Oak Creek Canyon, AZ
Watershed Education Curriculum

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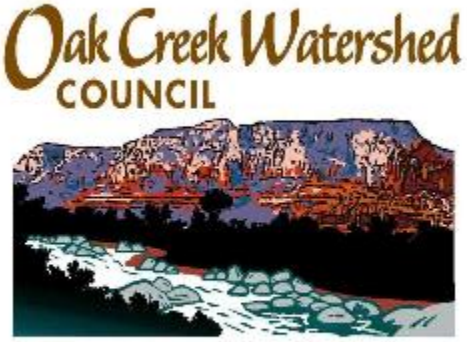
In Collaboration with
The Oak Creek Watershed Council



2014

Water Quality in the Oak Creek Watershed Curriculum

The Oak Creek Watershed is an area renown for its beauty, drawing visitors from all over the world, as well as local residents. The popularity of this area for recreation, although vital to the local economy greatly impacts the health of the watershed and water quality in Oak Creek. Pollution and specifically contamination from E.coli are major concerns as they can lead to human illness, and cause harm to native plants and animals. In addition, E.coli is often an indicator for the presence of other harmful bacteria. E.coli contamination in the Oak Creek Watershed comes from various sources most notably wildlife feces, dog feces, human feces, septic systems, agricultural and urban run off, as well as trash and litter. The overall goal of this curriculum is to provide students with an opportunity to understand the issues surrounding the watershed and develop viable solutions to better the health of the Oak Creek Watershed and improve water quality. The curriculum aims to produce students who are concerned and invested in their local communities, students who will be motivated to become active and responsible citizens, stewards of the land and champions for the environment.

This comprehensive two to three-week curriculum is designed for seventh and eighth grade students and aligned to the Arizona State Science Standards. The unit begins with a review of essential topics surrounding water: the water cycle, ground water, and watersheds. The unit then focuses specifically on water quality and water testing. Students are engaged through a variety of inquiry-based activities to cover these concepts. The curriculum truly comes to life with a field trip to Slide Rock State Park in which students are engaged in water testing, as well as an ecology scavenger hunt and a trash pick up. Ultimately, the curriculum culminates with a final project in which students form their own watershed councils and develop a strategic improvement plan for the health of the Oak Creek Watershed and water quality. Students present their improvement plans to other students as well as sharing this valuable information with their families.

The Oak Creek Watershed Council and the University of Arizona were instrumental partners in the development of this curriculum and the opportunity to take students to Slide Rock State Park. Their collaboration and expertise are greatly appreciated.

Lesson Title:

Journey through the Water Cycle

Objectives:

- Student will be able to compare the amount of potable water available on Earth to non-potable water
- Students will be able to describe the steps of the water cycle
- Students will write a short story describing a water molecules journey through the water cycle

Vocabulary:

- Potable water
- Evaporation
- Condensation
- Precipitation
- Infiltration
- Transportation
- Transpiration
- Ground water

Materials:

- 1 liter container
- 100 ml graduated cylinder
- 10 ml graduated cylinder
- eye dropper
- metal bucket
- salt
- water
- ice cube tray
- Water cycle journey stations and cards* (See appendix)
- Water cycle journey score card* (See appendix)
- Water cycle diagram (See appendix)
- Water Cycle Quiz (See appendix)

*Project learning Tree "Water Wonders" https://www.plt.org/prek-8-activity-44---water-wonders

Procedure:

1. Warm Up:
    a. Students estimate what percent of Earth's surface is covered by water (≈71%)
    b. Students estimate what percent of Earth's water is potable
2. "Drop in the Bucket" Demonstration
    a. Fill a 1 liter container with water to represent all the water on Earth
    b. Remove 30ml of water from the 1L container into a 100ml graduated cylinder to represent fresh water on Earth
    c. Add salt to the water remaining in the 1L container to represent salt water on Earth
    d. Remove 6 ml of water from the 100ml graduated cylinder into a 10ml graduated cylinder

e. Pour the water remaining in the 100ml graduated cylinder into an ice cube tray to represent the amount of fresh water that is frozen in glaciers
f. Remove 1 drop of water with an eyedropper from the 10ml graduated cylinder and drop in a metal bucket to represent the amount of fresh water that is potable and available to drink. The water reaming in the graduated cylinder is polluted.
g. Discuss what this demonstration reveals amount the amount of available potable water

3. Water Cycle Journey Activity
    a. Students imagine they are water molecules traveling through the water cycle
    b. Students will travel to the following stations; glacier, animal, cloud, ocean, stream, plant, and ground water
    c. At each station students will find an envelope filled with cards (see attached activity sheet) The card indicates to the student what happens to them and where they will go next for example; you are evaporated into the air and head to the cloud
    d. Students record their journey on their water cycle score card
4. Water Cycle Diagram (Project WET)
    a. As a whole class students complete the water cycle diagram
5. Water Cycle Vocabulary
    - Evaporation
    - Condensation
    - Precipitation
    - Infiltration
    - Transportation
    - Transpiration
    - Ground water

    a. Students include a definition for each term as well as an example and a picture

6. Water Cycle short story
    a. Students write a creative short story describing a water molecules journey through the water cycle. Students must incorporate into their story all the vocabulary they learned today. This may be used as an assessment of todays lesson.
7. Water Cycle Quiz
    a. See attached. Can be used as summative assessment or formative to see if students are ready to move on.

Lesson Title:

Watersheds from Big to Small & Three Rain Drops

Objectives:

- Students will analyze water movement within their local watershed
- Students will be able to determine the boundaries of their local watershed
- Students will be able to describe watersheds as being part of larger watershed

Vocabulary:

- Watershed
- Tributary
- Groundwater
- River/ Stream
- Confluence
- Run-off
- Colorado River Compact
- Primary, secondary, Tertiary

Materials:

- Colorado Watershed Map (See appendix)
- Oak Creek Watershed Map (See appendix)
- Three Rain Drops Worksheet (See appendix)
- Assorted color pencils, crayons or markers

Procedure:

1. Warm up
    a. Think, pair, share: What is a watershed?
        i. Let students know they are all part of a watershed and ask students to identify the nearest body of water.
    b. Ask students where the water ends up after it rains-
        i. give other examples as needed until students come up with definition on their own
2. Colorado watershed map activity
    a. Give students the Colorado river map (See appendix) and four different colored pencils, markers or crayons
    b. Using a document camera to help, have students locate the Colorado River.
    c. Tell students to outline the River with one of their colors and make a key on the top of the page (ex: Blue = Colorado River)
    d. Have students locate rivers that feed into the Colorado. Identify these as primary contributors and have students outline all of these using a different color and adding it to their key.
    e. Students should repeat step d, with secondary and tertiary contributers

f. **Ask Students to outline where they think the boundary of the Colorado river is.**
g. Show students the real boundary of the CO. river watershed. Google "Colorado river watershed boundary" to find an image. Have students fix their boundary if they didn't get it right. (Most students should be close)
h. **Probing Questions:** (Have your copy on display using doc cam or smart board)
    i. Point to various places and ask: "Where will water goes if it rains here"
    ii. If a farmer in SE Wyoming is spraying herbicide and it rains the next day, Where might those chemicals end up?
    iii. If a person in Western just emptied his Truck's oil on a dirt road in the dessert. Where might this oil end up?
    iv. Where does all the water from the Colorado River end up? (leading students to identify the Ocean as being the largest watershed).
    v. How many states are in the CO. River watershed?
    vi. Which state has the largest area in the watershed?
i. **Extension**:
    i. Students research or are given mini-lesson on the Colorado river Compact. You can make this as simple or detailed as you choose. Notice Arizona as being almost entirely in the Colorado Watershed and receiving one of the smallest portion of the river's water. Inversely, compare California water allowance to it's area within the watershed.

3. **Three Drops of Water Activity**
    a. Hand out Oak Creek watershed map, three drops of water worksheet and three colored pencils. (This can easily be modified for your local watershed. Just find a map and change the features listed in the worksheet)
    b. Show map on Doc cam or smart board, and have students point out major features on the map: Oak Creek, Verde River, OC watershed boundary, West Fork creek ,Sedona, etc.
    c. Students follow directions on the worksheet and trace the journey of each of the three drops of water and marking a X

where they all meet. All three drops of water should eventually meet in the same place.

d. Students answer questions on the worksheet.
e. **Probing Questions:**
    i. Are you surprised by the size or boundaries of the watershed?
    ii. What are the major topographical features that determine watersheds? A: (Mountains and ridges)
    iii. Did you realize that a farmer in Mountainaire could affect the quality of Oak Creek's water?
    iv. What watershed(s) is Oak Creek apart of. A: (Verde River WS and Colorado WS). Explain how smaller watersheds make up larger watersheds.

Lesson Title:

Get the Groundwater Picture (*adapted from Project Wet)*

Objectives:

- Student will examine how water flows differently through different types of soil.
- Students will be able to describe how groundwater moves and is stored
- Students will be able to determine how soil type and water use affects the water table

Vocabulary:

- Groundwater
- Aquifer
- Infiltration
- Confined Aquifer
- Unconfined Aquifer
- Runoff
- Cone of Depression
- Water Table

Materials:

- Clay
- Sand
- Pebbles
- Three water bottles with heads chopped off and holes in the bottom
- Copy of Groundwater cross section and data table* (see appendix)
- Strip of paper 1" by 12" for each student

*ProjectWet "Get the groundwater picture"

Procedure

1. Warmup:
    a. Ask students to write what they think happens to water after it enters the ground.
    b. Ask students where their water comes from. (A: groundwater for most of them in this area). Describe how city has wells and pumps water to their customers.
2. Demonstration:
    a. Show students the three water bottles, have students guess and discuss what will happen to each as water is poured in.
    b. Complete Demonstration one at a time, explaining the water movement for each one a: (Clay should be very slow, Sand should trickle gradually ,and pebbles should move the water quickly.
    c. Put your hand under the rock one as you pour water in and have students identify the pockets of water in between the rocks
    d. Show students the sand one and how the water is absorbed in the sand.

e. Define aquifer and have students write the definition in their journal or vocab sheet. A: (An underground area saturated with water).
f. Ask students what would happen if you were to drill a well into each of the samples. Would you be able to obtain water?
g. Discuss with students the soil type in your area A: (Sedona : Clay and rocks)

3. Hand out groundwater water cross section data.
    a. Instruct students to draw a cross-section of their ground makeup using the data provided.
    b. Have students describe water movement in each of their cross sections
    c. Show students the completed cross section (I personally found it a waste of time to have students tape their cross sections together as a class, but this is an option).
    d. Describe to students that this is a 25 mile area of land that runs 300 feet deep.
    e. Compare the movement of water through diverse substrates.
    f. **Probing Questions:**
        i. Where is the water table?
        ii. What is the water table like near the river or wetlands? Why is it like this
        iii. What is the water table like near the factories and development? Why do you think it is like this? A:(Run off from concrete, more wells, higher water use).
        iv. How far down should you go with your well in each cross section.
        v. Where will the water build up? Describe Confined Aquifer.
        vi. Where will the water run through quickly? Describe Unconfined Aquifer
    g. Have students define Unconfined and Confined Aquifer in their Journal or vocab sheet
    h. Cone of Depression: Show students Cone of depression picture (see appendix)
        i. Ask students to guess what a cone of depression is.
        ii. Describe to students what happens when water is drawn from a well and how that affects the surrounding area.

Lesson Title:

Watershed Terrain model demonstration and "Crumble a Watershed"

Objectives:

- Student's will be able to visualize and demonstrate how watershed's work

Materials:

- Watershed Terrain Model *Contact: Oak Creek Watershed Council Phone: (928)554-5460 e-mail: marie@oakcreekwatershed.org*
- Crumble a watershed worksheet* (See Appendix)
- Blank White Paper
- Construction paper
- Markers (Blue and Green)
- Spray Bottle

*expedition Northwest "Crumble a watershed"

Procedure

1. Contact Oak Creek Watershed to arrange the watershed model plus demonstrator to come to your classroom
2. Split class in two groups. Allow one group to be part of the demonstration while the second group completes the Crumble a Watershed activity.
3. Crumble a watershed activity - Student procedure:
    a. Take blank white paper and crumble it up into a wad.
    b. Uncrumble the paper and tape edgest to an additional blank paper underneath (Construction paper works fine).
    c. With a green (or other color other than blue) marker, outline the ridges and mountain tops
    d. With a blue marker outline or color in where they think rivers and lakes would be
    e. When finished bring your model up to teacher to get sprayed
4. Crumble a watershed activity – Teacher procedure
    a. When Students are finished have them line up to get sprayed.
    b. Spray models (you can do more than one at once) and have students watch where the water is moving. See if students were correct in their predictions of where the water is movinb.
    c. Probing Questions:
        i. Why did the flow where it did?
        ii. How accurate were you in your prediction?
        iii. Why were you incorrect or correct?
        iv. How does this activity represent a real watershed

d. Hand out worksheet if desired for students to complete

Lesson Title:

Oak Creek Watershed Resident's Survey-Data Analysis

Objectives:

- Student will complete the Oak Creek Watershed Resident's Survey
- Students will analyze the data from the Oak Creek Watershed Resident's Survey by creating bar graphs
- Students will draw conclusions from their analysis of the Oak Creek Watershed Resident's Survey and present their findings to the class

Standards Addressed:

- Strand 1: Inquiry Process
    - Concept 4: Communication
        - PO 1. Choose an appropriate graphic representation for collected data
        - PO 2. Display data collected from a controlled investigation
        - PO 3. Communicate results of an investigation with appropriate use of qualitative and quantitative information

Vocabulary:

- Watershed

Materials:

- Oak Creek Watershed Resident's Survey (See appendix)
- Computers with Microsoft Excel
- Instructions for creating bar graphs on Microsoft Excel (See appendix)
- Document Camera

Procedure:

1. Warm Up:
    b. Students come to class having completed the Oak Creek Watershed Resident's Survey as a homework assignment
    c. Students are given the first few minutes of class to discuss their responses on the survey with other students
2. Compile Class Results from Oak Creek Watershed Resident's Survey
    d. Using provided data tables the class compiles the results from the following questions on the Oak Creek Watershed Resident's Survey; 2, 3, 4, 6, 9c and 9d. When compiling the results from question 6 students only record how often each pollution source was marked as the number one contributor to contamination that can cause human illness.
3. Data Analysis Using Microsoft Excel

e. Students are divided into groups and each groups is assigned one of the questions from the survey in which the class data has been compiled.
f. Every student individually creates a bar graph on Microsoft excel to illustrate the data from their question, however as students are in groups they can assist each other and compare their graphs.
g. As outlined in the directions provided to students to create their graphs all graphs must include a title, and labels on the x and y-axis.
h. After students have completed and printed their graphs they draw conclusions from their data by answering the following questions; what does your graph show? What are the implications of your results for the health of Oak Creek and the Oak Creek Watershed?

4. Student Presentations
    i. Each groups is responsible for presenting one of the graphs created in their group and discussing what conclusions were drawn from their data analysis
    j. A document camera works very well for this presentation as students' graphs can be placed under the document camera and projected on the board for the entire class to see.
5. Assessment
    k. Students graphs and responses to the conclusion questions are submitted for grading

Lesson Title:

E. Coli and Stakeholders in Oak Creek.

Objectives:

- Student will identify water quality issues in Oak Creek
- Students will be able to define E. coli and analyze where it comes from
- Students will be able to describe and identify stakeholders of a body of water

Vocabulary:

- Stakeholder
- E. coli (Escherichia coli)
- Genus
- Species
- Bacteria
- Feces
- DOT (Dept. of Transpiration)
- Indicator

Materials:

- Three E. coli related articles (See appendix)
- E. coli questions to go with articles (See appendix)
- Multiple sets of the 11 different Stake Holder Sheets (See appendix)

Procedure:

1. Warm up:
    a. Ask students to write down some potential problems with the health of the creek
    b. Compile class list on white board and discuss.
2. E. coli lecture / articles
    a. Introduce E. coli if not already identified.
    b. Define E. coli as a bacteria and the main water quality issue in Oak Creek.
    c. Hand out the packet of E. coli articles and have students silently read articles and complete attached worksheets (~25 minutes)
    d. Go over questions with students, ask questions and formative assess for understanding
    e. Stress that E. coli alone isn't always a problem but is an indicator for other more harmful bacteria
    f. Stress that high E. coli levels often lead to public closures of major swimming areas along oak creek
3. Identify Stakeholders
    a. Ask students to define stake holders. Lead students to define stakeholders as anyone who affects or is affected by something have students write definition in their journal or vocab sheet.
    b. Ask students to independently write down potential stakeholders of Oak Creek
    c. Ask students if they are stakeholders of Oak Creek. Explore why students are stakeholders of the creek.
    d. Compile class list of stakeholders on white board. Discuss each stakeholder and why they are a stakeholder
    e. Assign each student a stakeholder (see appendix) and give them their stakeholder sheet.
    f. Pass out laptops (optional) or take students to computer lab(optional) to research why their assigned stakeholder is a stakeholder
    g. Tell students they will be playing the role of their stakeholder for the next few days.
    h. Students should complete their stakeholder sheet in preparation for the following lesson

Lesson Title:

Mini-Watershed Councils

Objectives:

- Student will identify issues surrounding Oak Creek and the Oak Creek Watershed from the perspective of a specific stakeholder
- Students will be able to define point source and non-point source pollution
- Students will collaboratively create an improvement plan for the Oak Creek Watershed that includes background research and five strategic improvement projects

Standards Addressed:

- Strand 3: Science in Personal and Social Perspective
    - Concept 1: Changes in Environments
        - PO 1. Analyze environmental risks (e.g. pollution, destruction of habitat) caused by human interaction with biological or geological systems
        - PO 3. Propose possible solutions to address the environmental risks in biological or geological systems

Vocabulary:

- Watershed
- Point-source pollution
- Non-point source pollution
- E.coli
- Stakeholder

Materials:

- Computers with internet access
- Access to the OCWHIP-Oak Creek Watershed Improvement Plan – Link to document: http://www.oakcreekwatershed.org/images/PDFfiles/FINAL_OCWIP/15_OCWIP_9-12-12_Complete.pdf
- Stakeholder Response Question Sheet (See appendix)
- Oak Creek Watershed Council Improvement Plan Direction Sheet (See appendix)

Procedure:

8. Warm Up:
    a. Students brainstorm a list of all the issues surrounding the Oak Creek Watershed. Students ask themselves, what affects the health of the watershed?
    b. After discussing students responses, students identify what issues they listed would be examples of point-source pollution and which would be examples of non-point source pollution

c. Students add point-source and non-point source pollution to their water quality dictionaries

9. Stakeholders
    a. The class first discusses what the term stakeholder means. Students discuss that in order to begin to solve all the issues they just mentioned all the appropriate stakeholders would need to be involved in the conversation.
    b. Students brainstorm what stakeholders would need to be involved to improve the issues surrounding the Oak Creek Watershed.
    c. Each student is assigned a role as a stakeholder. The following stakeholders are assigned; farmer, cattle rancher, park ranger, hiker/dog owner, hunter/fisherman, local resident (on a septic system), tourist, day user, ADOT, city manager, and local business owner.
    d. Students step into the role as their assigned stakeholder and respond to the following questions from that perspective; who am I (includes a description of what their stakeholder does or is responsible for), how do I uses the Oak Creek Watershed, what are the primary concerns for the Oak Creek Watershed, how can I help improve water quality in the Oak Creek Watershed?
    e. Students are given time to do internet research to help them answer their stakeholder questions
10. Mini Watershed Councils and Improvement Plans
    a. After completing their stakeholder responses students come together as a class to discuss the directions for the next step, their mini watershed councils and improvement plans.
    b. Students take a few minutes to look at the OCWHIP (Oak Creek Watershed Improvement Plan) on the Oak Creek Watershed Councils website (http://www.oakcreekwatershed.org) to see what a tremendous amount of work, research and collaboration goes into improving the complex problems surrounding our watershed.
    c. Students are put into groups of 4-5 to form a mini Oak Creek Watershed council. Every student in a group must represent a different stakeholder.
    d. Groups are provided with copies of chapter 1 and 3 of the OCWHIP to help them develop their own improvement plans.

e. Working collaboratively students write a background for their improvement plan that explains what issues impact the health of the watershed and why there is a need for an improvement plan. Students' background explanations must be supported by data and research.
f. Working collaboratively students develop five strategic projects that will improve the health of the Oak Creek Watershed. Students must describe in detail how their projects will get done, who will ensure they get done and when and where the projects will take place. If a project needs funding students must describe how they would go about securing funds for their project.

11. Improvement Plan Presentations
    a. Each group presents their improvement plan to the class. Specifically explaining the five strategic projects they would implement to improve water quality in the Oak Creek Watershed.
12. Extension:
    a. Students create PowerPoint presentations outlining their improvement plans.
    b. PowerPoint presentations can be used to present to other classes and/or younger students.
13. Assessment

    Students' improvement plans and PowerPoint presentations are submitted for grading.

Lesson Title:

Slide Rock Field Trip

Objectives:

- Students will be able to demonstrate how water is sampled and tested
- Students will be able to analyze why we test water quality
- Students will explore ecology at the park through the Slide Rock Scavenger hunt

Materials:

- Slide Rock Scavenger hunt (This can be used for an additional activity during the day and can allow students to split into two groups if needed to make group smaller

Procedure:

1. For this field trip we coordinated with Dr. Rock from University of Arizona Water Quality extention program. Dr. Rock provided field testing equipment and training. Oak creek watershed Council also has water sampling kits.
2. Students test water quality including turbidity, flow rate, depth, temperature and E. coli levels.
3. Students complete slide rock scavenger hunt (see appendix) to learn about slide rock ecology and history and as a way to split up groups to allow for smaller water sampling groups.