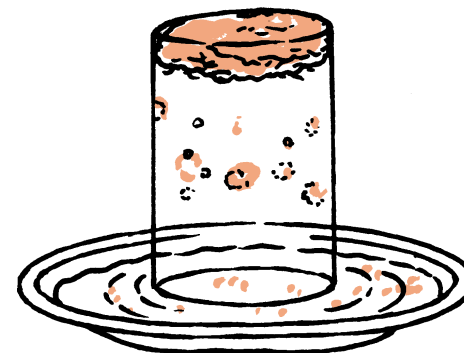
<p>1.</p>  <p>hainmpbai -----</p>	<p>2.</p>  <p>rgadnolyf -----</p>	<p>3.</p>  <p>emransifh -----</p>	<p>4.</p>  <p>eerd -----</p>	<p>5.</p>  <p>nedrlich -----</p>
<p>6.</p>  <p>afertwlow -----</p>	<p>7.</p>  <p>krowsre -----</p>	<p>8.</p>  <p>mmitiocunse -----</p>	<p>9.</p>  <p>kkyarsea -----</p>	<p>10.</p>  <p>hsif -----</p>
<p>11.</p>  <p>tesnisc -----</p>	<p>12.</p>  <p>spltan -----</p>	<p>13.</p>  <p>ileimfsa -----</p>	<p>14.</p>  <p>mimrewss -----</p>	<p>15.</p>  <p>diuerbsl -----</p>



Do The AMD Word Search

Can you find the hidden words in the puzzle?

abandoned	environment	mining	stream
acidic	foodchain	orange	sulfur
algae	groundwater	oxygen	treatment
alkaline	iron	plants	water
aluminum	limestone	pyrite	watershed
animals	manganese	seep	wetland
borehole	miner	slippery	
coal	minerals	sludge	



Make Your Own Rust!

Create a chemical reaction with oxygen and iron.
See what happens!

Here's what you need:

- A piece of steel wool
- A clean jar
- Water
- A saucer

Here's what you do:

1. Wet the steel wool.
Note: If you are using a steel-wool pad with soap on it, wash out the soap.
2. Push the steel wool into the bottom of the jar.
3. Turn the jar upside down and place onto the saucer.
4. Fill the saucer with water.
5. Set the saucer in a safe place where no one will disturb it. From day to day, check the experiment. As the water evaporates from the saucer, replace it with more water.
6. Notice changes in the steel wool. Also notice changes happening inside the jar. If you see something red forming on the steel wool and water droplets forming inside the jar, your experiment has worked.

Here's how you helped create the chemical change:

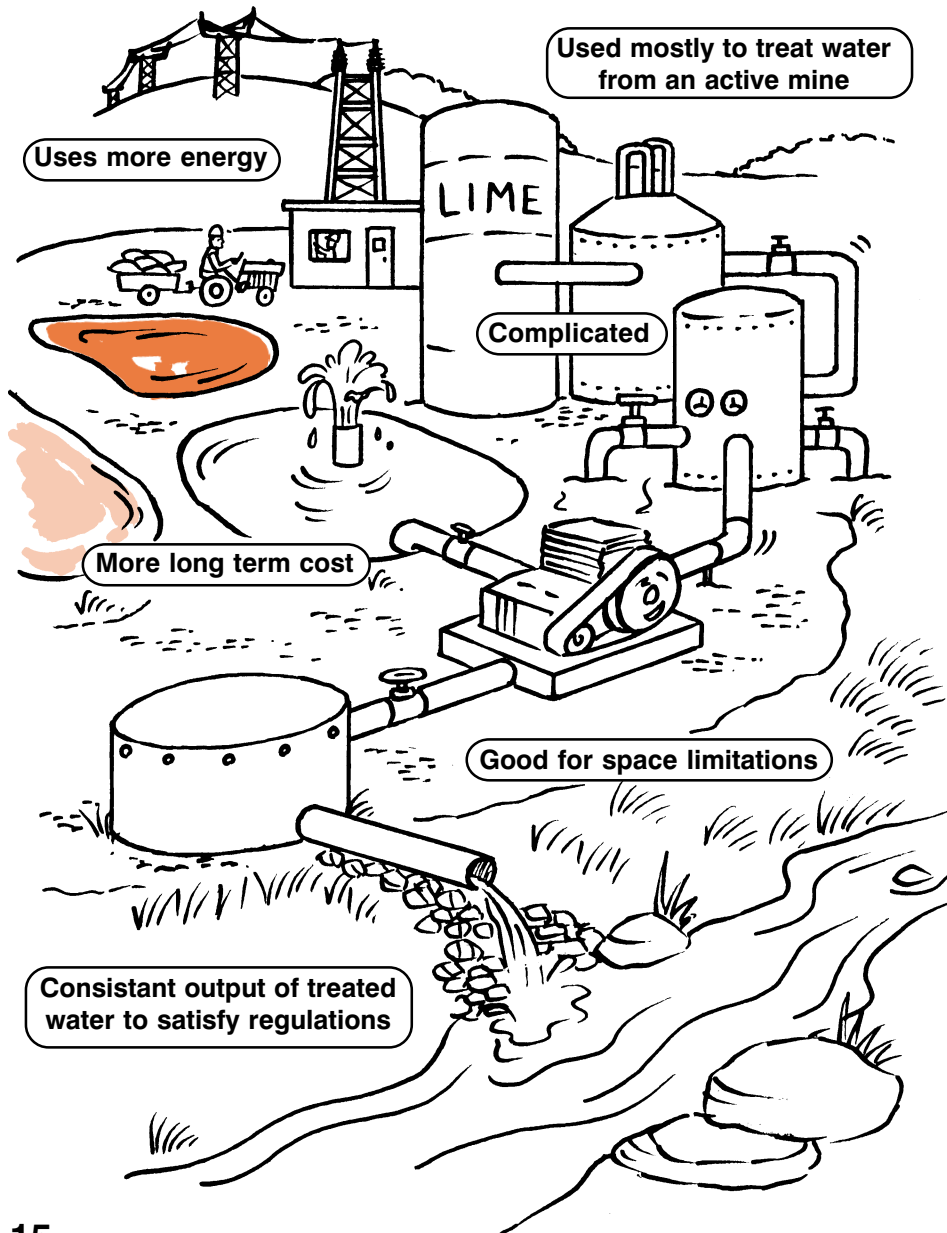
The iron in the steel wool combines with the oxygen inside the jar. As the oxygen leaves the air inside the jar, water rises into the jar to replace the oxygen. When iron unites with oxygen, the result is a new, rustlike substance, ferric oxide. (Ferric refers to iron. Oxide refers to oxygen.)*

R O U J J S T M Q P F U T E F R Z A F A
 N E X Y T W P P I N P H T L R K C K C N
 U F T N W A J G F N L D R O Q T L I K E
 V E A A G N I N I M N E E H G R D Q J G
 E L G Z W C O A L I S N A E U I O A S Y
 P D S N B D S L A S T O T R C G P L W X
 I V I L A P N H T A R D M O E D A A O O
 G R P X U R C U W X E N E B A R T Y W X
 K G O A O D O L O V A A N D E E G N P T
 V T M N O M G V J R M B T N R E A G L A
 T R B O V L A E T M G A I S P Y R I T E
 O C F H Q D T N J M H M H A V C M Z S R
 E N I L A K L A G V U E C S N P J U Q E
 L I M E S T O N E A D N C C I I L M W N
 F Q B M F Z D C W X N S I A V F M R E I
 S L I P P E R Y X E E E R M U U E A T M
 P B S M G F F Q F G Q E S R U T B G L P
 T N E M N O R I V N E P G E A L E A A S
 G W C H P P R O Z F X X Y W N P A B N C
 F D T G P W E L Y G Y Q Y P D M I A D P

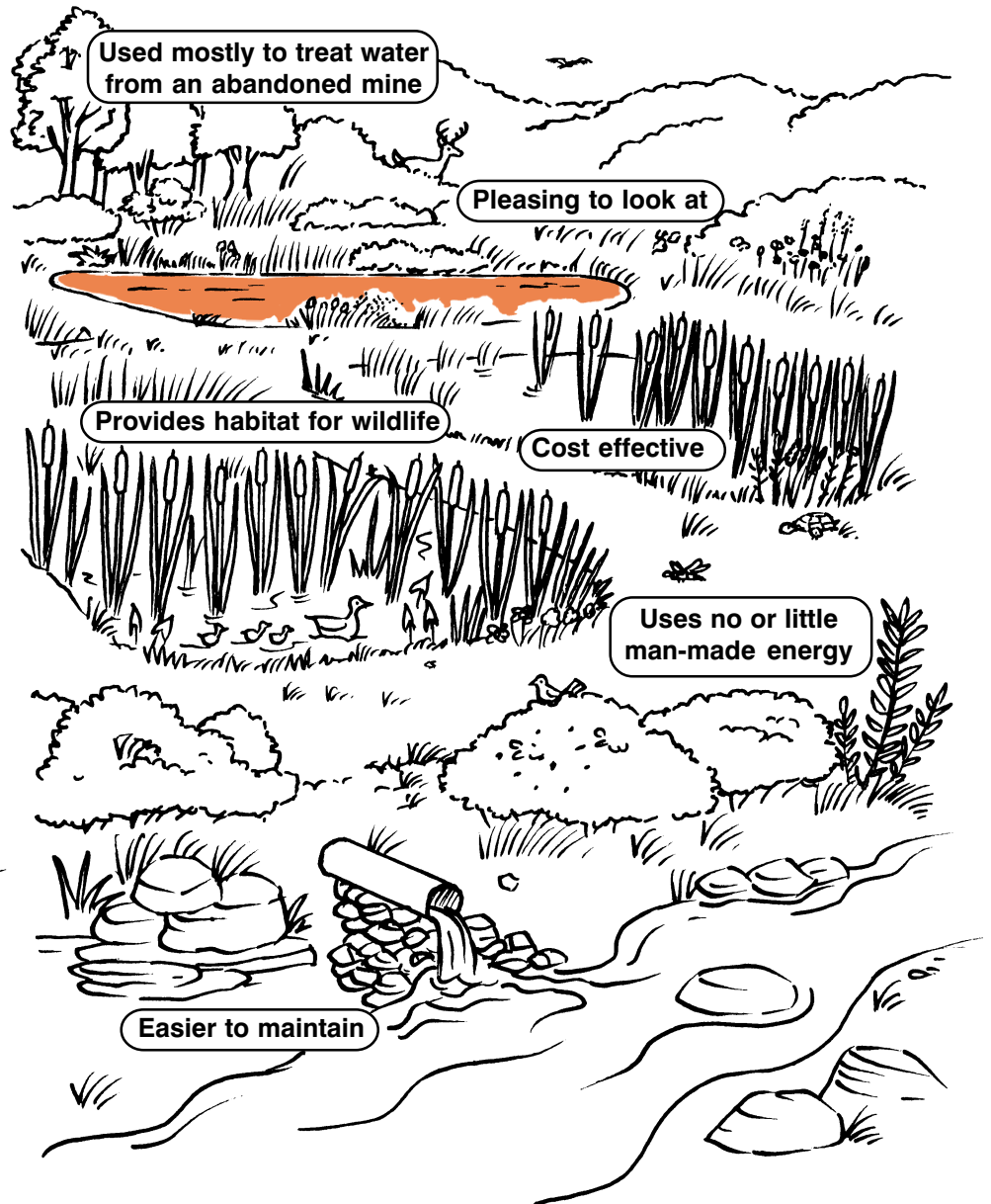
* Adapted from "Science Wizardry For Kids", Margaret Kenda and Phyllis S. Williams, 1992.

How Do We Clean It Up? Why Use Wetlands?

Active Chemical Treatment System

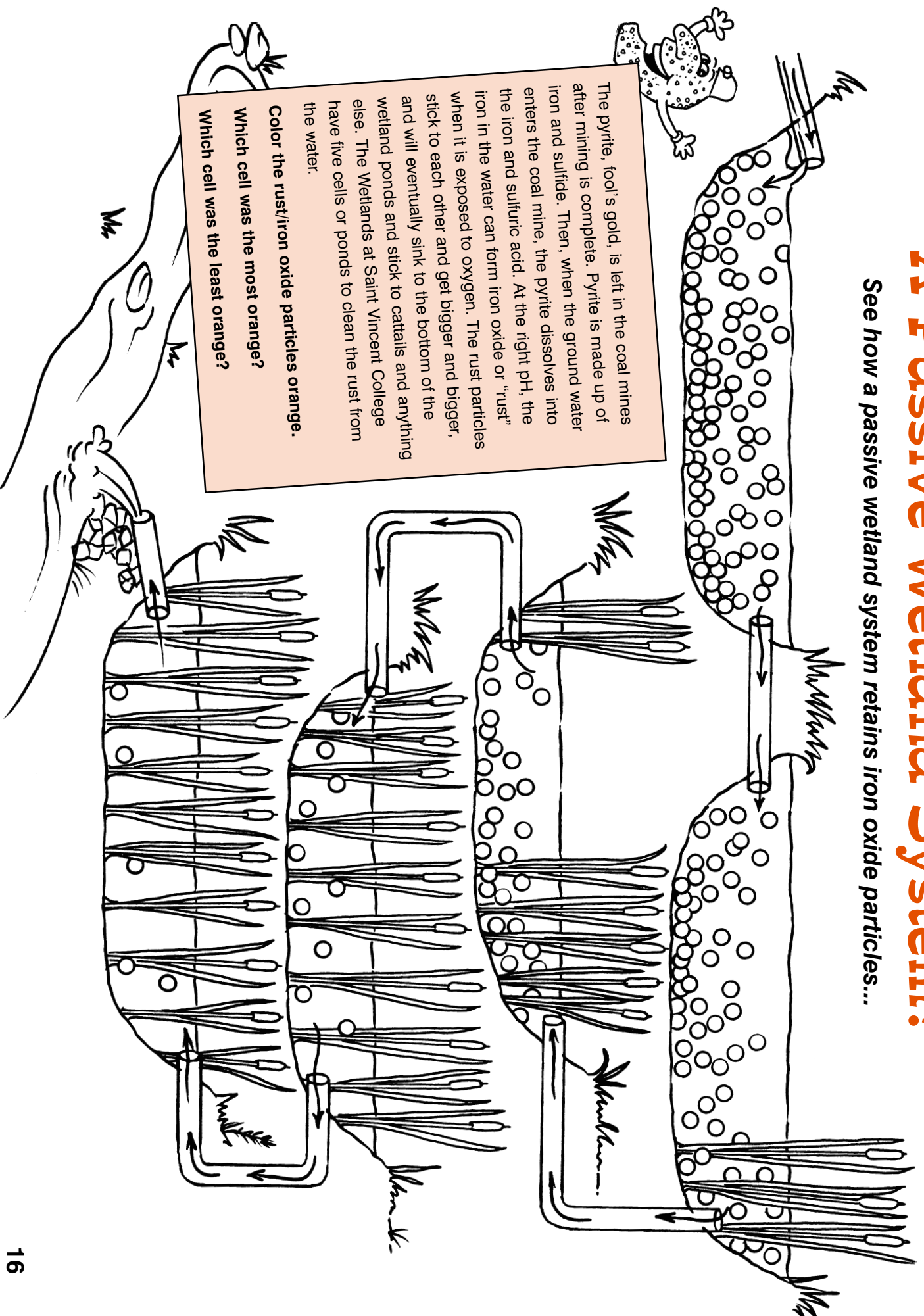


Passive Wetland Treatment System



What Happens To Iron Oxide In A Passive Wetland System?

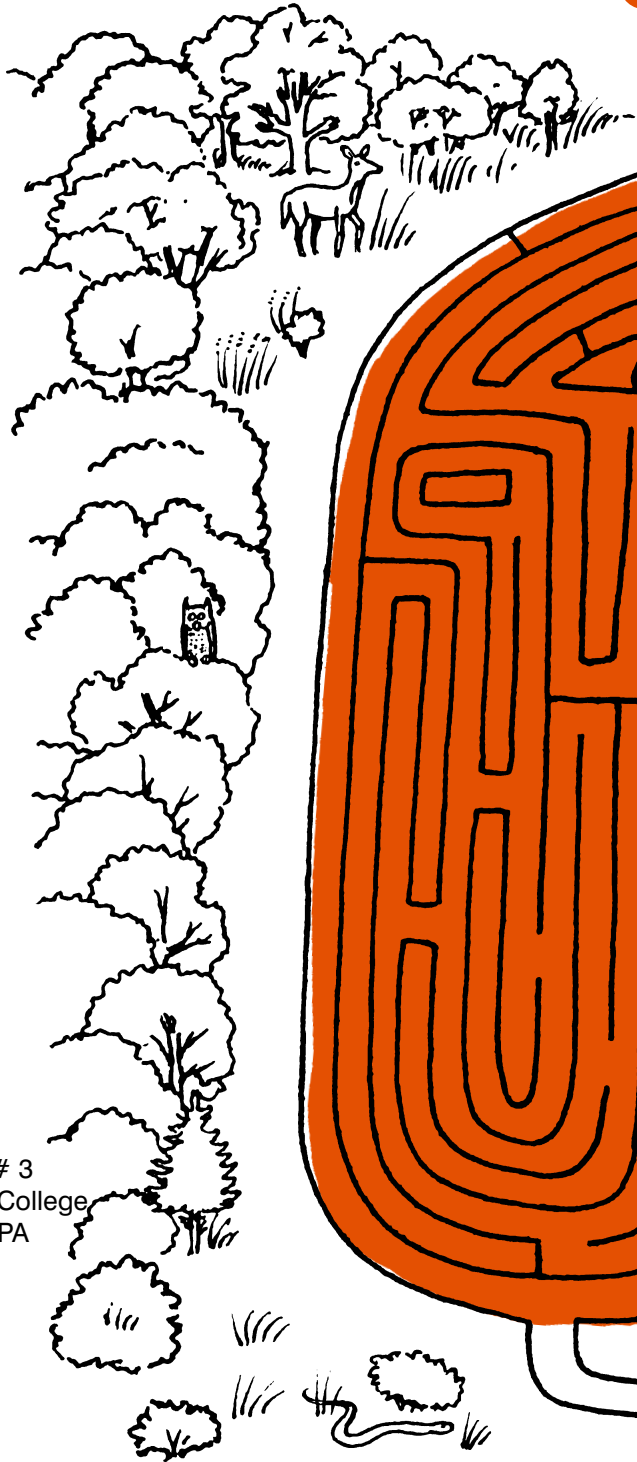
See how a passive wetland system retains iron oxide particles...



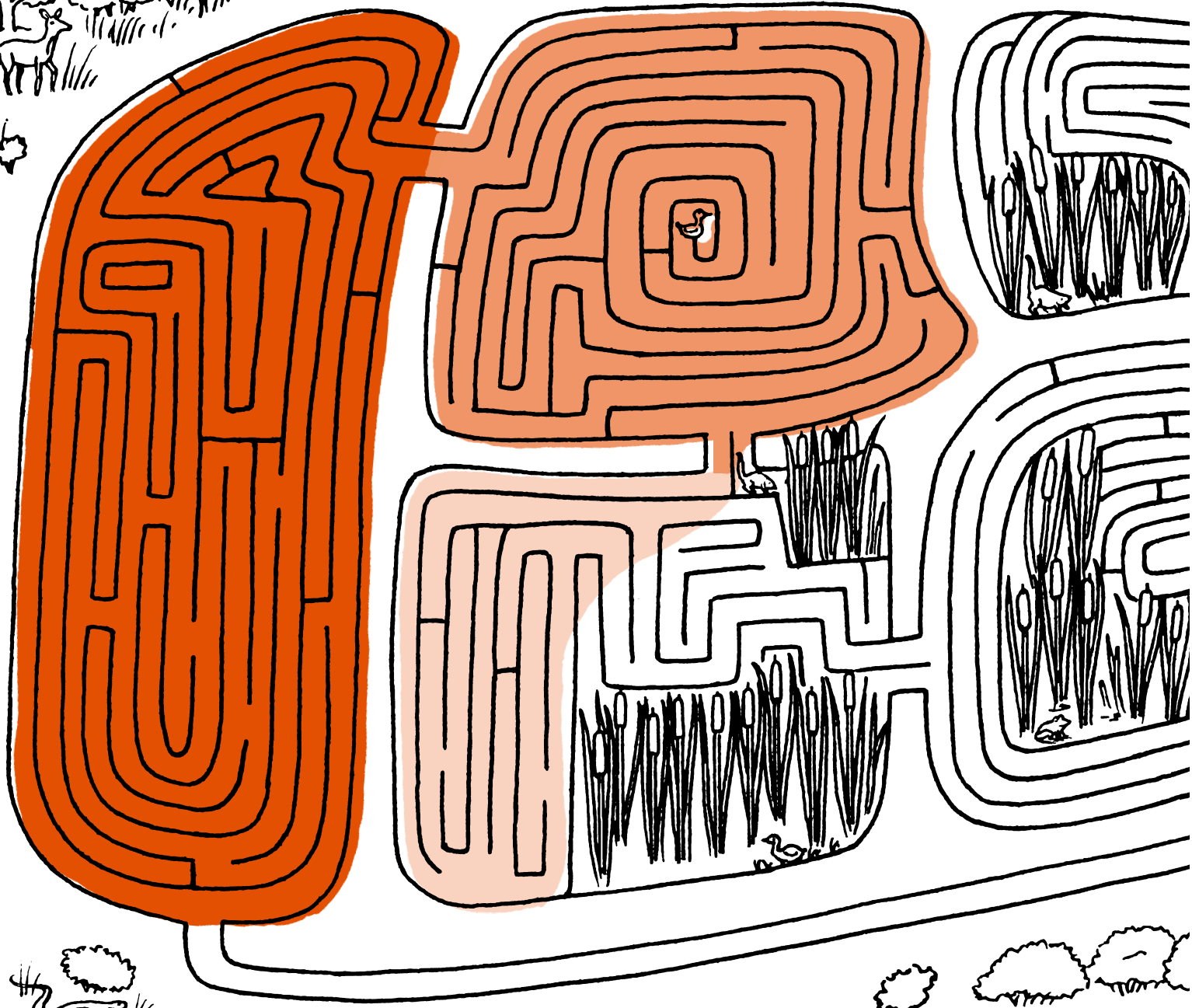
The pyrite, fool's gold, is left in the coal mines after mining is complete. Pyrite is made up of iron and sulfide. Then, when the ground water enters the coal mine, the pyrite dissolves into the iron and sulfuric acid. At the right pH, the iron in the water can form iron oxide or "rust" when it is exposed to oxygen. The rust particles stick to each other and get bigger and bigger, and will eventually sink to the bottom of the wetland ponds and stick to cattails and anything else. The Wetlands at Saint Vincent College have five cells or ponds to clean the rust from the water.

Color the rust/iron oxide particles orange.
Which cell was the most orange?
Which cell was the least orange?

Come Clean! Find Your Way T

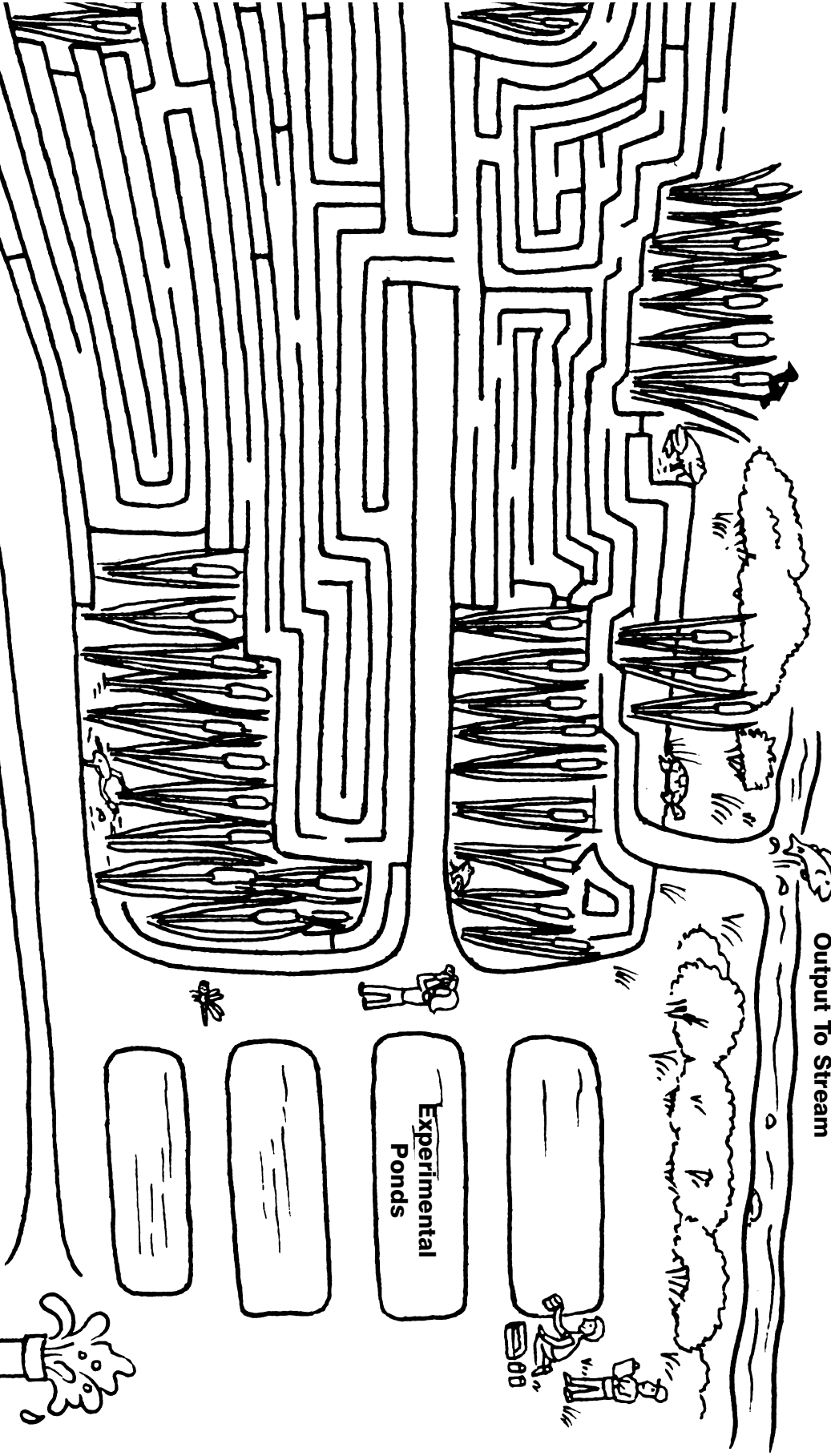


Wetland # 3
Saint Vincent College
Latrobe, PA



Wading Through The Wetland System!

Output To Stream



Start at "The Bubbler" and find your way through each wetland cell to reach the stream. Find and circle the hidden wetland animals.



"The Bubbler"
Start Here



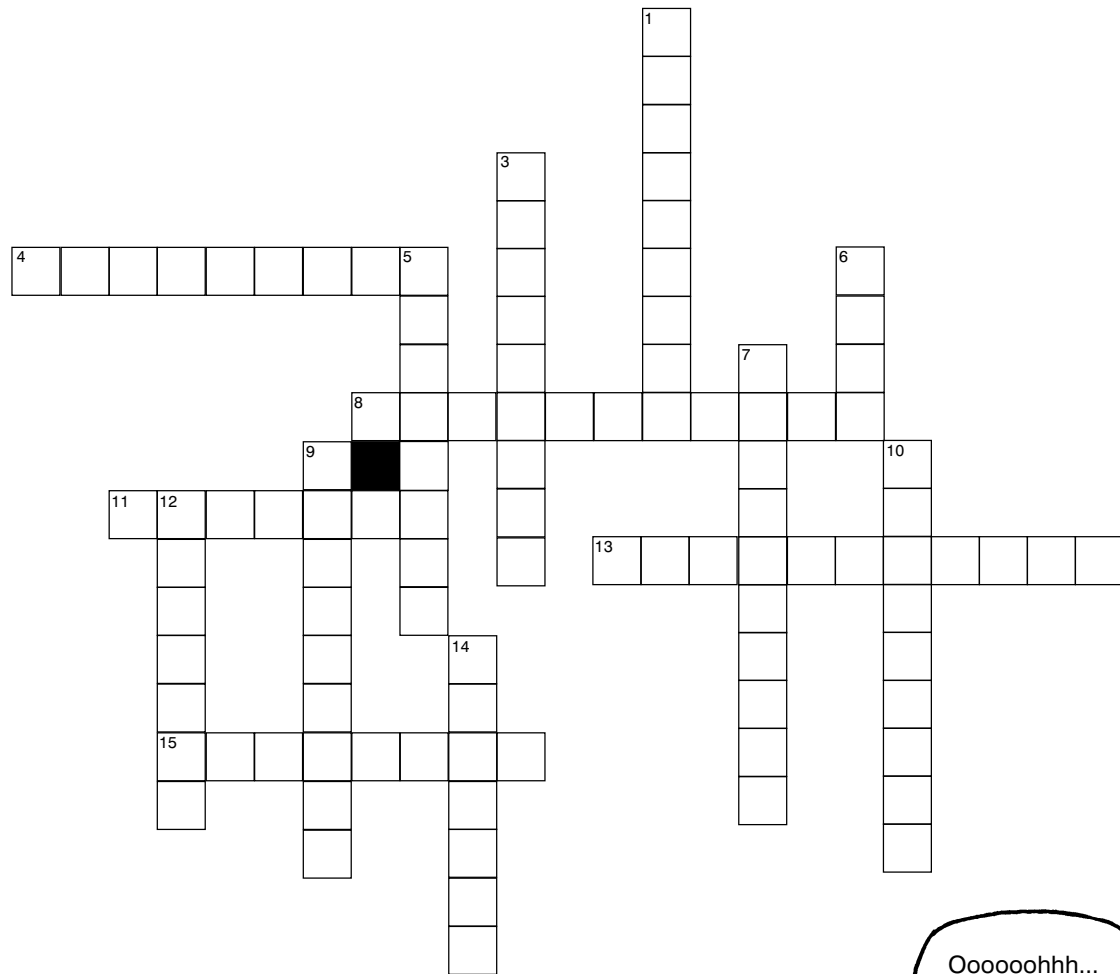
Who Helps Build AMD Wetlands?

Across

4. One who owns land.
8. People that provide funds for the continued support of an institution, project or activity.
11. One who attends classes at a school.
13. A scientist who studies the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.
15. A person who is trained to design and construct roadways, bridges and other structures.

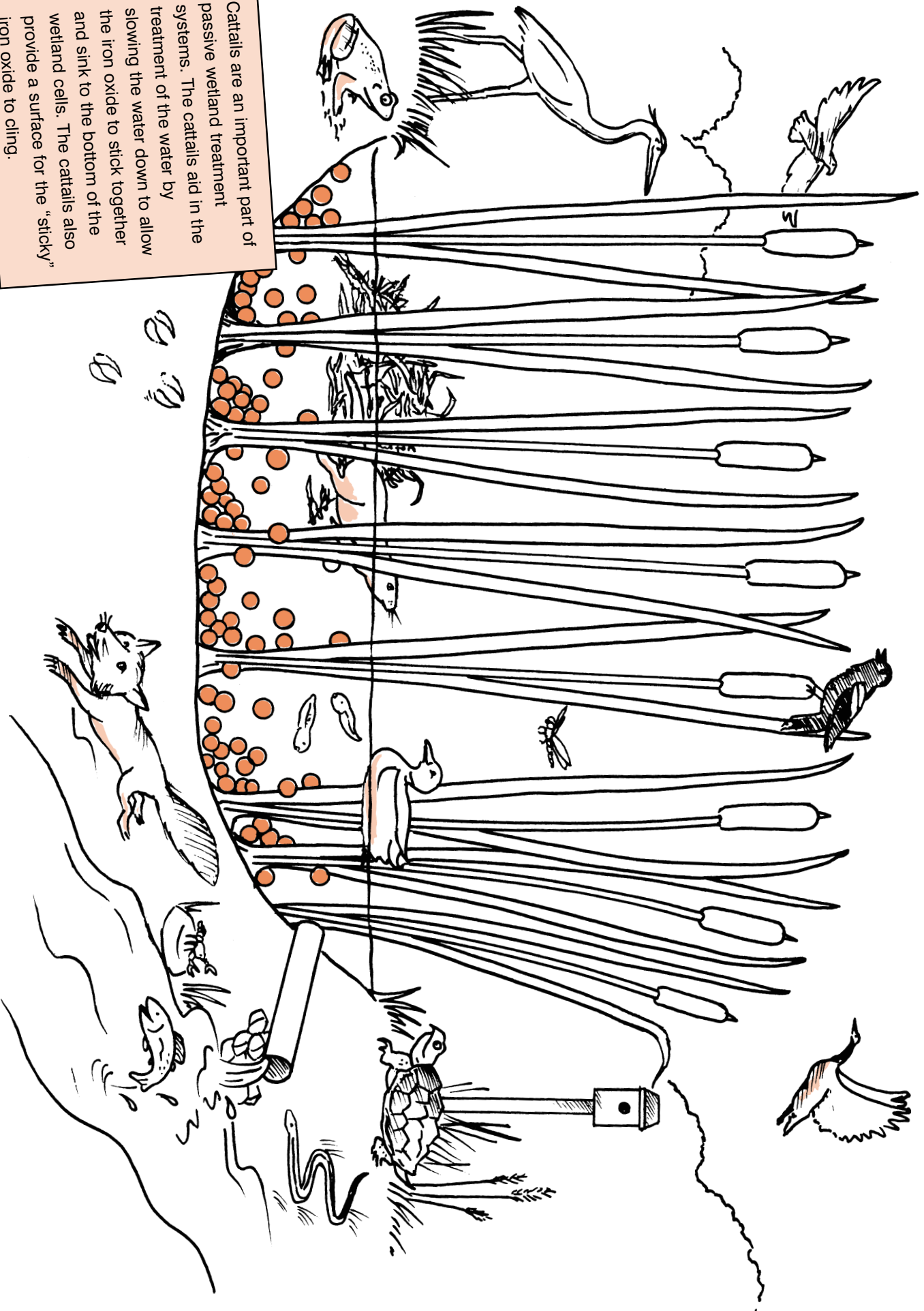
Down

1. A biologist who studies the relation between organisms and their environment.
3. A group of people living in the same locality and under the same government.
5. A writer, investigator, or presenter of news stories.
6. A set of rules or principles that protect the residents of the community, state and United States.
7. The agency through which a governing individual or body functions and exercises authority.
9. A scientist who studies the origin, history, and structure of the earth.
10. A scientist who studies living organisms.
12. A person who instructs or educates others.
14. A scientist specializing in chemistry.

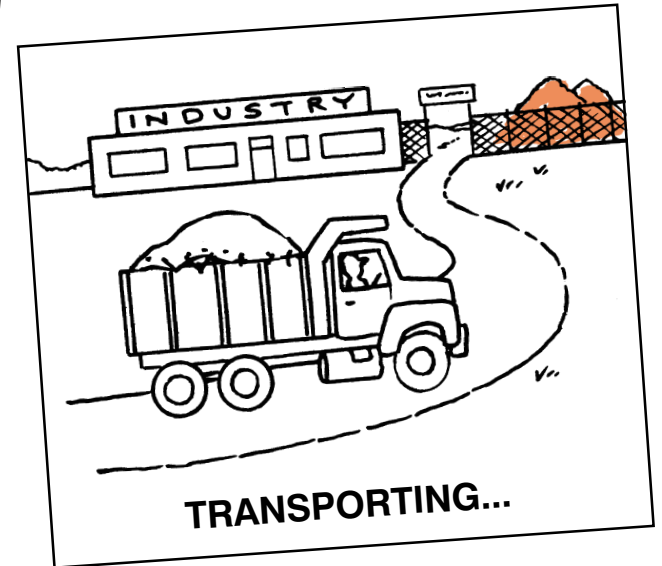
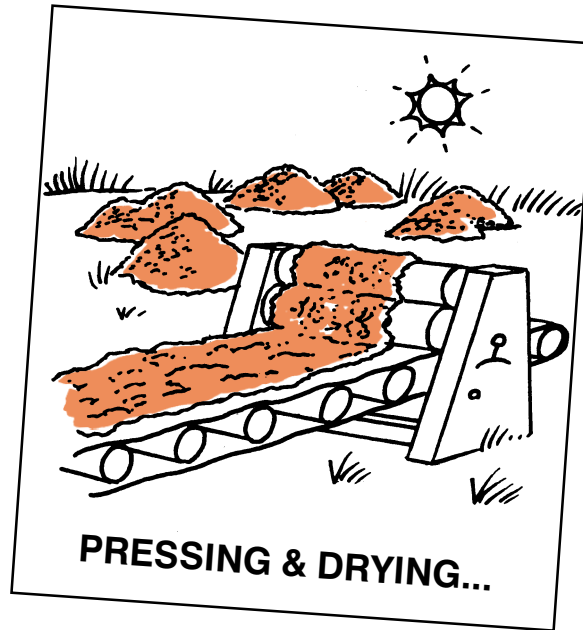
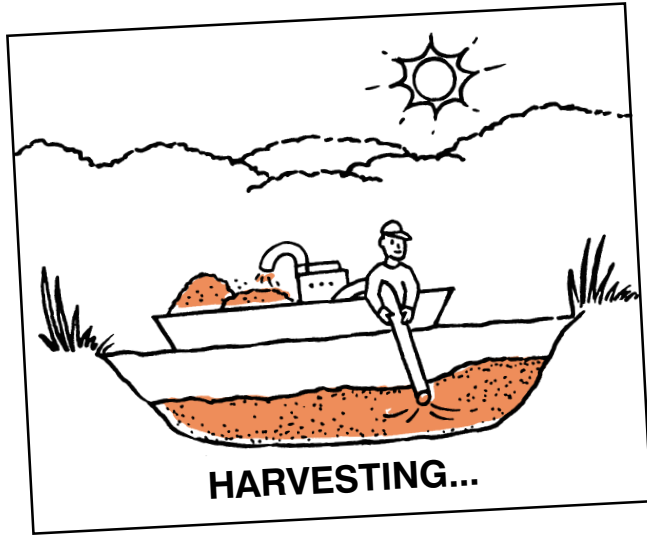


What Does A Cattail Do?

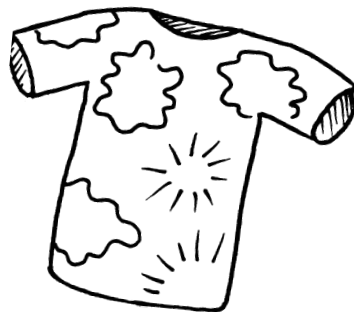
Cattails are an important part of passive wetland treatment systems. The cattails aid in the treatment of the water by slowing the water down to allow the iron oxide to stick together and sink to the bottom of the wetland cells. The cattails also provide a surface for the "sticky" iron oxide to cling.



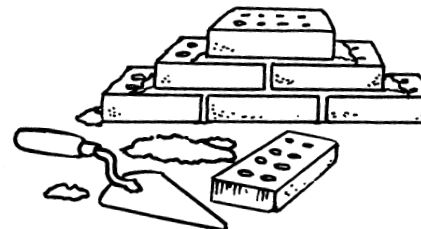
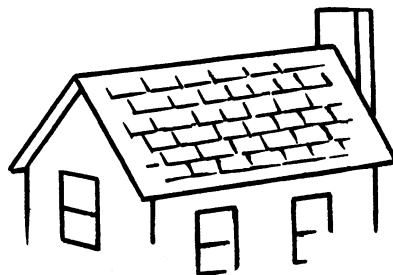
What Could Happen To The Iron Oxide That Settles In The Wetland?



Look at all the uses for iron oxide!



Look, we're recycling the pollution!



Splendid!



Word Bank

Alkaline - amounts of alkali or base in a solution; expressed in terms of pH.

AMD - abandoned mine drainage; water that exits an abandoned mine; two types Alkaline AMD, acidic AMD.

"The Bubbler" - man-made borehole through which water from inside the coal mine shoots out into the air.

Cattails - unique wetland plant; form a dense barrier to slow the flow of water and filter out some of the iron particles.

Chemical Precipitation - the formation of a solid from the mixing of two solutions.

Groundwater - water within the earth that may supply wells and springs.

Habitat - natural "home" of a plant or animal, where it normally grows or lives.

Iron Oxide - particles formed when oxygen reacts with iron in mine water; commonly called "rust".

Passive Wetland System - a constructed wetland that does not use pumps, motors, electricity, or chemicals to clean mine water.

pH - a measure of hydrogen ion concentration, or how much acid or base is in a solution.

Pyrite - iron disulfide; mineral found in coal deposits; when exposed to weathering, iron and acidity are released.

Survey

Name _____ Age _____

Address _____

City/State/Zip _____

Name of School _____

Where did you get this Activity Booklet?

School

Home

Other _____

Have you ever seen an orange colored stream?

Yes

No

Have you ever visited a passive wetland with mine water?

Yes

No

Where _____

What is the name of the metal that turns streams orange?

What plant can be used as a natural habitat and for cleaning mine water?

Name two products that use iron oxide.

Clip and Send

Please mail your survey to:

Saint Vincent College
c/o Environmental Education Center
300 Fraser Purchase Road
Latrobe, PA 15650

Answer Key

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Acidic (Red)

vinegar, lemons, orange juice, apple juice, tomato juice, bleach, pop, coffee, milk

Alkaline (Blue)

soap, Tums™, milk of magnesia, baking soda

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- | | | |
|--------------|----------------|--------------|
| 1) amphibian | 6) waterfowl | 11) insects |
| 2) dragonfly | 7) workers | 12) plants |
| 3) fisherman | 8) communities | 13) families |
| 4) deer | 9) kayakers | 14) swimmers |
| 5) children | 10) fish | 15) builders |

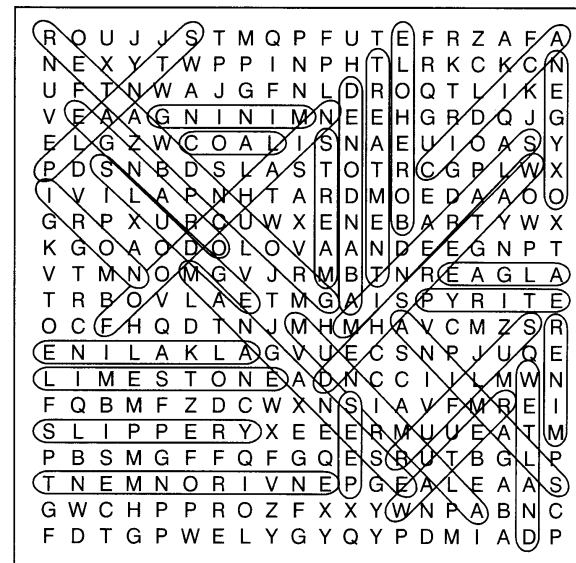
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Across

- | | | |
|-----------------|---------------|---------------|
| 4) landowner | 1) ecologist | 9) geologist |
| 8) foundations | 3) community | 10) biologist |
| 11) student | 5) reporter | 12) teacher |
| 13) hydrologist | 6) laws | 14) chemist |
| 15) engineer | 7) government | |

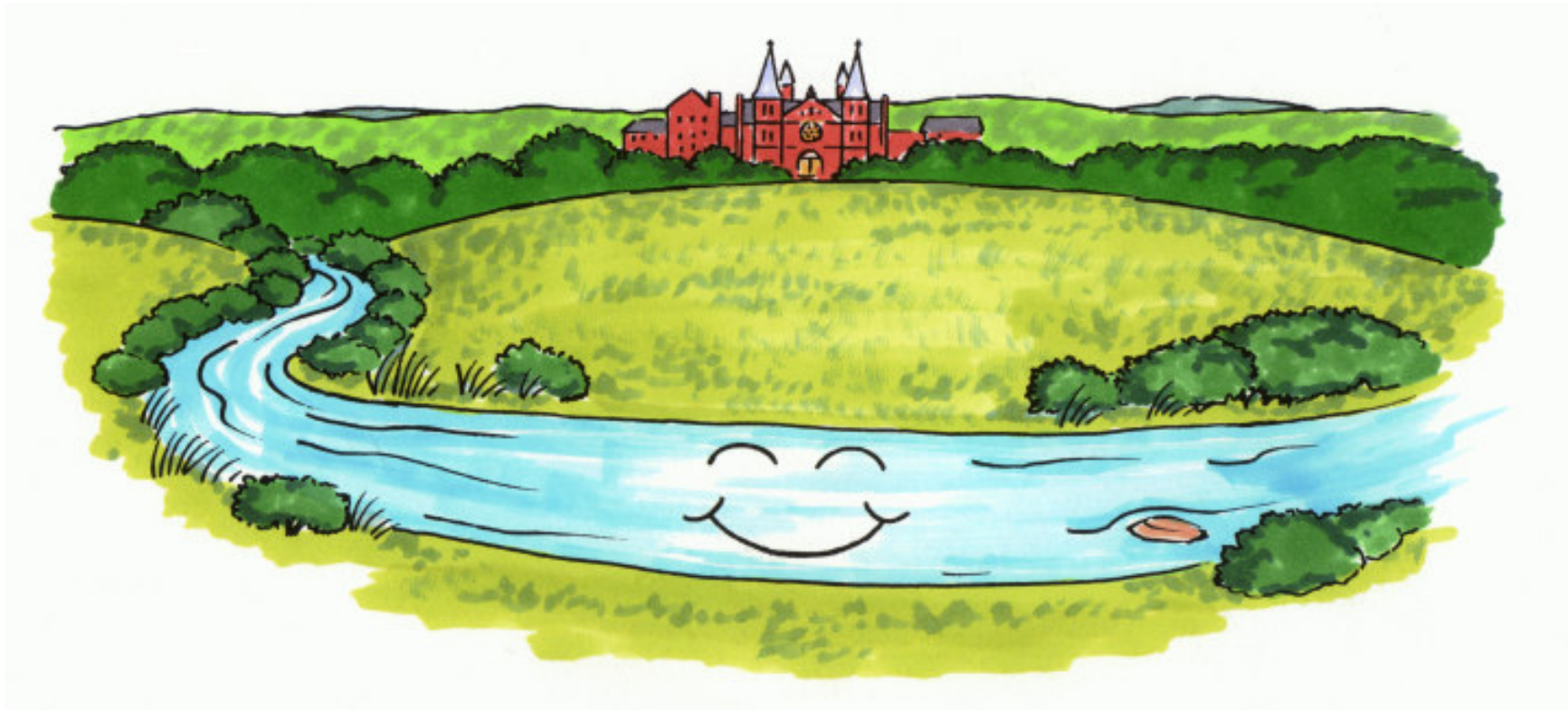
Down

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Everyone Enjoys A Clean Stream!

People throughout Appalachia are working together for the environment using wetlands to provide clean, healthy streams for the future.



For More Information:

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724-532-6600

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