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| **Title** | **Sustainability: Learning for a Lifetime – The Importance of Water** |
| **Introduction** | According to the Environmental Protection Agency (EPA) sustainability is based on the simple principle: Everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment. In this lesson students will become aware of the importance of a useable and safe water supply and will use the engineering design process to develop ways to clean water samples. |
| **Curriculum Alignment** | EEn.2.1.3 Explain how natural actions such as weathering, erosion (wind, water and gravity), and soil formation affect Earth’s surface.  EEn.2.2.1 Explain the consequences of human activities on the lithosphere (such as mining, deforestation, agriculture, overgrazing, urbanization, and land use) past and present.  EEn.2.3.2 Explain how ground water and surface water interact.  EEn.2.4.1 Evaluate human influences on freshwater availability.  EEn.2.4.2 Evaluate human influences on water quality in North Carolina’s river basins, wetlands and tidal environments. |
| **Learning Outcomes** | Students will identify ways in which water is essential to life on Earth.  Students will engineer an innovative approach to cleaning/filtering polluted water. |
| **Time Required and Location** | * 4-50 minute class periods * 2.5- 90 minute class period |
| **Materials Needed** | All printables provided in this lesson (Appendix 1 and Appendix 2)  • Carolina™ 9-Factor Classroom Water Quality Test Kit or similar kit  <http://www.carolina.com/product/carolina%26%23153-+9-factor+classroom+water+quality+test+kit.do?keyword=water%2Bquality%2Btest%2Bstrip&sortby=bestMatches>   * Contaminated water supplies for each pair/group  1. Add 2 table spoons of olive oil to local pond water 2. Add 1 table spoon of hot chocolate mix, 3-5 raisins to bottled water 3. Add 1 table spoon vinegar to local pond water 4. Add 1 table spoon crushed leaves, and 1 drop of green food coloring to tap water  * Water cleaning kit   + Cotton balls   + Coffee filter   + Panty house   + Sand   + Small rocks   + Soil   + Charcoal (fish supply)   + Marbles   + Leaves   + Any other supplies you have on hand that students might find useful   **Technology Resources**:   * Computers with internet access * Vernier probes (pH, temperature, turbidity, \* can use dissolved oxygen and nitrogen if available) * Projection/Smartboard |
| **Safety** | Students should follow typical lab safety procedures. |
| **Participant Prior Knowledge** | Students should understand and be able to test for pH. Students should have an understanding of sustainability. Students should have experience with the Vernier Probes. Students should be familiar with the engineering design process. |
| **Facilitator Preparations** | Print out all printables provided in this lesson. Prepare contaminated water supplies. |
| **Activities** | **Day 1**  **Exploration:**   1. Ask students to clear everything off the desk area. Students can work in pairs or small groups. Each pair/group will receive 4 clear containers labeled A, B, C, D each of which has different water samples and a premade test kit \* (includes pH sensor, temperature sensor, turbidity sensor all from Vernier probes.) 2. Propose the question to the class (making it clear that they are to NEVER drink lab supplies) which of these samples is safe to drink? 3. Give the students 30 minutes to hypothesize, run tests, and record observations in their science notebooks. 4. When the time is up, ask the class the question again, which of these samples is safe to drink? Allow students to defend their responses with their observations. Ask probing questions about the contents in the sample. Ask students if there could be anything in the sample that we cannot see or smell? There should not be any group that is 100% sure their sample is safe to drink. This discussion should take about 10-15 minutes. 5. In front of the class fill a glass with clean water and take a drink. Ask the students to research for homework the question, “What happens to the water you and I drink that makes it safe to drink?” (Project or write this question on the board and make sure to allow enough time that students are able to write it down.)   **Day 2**   1. Using the samples from yesterday and a glass of water straight from the tap ask the students again which of these samples is safe to drink? Use this time to discuss the answers student found to their homework question. This short discussion should take around 10-15 minutes. 2. **Guided Practice:** Explain that to clean up the water supply they must be able to properly test for contaminants that they can and cannot see. Following the guidelines provided in the kit walk the class through the first few tests for contaminants. Then allow them to test the rest on their own. They should be recording the contaminants in their write up. This should take 30-35 minutes. 3. After all pairs/groups have completed the testing go over the answers to ensure that the students were correctly identifying the contaminants. This should take 5-10 minutes.   **Day 3**  **Model System**   1. Students will work in groups or small pairs. Hand out each pair/group the scenario sheet. Read over the scenario together. Student group/pairs will each have water cleaning and water testing kit. Explain that they are to design and build a device that will clean the water supply. They will be using the engineering design model so they will have the opportunity to test their device and make improvements and test again. They will have 35 minutes to complete the task. 2. Pairs/Groups will write up their results and prepare to present them to the class.   **Day 4**  **Wrap-Up:**   1. Pairs/Groups will present their findings to the class. The class will take notes of the materials that seemed to do the best cleanup for each of the pollutants. After all students have presented ask the class of water contamination occurs in real life? Hand out the article. Have students read and answer the discussion questions on the article. |
| **Assessment** | Discussion, Water Clean Up Write Up (see Appendix 1), Article Thinking Questions (see Appendix 2) |
| **Critical Vocabulary** | • Sustainability: the capacity to endure. For humans, sustainability is the long-term maintenance of well-being, which has environmental, economic, and social dimensions, and encompasses the concept of stewardship, the responsible management of resource use.  • Potable: water pure enough to be consumed or used with low risk of immediate or long term harm.  • Turbidity: Turbidity is the cloudiness or haziness of a liquid caused by individual particles (suspended solids) that are generally invisible to the naked eye  • Water Treatment: Purification of water to make it suitable for drinking or for any other use |
| **Modifications** | Students can be shown an example of a filter system, students can be read the article, and students can answer multiple choice questions about the article. |
| **Alternative Assessments** | Students can draw pictures of their filter devices instead of completing the write up. |
| **References** | * The Environmental Protection Agency water pollution site provides more lessons, activities, and resources about the importance of water. <http://www.epa.gov/ebtpages/watewaterpollution.html> * The North Carolina Department of Natural Resources storm water and pollution provides resources about water pollution. <http://www.ncstormwater.org/> * Water and Sustainability site that concentrates on water quality. <http://www.unc.edu/~shashi/TablePages/watermain.html> * Our Future Planet (OFP) is an online community and think tank which aims to be the platform to create global change in the real world today. The long term goal is to harness the innovative ideas created through the website to write and publish a ‘Planetary Constitution’. <http://www.ourfutureplanet.org/topic-water> * The Center of Disease Control site explains the importance of water treatment. <http://www.cdc.gov/healthywater/drinking/public/water_treatment.html> |
| **Supplemental Information** | Information obtained from <http://www.cdc.gov/healthywater/drinking/public/water_treatment.html>  <http://www.ourfutureplanet.org/topic-water> |
| **Comments** | The article included in this activity is a sample. I would suggest finding an article that relates to water issues in the area in which your students live to make this activity more meaningful and relevant for your students. |
| **Author Info** | Tara Nye earned her Bachelor of Science degree from the University of Kansas and her Masters in Teacher Leadership from Lamar University. Mrs. Nye is currently a 7th grade science teacher and STeAM coordinator at Shughart Middle School located on Fort Bragg, NC. Mrs. Nye has worked with the DoDEA school system for 14 years. She has spent 10 of those years as a 7th grade science teacher and 4 of those years as a 9th grade Earth Science and Biology teacher.  This sustainable lesson was developed with the help of Mindy Love-Stanley of Sustainable Fort Bragg and Jon Parsons of Sustainable Sandhills. Mindy Love-Stanley is a sustainability education and outreach coordinator with the Environmental Management Branch in the Directorate of Public Works at Fort Bragg. In 2002, Mindy pursued completion of her Bachelor’s Degree at UNC Pembroke. She earned her B. S. in Environmental Science and graduated magna cum laude in 2008. That same year, Mindy accepted a position as a NEPA analyst in the Environmental Management Branch in the Directorate of Public Works at Fort Bragg. For nearly 2 years, she performed environmental analysis on construction projects.  In November 2010, Mindy moved to her current position in sustainability education and outreach. Since that time, the sustainability outreach program has expanded significantly to include Arbor Day, Earth Day, National Public Lands Day, conservation awareness campaigns and classes. Mindy is also active in her community. She serves on the Fayetteville Beautiful Board of Directors and the Fayetteville Area Metropolitan Planning Organizations Citizens Advisory Committee.  Jon Parsons has been the Executive Director of Sustainable Sandhills since August 2005. Jon holds a B.S. in Mechanical Engineering from the University of California at Santa Barbara. Jon is a registered Professional Engineer and Geothermal Ground Loop Designer and Installer (International Ground Source Heat Pump Association). As a research engineer in the Solar Heat Division of the Solar Energy Research Institute (now known as the National Renewable Energy Laboratory) in Golden, Colorado, Jon’s research focused on solar thermal technologies, including ocean thermal energy conversion and desiccant dehumidification. |

Appendix 1:

**Clean Up Our Water, Please**

The local water supply has been contaminated. You and your group of engineers have been called in to help the locals clean up the water supply as fast as possible. You will use your supplies to create a filtration/purification system that will best clean up the contamination.

**Part 1: Identify the Contaminates**

Carefully observe and test the contaminated water.

What does your group hypothesize has contaminated the water? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Part 2: Plan and Create the filtration/purification system**

Describe your groups plan to create the system. Draw a picture of the device

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**Part 3: Test the Device**

Write down your results from the first test.

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**Part 4: Improve the Device**

Explain how you improved your device

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**Part 5: Test the Improvements**

Write down your results from the second test

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**Part 6: Prepare Results for Presentation**

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| CATEGORY | **4** | **3** | **2** | **1** |
| **Experimental Hypothesis** | Hypothesized relationship between the variables and the predicted results is clear and reasonable based on what has been studied. | Hypothesized relationship between the variables and the predicted results is reasonable based on general knowledge and observations. | Hypothesized relationship between the variables and the predicted results has been stated, but appears to be based on flawed logic. | No hypothesis has been stated. |
| **Procedures** | Procedures are listed in clear steps. Each step is numbered and is a complete sentence. | Procedures are listed in a logical order, but steps are not numbered and/or are not in complete sentences. | Procedures are listed but are not in a logical order or are difficult to follow. | Procedures do not accurately list the steps of the experiment. |
| **Observations** | Clear, accurate diagrams are included and make the experiment easier to understand. Diagrams are labeled neatly and accurately. | Diagrams are included and are labeled neatly and accurately. | Diagrams are included and are labeled. | Needed diagrams are missing OR are missing important labels. |
| **Engineering Design Process** | Report illustrates an accurate and thorough understanding of the engineering design process. | Report illustrates an accurate understanding of most the engineering design process. | Report illustrates a limited understanding of the engineering design process. | Report illustrates inaccurate understanding of the engineering design process. |
| **Conclusion** | Conclusion includes whether the findings supported the hypothesis, possible sources of error, and what was learned from the experiment. | Conclusion includes whether the findings supported the hypothesis and what was learned from the experiment. | Conclusion includes what was learned from the experiment. | No conclusion was included in the report OR shows little effort and reflection. |

**Appendix 2:** SAMPLE ARTLICE

**Town X Officials Investigate E. Coli Contamination in Water Supply**

**TOWN X** – Primarily test results show potential contamination in the Town X water supply but officials are still waiting for a certified report to confirm the presence of E. Coli and fecal coliform.

As a precaution, Town X has ordered restaurants to temporarily shut down, and town officials have advised residents to boil their water before use.

“So far we have had only a verbal confirmation of the positive tests,” said Town X Manager. “The final results will guide us in which next steps we take.”

Town X has a closed water system but the water can be contaminated with bacteria when there is a break in the distribution system. The bacteria indicate the possible presence of human or animal feces. Town officials are investigating what could have caused the contamination.

Town X notified residents of the possible contamination by sending announcements to print, radio and television stations, posting information on the town's website and across social media, and updating the town's outgoing voicemail message.

**Questions to Make You Think**

1. Why were the restaurants in Town X shut down?

2. Why were residents of Town X told to boil their water?

3. Hypothesize two to three different ways you think the water could have been contaminated.

4. Town X is a pretty large community. What do you think would be the best way to get the message out that residences should not be drinking the water?

5. Explain the importance of clean water to life as we know it.

**Questions to Make You Think (Answers)**

1. Why were the restaurants in Town X shut down?

E. Coli and fecal coliform were found in the water supply.

2. Why were residents of Town X told to boil their water?

Boiling the water will kill the bacteria and make the water safe to drink.

3. Hypothesize two to three different ways you think the water could have been contaminated.

Answers will vary

4. Town X is a pretty large community. What do you think would be the best way to get the message out that residences should not be drinking the water?

Answers will vary

5. Explain the importance of clean water to life as we know it.

Answers will vary but should include that clean water is essential for all aspects of our lives including our health and our economy.