Water for People and the Environment

Water is important for people, but water is also essential for a healthy environment and the organisms that live there. How much water we have for the future will depend on what we do to conserve water today.

Chapter 14

Grade Levels/Courses

6th, 7th, 8th, Aquatic Science, Environmental Science

Chapter Objectives

Students will:

1. Become familiar with some of the history of water laws in Texas.
2. Identify ways *Prior Appropriation* and *Riparian Law* can work for or against the environment.
3. Brainstorm ideas for meeting the need for water for people and the environment.
4. Read the chapter and answer the questions
5. Explain how the *Clean Water Act* regulates point source pollution.
6. Differentiate between point source pollution and non-point source pollution.
7. Generate a list of ways that they can help manage water use at home, at school, and in their community.
8. Use a model to investigate how point source pollution affects a watershed.
9. Investigate how non-point source pollution affects a watershed.
10. Investigate human impact on water.
11. Identify laws or regulatory entities responsible for controlling pollution.
12. Discuss cost/benefits of controlling pollution or "going green."
13. Diagram a watershed and label parts and tell who owns the water and the law or entity that regulates the use of the water.
14. Take part in a game to model the progression of water consumption by humans.
15. Research water conservation or aquatic organism conservation organizations.
16. Present information on one organization that they think the class could help with their conservation efforts.
17. Make a persuasive talk and create a visual or electronic product to help them describe the water conservation organization they wish to support.

18. Work as a class to choose one organization and participate in a project to aid that organization in water conservation.
19. Publicize their project through local media. (Optional)
20. Make an individual commitment to be responsible in specific ways to take part in water conservation.

TEKS

6.2 C; 6.3 B, C; 6.12 E; 7.2 C; 7.3 B, C; 7.8 C; 8.2 C; 8.3 B, C; 8.11 C

Aquatic Science: 2 H, J; 7 A, B; 12 A, B, D, E

Environmental Science: 2 I, K; 5 B, C; 9 A, E, F, J, K

Materials Needed

Lesson 14.1

3 large pieces of butcher paper for each group of 4 students

Markers

Lesson 14.2

1 copy of *Instructions for Student Groups* to cut apart

Science journals

Pencils/pens

Lesson 14.3

For each group of 4 students

1 Rectangular container, such as a cookie sheet, or disposable metal baking pan, or large plastic storage container

Two sheets newspaper

White garbage bag

Spray bottle

Water

Cocoa powder, orange or red colored drink powder, chocolate cake sprinkles, and colorful cake sprinkles (about two tablespoons of each)

Colored pencils

Lesson 14.4

Water for our Village Game

5-gallon bucket,

A large area outside

About 6 of each size cups: tiny cups (2 oz. cup), small cups (8 oz. size), standard 12 oz. drinking cups, large 24 oz. cups

Water

6-two quart pitchers (1 for each group of 4 students)

Internet connection

Computer

Science journals

Pencils/pens

Vocabulary

- Clean Water Act
- Commitment
- Conservation
- Diffused surface water
- Environmental flow
- Groundwater
- Gulf of Mexico
- Headwaters
- Non-point source pollution
- Point source pollution
- Prior appropriation
- Riparian law
- River
- Spring
- Stakeholders
- Surface water
- Texas Commission on Environmental Quality
- Texas State Soil and Water Conservation Board
- Volunteer
- Watershed action planning committee

Enrichments

Project Wild Aquatic

- Silt A Dirty Word
- Dam Design
- Kelp Help

- Dragonfly Pond
- When is a Whale Right?
- Sea Turtles International

Project Learning Tree

- Publicize It!

Video

- *Texas the State of Water: Vol. II. Finding a Balance* by Texas Parks and Wildlife Department. Contains the following short programs:
  - Dealing with Drought–How Corpus Christi is working on water for the future
  - Prescription to Burn–Fire as a tool for managing and restoring natural areas
  - Diggin' School–Constructing a "Wildscape" at school
  - Forests of the River Bottom–Flooding cycles in bottomland hardwood forests
- *Texas the State of Water: Vol. I*. by Texas Parks and Wildlife Department

  Raises awareness of the variety of complex demands on aquifers, rivers and bays of Texas, interconnected ecosystems and the role of each in overall ecological health of our state.

Lesson 14.1: Who Owns the Water?

Essential Concept

Texas is unique in its laws about who owns the water. These laws come from merging legal systems from our diverse history.

Objectives

1. Students will become familiar with some of the history of water laws in Texas.
2. Students will identify ways *Prior Appropriation* and *Riparian Law* can work for or against the environment.
3. Students will brainstorm ideas for meeting the need for water for people and the environment.

TEKS

6.2 C; 7.2 C; 8.2 C

Aquatic Science: 2 J

Environmental Science: 2 K

Estimated Time

1 class period

Materials

3 large pieces of butcher paper for each group of 4 students

Markers

Procedure

1. What's the Law?

Ask if there are any students who live on a farm or a ranch in the class. If so, have them tell where they get their water and ask if they know what the law says about who owns the water on or under their land.

Some students may get their water from wells and may know that they have the right to pump and capture groundwater under their land. Others may not know anything about where the water comes from that they have in their homes.

- **If you owned a ranch, with a pond, and a river that cut through your property, would you get to use your pond water?**
- **Would you get to use the river water?**

2. Prior Appropriation

- **What do you think the idea of "prior appropriation" means?** *(Prior* means before and *appropriation* means to set aside) Water that is set aside before others has priority on the supply of water.
- **What do you think this has to do with Texas water?** (It means that whoever got permits from the government to use the water first has the rights to the water.)

For example: A pecan farm and a power plant may both have permits for water out of a river nearby. They don't have to be located on the river to have these permits. The pecan farm has had their permit for 30 years. The power plant has had their permit for 3 years. The pecan farm has the rights to use the water first. If there is water left, then the power plant can have the right to use the water.

Our water laws come from different countries. *Prior appropriation* is from Spanish Law when Texas was a part of Mexico and ruled by Spain.

3. Riparian Law

- **What do you think "riparian law" means?** (Riparian areas are the places with plants along steams so it has to do with laws governing stream water ownership.)
- **What do you think this has to do with Texas water?** (This law gives people who own land with a stream running through it the right to use the water from the stream.)

For example: If the Colorado river runs next to your back yard, you have the right to pump water out of it for your garden. You don't have to get a special permit.

Riparian law comes from our English background. It is an English law that reflects the conditions in England that allows people to take water from nearby streams. England has many streams and water is plentiful.

In Texas we have merged these two systems into a "dual doctrine", which recognizes both riparian and prior appropriation rights. The water in streams and rivers is owned by the state. The water is allocated to people by the state as a water right assigned through a permitting system of prior appropriation.

4. Who Takes Care of Nature?

Give students 3 large pieces of butcher paper to make notes of their ideas. Ask students to work in groups of 4 and brainstorm how they think these laws might work for or against the environment and the needs for water and aquatic life.

1) On one sheet of paper make a T diagram for *Prior Appropriation* with *For the Environment* on one side and *Against the Environment* on the other side.
2) On another sheet of paper make another T diagram for *Riparian Law* in the same manner.

For Example: Ways that Prior Appropriation works **For** the environment might include that water could be left in the stream to run undisturbed. Ways that Prior Appropriations Works **Against** the environment might include water could all be used up by the first person with a right to the water, or water may be polluted by the use made of the water by

the first person with a right to the water, or the first person with a right to the water might dam the stream and keep the water on his property.

Ways that Riparian Law works **For** the environment might include that water could be left in the stream to run undisturbed. Ways that Riparian Law works **Against** the environment might include water could all be used up by the owner of the property, or water may be polluted by the use made of the water, or the owner might dam the stream and keep the water on his property

3) On the third sheet of paper answer the following questions from your experience in doing the aquatic ecosystems activities this year.

- **What are some of the needs of people for water?**
- **What are some of the needs for water in our aquatic ecosystems?**
- **How would you prioritize water use in your area?**
- **How can we meet the needs of homes, farms, ranches, cities, towns, industries, aquatic organisms, wildlife, and plants for water every day?**

5. Sharing Ideas

Have each group share their ideas with the class and post their work where everyone can see it. Take a few minutes to think about the ideas that were shared.

- **What is similar about what the groups generated?**
- **What was different?**
- **How is the need for water in the environment taken into account with the allocation of water under these systems?** Student should come away understanding that there are no guarantees that there will be water for the environment under these systems.

Vocabulary

- Prior appropriation
- Riparian law

Lesson 14.2: Reading and Research

Essential Concept

Texas has limited water resources, which must be shared among cities, towns, farms, ranches, homes, industries, and the environment. In order to meet all of these needs, we must conserve water in every way possible.

Objectives

1. Students will read the chapter and answer the questions.
2. Students will explain how the *Clean Water Act* regulates point source pollution.
3. Students will differentiate between point source pollution and non-point source pollution.
4. Students will generate a list of ways that they can help manage water use at home, at school, and in their community.
5. Students will synthesize what they have learned to create a public service announcement to make people aware of the importance of managing water use to conserve water.

TEKS

6.2 C; 6.12 E; 7.2 C; 8.2 C; 8.11 C

Aquatic Science: 2 J; 12 A, B, D, E

Environmental Science: 2 K; 9 A, E, F, J, K

Estimated Time

1 class period

Materials

1 copy of *Instructions for Student Groups* to cut apart

Science journals

Pencils/pens

Procedure

1. Jigsaw

Put students in 7 groups. Give out slips with instructions for each group. (See *Instructions for Student Groups* at the end of the lesson) Ask each group to read the chapter in the *Student Guide* together and find the answer to their question. **All students should read the first two paragraphs.** When all groups are finished reading and answering the

question, each group will teach their section of the chapter to the class and share the answer to their question.

Group 1 answers question 1. What is the purpose of the *Clean Water Act*? What kind of water pollution is it intended to prevent? Why does the Act not stop all water pollution?

This group needs to read the first three paragraphs under "Clean water–it's the law!". (3 paragraphs)

Group 2 answers question 2. What is watershed action planning? What should people where you live consider when conducting watershed action planning?

This group needs to read the section starting with paragraph three under "Clean water–it's the law!" and going down to the section that is "Texas water law". (4 paragraphs)

Group 3 answers question 3. In Texas, who "owns" surface water? Who "owns" groundwater? Since all water is connected, why do we have different systems of regulation?

This group needs to read the section on "Texas water law" and "Classes of water allocation" and the first paragraph under "Natural Surface Water". They also need to read the first paragraph under "Groundwater". (8 paragraphs)

Group 4 answers question 4. What is a "water right?" What are the impacts of prior allocation?

This group needs to read "Texas water law". Then start reading at the second paragraph under "Natural Surface Water" and read three paragraphs ending with "Groundwater". (8 paragraphs)

Group 5 answers question 5. What is "rule of capture?" What rights and responsibilities are associated with it?

The group needs to read the section on "Groundwater" over to "Water for the environment". (6 paragraphs)

Group 6 answers question 6. What are environmental flows? How are they obtained?

This group needs to read the section on "Water for the environment" over to the section on "Texas' Water Future". (6 paragraphs)

Group 7 answers question 7. What will influence Texas' water supply for the future?

This group should start reading with "Texas' Water Future?" and read to the end of the chapter. (6 paragraphs)

1) What is the purpose of the Clean Water Act? What kind of water pollution is it intended to prevent? Why does the Act not stop all water pollution?

In 1972 the U.S. Congress passed the *Federal Water Pollution Control Act,* best known as the ***Clean Water Act***. The goal of the Act is to make surface waters of the US fishable and swimmable.

The Act made it unlawful to release any **pollutant** from a **point source** into most major waters of the US without obtaining a permit to do so. It also made filling of **wetlands** unlawful without a permit. The Act does not include waters that do not connect to a **navigable waterway**, although not everyone agrees which waters are exempt. The Texas

Commission on Environmental Quality monitors pollution and issues permits for discharge of pollutants in Texas.

Because of its diffuse nature, non-point source pollution can be more difficult and costly to describe and control than point source pollution. That's among the reasons there is no single law and permitting system for non-point source pollution as there is for point source pollution.

2) What is watershed action planning? What should people where you live consider when conducting watershed action planning?

One of the ways non-point pollution is addressed is through **watershed action planning**.

Landowners, scientists, local government officials, and staff from responsible agencies consider sound science to design, implement, and monitor water quality management strategies to protect and restore water quality.

Answers will vary, but should include something about the kinds of water resources available in the local area and how non-point source pollution affects them.

3) In Texas, who "owns" surface water? Who "owns" groundwater? Since all water is connected, why do we have different systems of regulation?

Natural surface water found in waterways, such as **rivers** and **streams**, is owned by the State of Texas and managed for the citizens of the state. This includes the ordinary flow in streams and **tidal** waters on the coast. Water from rains and floodwater found within natural rivers, streams, and lakes, and in manmade reservoirs on waterways is also state owned water. Water in springs that form **headwaters** is also considered surface water.

Whereas surface water is considered state property, the water beneath a landowner's property is private property. Landowners have a legal right to pump and capture whatever groundwater is available, regardless of the effect of that pumping on neighbors' wells or springs that may be fed by the groundwater. This is called **rule of capture**.

The legal rights to own and use water in Texas came from the cultures and legal systems of Mexico and England. Early Spanish settlers in Texas used extensive systems of ditches to move water from place to place, and to irrigate their crops. These early water systems were managed by the communities for the people served. This centralized control of water was generally based on Spanish law and is the origin of Texas' system of **prior appropriation**.

Prior appropriation gives the right to a certain amount of water to certain users. It divides available water among people who want it based on a government-issued permit that includes the principle of first come, first served. Senior water rights holders have first rights to a prescribed amount of whatever amount of water is available. This is also often referred to as the "first-in-time, first-in-right" rule.

Anglo-American settlers, who moved into Texas in the early 1800s, brought with them a different system granting rights to water, called **Riparian Law**. This gives people who own land bordering streams the right to use water from the stream. It is based on English law and reflects conditions in England where, unlike in Texas, water is plentiful and there are many streams everywhere.

Over time, these systems were merged, with Texas becoming what's called a **dual doctrine** state, recognizing both riparian and prior-appropriation rights.

4) What is a "water right?" What are the impacts of prior allocation?

A water right is like a ticket for a place in line for available water. Prior appropriation gives the right to a certain amount of water to certain users. It divides available water among people who want it, based on a government-issued permit that includes the principle of first come, first served. Senior water rights holders have first rights to a prescribed amount of whatever amount of water is available. This is also often referred to as the “first-in-time, first-in-right” rule.

In times of drought when water in streams and lakes may be very low, the person who holds the first water right permit, may take their full amount first from the water that's available. The next most senior permit holder may then take their full amount, and so on. Some people who have permits for water may not receive any water in drought years. In some Texas streams, more water has been allocated than flows in them in dry years.

5) What is “rule of capture?” What rights and responsibilities are associated with it?

Landowners have a legal right to pump and capture whatever groundwater is available, regardless of the effect of that pumping on neighbors' wells or springs that may be fed by the groundwater. This is called **rule of capture**.

Since groundwater exists underground, the surface landowner does not actually own the water until they take it from the ground, or capture it. Once captured, they have the right to use the water, or sell it to others. The right to capture the water can even be sold to others. Once sold or leased, any water captured may be transported by the new owners wherever they want.

There are some limits. Landowners are not to pump an unlimited amount of water when it is done maliciously to harm a neighbor, in a wasteful manner, or in a negligent manner to cause nearby land to collapse.

The amount of groundwater a landowner can take may also be restricted when the water is from an underground river or is regulated by a **groundwater conservation district**. There are about 100 groundwater conservation districts now in Texas, formed to create rules for conserving, protecting, recharging, and preventing waste of underground water. Some exert more control over use of groundwater than others. They can register and permit wells, keep drilling and well records, regulate how far apart wells are drilled, require a permit for water transfers, buy and sell water, and generally conserve and protect the aquifer.

6) What are environmental flows? How are they obtained?

While in the past, many people did not think about leaving much water in a stream or river for aquatic life, there are new laws in Texas that require **environmental flow**. Also called instream flow, this is an amount of freshwater, or flow, left in a river or other water body that is adequate to support an ecologically sound aquatic environment.

New laws require that some water be set aside for environmental flows in areas where water is still available. Where all the water has already been allocated to someone, environmental water will need to be acquired over time. For example, existing water rights owned by others could be donated or purchased and allocated to environmental flows. We could also improve ways to use water efficiently, leaving more water to return to our water bodies.

7) What will influence Texas' water supply for the future?

How much water we will have for the future will depend on what we do to conserve water today. We can't make it rain more, but we can more efficiently manage the water we get from the **hydrologic cycle** and water in our **aquifers**.

Texans will need to commit to more intensive water conservation and pollution prevention practices to reach a sustainable water goal that also protects aquatic ecosystems. It will take an understanding of water, watersheds, and life in Texas' many aquatic environments. It will obligate us to reserve water for species and habitats from our headwaters to ocean. It will require the combined efforts of our leaders in business and industry, our elected officials, our teachers, and you.

2. Class Presentation

After all groups finish reading and answering their question, they will work as a group to decide the best way to teach the information they read to the rest of the class.

All groups will write their question on butcher or chart paper and write the answer in a different color on the same paper.

Each group will present the information and the answer to their question to the class. All students should write the chapter questions and answers in their science journals.

3. Managing and Conserving Water: How can we help?

Ask the class to work together to generate ideas to address the following questions.

- **What are some of the causes of point source and non point source pollution?**
- **What effects may be expected of chemical, organic, physical, and thermal changes from humans on the living and nonliving components of an aquatic ecosystem?**
- **What is the cumulative impact of human population growth on an aquatic system?**
- **What kinds of effects do human activities such as fishing, transportation, dams, and recreation have on aquatic environments?**
- **What are some types of water pollution?**
- **How does "going green" (organic gardening and farming, natural methods of pest control, hydroponics, xeriscaping, energy efficient homes and appliances, and hybrid cars) affect the quality of water?**
- **Why don't more farmers take up organic farming? What is the cost- benefit**

trade off?

- **What is the impact of the *Clean Water Act* on aquatic systems?**
- **What are some things that people do that actually help the environment (specifically, keeping water clean and available)?**

4. Listing Ways We Can Help Conserve Water

Each group will contribute to a list of ways that they can help conserve water and manage its use at home, at school, and in the community. This list should be recorded in their journals.

5. Using What We Learned

Ask students to work in pairs to synthesize what they learned from the chapter and write a public service announcement to help make people aware of the importance of managing water use. This could be a jingle, a cartoon, a rap, a song, a short skit, a diagram, or other visual and auditory product to get the message across.

Vocabulary

- Clean Water Act
- Conservation
- Diffused surface water
- Environmental flow
- Non-point source pollution
- Point source pollution
- Prior appropriation
- Riparian law
- Stakeholders

Instructions for Student Groups

Cut between each group assignment and give one slip of paper with instructions to each group.

All students should read the first two paragraphs in the Student Guide.

Group 1 answers question 1. What is the purpose of the *Clean Water Act*? What kind of water pollution is it intended to prevent? Why does the Act not stop all water pollution?

This group needs to read the first three paragraphs under "Clean water–it's the law!". (3 paragraphs)

Group 2 answers question 2. What is watershed action planning? What should people where you live consider when conducting watershed action planning?

This group needs to read the section starting with paragraph three under "Clean water–it's the law!" and going down to the section that is "Texas water law". (4 paragraphs)

Group 3 answers question 3. In Texas, who "owns" surface water? Who "owns" groundwater? Since all water is connected, why do we have different systems of regulation?

This group needs to read the section on "Texas water law" and "Classes of water allocation" and the first paragraph under "Natural Surface Water". They also need to read the first paragraph under "Groundwater". (8 paragraphs)

Group 4 answers question 4. What is a "water right?" What are the impacts of prior allocation?

This group needs to read "Texas water law". Then start reading at the second paragraph under "Natural Surface Water" and read three paragraphs ending with "Groundwater". (8 paragraphs)

Group 5 answers question 5. What is "rule of capture?" What rights and responsibilities are associated with it?

The group needs to read the section on "Groundwater" over to "Water for the environment". (6 paragraphs)

Group 6 answers question 6. What are environmental flows? How are they obtained?

This group needs to read the section on "Water for the environment" over to the section on "Texas' Water Future". (6 paragraphs)

Group 7 answers question 7. What will influence Texas' water supply for the future?

This group should start reading with "Texas' Water Future, and read to the end of the chapter. (6 paragraphs)

Lesson 14.3: What's the Pollution?

Essential Concept

Point source pollution is regulated by the *Clean Water Act*. Non-point source pollution is not regulated by a single law, but is controlled through permitting, education, water quality management programs, and assistance to motivate and assist in reduction.

Objectives

1. Students investigate how point source pollution affects watersheds.
2. Students investigate how non-point source pollution affects watersheds.
3. Students distinguish between point source and non-point source pollution
4. Students investigate human impact on water.
5. Students identify laws or regulatory entities responsible for controlling pollution.
6. Students discuss cost/benefits of controlling pollution or "going green."
7. Students will diagram a watershed and label parts and tell who owns the water and the law or entity that regulates the use of the water.

TEKS

6.2 C; 6.3 B, C; 6.12 E; 7.2 C; 7.3 B, C; 7.8 C; 8.2 C; 8.3 B, C; 8.11 C

Aquatic Science: 2 H, J; 7 A, B; 12 A, B, E

Environmental Science: 2 I, K; 5 B, C; 9 A, E, F, J, K

Estimated Time

1 class period

Materials

<u>For each group of 4 students</u>

1 Rectangular container, such as a cookie sheet or disposable metal baking pan or large plastic storage container

Two sheets newspaper or butcher paper

White garbage bag

Spray bottle

Water

Permanent marker

Cocoa powder, orange or red colored drink powder, and chocolate cake sprinkles and colorful cake sprinkles (about two tablespoons of each)

Colored pencils

Procedure

1. Making the Model

Crumple two sheets of newspaper or butcher paper to represent hills, the high places in the model, and place them side-by-side in one end of the container. Cover your hills with a white plastic garbage bag. Press the plastic down into the container on the opposite end from the hills. This should form a shallow depression, which represents the Gulf of Mexico.

Use pebbles or centimeter cubes to represent homes, and construction sites on the lower area of the model. Use a permanent marker to mark areas for parking lots and roads. Mark an area off to represent a farm. At the top of the watershed mark a spring that forms the headwaters of the stream or river, add a paper cut out to represent an industry that requires a lot of water such as a paper mill.

Sprinkle orange or red drink powder as pollution at the paper mill site.

Use cocoa powder on the farm to represent fertilizer.

Use colorful cake sprinkles to represent motor oil on roads and parking lots.

Use chocolate cake sprinkles on construction sites to represent sediment.

2. Making Predictions

Use your science journal to answer these questions.

- **Where would you expect point source pollution?** (at the paper mill)
- **Where would you expect to find non-point source pollution?** (In the agricultural fields, on the roads, at homes and in parking lots in the city and at construction sites.)

Predict where the pollution will flow and how many watersheds you think you have.

3. What Happens When It Rains?

Now use the squirt bottle to make it rain on the hills and all over the area to show how rainfall carries pollution into the ocean and other water bodies.

- **Were your predictions accurate?**
- **What happens to the water as the rain runs off the land and into streams?**
- **How was this experiment NOT like the real world?**
- **How might we do this differently to better represent real world conditions?**

4. Comparing Point Source and Non-Point Source Pollution

- **What happened to the point source pollution?** (Some runs off into a river, some runs down to the Gulf of Mexico.)
- **What happened to the non-point source pollution**? (A lot of it spread out all over the land, some runs into rivers and down to the Gulf of Mexico.)

- **Which type of pollution seemed to have the most impact on the river, the land and the Gulf of Mexico?** (Non-point source pollution)
- **How would these changes affect organisms living in the water?**
- **Over time, what do you think the cumulative affect will be for organisms living in the water?**

5. Research Questions

Assign each group 1 question to research. Have groups share their research with the class

- **What laws or regulatory bodies could have an impact on improving the water quality in the watershed?** (*Clean Water Act*, Texas Commission on Environmental Quality, Texas Soil and Water Conservation Board, Groundwater Conservation Districts)
- **Humans caused these problems in the watershed. What might motivate humans to improve the watershed?**
- **How do we estimate cost-benefit trade-offs for human economic activities such as farming, industry, driving a car, constructing new buildings and parking lots, etc.?**
- **What advantages and disadvantages would there be for a farmer of "going green"?**

6. Using What We Learned

Ask students to diagram the river investigation. Include different categories of water. (Natural surface water [such as river, springs at headwaters, tidal waters], diffused surface water [such as runoff not in streams or rivers, floodwater] and indicate where groundwater would be [below the spring]).

Label the diagrams as to the type of water and as to who owns the water (the state, private landowner). Then label the law or entity that regulates, monitors, or designs management strategies for the use of the water of each type (Texas Commission on Environmental Quality, Texas State Soil and Water Conservation Board, Groundwater Conservation Districts, and local and regional watershed action planning committees.)

Draw the diagram in pencil.

Label the type of water in blue.

Label the owners of the water in red.

Label the law that applies in green.

Label the regulatory or planning and monitoring entity in purple.

7. Non-Point Source Pollution Hike and Photo Scavenger Hunt

Taking the students on a walk around campus. (The teacher should do this walk ahead of time to locate potential non-point source pollution such as oil in the parking lot, litter near garbage bins behind the school, etc. as potential sources of non-point source pollution.)

- **Where does the water drain from the school parking lot?**

Since so many students have cameras on their phones, challenge them to find examples of non-point source pollution in their daily lives, photograph it and show the class. (Make sure to tell them not to photograph people or signs that identify businesses in the photos.)

Download the photos and make a PowerPoint presentation to educate and encourage others to be careful with the ways they may contribute to non-point pollution. Show the PowerPoint in the halls or at parent meetings to help educate the community.

Vocabulary

- Clean Water Act
- Diffused surface water
- Groundwater
- Groundwater conservation districts
- Gulf of Mexico
- Headwaters
- Non-point source pollution
- Point source pollution
- River
- Spring
- Surface water
- Texas Commission on Environmental Quality
- Texas State Soil and Water Conservation Board
- Watershed action planning committee

Lesson 14.4: Water Conservation

Essential Concept

Water is a limited resource. We must conserve it in order to survive.

A variety of organizations work for conservation of water and aquatic resources.

Objectives

1. Students will take part in a game to model the progression of water consumption by humans.
2. Students will research water conservation or aquatic resource conservation projects.
3. Students will present information on one organization that they think the class could help with their conservation efforts.
4. Students will create a visual or electronic product to help them describe the water conservation organization they wish to support.
5. Students will work as a class to choose one organization and participate in a project to aid that organization in water conservation.
6. Students will publicize their project through local media. (Optional)
7. Students will make an individual commitment to be responsible for water conservation in specific ways.

TEKS

6.2 C; 6.3 B; 7.2 C; 7.3 B; 8.2 C; 8.3 B

Aquatic Science: 2 H, J; 12 B

Environmental Science: 2 I, K; 5 B

Estimated Time

1 class period for the *Water For Our Village Game*

1-2 days for set up of activity and student presentations

Time for volunteering varies depending on the project the class chooses to work on. It might be as little as a one day bake sale to raise money for an organization or as much as water testing with a Texas Stream Team on a regular basis.

Materials

Water for our Village Game

5-gallon bucket,

A large area outside

About 6 of each size cups: tiny cups (2 oz. cup), small cups (8 oz. size), standard 12 oz. drinking cups, large 24 oz. cups

Water

6-two quart pitchers (1 for each group of 4 students)

Internet connection

Computer

Science journals

Pencils/pens

Procedure

1. Water for our Village

Students will play a game to model the changes in humans' increasing demand for water.

Setting up the model:

Split the class into groups of 3-4 students per group. They are "tribes" and they have separate villages.

Set the 2-quart pitchers around in random areas, different distances around. Try to create a good mix of distances with one group much further than the others, one obviously closer than the others. The pitchers are their villages. They cannot be moved.

Fill the 5-gallon bucket with water. The bucket is the water source for the villages and cannot be moved.

Everyone uses the same water source, the 5 gallon bucket, and only one team member at a time can go get water.

Use a tag team method to rotate the person who will go get water; each team member must go before a person goes twice.

Students must use the provided water gathering utensils.

The goal is to get as much water as possible.

Playing the Game

Round I - Primitive Man and Water

Water has to be hauled in small quantities in animal skins.

Using only the tiny cups, teams start to fill their pitchers from the central water source. When you say, "Go!" the teams will begin to carry water to their villages.

Allow students to continue until most students have been able to have at least 1 turn carrying water.

Allow time for a short discussion.

This round of the game represents primitive times when water was difficult to transport, and couldn't be transported in large amounts.

- **Which group got the most water? Why?**

Each village MUST have collected 1 quart of water or it cannot live.

- **Were there any villages that did not get enough water to survive?**
- **What would people in that village have to do to get the water to the village?** (What often happens is that the village closest to the water source gets the most water, and sometimes a village that is far from the water cannot sustain itself.)
- **What could the villagers that did not survive do to be better able to collect enough water? (**Students will probably suggest that the group should move closer to the water supply, but the villages should all stay in the same places to control variables so that we can compare water left in each round.)

Round II: Development of Technology

Irrigation Ditches Are Invented.

Have the students dump their pitchers back into the 5-gallon bucket. Remind them that the amount of water on our planet is basically stable. But now we'll exchange our tiny 2 oz. cups for full 8 oz. cups to represent the progress in technology.

Repeat instructions for Tag Teams.

Allow students to continue to get water until all the students have had at least 1 turn to collect water. Some students will have more than one turn.

Allow time for another short discussion.

- **How much water was taken out of the bucket this time?**
- **How much water is left in the bucket?**
- **What groups have the most water?**
- **Are there any villages that did not collect enough water to survive?**
- **What made the difference in the number of villages that could survive?**

Round III: Technology Improves

Water Is Hauled in Barrels on Carts

This invention helps those that live farther from the water source to survive.

Return all water to the bucket. Some water may have been sloshed out as students hurried to empty their cups. You might have to refill it to be sure there is enough water for the villagers to collect what they need.

Our populations are growing, so we need to draw water faster.

Exchange the 8 oz. cups with 12 oz. drinking glasses.

Repeat instructions from Tag Teams.

Allow students enough time so that each student gets at least 1 turn to collect water. Some groups will have enough time, so students may have more than one turn.

Allow time for a short discussion.

- **How much water was taken out of the bucket this time?**
- **Is there any water left in the bucket?**

- **How much water is left in the bucket?**
- **What groups have the most water?**
- **Were there any villages that did not get enough water to survive?**

Round IV: More Improvements in Technology

Humans Learn to Build Dams.

Building dams doesn't "create" more water. It just keeps water in a particular place for a little longer instead of flowing downstream as it normally would. Dams and other technology allow us to draw water even faster.

Have students return all water to the bucket, and replace the 12-ounce drinking cups with 24 oz cups.

Repeat instructions for Tag Teams.

Allow students to continue to get water until all the students have had at least 1 turn to collect water. Some students will have more than one turn.

Provide time for students to discuss the changes they see in the source of their water.

- **How much water was taken out of the source this time?**
- **Is there any water left in the bucket?**
- **How much water is left in the bucket?**
- **What groups have the most water?**
- **Were there any villages that did not get enough water this time?**
- **What problems do the villagers face now?** (The source of water is drying up.)
- **How could these problems be resolved?** (There could be rules that say you can only take out enough water to support your village, 1 quart. This would allow the village to survive and keep some of the water at the source to be used over a longer period of time and allow time for rains to replenish the water.)
- **How does this activity model our water issues as our population grows?**
- **In real life, what does the bucket represent?** (The finite amount of water on the Earth)
- **What do the cups represent?** (Humans using more water as they get better methods of transport and larger populations)
- **Can we, using our modern technology, similarly drain the source of water in our area?**
- **How can we ensure that we do not deplete our water resources?**

2. Using What We Learned

Ask students to work in their groups to come up with some ideas about how we can keep from depleting our water resources. Ask them to think about the many ways water is necessary for our survival and list them in their science journals. Then have student prioritize the uses to show where water is needed most.

Examples include:

- Agricultural uses
- Drinking
- Generating electricity
- Industries
- Cleaning
- Personal Hygiene
- Recreation
- Spiritual renewal
- Household waste removal
- Transportation
- Wildlife
- Aquatic environments

3. Conservation Organizations

We want be able to help conserve and manage our water resources. The state and federal government makes laws and regulations concerning water use and pollution and many conservation organizations are trying to help protect and maintain our water.

If we want to help, we can work individually to monitor our use of water and protect its quality with the actions we take daily. In addition, we can work with some of the conservation groups on special projects.

- **What are some organizations that we could work with to help maintain the quality and quantity of water needed in Texas?** (Texas Stream Teams were in our reading. Do we know of other organizations?)
- **What interests as an individual would you like to pursue to help maintain water quality and protect aquatic species?** (Some students may be interested in saving sea turtles or marine mammals, others may be interested in water quality monitoring, others might want to raise money for a cause such as The Nature Conservancy that buys land to protect it and the water on it, or an organization that provides education to the general public or to students about the importance of water conservation, etc.)
- **Are there local problems or projects with which you would like to work?** (Neglected park ponds or streams, litter on trails that will wash into streams, an endangered species that you would like to work to protect, etc.)

4. Researching Conservation Organizations

Ask students to work individually to research some water organizations that work for their particular interests. Ask each student to look on the Internet under their special interest and find a group that they might be interested in working with. If possible, a local group would work best, if you live in Amarillo, it is difficult to do beach clean up on a

regular basis, but it would be possible to do litter clean up at a stream or lake in your area or to join a water quality monitoring group.

If students have difficulty finding organizations, here are a few websites to get you started. Remember websites come and go, so be sure to check these before giving them to students.

http://txstreamteam.meadowscenter.txstate.edu/

Texas Stream Team is a network of trained volunteers and supportive partners working together to gather information about the natural resources of Texas and to ensure the information is available to all Texans. Established in 1991, Texas Stream Team is administered through a cooperative partnership between Texas State University, the Texas Commission on Environmental Quality (TCEQ), and the U.S. Environmental Protection Agency (EPA). Currently, hundreds of Texas Stream Team volunteers collect water quality data on lakes, rivers, streams, wetlands, bays, bayous, and estuaries in Texas.

Texas Stream Team is a program of the Meadows Center for Water and the Environment at Texas State University-San Marcos.

http://www.tmmsn.org/

The Texas Marine Mammal Stranding Network (TMMSN) is a non-profit organization created in 1980 to further the understanding and conservation of marine mammals through rescue and rehabilitation, research and education. The TMMSN consists of seven regions along the Texas coast and Louisiana, which provide a coordinated response to all marine mammal strandings.

The TMMSN is the only Stranding Network in the State of Texas and receives no state funding and receives only limited institutional support in the form of grants. TMMSN relies on the donations of time and funds from generous supporters. There is no other team in the State of Texas with the authority, experience, and ability necessary to care for the marine mammals of the Texas Gulf Coast.

http://www.ccatexas.org/

Coastal Conservation Association Texas (CCA Texas) is a non-profit marine conservation organization comprised of tens of thousands of recreational anglers and coastal outdoor enthusiasts. Founded in 1977, CCA started in Texas and has grown to a national organization. CCA Texas' unmatched breadth and depth of volunteer involvement has made it the largest marine conservation group of its kind. CCA Texas has been engaged in hundreds of local, state and national programs and projects related to marine conservation, such as initiating scientific studies, supporting local marine law enforcement, working to pass pro-resource legislation, funding marine science scholarships, initiating habitat-restoration projects, funding state-of-the-art hatcheries, fighting for quality and quantity of freshwater inflows for coastal bays & estuaries.

http://www.glo.texas.gov/adopt-a-beach/

The Texas General Land Office has been sending the Adopt-a-Beach message across the state for twenty-six years, and Texans have responded. Since the first cleanup in 1986, more than 446,000 Texas Adopt-A-Beach volunteers have picked up more than 8,500 tons of trash from Texas beaches, some of it originating from as far away as South America.

Due to tide patterns in the Gulf of Mexico, trash dumped anywhere in the gulf is likely to end up on a Texas beach. Volunteers record information such as the source and type of debris collected on data cards. This data has been instrumental in the passage of international treaties and laws aimed at reducing the amount of offshore dumping.

http://www.seaturtleinc.org/

At Sea Turtle Inc., our mission is to rescue, rehabilitate, and release injured sea turtles, educate the public, and assist with conservation efforts for all marine turtle species. As part of our mission of sea turtle conservation, Sea Turtle, Inc. administers nesting sea turtle patrols on the beaches of South Padre Island and Boca Chica. The primary sea turtle that nests on these beaches is the Kemp's ridley. During nesting season, specially trained volunteers and interns search our beaches for nesting female sea turtles and their tracks. This allows us to find the nests and relocate them to a safe location. Sea turtle nests are protected through the spring/summer incubation period.

5. Presenting our Research

Students should check with the teacher to see if anyone else is interested in the same organization. If so, students can work together on their presentation to the class.

Have students make a 3-5 minute report to the class about a water conservation organization that they think is important in protecting water or aquatic organisms. They should explain:

- What the purpose of the organization is
- What the organization does
- How it raises money
- Why they think it is doing a good job
- Why they think it is an important organization making a contribution to water conservation.

Students should use some type of graphic organizer or other visual method to display their information. It might be a diagram, a poster, a PowerPoint presentation, a short video, etc. The main requirement is that they stay under 5 minutes.

They will use their presentation to try to persuade the class that this organization is one that the class could support through volunteer participation in projects or through fund raising or informing the public about the organization.

At the end of the presentations, the class will vote on the organization that they feel they can support with volunteer work from the class. The volunteer work might be monitoring water quality on a monthly or quarterly basis or it might be publicizing water conservation projects, or it might be raising money for an organization. Students and teachers can make the decision on the type of participation and amount of time and work they can provide to the organization.

Enrichment

Project Learning Tree

Project Learning Tree has an activity called "Publicize It!." This activity gives instructions for how to contact media and publicize class projects. A volunteer conservation project would be a good opportunity to involve the media. Any coverage that students get will reinforce their interest in continuing their conservation projects.

Television, radio, and newspapers like to use stories about students participating in community projects and taking responsible action. This *Project Learning Tree* activity is a straightforward way of helping the class make the contacts needed to get media coverage.

6. Taking Responsibility: What Can I Do?

Ask students to use their lists of water priorities and their ideas on conservation to write an essay of at least 3 paragraphs on the importance of water, the need for conservation, and how they can help protect the quality and quantity of water in their community.

Ask students to make a commitment to themselves of ways they can participate in water conservation on a daily basis. Have each student make a list of things they can do to conserve water. (Everything from using a bucket to wash the car instead of leaving the hose running, to writing a letter to the editor, or contacting a state representative about changing laws and regulations)

Students should make their lists and decide how they can remember to do these things on a daily basis. Then they should write a pledge and sign it and turn it in with their lists.

Vocabulary

- Commitment
- Conservation
- Volunteer

My Conservation Action Pledge

I Pledge to take Responsibility For Conserving Water and Keeping Water Clean by Doing the Following Things in My Daily Life.

1.
2.
3.
4.
5.

In addition I pledge to make a special effort to help change the way we use water in the community by:

_____

_____

_____

Signed _____

Chapter 14: Assessment

Directions

Select the best answer for each of the following multiple-choice questions.

1. Predict the impact of human activity in a watershed.

A Sediments could be brought into the water

B Nitrates could be brought into the water

C Toxic chemicals from roads could be brought into the water

D All of the above

2. What is an example of a source of point-source pollution?

A An agriculture field

B An industrial site that collects its pollution and discharges it through a pipe into a river

C A construction site where water just runs off the site in all directions

D All of the above

3. What is an example of a possible source of non-point source pollution?

A An agriculture field

B An industrial site that collects its pollution and discharges it through a pipe into a river

C A construction site where water just runs off the site in all directions

D A and C above

4. What kind of pollution does the *Clean Water Act* address?

A Point source pollution from industry

B Non-point source pollution from agriculture

C Local pollution from cities

D Statewide pollution running off roads containing oil from cars and trucks

5. What is the basis for Texas' water laws?

A Prior Appropriation

B Riparian Law

C Water rights

D All of the Above

Chapter 14: Assessment

Directions

Write your own answer for each of the following questions.

1. What are the three categories of water under Texas' law and who "owns" each category?

2. What are environmental flows and why are they important?

3. What will influence Texas' water supply in the future? Who are the primary users and why do they need the water? How can their use be changed or improved?

Chapter 14: Assessment Answer Key

Multiple-choice questions

1. Predict the impact of human activity in a watershed.

D All of the above

2. What is an example of a source of point-source pollution?

B An industrial site that collects its pollution and discharges it through a pipe into a river

3. What is an example of a possible source of non-point source pollution?

D A and C

4. What kind of pollution does the Clean Water Act address?

B Point source pollution from industry

5. What is the basis for Texas' water laws?

D All of the Above

Chapter 14: Assessment

Directions

Write-in questions

1. **What are the three categories of water under Texas' law and who "owns" each category?**

Category	Owner
Natural Surface Water	The State of Texas
Diffused Surface Water	Landowner
Groundwater	Landowner

2. **What are environmental flows and why are they important?**

Environmental Flow is the water left in a stream or river for aquatic life. It is important because without water there will be no habitats for aquatic organisms. Without freshwater inflows there will be no nurseries for fish, shell-fish, and other marine organisms.

3. **What will influence Texas' water supply in the future? Who are the primary users and why do they need the water? How can their use be changed or improved?**

How we are able to conserve water by using it more efficiently will determine the amount and quality of water that we will have available in the future.

The primary users of water are farmers and ranchers who grow our food, and industry and business who make and sell products we need, and urban areas where most of us live.

Answers may vary, but might look something like this.

Scientific research can help us learn new ways to improve irrigation and water conservation in agriculture, and reduce pollution from business and industry, and may help us find new ways to fuel our cars, power our electric plants, or clean our water.

Conservation measures can help reduce use.

Improving prevention of pollution can help maintain water quantity and quality. Having enough water for future uses will require all of us to be aware of what we do in our everyday lives. Do we waste water or do we conserve it? The choice is ours. Texas' water future is in our hands.