CONDUCTIVITY

Fresh water is not highly conductive of electricity unless it has certain types of soluble minerals in it. Seawater is much more conductive than fresh water because of its high concentration of dissolved salt. Conductivity greatly affects the types of creatures that can survive in water. Conductivity can also inform us about the level of development in the watershed, because the more development, the more salt is used in an area over the winter to de-ice roads and sidewalks. Conductivity is one way we can measure how healthy a stream is. In this activity students will measure conductivity of water samples from a stream.

Although the pre and post discussions are necessary to provide important information about each topic, it is the activity that is most vital to this unit. Be sure to allow plenty of time to complete the activity.

Equipment needed

- Small table (convenient but not essential)
- 2 Conductivity meters
- Salt (Magnesium chloride)
- Spoons or stirrers
- 2 Sampling containers (a small glass or plastic jar is fine)
- Boots or waders (not usually necessary)
- Data form and clipboard
- Display board

How the Conductivity Meter Works

The instrument applies a known voltage across two electrodes, one on either side of the cell containing the water sample (or on the body of the probe if the instrument uses a probe). The instrument then measures how much electric current is flowing between the electrodes; the more current, the higher the conductivity of the water sample. Current is measured in microsiemens. (See definition under Background Information.)

Conductivity Chart (in microsiemens per centimeter- µs/cm)

Pure (distilled) water	0.5 to 3 µs/cm
Most fresh drinking water	100 µs/cm or less
Range found in lake and river water in the U.S.	50 to 1500 µs/cm.
Lake and stream water with healthy fish populations	150 to 800 µs/cm
Industrial wastewater/ Water softener backwash	10,000 µs/cm or more
Sea water	~ 50,000 µs/cm
Great Salt Lake in Utah	158,000 µs/cm

Conductivity Lesson Narrative

The mission is make these points:

- The most common pollutant that causes an increase in conductivity is salt, although some other pollutants can also contribute to high readings.
- Three ways to keep salt from reaching streams and lakes:
    - 1) Encourage local highway departments to use sand on their roads whenever possible rather than salt, and, where salt is necessary, to use as little as possible to do the job.
    - 2) Minimize the use of salt on your sidewalk and driveway; use sand instead, if possible.
    - 3) Don't soften your water unless there is a serious need to do so.

Introduction: 5 min

1. My name is _____ and I'm a volunteer with the Conductivity station.

2. Ask students: What is conductivity? *(They probably won't know - explain that it measures how much electricity be conducted through water)*

3. Pure water wouldn't conduct electricity. We would get a zero when we measured it. What might be in this stream water that would give us a higher number? *(Hint: Towns and cities buy a lot of this pollutant, load it on trucks and spread it around sometimes.)*

4. We put salt on our roads in the winter to help melt the ice. Where does the salt go after it has done its job? *(Solicit 2-3 answers. Explain that it gets dissolved in water and runs off to the nearest stream, and then to the river.)*

5. *Ask students:* Why do we care about salt in our water? *Explain it is unhealthy for the organisms who live in the water, it takes more energy to clean for human use.*

6. One way we can test for salt is to use the conductivity meter. Pure water won't carry a current, so the conductivity meter won't register. But tiny particles of salt dissolved in the water can carry a current. When salt is present, the meter will show it. Some other pollutants can also increase the readings, but the main issue for the Huron River is salt from de-icing.

7. Given the time of year we are in, do you think we will get a high conductivity or low conductivity reading? *(Get a few answers)*. All right, let's see what we find!

The Activity: 15 min

1. Select a site along the stream where the water has not been stirred up so that clear water samples can be easily obtained. If sampling from the bank, pick a spot that is not obstructed by brush and watch out for poison ivy, stinging nettle, and thorny plants.

2. Go with students to collect 2 clear water samples using the cans-on-a-stick and bring them back to your station.

3. Explain we will be looking at the big, top number on the probe. Put one probe in each can. Wait until the numbers stop changing *(This could take 30 seconds. The 2 numbers should match before you add the salt.)*

4. Read the conductivity on the panel on the front of the instrument.

5. Take one conductivity meter out, add 1 pellet of salt to that can and stir to dissolve. Place the meter back in and read the conductivity on the panel on the front of the instrument.

6. Wait at least 30 seconds for the reading to stabilize. Record the results on the data sheet.

7. If time is available, repeat steps 2 - 6 to re-measure to be sure you have obtained an accurate reading, and to give everyone a chance to participate.

8. Explain that a healthy range for lakes and streams is between 150 to 800 ms/cm. (Show data sheet or Conductivity poster.)

Wrap Up: 5 min.

1. Does it look like there is something in the water? What about with salt added?
    a. *Answers will vary*

2. Salt is a common cause of higher than normal conductivity. What are some ways that salt gets into our watershed?
    a. *Road salting, sidewalk and driveway salting, water softening, sewage and septic tank leakage*

3. How would the conductivity level change for our river in the winter versus the summer? Why would it be different?
    a. *Late winter conductivity is higher than late summer because of the salt used on the roads*

4. The Huron River Watershed Council collects conductivity data all over the watershed. They have found higher levels in towns than out of town. Why might that be the case?
    a. *More development = more roads = more salt = higher conductivity*

5. How can people like you and me keep the conductivity of the stream in a healthy range?
    a. *Encourage local highway departments to use sand on their roads whenever possible rather than salt, and, where salt is necessary, to use as little as possible to do the job.*
    b. *Minimize the use of salt on your sidewalk and driveway; use sand instead, if possible. Shovel early and often!*
    c. *Don't soften your water unless there is a serious need to do so.*

Background Information

Conductivity is a measure of the ability of the water sample to conduct an electric current. Pure water itself has almost no ability to carry an electric current. The presence of dissolved atomic-sized particles (ions) in the water allows it to carry a current. These positively charged ions (cations) and negatively charged ions (anions) are the actual current carriers.

These charged ions come from dissolved minerals such as gypsum, limestone, clay soils, and weathering rock. Other sources include: common salt (sodium chloride) and calcium chloride put on roads for de-icing; salt (sodium chloride) or potassium chloride present in the backwash from water softeners; industrial wastewaters; and treated and untreated domestic sewage. The conductivity of a water sample gives a fairly good measure of the overall concentration of ionic substances (salts, acids, alkalis) in the water.

The unit for measuring conductivity in water is the microsiemen per centimeter (µs/cm). A siemen is a unit of conductivity. A microsiemen is a millionth of a siemen. A siemen is the reciprocal of an ohm, a unit of resistance.

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The chart above gives a range of measurements of conductivity for various types of samples of water. The concentrations given above for some industrial wastewaters and home water softener backwash are very toxic to a number of species of fish and other aquatic life. The Great Salt Lake is so salty that most types of aquatic life would die almost instantly in it, although there is a brine shrimp that thrives in it.

All living organisms, including us, can survive only if the parameters of their environment are in the right ranges. Conductivity of water is an important parameter. Seawater, which has a very high conductivity because of the salt it contains, is poisonous to us; humans can die of thirst in the middle of the ocean. High conductivity in water indicates generally that the concentration of salts is high. The most common salt is ordinary table salt, NaCl. Water that contains strong acids or strong alkalis (bases) also has high conductivity.

Often when we see an increase in conductivity this is a warning sign of pollution so it alerts us to look for the problem by doing additional testing and surveying. By monitoring our lakes and streams and taking measures to prevent or mitigate against high conductivity levels, we can protect the creatures that live there.

Three ways to keep salt from reaching streams and lakes: 1) Encourage local highway departments to use sand on their roads whenever possible rather than salt, and, where salt is necessary, to use as little as possible to do the job. 2) Discharge water softener backwash into a drywell or other outdoor container rather than into a sewage system; 3) Use potassium chloride (KCl) in water softeners rather than sodium chloride (NaCl). However, both of these products cause other problems. (See below.)

Excessive chloride is a real problem, particularly if the water is to be used subsequently for crop irrigation, lawn watering, etc. It also has a damaging effect on aquatic life. These problems are independent of whether

one is using cheap NaCl or expensive KCl. Several areas in Southern California have made home water softeners illegal unless the backwash brine is disposed of in such a way that it doesn't contaminate streams or groundwater. Ocean disposal may be the most common method. Unfortunately, drywell disposal generally contaminates groundwater.

The bottom line is that if salinity is a problem in your watershed you should either (1) not soften your water, or (2) if softening is essential, use a technology that does not result in the discharge of large amounts of chloride ion. Unfortunately, this technology is quite expensive and high-tech.

For this and all other units, advanced level information is available if desired. Contact HRWC and request an electronic version of the unabridged manual.

Stream Electrical Conductivity Data Sheet

Conductivity tests the amount of ions in the water. It tells us if there might be salt in the stream. If there is too much salt, it hurts the organisms that live in the water.

Conductivity Chart (in microsiemens per centimeter- µs/cm)	
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Reading	Stream Water	Salt Added
First:		
Second:		

1. **Does it look like there is something in the stream water? What about with salt added?**

2. **Salt is a common cause of higher than normal conductivity. What are some ways that salt gets into our watershed?**

3. **How would the conductivity level change for our river in the winter versus the summer? Why would it be different?**

4. **The Huron River Watershed Council collects conductivity data all over the watershed. They have found higher levels in towns than out of town. Why might that be the case?**

5. **How can people keep the conductivity of the stream in a healthy range?**

KEY to Stream Electrical Conductivity Data Sheet

1. Does it look like there is something in the stream water? What about with salt added?
    a. **Answers will vary**

2. Salt is a common cause of higher than normal conductivity. What are some ways that salt gets into our watershed?
    a. **Road salting, sidewalk and driveway salting, water softening, sewage and septic tank leakage**

3. How would the conductivity level change for our river in the winter versus the summer? Why would it be different?
    a. **Late winter conductivity is higher than late summer because of the salt used on the roads during the winter.**

4. The Huron River Watershed Council collects conductivity data all over the watershed. They have found higher levels in towns than out of town. Why might that be the case?
    a. **More development = more roads = more salt = higher conductivity**

5. How can people keep the conductivity of the stream in a healthy range?
    a. **Encourage local highway departments to use sand on their roads whenever possible rather than salt, and, where salt is necessary, to use as little as possible to do the job.**
    b. **Minimize the use of salt on your sidewalk and driveway; use sand instead, if possible. Shovel early and often!**
    c. **Don't soften your water unless there is a serious need to do so.**