WATER HEROES INSTRUCTOR MANUAL

SUMMER 2016

July 5 – July 8

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Activity 1 – Opening Ceremony

Created by: Chris Gorski, 6/17/16

Estimated time: 45 minutes
Time frame: 8:30 – 9:15 Tuesday
Location: 102 Chemistry

Purpose: The opening ceremony will (1) provide an overview of the camp to campers and their parents and (2) be used to divide the campers into groups. Michael Zeman will give a brief overview of Science U.

Mentors' Role: We will introduce you at the start of the camp. When we divide the campers into their groups, you will meet with them. They will receive color-coded water bottles corresponding to their groups and will get markers to write their names on them. The campers should introduce themselves to each other – have each person go around in a circle and say their name and use any ice-breaker techniques you know. Finally, have them pick a team name that we will use for the rest of the camp.

Materials needed:
- Markers to decorate water bottles.

Lab Director's Role: Provide markers for water bottles and return them to Science U.

Procedure:
1. Manish and Chris will give an overview of the camp. We will introduce ourselves and ask the volunteers and mentors to introduce themselves.
2. After the introduction, we will break the campers into their respective groups. They will receive water bottles, which they should write their names on.
3. In the groups, the mentors will have them decorate or write their names on the bottles, introduce themselves to each other, and come up with a team name.

Information that will go in the students' manuals. None.

Activity 2 – Is your water safe to drink?

Created by: Boya Xiong, 6/30/16

Estimated time: roughly 120 minutes
Time frame: 9:15 – 11:30 Tuesday
Location: 108 S. Frear

Purpose: In this activity, students learn about important water quality parameters, where are they coming from and why is it important to keep them below a certain concentration for a safe drinking water. Students will bring their own water source and measure each water quality by themselves in order to investigate whether their water is safe to drink.

Mentors' Role: In this activity, the groups will compete by finishing and filling out all the 8 measurements listed in the manual for their own individual water sample. <u>We will need one mentor for each group</u>. Each measurement uses a different set of materials, thus <u>mentor's role (VERY IMPORTANT) is to make sure camper follow the procedure and each test for every camper's water is conducted correctly</u>. Most of the tests use strips that will show a color after dipping in water for a specific time period. Afterwards the color on strip should be matched with the color code on the flyer, which has to be conducted in a specific time period. So following the exact time is crucial to perform the test properly.

Materials needed:

1. Stopwatches
2. Water source: brought by each camper (<u>**at least 500ml, 16.9 oz**</u>)
3. Kimwhipe tissues
4. Eight water quality tests:
    a. Total dissolved solids (TDS)-TDS meter (we have 12)
    b. Hardness: test kit
    c. Turbidity - turbidimeter (from Manish Kumar's group, one mentor in charge of the measurement)
    d. pH - test kit
    e. Nitrate/nitrite nitrogen- test kit
    f. Free chlorine- test kit
    g. Iron- test kit
    h. Copper- test kit

Lab Director's Role and how to set up the lab: Prepare the following before the students arrive:

1. Set aside all the materials used for each measurement. Get kits and tudbidimeter and TDS meter from Boya in the morning prior to activity.
2. Spread 6 kits and 2 turbidimeters for each group. Unpack the kit and wrap the strips into the color code booklet. Lay six of the kits for each group. One student will get one kit.
3. Have the turbidity meter set up and demo it.
4. Have a whiteboard set up for listing water quality standards with the following table:

Water quality	EPA recommended secondary drinking water standards (ppm)	Group 1 (ppm)	Group 2 (ppm)	Group 3 (ppm)	Group 4 (ppm)	Group 5 (ppm)
Total dissolved solids (TDS)	500					
Total hardness	Considered in TDS					
Turbidity	1 NTU					
pH	6.5 - 8.5					
Nitrate/nitrite nitrogen	10					
Free chlorine	4					
Iron	0.3					
Copper	1.3					

1. **Procedure:** Introduce each water parameter to the students, where they come from, what problem they can bring to drinking water safety. Ask questions what are the parameters are most dangerous?
2. Explain briefly how to measure each parameter. Mention mentors will be there for help.
3. Start the water quality test. **There are 8 measurements**.
4. **Hardness, nitrogen, chlorine, pH, iron and copper (using test kit).** Each test has a specific strip that will show color after it was dipped in water (assuming the water

contains the target component). Then the color should be compared with the color code listed to determine a concentration. Write down the concentration in the manual. The time for both the dipping and the matching process have to be very well controlled. The specific time for each test is listed in the table below. Therefore, mentor has to lead the whole group to conduct the test together in order to guarantee a good measurement.

Water quality	Dipping time (second)	Matching time (second)
Total hardness	3	60
pH	10	15
Nitrate/nitrite nitrogen	2 (then wait for 1 minute)	60
Free chlorine	10 (shake briskly, wait 15 second)	
Iron	5 (shake briskly, remove excess water, wait 15 second)	15
Copper	15 (shake briskly, remove excess water, wait 30 second)	15

5. **TDS measurement**: use the TDS probe by dipping it to water and record the value until the value is stable. Press hold if you want the value to freeze on the meter.
6. **Turbidity measurement**: mentor should guide each camper to measure the turbidity at the turbidimeter station. Mentor should coordinate with other mentor or the activity leader to perform the measurement.
7. Have each group report, while writing down on the board:
    - **a.** Whether all their water is safe or not?
    - **b.** Which parameter/parameters that exceed the standard?
    - **c.** Please tell us where is the water coming from and why do you think this parameter might exceed the standard.

Information in the students' manuals.

Purpose: In this activity, we learn about important water quality parameters, where are they coming from and why is it important to keep them below a certain concentration for a safe drinking water. Please read carefully about each parameter listed in the table and learn about their significance. You will bring your own water source and measure each water quality in order to investigate whether your water is safe to drink.

Test your water!

There are 8 measurements in total: **Hardness, nitrogen, chlorine, pH, iron and copper (using test kit).** Each test has a specific strip that will show color after it was dipped in water (assuming the water contains the target component). Then the color should be compared with the color code listed to determine a concentration. Write down the concentration in the manual. The time for both the dipping and the matching process have to be very well controlled. The specific time for each test is listed in the table below.

Please pay very close attention to the time and procedure in order to guarantee a good measurement!

Water quality	Dipping time (second)	Matching time (second)
Total hardness	3	60
pH	10	15
Nitrate/nitrite nitrogen	2 (then wait for 1 minute)	60
Free chlorine	10 (shake briskly, wait 15 second)	
Iron	5 (shake briskly, remove excess water, wait 15 second)	15
Copper	15 (shake briskly, remove excess water, wait 30 second)	15

TDS measurement: use the TDS probe by dipping it to water and record the value until the value is stable. Press hold if you want the value to freeze on the meter.

Turbidity measurement: mentor should guide each camper to measure the turbidity at the turbidimeter station. Mentor should coordinate with other mentor or the activity leader to perform the measurement.

Activity 2 – Is your water safe to drink?

Parameter	EPA Recommended Standard (parts per million, ppm)	Risks if value is above Recommend Standard value	Where can it come from?
Total dissolved solids (TDS)	500	Form deposits; colored water; staining; salty taste	Sedimentary rocks and minerals
Total hardness	-	Hard water test; scales and precipitates	Natural minerals such as limestone
Turbidity	1 NTU	Turbid and muddy looking water	Dust, dirt, mud and sand
pH	6.5 - 8.5	Low pH: bitter metallic taste; corrosion; high pH: slippery feel; soda taste; deposits	Natural minerals and industrial activity. Limestone increase pH by adding carbonate to water; Sulfur dioxide from coal power plant can form sulfuric acid and acidify water.
Nitrate/nitrite nitrogen	10	Infants below the age of six months could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Agriculture runoff from using fertilizer, leaching from septic tank, sewage
Free chlorine	4	But high concentration of chlorine can cause eye/nose irritation; stomach discomfort	Added as a disinfectant during drinking water treatment to control bacteria
Iron	0.3	Give the drinking water a rusty color, metallic taste, reddish or orange staining	Corrosion of household plumbing, corrosion of natural minerals
Copper	1.3	Short term exposure: Gastrointestinal distress; Long term exposure: Liver or kidney damage; Give the drinking water a metallic taste; blue-green staining	Corrosion of household plumbing, corrosion of natural minerals

Parameter	EPA Recommended Standard (parts per million, ppm)	Your Water	Lowest value in your group	Highest value in your group
Total dissolved solids (TDS)	500			
Total hardness	-			
Turbidity	1 NTU			
pH	6.5 - 8.5			
Nitrate/nitrite nitrogen	10			
Free chlorine	4			
Iron	0.3			
Copper	1.3			

From your measurement, please answer:

a. Is your water safe to drink?

b. Is there any water from your group is **UNSAFE** to drink? If so, which parameter/parameters that exceed the standard?

c. Please tell us where is the water coming from and why do you think this parameter might exceed the standard.

Activity 3 – Can you build a filter system to treat polluted water?

Created by: Tyler Culp, 6/30/16

Estimated time: 2 hours
Time frame: 12:30 - 3:00 Tuesday
Location: 108 S. Frear

Purpose: In this activity, students investigate how different filter materials remove water contaminants in an inquiry-based exercise. Students will build their own water filters using different materials in order to explore how contaminants such as clay, methylene blue and salt may be removed from water to make it safe for drinking.

Mentors' Role: In this activity, the groups will compete by designing filters to make artificially contaminated water as clean as possible. They will design filters using common materials. Help them build the filters, then test how clean the water is by visual inspection (color), measuring salinity (using a conductivity meter), and measuring the cloudiness (turbidity). Each group can write and update their best results (color, turbidity, and conductivity) on the board in the lab.

Materials needed:

1. Filter materials:
    a. 20 oz soda bottles cut in half [8]
    b. Paper towels
    c. Package of coffee filters
    d. Gravel
    e. Sand
    f. Activated carbon, or "charcoal"
    g. Cups or scoops for materials
    h. Conductivity meters (from Manish Kumar's group)
    i. Turbidity meter (from Env. Engr. Teaching lab)
    j. Tubes for turbidity measurements (from Env. Engr. Teaching lab)
    k. Waste bucket for water
    l. Large stir rods

m. Whiteboard and markers

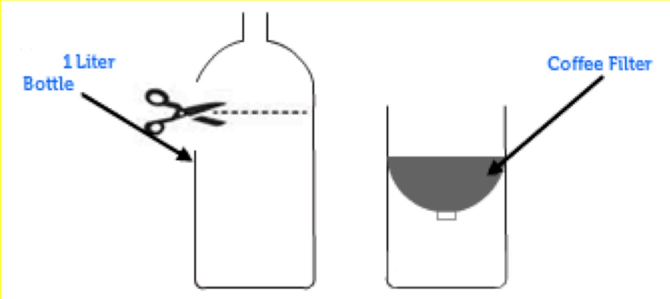
2. Dirty water:
   Dirty water has to be made by adding –
   a. Salt (1.5 g/L)
   b. Clay (Kaolinite, 10 g/L)
   c. Methylene Blue (2 mg/L)

3. Tap water (20 L)

Lab Director's Role: Make sure the setup detailed below is executed.

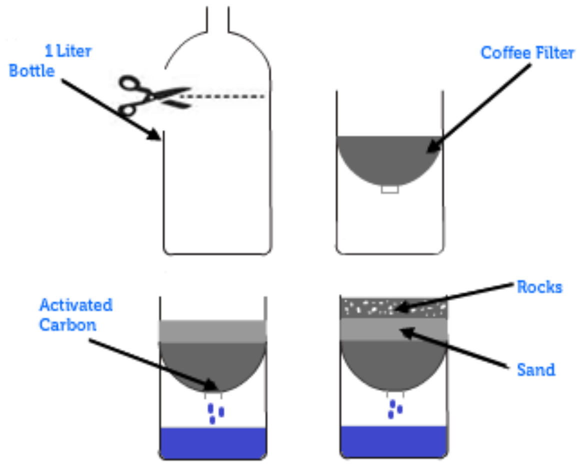
Setup Instructions: Please prepare the following before the students arrive:

1. Set aside one 20 oz. soda bottles for the each group (total three or six groups) and several coffee filters for each group.
2. Cut the top off the one liter plastic soda bottles using a scissor or a box cutter (about ¾ the way up from the base of the bottle).



3. Setup spots for scooping in the following filter materials (bucket with scooper): sand, activated carbon, gravel, lime, and bleach.
4. Have conductivity meters set up (will have used it on the previous day).
5. Have the turbidity meter set up and demo it.
6. Have a whiteboard set up for a water cleanup competition between the groups with the following table:

Group number	Turbidity (absorbance)	Saltiness (conductivity)	Color?



Procedure:

1. Make dirty water by adding the salt, methylene blue and clay to tap water in front of the kids. Measure the initial turbidity and conductivity.
2. Have a discussion on how the water changed visually as the contaminants were added, and whether they would call this water polluted. ***Note to mentors: encourage this discussion by drawing analogies to the color and turbidity of muddy water or stream water.***
3. Show students a coffee filter. Have discussion on how a filter works, and which filter media could remove the clay, methylene blue and salt. ***Note to mentors: compare different filter media to the size of particles the filter should remove. Students should ideally come up with the idea that smaller holes can hold back more particles while larger holes will let smaller particles through.***
   At the end of the discussion, the group should decide which media to use and in what order.
4. Introduce the water cleanup competition- each group's water will be tested after filtration, and the group with cleanest water wins! The cleanliness of the water will be decided using the turbidity meter and the conductivity meter. Lower the values measured, cleaner the water.
5. Guide students through building their own filter:
   a. Instruct students to create the main structure of their filter. Invert the top plastic bottle piece to form a funnel into the remaining bottle, which will now serve as a reservoir or basin for water to collect. The top portion will act as a funnel for filtering your sample water.
   b. Using a coffee filter, instruct students to place this in their makeshift funnel top portion. Now have each team construct layers that will make up their filter.
   c. Encourage students to begin laying down their first layers.

    d. Let each group decide on an order of the filtration material for their own filter for contaminated water

6. Now have students try to determine what materials remove what contaminants. Guide them along. ***Note – They will not be able to remediate the salty water.***
7. As they pass water through the filter, have the group come up to the conductivity meter and turbidity meter and measure the conductivity and transmittance of each filter configuration.
8. Use these numbers to make this a competition of which group can clean up the water the most. As each group's filtered sample is measured, write these values as scores on the board, and encourage them to try and get the lowest numbers.

Information that will go in the students' manuals.

	Was it removed? How much?		
Material(s) tested	**Turbidity (absorbance)**	**Saltiness (conductivity)**	**Color?**

Hint: Try combining materials!

	Was it removed? How much?		
Material(s) tested	**Turbidity (absorbance)**	**Saltiness (conductivity)**	**Color?**

Hint: Try combining materials!

What cleaned up the cloudiness of the water?

What cleaned up the color in the water?

What cleaned up the salt in the water?

What else would you want to consider when you make a filter?

Activity 4 – Blind Taste Test of Different Waters: Bottled, Tap, and Filtered Waters

Created by: Dr. Manish Kumar, Megan Farell, 6/27/2016

Estimated time: 1 hour
Time frame: 3:00 to 4:00 Tuesday
Location: 14 Life Sciences

Purpose: In this activity, students will explore the various qualities and different flavors of bottled, tap, and filtered water. Students will blind taste test water from different sources and critique the flavor and characteristics of the different water types. Students will learn about the differences between bottled water brands, the advantages and disadvantages of bottled water, and the distinct features of bottled, tap, and filtered water.

Mentors' Role: For this activity, students will learn about the advantages and disadvantages of bottled water and participate in a blind taste test for different sources of water to decide which water is "best". The mentor will describe where bottled water comes from, what it contains, and its possible impurities through Powerpoint and YouTube videos. The mentor will lead a discussion on the whiteboard/Powerpoint for listing the pro's and con's of bottled water. Students will answer on what they think is advantageous and not about bottled water. The mentor must facilitate students contributing to the pro's/con's list. For the taste test, students will test the water in different colored cups one by one, and the mentor will ask questions about what the students think of the taste for each water sample. At the end of the taste test, students will vote for their favorite water, and a handful of students will be asked to explain their choice. Lastly, the mentor will explain the differences between each of the water samples taste-tested.

Materials needed:

- Powerpoint
- Internet connection
- Dry erase markers/chalk
- Small Dixie cups in 5 different colors/patterns
- Tap water
- Brita filtered tap water

- Fiji water
- Dasani water
- A mineral springs water

Lab Director's Role: The lab director must pour the different water samples into small Dixie cups of different colors and record what type of water went into each color of Dixie cup. These must be distributed to all of the students for taste testing. A computer is needed for watching YouTube videos, showing a powerpoint for bottled water, and comparing filtered, tap, and bottled water.

Setup Instructions:

1. Pour water samples in different colored Dixie cups. Record which type of water went into each color of cup (e.g. tap water into red)
2. Make sure the computer is connected to Internet
3. Prepare a powerpoint with information on bottled water and the differences of filtered, tap, and bottled water

Procedure:

1. The mentor will provide background information on bottled water: where it comes from, what it contains, and its possible impurities
2. Two YouTube clips will be shown:
    a. https://www.youtube.com/watch?v=KrwmQqQ16gE&feature=youtu.be

    b. https://www.youtube.com/watch?v=r-4P0G1D2cw&feature=youtu.be

3. A discussion will be held for what was learned about bottled water from the presentation and videos. A pro's and con's list of bottled water will be made either on the board or in powerpoint. Students will participate in giving answers for the advantages and disadvantages of bottled water. Make sure that students are providing answers and to list what they say.
4. Following student input, list pro's and con's of bottled water not mentioned by students to give them a complete list of pro's and con's.
5. For the taste test, make sure a certain color is assigned to each of the water types.
6. Pick two-three volunteers to come to the front of the room.
7. Select a color and have the students taste that water sample.

8. Ask the volunteers their opinion of that sample:
    a. Do you think this water tastes metallic?
    b. Do you think this water tastes salty?
    c. Do you like this water?
    d. Would you drink this at home?
    e. Is there anything else you think that this water tastes like?
9. Ask the rest of the students to raise their hands if they think the water tastes metallic, salty, etc.
10. Have all students record their thoughts about each water sample.
11. Repeat for each of the water samples.
12. Have the students vote on which water sample was their favorite. Ask a couple of the students why that water was their favorite.
13. Reveal what type of water was in each color of Dixie cups.
14. Briefly explain the differences between bottled, tap, and filtered water.

Information that will go in the students' manuals.

Dixie cup color	Metallic?	Salty?	Do you like the taste?	Would you drink this at home?	Other comments

Students will record their comments for each of the water samples in the above table.

Activity 5 – Water Treatment Technologies

Created by: Hasin Feroz, 6/29/16

Estimated time: 75 minutes
Time frame: 9:15 – 10:30 Wednesday
Location: 108 S. Frear

Purpose: In this activity, students investigate how different technologies remove water contaminants such as clay, methylene blue and salt may be removed from water to make it safe for drinking.

Mentors' Role: In this activity, the mentors demonstrate how to clean artificially contaminated water using different technologies and what each technology removes. They then test how clean the water is by visual inspection (color), measuring salinity (using a conductivity meter), and measuring the cloudiness (turbidity).

What can be used to remove pollutants from water?

Materials

1. Technology materials
    a. Activated carbon, or "charcoal"/ Britta filter
    b. Life straw
    c. Reverse osmosis set-up
    d. Distillation set-up
    e. Cups or scoops for materials
    f. Beakers
    g. Conductivity meters (from Manish Kumar's group)
    h. Turbidity meter (from Env. Engr. Teaching lab)
    i. Laser
    j. Tubes for turbidity measurements (from Env. Engr. Teaching lab)
    k. Waste bucket for water
    l. Large stir rods and glass jar with the dirty water
    m. Whiteboard and markers

2. Dirty water:

Dirty water has to be made by adding –
    a. Salt (1.5 g/L)

    b. Clay (Kaolinite, .5 g/L)
    c. Methylene Blue (2 mg/L)

3. Tap water (20 L)

Lab Director's Role: Groups at a time should spend 15 minutes at each station (4 stations)

Setup Instructions: Prepare the dirty water that needs to treated with the composition provided above. Kumar lab should be able to collect all the materials necessary.

Procedure: Graduate student/mentors with experience in handling the technologies will bring in, set-up and demonstrate the technologies-Britta filter (Tingwei), life-straw (Hasin), distillation (Patrick) and RO(Yuexiao). We can coordinate with interested mentors so that they can learn and demonstrate activity to the campers.

Information that will go in the students' manuals.

Today we are going to talk about how we can treat water with different technologies. Here is a list of the technologies we will demonstrate.

Station	***Technology***	***How is it removed?***
1	*Activated Charcoal*	*Adsorption of material on to activated charcoal*
2	*Microfiltration (Life straw)*	*Difference in particle size and pore size of membrane*
3	*Reverse Osmosis*	*Difference in size of salt molecule and size of membrane pore*
4	*Distillation*	*Difference in boiling point of salt and water*

EXPERIMENTAL

Note down the data for conductivity and/or turbidity for each untreated and treated sample in the following Table.

<table>
<tr><th></th><th>Technology</th><th>Sample tested/Procedure</th><th colspan="2">Observed results</th></tr>
<tr><td>1</td><td>Activated charcoal</td><td>Dirty water was filtered through activated carbon in a Britta filter</td><td colspan="2">Water color changes from blue to _______</td></tr>
<tr><td rowspan="6">2</td><td rowspan="6">Microfiltration (Life straw)</td><td rowspan="6">Dirty water (50 – 100 mL) was filled into the lifestraw reservoir and allowed to drip out. Sufficient sample could be collected for further analysis within 15 mins.</td><td colspan="2">Conductivity(microS/cm)</td></tr>
<tr><td>Before filtration</td><td>After filtration</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Turbidity(in NTU)</td></tr>
<tr><td>Before filtration</td><td>After filtration</td></tr>
<tr><td></td><td></td></tr>
<tr><td rowspan="6">3</td><td rowspan="6">Reverse Osmosis</td><td rowspan="6">Dirty water (50 – 100 mL) was pressurized in an 180 mL pressurized cell equipped with a reverse osmosis membrane, at 50 psi pressure under vigorous stirring. Sufficient sample could be collected for further analysis within 15 mins.</td><td colspan="2">Conductivity(microS/cm)</td></tr>
<tr><td>Before filtration</td><td>After filtration</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Turbidity(in NTU)</td></tr>
<tr><td>Before filtration</td><td>After filtration</td></tr>
<tr><td></td><td></td></tr>
<tr><td rowspan="6">4</td><td rowspan="6">Distillation</td><td rowspan="6">Dirty water (50 – 100 mL) was heated in a distillation set-up. Sufficient sample could be collected for further analysis within 30 mins.</td><td colspan="2">Conductivity(microS/cm)</td></tr>
<tr><td>Before filtration</td><td>After filtration</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Turbidity(in NTU)</td></tr>
<tr><td>Before filtration</td><td>After filtration</td></tr>
<tr><td></td><td></td></tr>
</table>

Activity 6 – Build a water filter – part 2

Created by: Tyler Culp, 6/30/16

Estimated time: 90 minutes
Time frame: 10:30 - 12:00 Wednesday
Location: 108 S. Frear

Purpose: In this activity, students will use what they learned with the advanced treatment technologies to redesign their filters.

Mentors' Role: In this activity, the groups will compete by designing filters to make artificially contaminated water as clean as possible. They should develop hypotheses based on what they learned in the previous exercise.

Materials needed:

4. Filter materials:
    a. 20 oz soda bottles cut in half [8]
    b. Paper towels
    c. Package of coffee filters
    d. Gravel
    e. Sand
    f. Activated carbon, or "charcoal"
    g. Cups or scoops for materials
    h. Conductivity meters (from Manish Kumar's group)
    i. Turbidity meter (from Env. Engr. Teaching lab)
    j. Tubes for turbidity measurements (from Env. Engr. Teaching lab)
    k. Waste bucket for water
    l. Large stir rods
    m. Whiteboard and markers

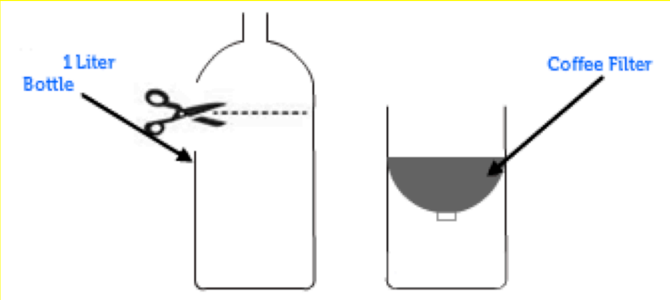
5. Dirty water:
    Dirty water has to be made by adding –
    a. Salt (1.5 g/L)
    b. Clay (Kaolinite, 10 g/L)
    c. Methylene Blue (2 mg/L)

6. Tap water (20 L)

Lab Director's Role: Make sure the setup detailed below is executed.

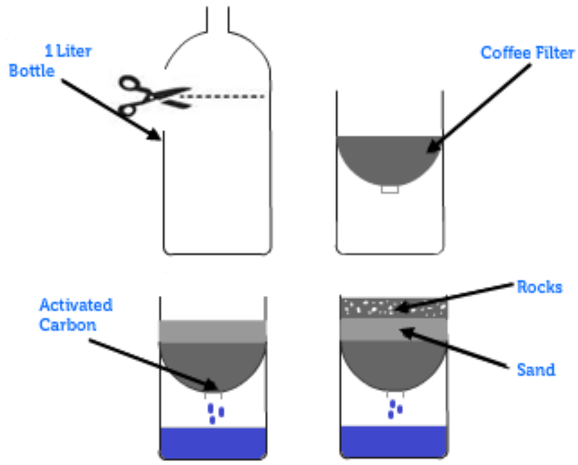
Setup Instructions: Please prepare the following before the students arrive:

7. Set aside one 20 oz. soda bottles for the each group (total three or six groups) and several coffee filters for each group.
8. Cut the top off the one liter plastic soda bottles using a scissor or a box cutter (about ¾ the way up from the base of the bottle).



9. Setup spots for scooping in the following filter materials (bucket with scooper): sand, activated carbon, gravel, lime, and bleach.
10. Have conductivity meters set up (will have used it on the previous day).
11. Have the turbidity meter set up and demo it.
12. Have a whiteboard set up for a water cleanup competition between the groups with the following table:

Group number	Turbidity (absorbance)	Saltiness (conductivity)	Color?



Procedure:

9. Make dirty water by adding the salt, methylene blue and clay to tap water in front of the kids. Measure the initial turbidity and conductivity.
10. Have a discussion on how the water changed visually as the contaminants were added, and whether they would call this water polluted. ***Note to mentors: encourage this discussion by drawing analogies to the color and turbidity of muddy water or stream water.***
11. Show students a coffee filter. Have discussion on how a filter works, and which filter media could remove the clay, methylene blue and salt. ***Note to mentors: compare different filter media to the size of particles the filter should remove. Students should ideally come up with the idea that smaller holes can hold back more particles while larger holes will let smaller particles through.***
    At the end of the discussion, the group should decide which media to use and in what order.
12. Introduce the water cleanup competition- each group's water will be tested after filtration, and the group with cleanest water wins! The cleanliness of the water will be decided using the turbidity meter and the conductivity meter. Lower the values measured, cleaner the water.
13. Guide students through building their own filter:
    a. Instruct students to create the main structure of their filter. Invert the top plastic bottle piece to form a funnel into the remaining bottle, which will now serve as a reservoir or basin for water to collect. The top portion will act as a funnel for filtering your sample water.
    b. Using a coffee filter, instruct students to place this in their makeshift funnel top portion. Now have each team construct layers that will make up their filter.
    c. Encourage students to begin laying down their first layers.

   d. Let each group decide on an order of the filtration material for their own filter for contaminated water

14. Now have students try to determine what materials remove what contaminants. Guide them along. ***Note – They will not be able to remediate the salty water.***
15. As they pass water through the filter, have the group come up to the conductivity meter and turbidity meter and measure the conductivity and transmittance of each filter configuration.
16. Use these numbers to make this a competition of which group can clean up the water the most. As each group's filtered sample is measured, write these values as scores on the board, and encourage them to try and get the lowest numbers.

Information that will go in the students' manuals.

Based on what you learned in the previous activity, what filter materials would you expect to remove turbidity? Why?

Based on what you learned in the previous activity, what filter materials would you expect to remove saltiness? Why?

Based on what you learned in the previous activity, what filter materials would you expect to remove color? Why?

Ok, now let's test these hypotheses.

	Was it removed? How much?		
Material(s) tested	**Turbidity (absorbance)**	**Saltiness (conductivity)**	**Color?**

	Was it removed? How much?		
Material(s) tested	**Turbidity (absorbance)**	**Saltiness (conductivity)**	**Color?**

Hint: Try combining materials!

Did the material you proposed remove turbidity? If not, why do you think it didn’t?

Did the material you proposed remove saltiness? If not, why do you think it didn’t?

Did the material you proposed remove color? If not, why do you think it didn’t?

Activity 7 – Advanced Water Treatment Technologies – Field Trip

Created by: Sarah Cronk, July 6, 2016

Estimated time: 80 minutes
Time frame: 1:00 – 2:30 Wednesday
Location: Tertiary Treament Facility at UAJA, Contact is Art Brant (abrant@uaja.com) the Plant Superintendent

Purpose: On this field trip, students will get to observe large scale drinking water treatment technologies found at UAJA. Throughout the camp, students will be given the opportunity to use these technologies, like activated carbon, reverse-osmosis, distillation, on a small-scale in the lab, and this field trip compliments this experience. The tertiary treatment that occurs at the plant includes reverse-osmosis, UV-treatment, and ozone treatment.

Mentors' Role: The mentors will need to break the student group into two, as the tertiary treatment facility cannot accommodate the entire group. One group will go on a tour in the facility, and the other group will tour the tail-end of the wastewater treatment plant (secondary treatment).

We hope that mentors can encourage students to draw parallels between the lab research that they performed in the lab and the large-scale processes at the plant.

Materials needed:

- None

Lab Director's Role: N/A

Setup Instructions: N/A

Procedure:

1. Students will arrive at the UAJA facility by bus.
2. Once there, mentors will split the group into two. Half of the group will go on a tertiary treatment tour with a facility operator and the other group will tour the tail

end of the wastewater treatment plant. The tours will take approximately 30-40 minutes.

3. Once the first round of tours is over, students will switch to the other tour.
4. Throughout the tours, we are encouraging students to ask questions about the large scale water treatment processes.

Information that will go in the students' manuals

N/A

Activity 8 – Water Questions!

Created by: Chris Gorski, 6/30/16

Estimated time: 60 minutes
Time frame: 2:30 – 3:30 Wednesday
Location: 4 Life Sciences

Purpose: In this activity, groups will pick a question related to drinking water and research the answers online. We will then discuss the answers as a group.

Mentors' Role: Help the campers pick a question and research it on computers using the internet. Try to keep them on "credible" sites.

Materials needed:
- None

Lab Director's Role: Make sure we are logged into the computers (at least 2 per group).

Procedure:
1. Introduce the that we have a list of water quality questions to answer, and each group can pick one to research – or they can pick their own question (with the mentor's approval).
2. Have a powerpoint slide with the options up or write them on the board.
3. Possible questions:
    a. How can water become contaminated from hydraulic fracturing? (And what is hydraulic fracturing?)
    b. Is it safe to drink pool water?
    c. Why is peeing in the pool bad? (And why is it bad to not shower before going in the pool?
    d. What happened to the drinking water in Flint, Michigan recently?
    e. Why is it good to use phosphate free laundry detergent and soap?
    f. What happens if I over fertilize my lawn?
    g. What happens if I flush old medicine down the toilet?
    h. What water is safest to drink in the wild?
4. Give each group approximately 40 minutes to do their research, then each group will give a few minute answer to the rest of the group, who can ask more questions.

Activity 9 – Salt water lemonade tasting

Created by: Yuexiao Shen, **07/06/2016**

Estimated time: 60 minutes
Time frame: 1:30 – 2:30 Wednesday
Location: 4 Life Sciences

Purpose: Organic matter, inorganic matter and microorganisms are the major pollutants in drinking water. Salinity (belong to inorganic matter) in water can be measured using conductivity, more salt conducts more electricity and thus "conductivity" can be used to measure salt content. We also have a salt meter – our tongue. We have made several concentrations of salt in lemonade for you. Guess what salinity these are (connect lines between sample numbers and the right concentrations. Also write down the conductivities measured.

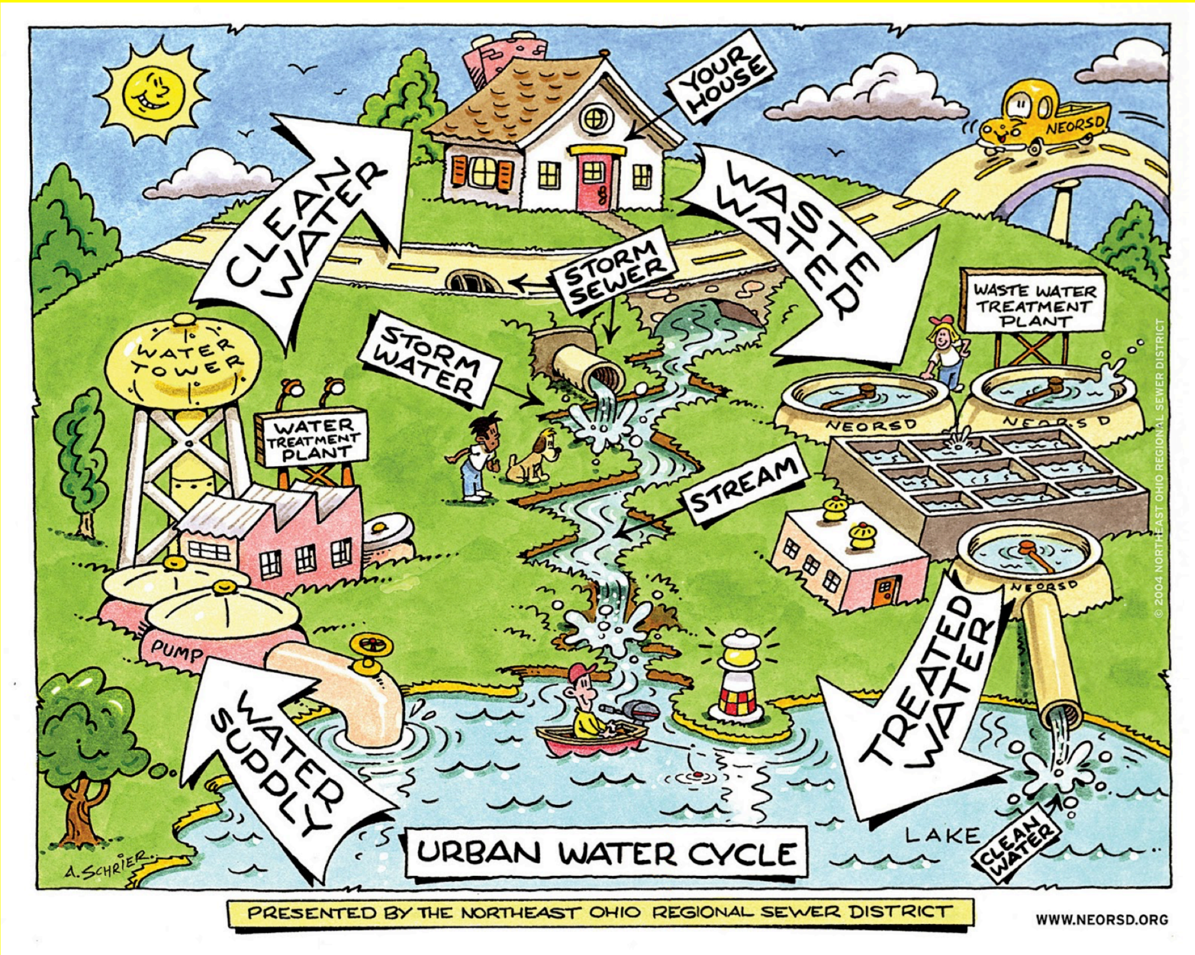
Mentors' Role: Let the campers be familiar with the common pollutants in drinking water (show on a black board and explain to the campers). Teach the campers there are many methods to measure the salt concentrations. One direct method is using our tongue, but this is only limited to food-grade salt. After the tasting experiment, we can show that the salinity can be showed on a conductivity meter.

Materials needed:

- Black board
- 6×2 L lemonade
- 1 bottle of salt
- 150 paper cups
- 1×1 gallon water bottle (for mixing)
- Conductivity meter

Lab Director's Role: Find a meeting room with at least 5 tables.

Setup Instructions: Draw a water cycle on a black board and show the potential pollutant sources. Make lemonade with different salt concentration the day of the activity: 0.5 g/L (2L), 1.0 g/L (2L), 2.0 g/L (2L), 10 g/L (2L), 35 g/L (2L). Before the experiment, set up 5 tables (Mark the tables from 1 to 5, indicating the samples from 1 to 5) and each table has 30 cups half-filled with the lemonade. Set up a conductivity meter.



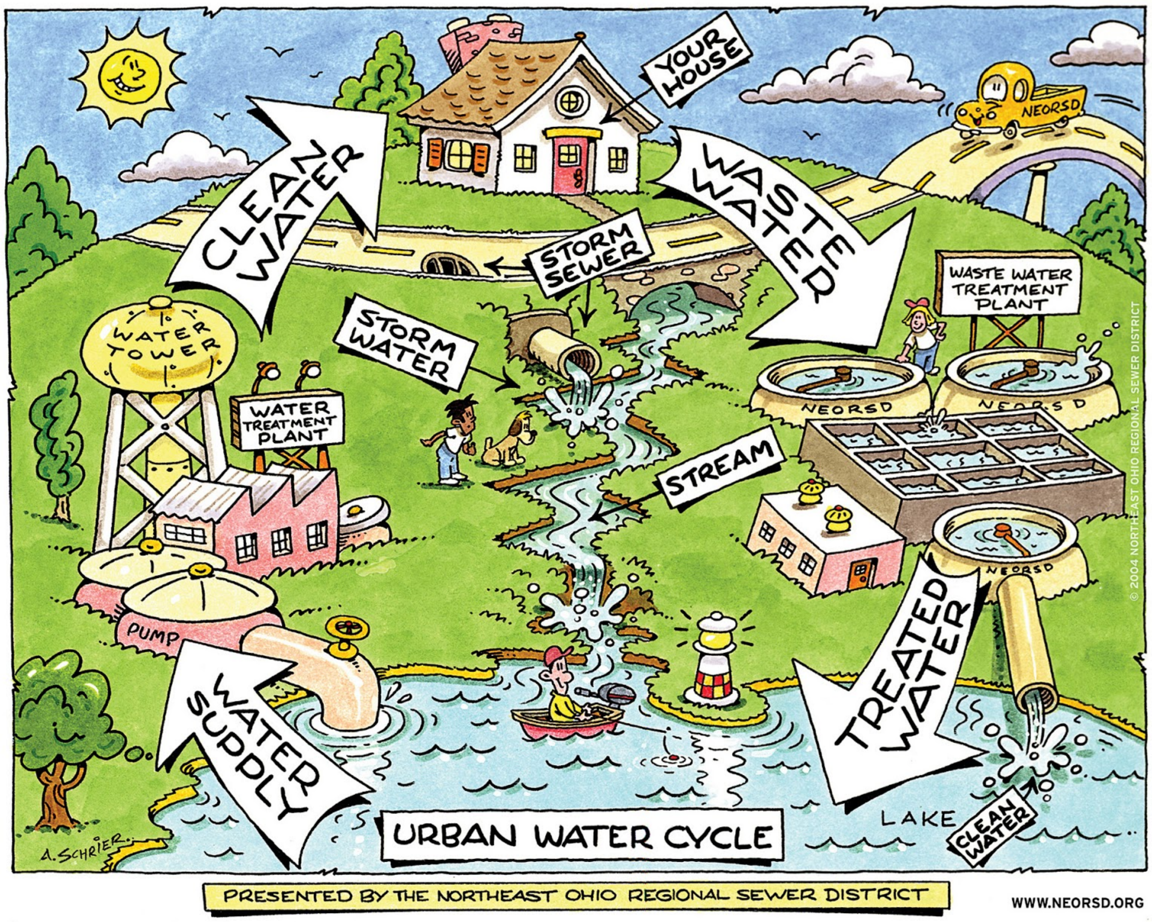
Procedure:

1) Introduce the common pollutants in drinking water
2) Make lemonade with different salt concentration 1 day before the activity: 0.5 g/L (2L), 1.0 g/L (2L), 2.0 g/L (2L), 10 g/L (2L), 35 g/L (2L);

Sample 1	35 g/L (seawater!)	_______________
Sample 2	0.5 g/L (~tap water)	_______________
Sample 3	1.0 g/L	_______________
Sample 4	2.0 g/L	_______________
Sample 5	10 g/L	_______________

3) Set up 5 tables (sample 1 to 5) and each table has 30 cups;
4) Let the campers taste the lemonade and guess the concentrations;
5) Measure the conductivities.

Information that will go in the students' manuals.
Pollutants in drinking water



The pollutants in drinking water can be classified in to organic pollutants, inorganic pollutants and microorganisms. Recent lead pollution in Flint, Michigan belongs to inorganic pollutions. The drinking water pipe contains lead and lead was released into the drinking water because of the water chemistry was not stable in the drinking water wipe. The drinking water issue in Milwaukee, Wisconsin in 1990s belongs to microorganism pollution because the drinking water resource was contaminated by parasite.

Lemonade tasting

How salty is salty? You measured salinity using conductivity, more salt conducts more electricity and thus “conductivity” can be used to measure salt content. You also have a salt meter – your tongue. We have made several concentrations of salt in lemonade for you. Guess what salinity these are (connect lines between sample numbers and the right concentrations. Also write down the conductivities measured.

Sample 1 ________________

Sample 2 ________________

Sample 3 ________________

Sample 4 ________________

Sample 5 ________________

Which lemonade tasted the best to you?

Activity 10 - What can live in the water you drink (or don't drink!)?

Created by: Tingwei Ren 06/24/2016

Estimated time: 150 minutes
Time frame: 9:30 to 12:00 Thursday
Location: 108 S. Frear

Purpose: In this activity, students investigate what kinds of microorganisms may live in our drinking water (or the water related to our life). Students will build their own microscope slides and observe microorganisms under microscope using the water they bring. Students will also draw the microorganisms based on what they observed. If there is extra time, students can filter their water samples and re-look at them under microscope. In the way, they can understand what kinds of microorganisms can be removed by water filtration.

Mentors' Role: In this activity, student groups will look at microorganisms in the drinking water under microscopes. They need to build up microscope slides and adjust the microscope so that they can see microorganisms. Help them to build microscope slides and focus the microscope if needed. Also, prepare some water samples in case some groups observe nothing from their water samples. Each group can draw microorganisms they observed. Also, mentors can help students filter their water samples and compare the microscope observation results before and after filtration

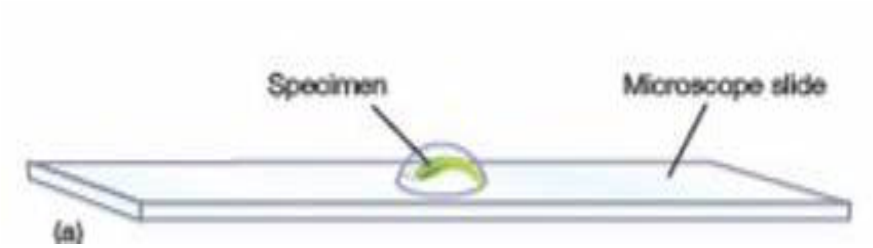
Materials needed:
1. Microscope (need to be tested before Water Camp, **mentors should know how to adjust and focus the microscope.)**
2. Microscope manual (will be prepared after we tested the microscope. We will print out the manual and give to students on the activity day)
3. Microscope slides and coverslips.
4. Filter paper (use to clean the edge of microscope slides)
5. Prepared water samples (bottle water, tap water, pond water or even yogurt are recommended)
6. Plastic transfer pipettes

Lab Director's Role: Lab director need to set up the microscopes, including prepare microscopes slides and plastic pipettes for each microscope. Also, lab director and volunteers need to help focus the microscope.

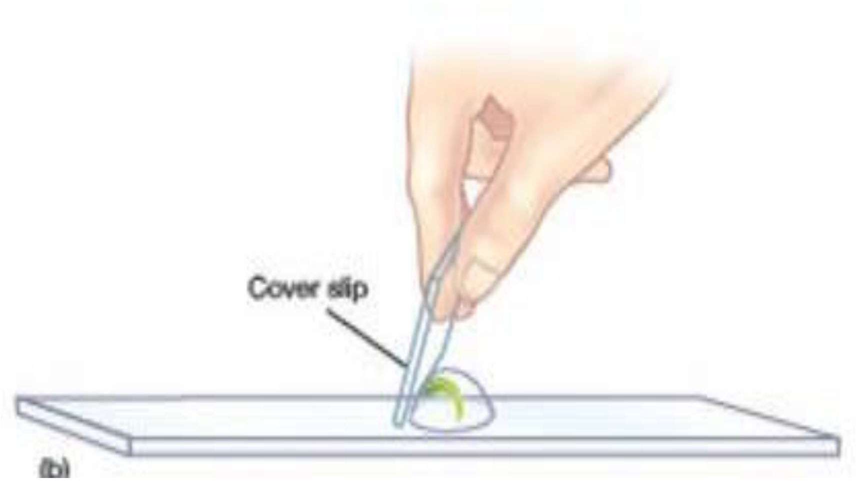
Setup Instructions:
1. Pre-adjust the microscope close to the focus position, so that students won't spend too much time on finding the focus of microscope.
2. Prepare 4-5 sets of microscope slides for, coverslips and pipettes for each microscope

Procedure:

1. Look at the water you bring, can you see anything in it? If so, please write down them.
2. Use plastic pipettes to add one drop of your water sample on the center of microscope slide



3. Gently touch the coverslip to the edge of water and cover the water drop slowly



4. Use the filter paper to remove water outside the coverslip

5. Put your microscope slides under microscope, and focus the microscope until you see something under microscope. Please ask mentors for help if you have difficulties to adjust the microscope.

Focus Statue

Defocus Statue

6. Draw the microorganisms you observed
7. You can filter your samples based and re-look at them under microscope again. Can you see the differences?

Information that will go in the students' manuals.

What can live in the water you drink (or don't drink!)?		
What's the water you bring?	Can you see anything in the water directly?	What do you see under microscope?

What happened to the water sample after filtration?		
What's the water you bring?	What kind of filtrations you used ?	What do you see under microscope?

Will you drink the water if it looks “clean”? Why?

What may exist in the water? Can you remove them by filtration?

What else can you do to remove the things you observed under microscope?

Additional resources for mentors and volunteers:

1. YouTube Videos on how to set up the microscope observation experiment:
Yogurt under microscope: https://www.youtube.com/watch?v=3ktFHq5pKbo
Pond water under microscope: https://www.youtube.com/watch?v=guAcLiP4DlM
2. Examples of microorganisms (we can draw these microorganisms on the board and help students identify organisms they observed): http://www.microscopy-uk.org.uk/index.html?http://www.microscopy-uk.org.uk/pond/

Activity 11 – Public Service Announcement

Created by: Chris Gorski, 6/17/16

Estimated time: 3 hours on Thursday afternoon, finishing on Friday afternoon before closing ceremony
Time frame: 2:00 – 4:00 Thursday, 1:00 – 2:00 Friday
Location: 8 Life Sciences, other locations if the groups need to separate.

Purpose: This is the cumulative activity of the camp. The campers will create a public service announcement video related to water safety. It is up to the campers to decide what topic they will cover, but it should be related to water treatment or protection in some way, and it will hopefully incorporate information from the camp. The idea is that they will convey information they learned from the camp and/or independent research to develop actionable steps that they will share with their parents at the closing ceremony.

Mentors' Role: The goal of this activity is for the campers to develop a public service announcement video that they will present to the parents at the closing ceremony. We will be providing the campers with cameras, and they should be able to upload these videos and do minimal editing to make them.

Please help the students outline an idea for their video and an action plan for making it. They may need to do some research on the topic, which they can use the internet for our interview others involved with the camp. They will have computer access in 8 Life Sciences. It is ok for it to be silly, but try to have some science in there that is accurate. Aim for 1 – 5 minutes.

Materials needed:
- 5+ cameras capable of recording videos (one for each group). (Mentors should use their cell phones)
- Computers with internet access and video editing software to do research and edit videos.

Lab Director's Role: The lab director will make sure that the computers are working and that the campers are able to use the cameras.

Setup Instructions:

- Log into at least 10 computers in 8 Life Sciences before the students arrive. Space out the computers so groups can be separated.
- Make sure the cameras are charged and have their memory cleared.
- Check that the cameras can be hooked up to the computers.

Procedure:

1. Have all the campers attentive and explain to them that they will be creating a public service announcement related to protecting water resources from contamination or cleaning up dirty water for use. They will make a video with the help of a mentor to show the parents at the closing ceremony. The video should be approximately 1-5 minutes in length and should cover a topic related to what we learned this week. The campers will be given cameras that can record videos and access to computers to do research and edit their videos.
2. The campers will first spend time brainstorming possible ideas for their public service announcements as groups. Mentors should encourage and record ideas. After ~10 minutes of brainstorming, they should decide as a group on a topic. If a consensus cannot be reached, we can reshuffle campers from different groups or break the groups down further.
3. The mentor will then help them come up with ideas for how they will cover the topic in their announcement.
4. Once an idea is settled upon, the campers should research any information they need for making the video. They can do this by searching the Internet or interviewing the instructors.
5. The campers should then outline what will go into the video, decide if they need any props, and began making it.
6. They can edit the videos they record using one of the following programs in the computer labs: Adobe Prelude or Microsoft Movie Maker.
7. The campers will be called up when their video is shown at the closing ceremony and can answer questions.

Information that will go in the students' manuals.

Public Service Announcement

Time frame: 1:00 – 4:00 Thursday, 1:00 – 2:00 Friday
Location: 8 Life Sciences, other locations if the groups need to separate.

For the final activity of the camp, you and your group are going to share what you have learned with your parents and community by creating a **Public Service Announcement.** This will be a short video (1-5 minutes) that you make on an issue related to this camp that addresses protecting water resources or cleaning up dirty water. As a group, you will plan, make, and edit the video, which will be shown to all the other campers and parents at the closing ceremony on Friday afternoon.

First, take time (~10 minutes) with your group to brainstorm some ideas of what topic you'd like to focus on. Write any ideas you have below.

Once your group has decided on a topic, brainstorm different ideas for how you'd like to discuss it in a video and decide if there is any research you need to do to make it. Feel free to split up tasks among the group! Use the space below for any notes.

Once you have recorded parts, you may begin editing the video on a computer. Use one of the following software programs: Adobe Prelude or Microsoft Movie Maker.

Activity 12 – Spring Creek Stream Health Survey

Created by: Sarah Cronk, Sydney Stewart (July 8, 2016)

Estimated time: 180 minutes
Time frame: 9:00 am – 12:00 pm
Location: Spring Creek Park, State College PA (https://goo.gl/maps/efbYKprsAiM2)
Pavilion Rental 1 or 2: http://www.crpr.org/Parks/pavs-lge/picnic_pavilions.html

Purpose: In this activity, students will examine the physical attributes of an area in and around a stream and the wildlife present. With the information they gather through a sketch of the site, an in-stream survey, and macroinvertebrate sampling, they will assess the stream health. Activities like these allow students to understand what effect human impact has on pristine stream environments.

Mentors' Role: Students will be divided into group of 4 or 5 students for the entire morning's activities. We will need to number off the groups for competitions, too. Mentors will need to firmly establish the boundaries in which the students can perform their survey and keep a general watch over them.

For the first activity (sketch of the site), mentors need to make clear that students are not allowed in the water. As students work on their sketch, mentors should be looking over them and asking them to draw in some of the subtler details (like the variation in vegetation, boulders, logs and sticks, and how fast water is moving).

For the second activity (in-stream survey), mentors need to make clear that students are to stay within delineated boundaries while in the water. Mentors are encouraged to perform the activity with the students and to inspire students to get their hands wet and really explore the stream as guided in the worksheet.

For the third activity (macroinvertebrate sampling), mentors will divide their group of five into two: with two students fetching macroinvertebrates with the D-net in the stream, and three students staying on shore to help sort the insects in a tray. Ideally, these roles will be rotated throughout the activity. Mentors should accompany two students into the stream and guide them on how to use the D-frame net. Another mentor should also be on shore helping students sort macroinvertebrates. After a few rounds of using the D-net in the stream, enough macroinvertebrates should be collected and sorted to count them up and report them on the white board. Between groups there will be a competition of who can find the most macroinvertebrates. Mentors can view this video for an idea: https://youtu.be/IuNn4VqFtJI

Materials needed:
The only materials needed are for the third activity (macroinvertebrate sampling):

1) D-Frame Nets (5 – for catching macroinvertebrates)
2) White Sorting Trays (5 –for sorting)
3) Forceps (5 pairs – for sorting)
4) Plastic spoons (for sorting)
5) White ice cube trays (5 – to sort the macroinvertebrates)
6) Handheld magnifier (10 – to view the macroinvertebrates)
7) Buckets (5 – for initial sorting)
8) White board for writing out competition results (1)
9) Poster with common macroinvertebrates, particularly stoneflies, caddisflies, and mayflies. (5 small posters, 1 large poster)

Lab Director's Role: Since Spring Creek is a pretty busy area, the lab director will need to "set up shop" in a space that can accommodate our large group for macroinvertebrate sampling. What this will require is access to the stream and access to a wide shore. We'll need items set out for the macroinvertebrate sampling.

Setup Instructions:

1) Collect materials to take to Spring Creek (see above)
2) Once at Spring Creek Park, arrive at the beach area with materials. This is the site where students will perform the macroinvertebrate sampling.
3) In the grassy area near the beach, we will need to set up 5 or 6 stations (depending on how many groups of students there are). There needs to be enough space to accommodate 5 excited students and 2 mentors.
4) At the station (known as the sorting station), there needs to be one bucket, one sorting tray, one ice cube tray, a pair of magnifiers, a pair of tweezers, several plastic spoons, one D-frame net, and small poster.

General Procedure:

1. Students will have packet beforehand, so while on the bus to Spring Creek have students fill out the first page of the Sprink Creek Stream Health Evaluation. This means asking students how healthy they think Spring Creek is, etc.
2. Once on site, have students gather at the 'UPPER BOUNDARY' (see sketch map). Here, either mentors/grad students will describe the rules for the day:
   RULE 1: Stay within the delineated boundaries. Anyone going outside the boundary will sit out for the entire morning's activities.
   RULE 2: Do NOT enter the water until you are told by an adult to do so. Anyone in the water when not allowed will sit out for the entire morning's activities.

RULE 3: Be respectful of those around you. Spring Creek Park is for the public so there will be children and families surrounding us. No splashing or rough-housing. Anyone violating this rule will sit out for the entire morning's activities.

3. After describing rules, mentors/grad students will go on to give a brief introduction to a) what stream health is and b) what the morning's activities are. The morning's activities include a sketch to begin, an in-stream survey, and finally, macroinvertebrate sampling. Besides describing the science and validity of a stream survey, we have to make it clear that this isn't an activity of swimming. We are doing science in a fun place!
4. After rules and the intro are done, the ENTIRE group will follow the lead mentors/grad students to the 'LOWER BOUNDARY' (see sketch map). Throughout this walk, mentors/grad students will be delineating the boundaries (like keeping only on the streamside that we are walking on, out of the water, and not past the upper or lower boundaries).
5. This whole explanation from start to finish should take around 15 minutes.
6. Afterwards, students will split into their groups for the day and a mentor/grad student will give a more in-depth explanation of the first activity. The first activity is a sketch and students will fill in the details of an outlined sketch and also fill out a cross-section. A mentor/grad student will have to explain what a cross-section is.
7. After this explanation, the students will be free to roam on the streamside between the upper and lower boundaries for 20 minutes or so to fill out their sketch. Assigned mentors will be watching them loosely and examining their sketches to ensure they are thinking about the details of the sketch.
8. Once complete, everyone will meet at the beach area of Spring Creek Park. We will take a 5-10 minute bathroom/changing break so students can put on their swimming gear/water shoes/sunscreen.
9. Once the break is over, a mentor/grad student will give the group an overview of what an in-stream survey is, going through almost point-by-point in the survey to point out methods. Further, mentors will explain the boundaries while in the stream, warning students about poison ivy and possible water snakes. There may be some students that don't want to go in, but they can still fill out most of the survey.
10. Students will be given 45 minutes to complete the in-stream survey. Mentors should encourage them to really examine the stream-bed and all its features.
11. Once complete, students will return to the beach and we'll do a Q&A session, asking the students what they observed in the stream. We'll also ask them what they think of the health of the stream and what some sources of pollution might be. This should take 10 minutes.

12. By this time, the stations for the third activity (macroinvertebrate sampling) should be assembled by the lab coordinator or mentors/grad students. Students will break up into their groups and stand by a station.
13. Once at their stations, a mentor/grad student will explain the third activity, using the whiteboard and big bug poster to explain how the event is a competition to find the most diversity and abundance of macroinvertebrates.
14. Different groups will be assigned to different parts of the stream by a mentor/grad student.
15. Mentors with each group will assign two students to go into the stream with the D-frame net to collect insects and will assign three students to stay on shore to prepare for sorting insects.
16. Mentors with students in the stream will listen to instructions on using a D-frame net and kicking technique. Then they will monitor as their students use the D-frame net.
17. Mentors with students on the shore will listen to instructions on preparing the sorting station. Then they will monitor as their students prepare the sorting station.
18. Once insects are collected from the stream, they will go onto be sorted at the sorting station. The insects will be SMALL and it will take a moment to see them as the eyes have to orient. We'll have to teach the kids some patience, but eventually, they'll see lots of things.
19. Using the group poster as a guide, students will use spoons and tweezers to sort macroinvertebrates into the ice cube tray (filled with water).
20. This process of collecting and sorting will go on for 40 minutes.
21. Once sorted, groups will write up how many of each insect they found up on the big white board.
22. A mentor/grad student will report the results to the group, along with using a stream health survey for caddisflies, stoneflies, and mayflies to assess if Spring Creek is healthy. We will then revisit the Q&A we had after group to. We'll ask students about their initial hypothesis and what they think of stream health, etc.
23. Then we'll have students clean all the equipment in a stream and stack it together as we await the bus to return to campus.

Student's Worksheet on following page:

Spring Creek Stream Health Evaluation

Introduction: A visual observation of stream habitat characteristics can reveal a lot about water quality problems. Today we will be performing a preliminary screen evaluation to determine the health of Spring Creek. We'll be sketching the site, getting into the stream to survey physical stream characteristics, and then looking at the abundance of particular bugs by sampling macroinvertebrates.

My hypothesis is that I think Spring Creek is (circle) **HEALTHY** OR **UNHEALTHY**

because ____

____.

Stream Name: ____

County: ______________________________ **State:** ______________________________________

Investigator: ____

Date: ______________________________ **Time:** ________________________________

Weather in the past 24 hours:

__ Storm (heavy rain)

__ Rain (steady rain)

__ Showers (intermittent rain)

Weather now:

__ Storm (heavy rain)

__ Rain (steady rain)

__ Showers (intermittent rain)

__ Overcast

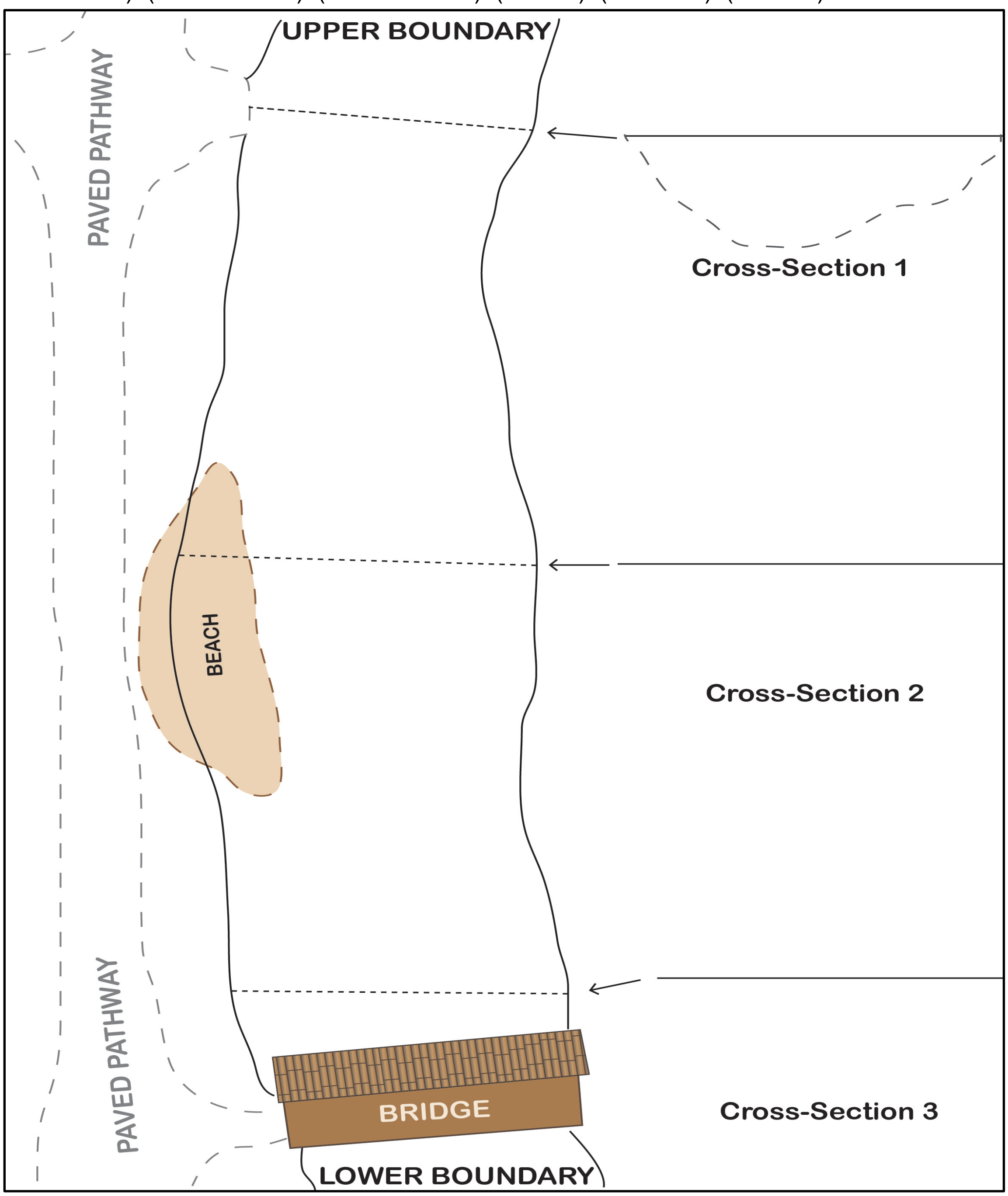
__ Clear and/or Sunny

__ Overcast

__ Clear and/or Sunny

Activity 1. Sketch of the Site

Directions: Draw an aerial image sketch of the stream habitat within the boundaries drawing and crossing off the following details: (**Vegetation**) (**Logs**) (**Boulders**) (**Fast Flow**) (**Slow Flow**) (**Runs**) (**Riffles**) (**Pools**)



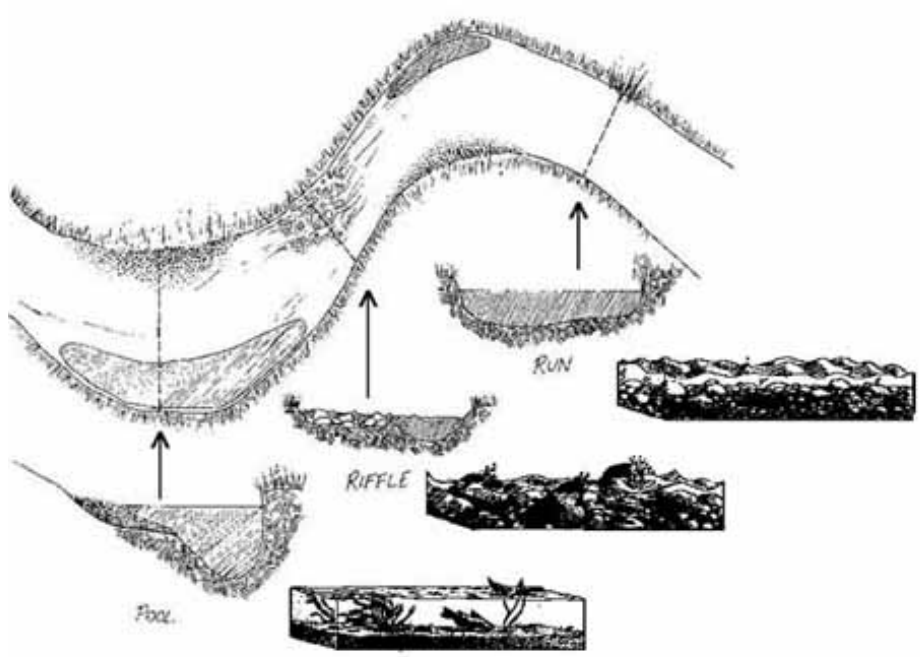
Activity 2. In-Stream Survey

IN-STREAM CHARACTERISTICS

1. Check which habitats are present:

__ Pool(s) __ Riffle(s) __ Run(s)

A mixture of flows and depth and provide a variety of habitats to support fish and invertebrate life. ***Pools*** are deep with slow water. ***Riffles*** are shallow with fast, turbulent water running over rocks. ***Runs*** are deep with fast water and little or no turbulence.



2. Nature of the particles in the stream bottom at site

Substrate	None/Little	Some	Most
Silt/clay/mud. This substrate has a sticky, cohesive feeling. The particles are fine. The spaces between the particles hold a lot of water, making the sediments behave like ooze.			
Sand (up to 0.1 inch). A sandy bottom is made up of tiny, gritty particles of rock that are smaller than gravel but coarser than silt (gritty, up to ladybug size).			
Gravel (0.1-2 inches). A gravel bottom is made up of stones ranging from tiny quarter-inch pebbles to rocks of about 2 inches (fine gravel - pea size to marble size; coarse gravel - marble to tennis ball size).			
Cobbles (2-10 inches). Most rocks on this type of stream bottom are between 2 and 10 inches (between a tennis ball and a basketball).			
Boulders (greater than 10 inches). Most of the			

rocks on the bottom are greater than 10 inches (between a basketball and a car in size).			
Bedrock. This kind of stream bottom is solid rock (or rocks bigger than a car).			

3. To what extent are gravel, cobbles, and boulders on the stream bottom embedded (sunk) in silt, sand, or mud? (Use your hands!)

Embeddedness is the extent to which rocks (gravel, cobbles, and boulders) are sunken into the silt, sand, or mud of the stream bottom (Figure 2). Generally, the more rocks are embedded, the less rock surface or space between rocks is available as habitat for aquatic macroinvertebrates and for fish spawning. Excessive silty runoff from erosion can increase a stream's embedded-ness. To estimate embeddedness, observe the amount of silt or finer sediments overlying, in between, and surrounding the rocks.

Somewhat embedded
_____

Halfway embedded
_____

Mostly embedded
_____

Completely embedded
_____

4. Presence of logs or large woody debris in stream:
__ None __ Occasional __ Plentiful

5. Presence of naturally-occurring organic material (i.e. leaves and twigs) in stream:
__ None __ Occasional __ Plentiful

6. Water appearance (check all the apply):
__ Clear __ Milky __ Foamy __ Turbid
__ Light Brown __ Dark Brown
__ Oily Sheen __ Orange __ Greenish __ Other __________

7. Water Odor:
__ Sewage __ Fishy __ Rotten Eggs
__ Chlorine _Other _______________
__ No Unusual Odor

BIOLOGICAL CHARACTERISTICS

1. Wildlife in or around the stream? What wildlife do you observe?
____
____
____
____
____
____
____

2. Fish in the stream? (Mark all that apply)
__ No __ Yes, but rare __ Yes, abundant
__ Small (1-2”) __ Medium (3-6”)
__ Large (>7”)

3. Are there any barriers to fish movement?
__ Beaver dams __ Waterfalls (>1’)
__ Dams __ Road Barriers
__ Other _______

4. Aquatic plants in the stream? (Mark all the apply)
__ None __ Occasional __ Plentiful
__ Attached __ Free-floating __ Pools
__ Near Riffle __ Stream Margin

Extent of algae in the stream (Mark all the apply):

Are the submerged stones, twigs, or other material in the stream coated with a layer of algal “slime”?
__ None __ Occasional __ Plentiful
__ Light coating __ Heavy coating
__Brownish __ Greenish
__ Other _________

Are there any filamentous (string-like) algae?
__ None __ Occasional __ Plentiful
__Brownish __ Greenish
__ Other _________

Are there any detached “clumps” or “mats” of algae floating on the water’s surface?
__ None __ Occasional __ Plentiful
__Brownish __ Greenish
__ Other _________

STREAMBANK AND CHANNEL CHARACTERISTICS

1. Average depth of stream:
____

2. Approximate width of the stream channel:

____

3. Looking upstream 100 yards, describe:
The shape of the stream bank:
____
Extent of artificial, man-made entrances to the stream:
______%
Shape of the channel:
____

4. Describe streamside vegetation cover with "1" for present and "2" for common:
__ Trees __ Bushes, shrubs __ Lawn
__ Tall grasses, ferns, etc. __ Boulders/rocks
__ Gravel/sand __ Bare Soil __ Pavement

5. To what extent does the vegetation shade the stream at your site?
__ 0% __ 25% __ 50% __ 75% __ 100%

Looking upstream, note if the following are present in
Streambanks:
__ Natural streamside plant cover degraded
__ Banks collapsed
__ Garbage/junk adjacent to the stream
__ Foam or sheen on bank
Stream Channel:
__ Mud, silt, or sand in or entering the stream
__ Garbage/junk in the stream
Other:
__ Yard waste on the bank (grass clippings, etc)
__ Livestock with unrestricted access to stream
__ Actively discharging pipe(s)
__ Other pipe(s) entering the stream
__ Ditches entering the stream

LOCAL WATERSHED CHARACTERISTICS

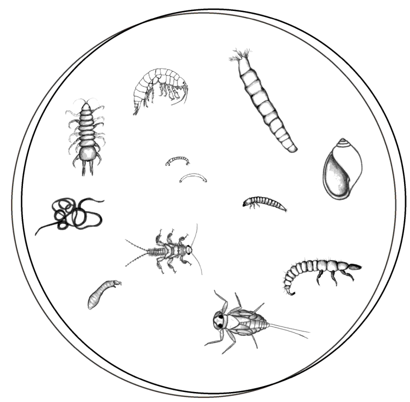
Consider the area within ¼ mile of the stream site, ponder the following land uses and what potential impact they have on the stream:

__ Single-family housing __ Multi-family housing __ Lawns __ Commercial Industry
__ Paved roads or bridges __ Unpaved roads __ Animal Grazing Land __ Cropland
__ Construction underway in housing and commercial development or road/bridge repair
__ Powerboating __ Golfing __ Camping __ Hiking __ Swimming/fishing/canoeing
__ Mining or gravel pits __ Oil and gas drilling __ Trash dump __ Landfills __ Industry
__ Logging

From your evaluation, does this stream habitat seem healthy?

What measures could be taken to maintain or improve the health of this stream habitat?

Activity 3. Macroinvertebrate Sampling



Background: Macroinvertebrates are small animals that have no backbone that you can see with the naked eye. These include insects, crustaceans, mollusks, arachnids, and annelids (segmented worms). Aquatic macroinvertebrates live in the water for part or all of their lives, and some are more sensitive to chemical and physical conditions in the water than others. For example, caddisflies, mayflies and stoneflies are aquatic insects known to be increasingly sensitive to chemical pollution, and therefore are good indicators of water quality. Healthy streams generally have a high diversity of macroinvertebrates.

Directions:

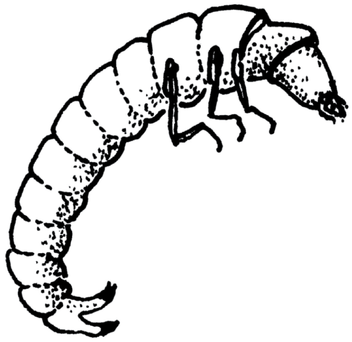
1) Put your water shoes on and listen to a tutorial about how to properly use the instruments for sampling aquatic macroinvertebrates.
2) Get into your group and figure out who will go to the collecting station in the stream and who will go to the sorting station on the shore.
   a) **For those who are at the collecting station**: Follow the guidance of the mentor when using the D-frame kick nets and work with your partner to collect insects. Once insects are collected, empty the net into the bucket with water and return to collect more bugs. Once you've done this transfer two or three times, there should be enough macroinvertebrates transferred to start sorting. Join the group who is sorting.
   b) **For those who are at the sorting station:** Fill bucket and ice cube tray with clean water from the stream. After bucket is filled with macroinvertebrates,

pour water into the sorting tray and begin sorting, using a spoon or tweezers, in the ice cube tray.

3) Once done sorting, write up how many caddisflies, mayflies, stoneflies, and other insects you counted on your worksheet and then write it up on the whiteboard. This is a competition!

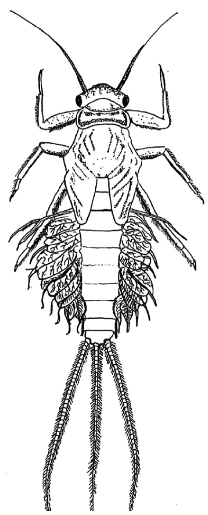
	Number of Mayflies (Ephemeroptera)	Number of Stoneflies (Plecoptera)	Number of Caddisflies (Trichoptera)	Number of other living things
Group Sample				

See if you can find these macroinvertebrates that are sensistive to pollution!



CADDISFLIES

Hooked legs on upper third of body;
no gills; may live in a stick, rock, or leaf case



MAYFLY NYMPH

Feathery gills on abdomen;
three tails;
one clay on the end of each leg

STONEFLY NYMPH

Two claws on the end of each leg;
No gills on abdomen; two tails