CONNECTING CLASSROOMS AND COMMUNITIES THROUGH WATERSHEDS

Teacher Author: Jeremy Stumpf, Lehman High School

Grades: Secondary (9-12)
Subject: Environmental science or geography
Duration: Five 50-minute classes + Service Learning

Unit Purpose: The purpose of this unit is to help students understand watersheds, human impact on watersheds, and way watersheds can be protected and conserved.

Unit Description: The purpose of this unit is to help students understand watersheds and their role within a watershed, including pollutants that affect watersheds and ways humans can protect and clean-up watersheds. On the first day of the unit students learn about watersheds and complete a mapping activity to locate themselves within their local watershed. On second day of the unit, students learn about land-use within watersheds, including sources of pollution and ways human activity affects the watershed. On the third day of the unit, a guest speaker visits with the students, using a large model of their local watershed, and demonstrates the affects of human activity within the watershed. On the fourth day of the unit, another guest speaker from the local community speaks with students about how they can get involved in protecting their own watershed. A culminating activity for the students in a service learning project held one week later in which students visit a local park within the watershed and host a community watershed clean-up and water quality testing event. This is followed by a reflective discussion in class on the fifth day of the unit. This five-day lesson and community activity emphasizes using community resources and service learning to help students understand watersheds and watershed management. By the end of the entire unit on watersheds, students will have knowledge of their role within the watershed, human activities that affect watersheds and water quality, and ways to find community resources that help them become more knowledgeable about their local watershed.

LEARNING OBJECTIVES

The student will define watersheds, describe the impact of human activity on watersheds, and identify ways watersheds are managed and conserved.

The student will define and give examples of non-point source and point source pollution that affects watersheds, and identify land use activities within watersheds, including their local watershed.

Materials:
Local watershed maps
Deck of cards
Sticky tack or "benda-roos"
Markerboards and dry-erase markers

Unit Vocabulary:
Watersheds, Impaired, Point Source Pollution, Non-point Source Pollution, Impervious Cover

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National Standards

National Science Standards:
Strand 4: Earth and Space Science
Strand 6: Science in Personal and Social Perspectives

National Environmental Education Standards:
Strand 1: Questioning, Analysis and Interpretation (A, E, F, G)
Strand 2.1: The Earth as a Physical System
Strand 2.4: Environment and Society
Strand 3.1: Analyzing and Investigating Environmental Issues
Strand 3.2: Decision-making and Citizenship Skills
Strand 4: Personal and Civic Responsibility

National Geography Standards:
Standard 1: How to Use Maps and Other Geographic Representations, Tools, and Technologies to Acquire, Process, and Report Information From a Spatial Perspective.
Standard 4: The Physical and Human Characteristics of Places.
Standard 7: The Physical Processes That Shape the Patterns of Earth's Surface.
Standard 14: How Human Actions Modify the Physical Environment.

Texas Essential Knowledge and Skills (TEKS):

Environmental Systems: 12.4.C, 12.5.A, 12.5.B, 12.5.C, 12.5.E, 12.5.F, 12.8.A, 12.9.A, 12.9.C, 12.9.E

Aquatic Science: 7.A, 7.B, 7.C

Geology, Meteorology, Oceanography: 10.A, 10.B, 10C

World Geography: 9.8.A, 9.8.B, 9.8.C, 9.9.A, 9.12.C

Teacher Masters:
Watershed Definition Cards
Water Quality Jigsaw Activity
Watershed Powerpoint

Student Masters:
Water Factors Checklist

Advanced Preparation:

1. Contact your local parks and recreation department, river authority, or environmental department to find out what resources, watershed models, and guest speakers are available for schools and what topics they can present to students.
2. Gather Materials: Maps of local watershed, deck of cards, posterboard
3. Make copies of student handout: Watershed Definition Cards, Watershed Factors Checklist, Jigsaw Handouts, Vocabulary words for definition activity.
4. Cut out Watershed Definition Cards and laminate if desired.
5. Optional: Download video from Weather Channel on Watersheds (from You Tube at: http://www.youtube.com/watch?v=xUYWb8XTo58)

Assessment Instructions:
Formative assessment: During the lesson, monitor students' understand of the definition of a watershed and their understanding of human impact on watersheds through group activities, class discussions, and student work.
Summative assessment: On the final day of the lesson, students will write a reflection essay explaining what they learning about watersheds and their experience during the service learning project.

Procedures

Day 1 What is a Watershed?

1. Vocabulary Development (5 minutes). Begin the class by asking student "What does "shed mean"? Show pictures that illustrate the concept of "shed", such as a picture of a duck's back with water (5 minutes). Students should fully understand what the word "shed" means (*to get rid of* or to *run over*). *Note: Many students will also define "shed" as a small building. Let them know that "shed" can mean many things.*

2. Watershed Definition Activity (20 minutes).

- Now connect the concept of "shed" to the vocabulary word "watershed." On the board, write out the following statements and the leave the blank spots for student to fill-in the correct words:
  - An _____ of _____ surrounding a _____ of _____water that _____ the _____.
  - The _____ area that is _____ when _____ of rain or _____ _____ _____ to _____ to a _____, _____, _____, _____, or _____.
- Using the Watershed Definition Cards, give each student (or pairs of students) a word. Have students arrange the words to create the correct definition on the board. Note: Cards with "1" on back go only with the first definition. Cards with "2" on the back go only with the second definition. Students can divide into two groups to solve their definition.
- *Correct responses:*
  - *An area of land surrounding a body of water that receives the runoff.*
  - *The land area that is drained when drops of rain or precipitation joins others to flow to a particular, river, lake, stream, or wetland.*
- Ask students to summarize these two statements to describe a watershed. Now that student have a good understanding of the concept of a watershed, develop their understanding further by briefly posing these two discussion questions:
  a. What force causes water to flow*? Correct responses: gravity or elevation/topography*
  b. Are watersheds large or small? *Possible responses: can vary, but it can be both. Emphasize that watersheds can be small or large land areas and that watersheds can be divided into small units. For example, the Guadalupe River Basin is divided into 10 smaller watersheds, including the Plum Creek Watershed.*
- Optional: Show clip from Weather Channel on "Watersheds"

3. Our Watershed and Plum Creek (20 minutes).

- Ask students: What percentage of the class lives in watershed? *Answers vary, but students should understand that most of their class lives within local watershed, and all students live in a watershed.*
- Show maps of the Plum Creek Watershed and ask students to identify their homes, school, roadways, and local businesses on the map. Insert placemarkers for homes, school and businesses. Emphasize student proximity to streams, creeks, and parks within the watershed. *Note: If using Google Earth, watershed boundaries must imported shape files into the software.* This activity can also be done with printed maps of the watershed and placing sticky notes to mark homes, school and businesses.
- It is important for students to see the watershed boundaries

during this activity to better understand the impact of human development within a watershed.

- Zoom out on Google Earth to allow students to see all placemarks that are within and outside of the watershed boundaries. The majority of students will live in the same watershed as the school's location, but *all* students live in a watershed.

4. **Wrap-up and Build Expectations** for Day Two (5 minutes). Now that students understand the concept of watershed and have used maps to locate their homes within the watershed, now ask students:

a. What are the major cities and towns in the Plum Creek Watershed? *Answers will vary depending on the local watershed used.*

b. How do people affect watersheds? *Possible responses: littering, releasing chemicals or oil from cars through runoff, animal feces, using drinking water, building homes, building businesses, using water from creeks*

<u>Day 2 Human Impact on Watersheds</u>

1. Review (5 minutes) with students the definition of a watershed they learn on the first day. Ask students: "Which watershed do we live in?" *Answers will vary by location.*

2. Introduce Jigsaw (10 minutes). Begin the Jigsaw activity by explaining expectations to students. Post the directions for the Jigsaw on the board or projector screen. Students might ask what each group means (Home group or Study group). Give them an explanation of how Jigsaw activities work. To divide students into "Home groups" and "Study groups" use a deck of cards. For a class of 18 students, use the 2, 3, 4, 5, 6, and 7's and hearts, clubs and diamonds. The suit designates the Home Group (3 groups of 6). The number designates the Study Group (6 groups of 3). Add spades for a class of 24 (this creates another Home Group). Add another number to create another Study Group, and so on.

3. Jigsaw (25 minutes). Using the cooperative learning strategy, Jigsaw, students investigate more about each factor that affect watersheds.

- **Pre-ranking Water Quality Factors** (5 minutes). Assemble Home Groups, and down one half of a mini markerboards (or paper) they will rank the Water Quality Factors on a scale of 1-5, (1 being the most impact; 5 being the least impact; students can use ranking more than once). The factors they will get are Construction, Industrial Pollution, Urban Runoff, Residential Runoff, Wastewater Treatment Plants, and Agriculture. They'll rank these without knowing too much about each factor.

Note from the Teacher

By the end of the lesson, students should have a clear understanding of two key concepts:

- *Watersheds are land areas where water drains or runs off.*
- *Point source pollution is easier to identify and contain. Non-point source pollution is much more difficult to identify since it comes from a variety of sources (residential laws, parking lots, pet waste). Non-point source pollution can be helped with education and outreach to the community.*

Connect activities to the local watershed so students have relevant connections to the content they are learning during the lesson. This can be done using local maps and pictures, community resources, and guest speakers.

- **Move to Study Groups**. At the signal, students will put their mini markerboards on the markerboard ledge and head to a station to study one of the factors. Stations will be 2-7, according to their study group number on their card.
- **Study Groups**. At each station they will read/look at the information there and fill in the Checklist for that factor. When finished they will return to their Home Group area and will have a few minutes to share their information with the Home Group.
- **Home Group Sharing and Re-Ranking**. In Home Groups, students will re-rank the factors based on what they have learned at their Study stations, and will also indicate on the markerboard if the factor is point source or nonpoint source pollution.

4. Discussion (10 minutes). Once all groups are finished we will lead discussion on why any rankings changed or why they stayed the same, as well as differences between the groups. Discuss the difference between point source and non-point source pollution (*pollution from sources that are either unknown or from general areas such as parking lot runoff, park litter, or agricultural runoff*).

Day 3 Watershed Models and Demonstrations

1. **Review** (5 minutes). At the beginning of class, review the previous day's rankings and ask students if they have any questions about what they have learned so far.
2. **Guest speaker** (30-40 minutes). A guest speaker from the local river authority demonstrates the affects of Water Quality Factors using a large model of a watershed.
   - Ask the guest speaker to talk to students about the local watershed, including the location and boundaries of the watershed, factors affecting the watershed, and agencies/laws that monitor water quality.
   - Using a watershed model, demonstrate the flow of water and pollutants through a watershed. This model allows students to see the movement of water through sub-watersheds within a larger watershed, and pollution through the watershed. The guest speaker also discusses other factors that affect the health of the Plum Creek Watershed (*point source and non-point source pollution*). The emphasis of this demonstration is on the increase of non-point source pollution and impaired river systems. The watershed model allows the guest speaker (or teacher) demonstrate the flow of water from higher elevation to lower elevations, and the flow of pollution and sediments. *Note: The Plum Creek Watershed is classified as in impaired because of high bacteria levels.*
3. **Wrap-up and Build Expectations** (5 minutes). Now that students have seen the flow of water through the watershed model and listened to an expert guest speaker discuss ways in which pollution affects the health of the watershed, ask the students these closing questions:
   a. Where does our drinking water come from? *Answers vary, but students should identify the mix of surface water from local rivers and groundwater from local aquifer.*
   b. How can the park cleanup affect our water quality? *Removing litter and pet waste that contribute to bacteria in water sources.*

Day 4 Connecting the Classrooms to Community Service Learning

1. Review (5 minutes). As students enter class, give them the opportunity to ask questions about what they have learned so far during the lesson. Prepare students for guest speakers by giving them

expectations for guest speakers and for service learning. Introduce guest speakers. *Note: Mr. Stumpf chose to have city personnel come talk to students about the local water quantity and quality issues and to prepare students for expectations for the community watershed clean-up*.

2. Guest speakers (30-40 minutes) – Director of Parks and Recreation and Assistant City Manager. By bringing in these guest speakers, students learn about the local water needs for their community, sources of water, issues affecting water quality, and ways the watershed clean-up will help the water quality. Ask guest speakers to discuss the following topics with the students:

- Sources of local water (surface water and groundwater)
- Quantities of water needed and population growth
- Water permits, regulations, and competing needs for water and for conservation of water
- How water is retrieved from the watershed
- Point source and non-point source pollution
- Land acquisitions to create local parks and natural areas
- Regulations to protect parks and water sources from pollution.
- Land use patterns within the watershed (agriculture, industry, residential)
- Best Management Practices (BMP) and regulations
- Stakeholders and Planning groups
- The effects of floods and droughts

3. Question and Answer Time (5-10 minutes). Use this time to address student questions or misconceptions, and expectations for the community service learning.

Day 5 – Watershed Cleanup Service Project

Working with local parks department, river authority or water system, gather students and community members. Assign groups of students to tasks to clean-up the watershed. Some tasks include litter pick-up (trash and recycling) and animal waste pick-up.

Day 6 – Discussion and Reflection Essays

1. Discussing Clean-up Experiences (25 minutes). Ask students to share with one another their experiences cleaning-up the local watershed. What did they find during the clean-up? What did they learn about human impact on watersheds? If possible, use pictures of the students from the clean-up to engage the students in the discussion.

2. Writing Letters (25-30 minutes). Now that students have learned about watersheds and have participated in the clean-up of their local park, ask the students to write thank-you letters to the speakers and organizers of the event, particularly explaining what they learned through the experience. In addition, students can write letters to other local city leaders and state politicians explaining the importance of protecting and conserving water resources.

References and Resources:

Surf Your Watershed: http://cfpub.epa.gov/surf/locate/index.cfm
National Conservation Resource Service; Education: http://www.nrcs.usda.gov/feature/education/
Environmental Protection Agency; Water: http://www.epa.gov/water/education.html
Texas Water Development Board; Education: http://www.twdb.state.tx.us/kids/index.htm
National Water Program: http://www.usawaterquality.org/
U.S. Geological Survey; Water Education: http://water.usgs.gov/education.html
Project WET: http://www.projectwet.org/ and www.watereducation.org
Water Science for Schools: http://ga.water.usgs.gov/edu/

Watershed Definition Cards

Instructions: Cut out each word and mix them up. Distribute several words to each group of student. Using a portion of the definition (below), ask students to figure out the correct order of the words to make the definition complete.

- An _____ of _____ surrounding a _____ of _____water that _____ the _____.
- The _____ area that is _____ when _____ of rain or _____ _____ _____ to _____ to a _____, _____, _____, _____, or _____.

AREA

LAND

BODY

WATER

RECEIVES

RUNOFF

LAND

DRAINED

DROPS

PRECIPITATION JOIN FLOW OTHERS PARTICULAR STREAM, RIVER, LAKE, WETLAND

Water Quality Factors
Agriculture

Non-point source pollution sites are much harder to discover and trace. This makes them harder to regulate and monitor.

Non-point source pollution is corrected by:

- preventing the pollution in the first place,
- keeping the pollutants from reaching streams and rivers.

Agriculture practices, such as farming and ranching, can contribute pollutants to watersheds. Crops, feedlots, and pastures are considered nonpoint source pollution sites. These sites can be a source of runoff that includes:

- fertilizers from crops
- sediments eroding from bare soils
- elevated bacteria from animal wastes
- ammonia
- pesticides, insecticides and herbicides

Livestock can overgraze, creating very short grass. This holds back less runoff than longer grasses.

Water Quality Factors
Cities and Towns

Cities and towns contribute nonpoint source pollutants. This is sometimes called “urban runoff.” Most street drains flow through pipes directly into streams or lakes – rainwater (stormwater) is NOT treated!

Common pollutants found in urban runoff are:

- sediments from bare soils
- bacteria from wastes
- nutrients from fertilizers
- oil from parking lots
- gasoline
- metals
- antifreeze and grease
- pesticides
- trash

Impervious cover refers to parts of the landscape that cannot absorb water the way soil and vegetation do. Concrete, asphalt roads, and rooftops all create impervious cover. They increase the flow of water to streams, lakes and rivers.

Illegal dumping of trash along roads contributes to urban runoff.

Accidents and spills along highways and roads may be infrequent but can cause concentrated pollutants to enter the watershed in a short amount of time.

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Water Quality Factors
Construction

Construction sites are considered nonpoint sources of pollution. These areas can cause high levels of sediments to reach waterways, as well as nutrients from fertilizers applied to new lawns and landscaping.

Sediments such as soil, clay and silt settle on aquatic plants and reduce the sunlight they can absorb. This reduces photosynthesis, which in turn reduces the oxygen available to animal life.

Sediments can cover nesting sites as well. They cause water to turn brown and muddy, and they increase turbidity.

Constructions sites are required by law to install erosion control devices and equipment. These include black cloth fencing to slow sediment, and sand bags and barriers in storm drains to slow runoff.

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Non-point source pollution is corrected by:

- preventing the pollution in the first place,
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Water Quality Factors
Industrial Pollution

Industrial pollution sites are often thought of when most people think of pollution. Industrial facilities are considered point sources of pollution. They can contribute numerous types of toxic substances, chemicals and products (depending on the type of industry).

Oil and gas facilities can be sources of pollution if they leak these products into the groundwater.

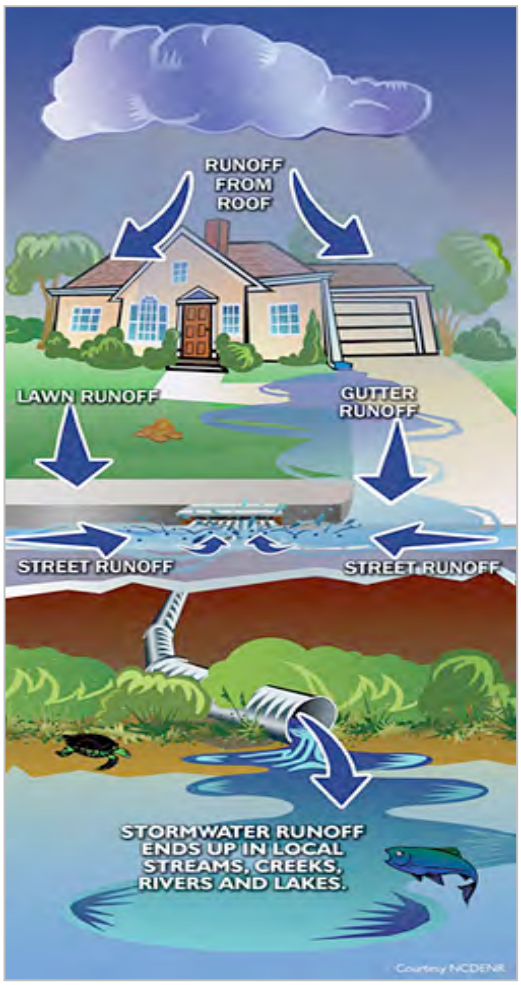
Effects of industrial pollution can include:

- color changes
- excessive algae
- odors
- absence of aquatic life
- fish kills
- elevated BOD
- sewage fungus

The United States Environmental Protection Agency (EPA) and the Texas Commission on Environmental Quality (TCEQ) are responsible for regulating point source pollution and how to treat it.

Point source pollution is relatively easy to find and trace – all you do is find the pipe. It is usually corrected by removing the pollution from the water before it leaves the pipe.

Water Quality Factors
Residential Runoff



Subdivisions and residential areas contribute nonpoint source pollutants. This is sometimes called “residential runoff.” This runoff is NOT treated and goes through sewers directly into streams, rivers, and lakes. Common pollutants found in residential runoff are:

- lawn fertilizers
- sediments
- bacteria from pet wastes
- oil drained from cars
- septic tank overflows
- gasoline
- detergents used to wash cars
- antifreeze and grease
- pesticides
- trash

Impervious cover means parts of the landscape that cannot absorb water as well as soil and vegetation. Concrete, asphalt, and rooftops all create impervious cover. They increase the flow of water to streams, lakes and rivers.

Non-point source pollution sites are much harder to discover and trace. This makes them harder to regulate and monitor.

Non-point source pollution is corrected by:

- preventing the pollution in the first place
- keeping the pollutants from reaching streams and rivers.

Water Quality Factors
Wastewater Treatment Plants

Municipal wastewater treatment plants are considered point sources of pollution. These facilities can release:

- nutrients
- bacteria
- sediments

The effects of these pollutants include:

- excess algae (algal blooms)
- white foam
- sludge deposits (brown or gray solids)
- absence of fish and insects
- variable DO levels
- high BOD

The United States Environmental Protection Agency (EPA) and the Texas Commission on Environmental Quality (TCEQ) are responsible for regulating point source pollution and how to treat it.

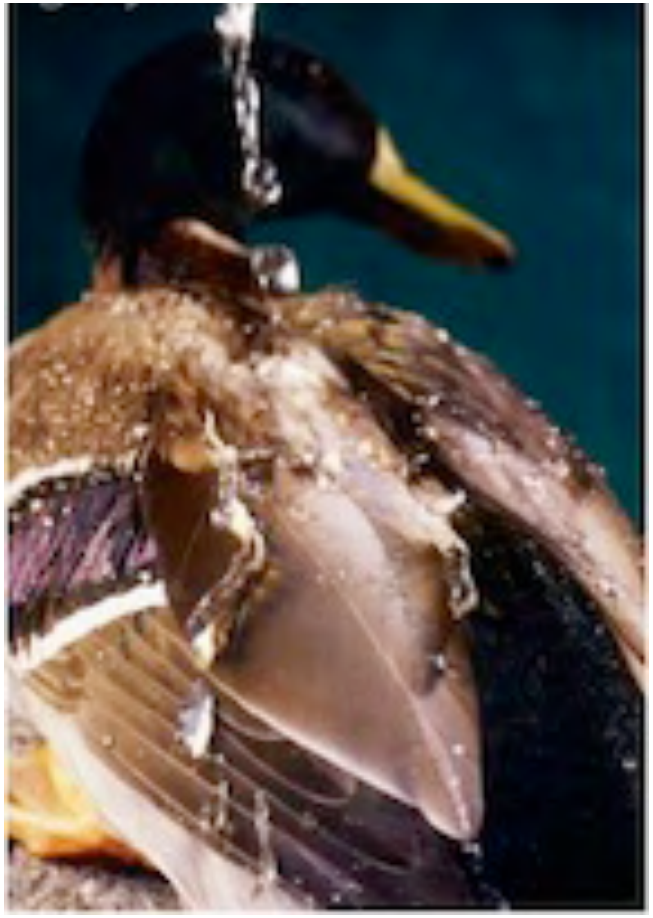
Point source pollution is relatively easy to find and trace – all you do is find the pipe. It is usually corrected by removing the pollution from the water before it leaves the pipe.

Watersheds Day 1

What is a Watershed? *Where am I in the watershed?*

- What does shed mean?
- Watershed Definition Activity
  - Look on the back of your card –
    - 1's are part of Definition 1; 2's are Definition 2
  - Fit your card in its proper place on the board!
- What is a Watershed? Video
- What force causes water to flow?
- Are watersheds large or small?
- What's the name of *our* watershed?

“Like water off a duck’s back.”



A snake sheds its skin.

Watersheds Day 2

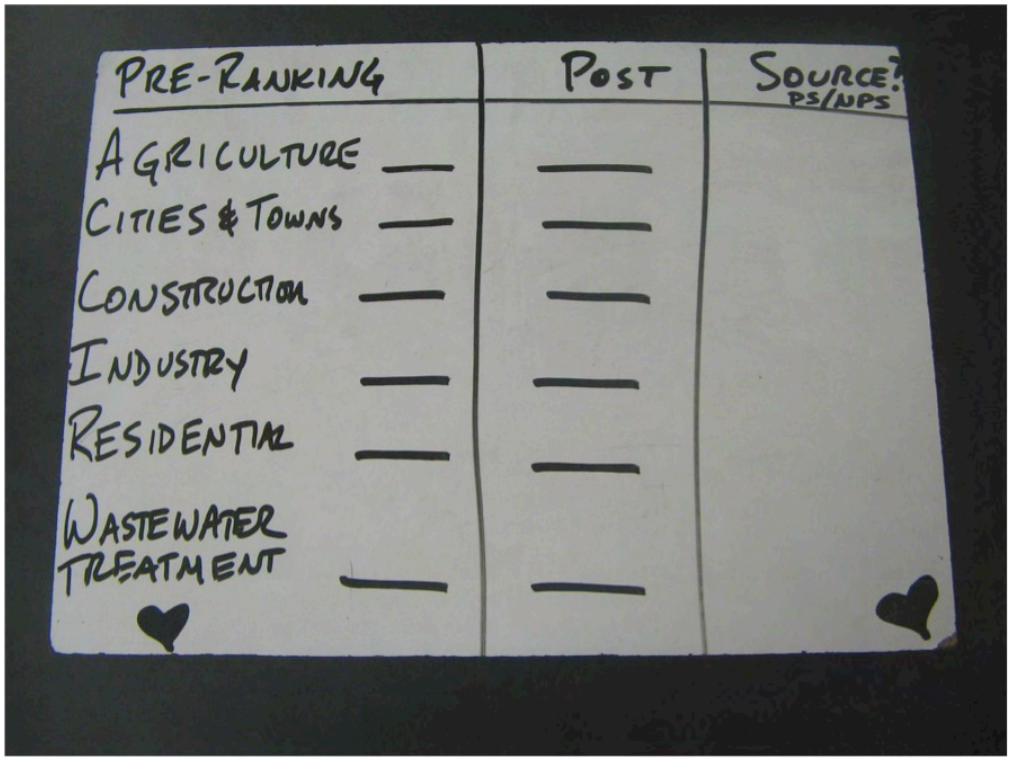
How do human activities affect watershed quality and health?

- Pre-Ranking of Factors
  - **Assemble into <u>Home Groups</u> - Hearts, Clubs, Diamonds**
  - **Write each of the factors down one half of your group's markerboard.**
  - **Rank them on a scale of 1-5,**
    - **1 being the LEAST harmful to watersheds,**
    - **5 being MOST harmful to watersheds**
  - **You can have more than one ranked as 3, 5, etc.**
  - **Keep the other half of your markerboard clean**

Watersheds Day 2

How do human activities affect watershed quality and health?

<u>Agriculture</u>, <u>Industrial Pollution</u>, <u>Cities and Towns</u>, <u>Residential Runoff</u>, <u>Construction</u>, <u>Wastewater Treatment Plants</u>



Include your suit!

Watersheds Day 2 - Jigsaw Activity

Study Groups are 2's, 3's etc.

- 2's study Agriculture
- 3's Cities and Towns
- 4's Construction Treatment Plants
- 5's Industrial Pollution
- 6's Residential Runoff
- 7's Wastewater

- **Fill out your portion of the Watershed Factors Checklist as you study the factor.**
- **Make sure you include at least 2 reasons for your Justification/Reasoning/Support section**
- **Leave the Home Group Final Ranking blank**
- **Return to your Home Group area when finished**

Watersheds Day 2

- **Post-ranking and labeling:**
  - **Fill out the rest of your checklist with your Home Group**
  - **Re-Rank the factors on the other half of your group's markerboard**
  - **Label each as PS (point source) or NPS (nonpoint source)**
  - **Your ranking may or may not change!**
- **Discuss:**
  - **What rankings changed for your group and why?**
  - **What rankings stayed the same and why?**
  - **What is the difference between point source and nonpoint source pollution?**

Watersheds Day 3

Watershed Models and Demonstrations

- Cinde Thomas-Jimenez from GBRA

(Guadalupe-Blanco River Authority)

Watersheds Day 4

Connect our learning to our service activity – How will the Plum Creek Watershed Cleanup improve the health of the Watershed?

- Kerry Urbanowicz – Kyle Parks and Recreation Director
- James Earp – Kyle Assistant City Manager

Watershed Factors Checklist

Name _____

Circle one for each -

Home Group: Hearts Clubs Diamonds

Study Group: 2 3 4 5 6 7

Water Quality Factor	**Point Source?**	**Nonpoint Source?**	**Your Home Group's Final Ranking**	**Justification/Reasoning/Support**
Cities & Towns (Urban Runoff)				
Wastewater Treatment Plants				
Residential Runoff				
Industrial Pollution				
Construction				
Agriculture				