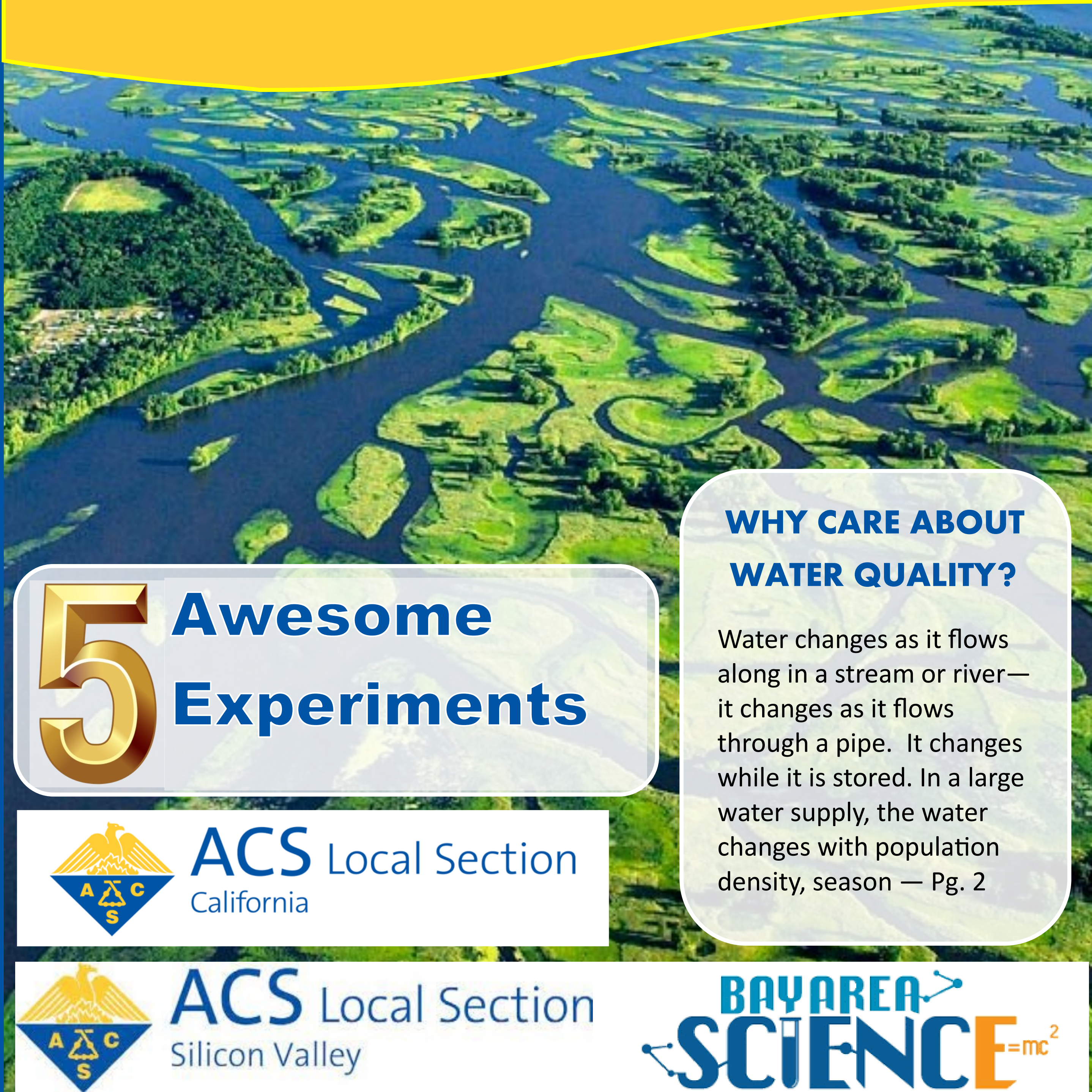
Water Quality

Citizen Science | Project Kit



5 Awesome Experiments

ACS Local Section California

WHY CARE ABOUT WATER QUALITY?

Water changes as it flows along in a stream or river—it changes as it flows through a pipe. It changes while it is stored. In a large water supply, the water changes with population density, season — Pg. 2

ACS Local Section Silicon Valley

BAY AREA SCIENCE $E=mc^2$

WHY CARE ABOUT WATER QUALITY?

In a large water supply, the water changes with population density, season, climate, and demand. In any watershed, changing population densities, water use patterns, drainage, land use changes, industrial development and other changes that people make, change the properties of water and they change the range of changes that go on. Even if there were no people, the streams, rivers, and lakes changes. The properties of water are altered by very small amounts of dissolved or suspended materials.

SO WHAT?

At its core, the practice serves five major purposes.

1) Results are used to changes in the water over time.
2) Regularly monitoring water quality allows scientists to identify any existing problems and anticipate future issues.
3) Water quality data is also helpful when designing and developing pollution prevention and management strategies.
4) Monitoring data is also used to determine whether or not pollution regulations issued by the government are being complied with.
5) From oil spills and radiation leaks to floods and mass erosion, water quality monitoring data is a must when developing emergency strategies.

Overall, monitoring water quality is an important part of helping us determine whether or not we are making progress in cleaning up our waterways. It reveals the health and composition of streams, rivers, and lakes at a snapshot in time, as well as over weeks, months, and years.

The importance of tracking changes in water quality can't be overstated: human health and livelihoods depend on clean, reliable water supplies. Monitoring drinking water is required under the US Safe Drinking Water Act, which sets federal requirements for monitoring water for contaminants, such as microorganisms and chemicals, to protect human health. And clean water keeps all the aquatic organisms healthy too!

SUSTAINABILITY, DROUGHT, LANDSCAPE RESILIENCE, SANITATION, AND WATER CONSERVATION

Great cities are defined and illuminated by the water that surrounds or flows through them. Water defines civilizations. From harbors of New York to the river estuaries of London to Amsterdam's canals or the beaches of Sydney, water is what gives a city its unique magnetism.

Top cities understand and address their water in a sustainable manner. This means efficiently providing safe, reliable, and easily accessible water as well as reliable sanitation and waterways protected from pollution. Sustainability also means being resilient and adaptable to extreme weather events that may contribute to issues such as flooding and scarcity.

It is obvious that freshwater is essential to ensure a good quality of life and general wellbeing. Yet the ways we utilize water often undermines water quality, provision, and health as such. There are many things that can be done to improve water sustainability. Regularly monitoring and maintaining water quality is arguably where urban sustainability performance is highest.

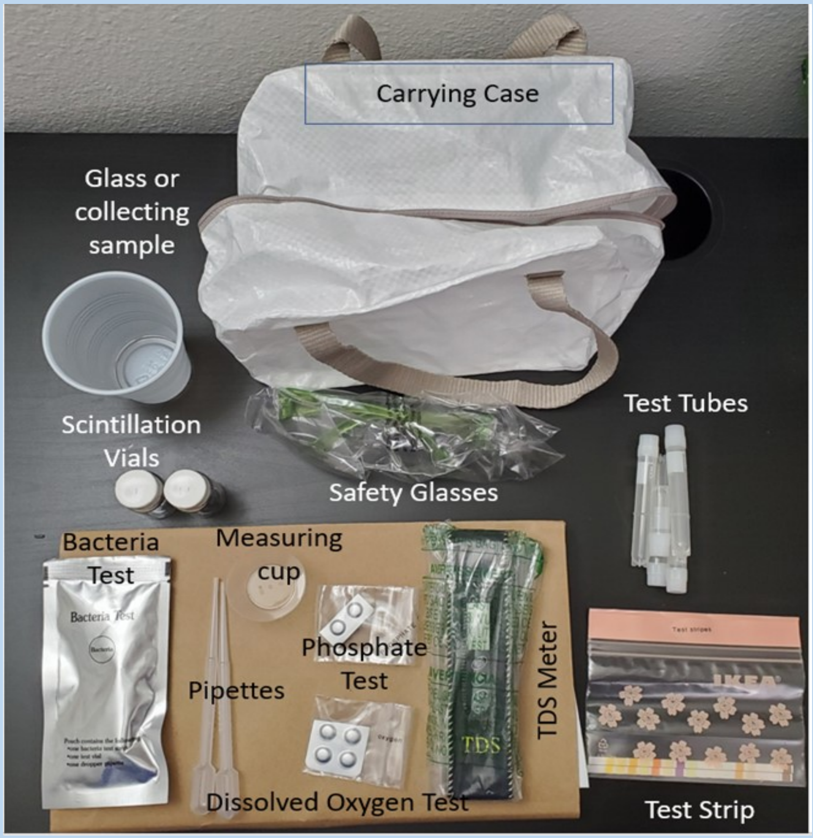
Thus, we have designed a kit to provide simple affordable, non-hazardous method for testing our watershed for some basic water quality parameters like Coliform Bacteria, Dissolved Oxygen, Nitrate, Phosphate, Turbidity, etc. Step-by-Step instructions are provided to guide you through these tests.

Remember that just monitoring your watershed is not enough. Once an issue has been identified, we have to work hard to address the issue through practices and policies. The health of our water bodies is our responsibility!

Kit Opening

Join members from ACS for a "kit opening party" !The purpose is for everyone to open their kit together, go over the supplies, and ask questions!

1) There are three ways to get more information about your kit.
   Saturday, May 22, 2021 at 2PM, on Zoom link: **https://www.redwoodcity.org/Home/Components/Calendar/Event/49495/2055**
2) Help scientists understand water quality from your region by entering your data here: **https://docs.google.com/forms/d/11hAaF9PzBKki8P7YpHXxBn5JwibaWnXi5fj-hnQjxgQ/edit?ts=60920d62**
3) The zoom event will be recorded and can be requested at the below emails.
4) Email kit leaders for help regarding links, experiments, and more! : office@calacs.org, aliciaataylor@gmail.com, and jssheth@syr.edu
5) Please go to calacs.org or svacs.org to watch a helpful video on how to perform all the experiments. The video is found on the homepage of both websites. Search for "Water Quality Kit Citizen Science".



WHAT'S IN THERE?

1) Booklet
2) Carrying Case
3) Glass for collecting a sample
4) Scintillation vials for tests
5) Test tubes for tests
6) Pipettes
7) Safety Glasses
8) Tests Strip x 2
9) Phosphate test Tablets X 2
10) Dissolved Oxygen Test Tablets X 4
11) TDS Meter
12) Bacteria Test

TEST TIME!

Identify a Location to Collect Water Samples

The kit contains enough supplies to conduct each water quality test numerous times. We encourage students and/or their family members to first try our water quality tests on water samples such as kitchen sink water, dog bowl water, bird bath water, or toilet water! These samples are easy to collect and can be used to learn the water quality tests. Once you are ready, then try out samples from your community!

Collect your water sample in a clean cup (plastic or glass is ok). For some tests, you will have enough supplies to measure up to four different water samples.

Scavenger Hunt

How many different types of water can you collect?
Can you find water samples from the following:

- A local neighborhood stream or creek
- A lake or reservoir
- The Bay

General Observations at your Water Location

Location #1

1.What is the weather like?

2.What is the temperature?

3.Describe your surroundings (inside your home, the creek bed, are there trees, roads, is the ground muddy, is the grass green or brown, etc.)

4.Describe the sampling location. Did you take water from a deep, shallow, moving or standing, rocky, or silty location?

5.Do you see any animals or insects? Do you hear or see any birds?

6.What other observations do you have?

7. Take pictures with the help of an adult to document your sampling location.

Location #2

1.What is the weather like?

2.What is the temperature?

3.Describe your surroundings (inside your home, the creek bed, are there trees, roads, is the ground muddy, is the grass green or brown, etc.)

4.Describe the sampling location. Did you take water from a deep, shallow, moving or standing, rocky, or silty location?

5.Do you see any animals or insects? Do you hear or see any birds?

6.What other observations do you have?

7. Take pictures with the help of an adult to document your sampling location.

General Observations at your Water Location Continued

Location #3

1.What is the weather like?

2.What is the temperature?

3.Describe your surroundings (inside your home, the creek bed, are there trees, roads, is the ground muddy, is the grass green or brown, etc.)

4.Describe the sampling location. Did you take water from a deep, shallow, moving or standing, rocky, or silty location?

5.Do you see any animals or insects? Do you hear or see any birds?

6.What other observations do you have?

7. Take pictures with the help of an adult to document your sampling location.

Location #4

1.What is the weather like?

2.What is the temperature?

3.Describe your surroundings (inside your home, the creek bed, are there trees, roads, is the ground muddy, is the grass green or brown, etc.)

4.Describe the sampling location. Did you take water from a deep, shallow, moving or standing, rocky, or silty location?

5.Do you see any animals or insects? Do you hear or see any birds?

6.What other observations do you have?

7. Take pictures with the help of an adult to document your sampling location.

Safety and Disposal

- **Read any labels on the supplies.**
- **Any liquids and test supplies should be used in a serious manner.**
- **Wear eye protection. If eye protection is not available, ask an adult for advice on how to be safe.**
- **Wash hands after any tests**
- **Used test supplies can be disposed of in the toilet (liquids only) or in the trash.**

TDS Meter!

The TDS meter takes three measurements:

1) Temperature

Water temperature affects aquatic organisms. And may impact their growth and survival. For example, too hot water might be bad for some species of fish.

2) Electrical Conductivity

Electrical conductivity measures salts and metals in water. Salt and metals are expected to be in water. Salt water contains a lot of salt whereas freshwater does not. Therefore, freshwater has lower conductivity. Some metals are important for health when water is ingested, but too many metals are typically bad. Therefore, electrical conductivity is important because it measures salinity and determines if safe levels of metals are in the water.

Typical measurements:

- Drinking water: 200 - 800 µS/cm
- Rivers: 50 to 1500 µS/cm
- Sea water: 50,000 µS/cm

Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a range between 150 and 500 µhos/cm.

TDS Meter!

3) Total Dissolved Solids

Even though your water sample may appear clear, there are tiny particles floating around! These are called total dissolved solids (TDS). TDS may include minerals, salts, small particles of leaves or plants, and metals. TDS is important because water with high TDS may be unsuitable for drinking, water plants, or aquatic organisms.

Typical measurements:

Fresh water: TDS is less than 1,000 ppm

Brackish water: TDS = 1,000 to 10,000 ppm

Saline water: TDS = 10,000 to 35,000 ppm

Hypersaline: TDS greater than 35,000 ppm

Directions

1. Remove the cover and press the ON key to turn on the meter.

2. Put the meter in the water to be tested, the height of the water should not exceed 4 cm (from the end of the meter).

3. Gently stir the meter a few times in the water to be measured and wait for the reading to stabilize. You may need to wait up to one minute for the reading to stabilize.

4. After use, rinse the meter in water from your sink, gently dry with a cloth and cover with the meter. Cover.

Precautions:

1. Avoid soaking the entire TDS meter in water.

2. Avoid high temperatures and direct sunlight.

3. Avoid impact, heavy pressure or dropping the meter.

Data Entry:

Scientists take measurements in "triplicate". The reason is because by taking multiple samples, you can check for errors. Errors could be equipment malfunction, human error, or other issues. Reliable data should show values that are similar. An example might be for water temperature, values such as 80.1 F and 82.0 F. These values are similar. However, if you left your water sample on the counter for hours, your readings might be 81.3 F (for the first reading) and 87.9 F (for a reading a few hours later). In this example, this data would not be considered very reliable. We have provided three entries for each measurement, per water sample!

Sample #1

Water temperature:

____________ ____________

____

Electrical conductivity:

____________ ____________

____

TDS:

____________ ____________

____

Sample #2

Water temperature:

____________ ____________

____

Electrical conductivity:

____________ ____________

____

TDS:

____________ ____________

____

TDS Meter!

What do results mean?

1. Water temperature **:** Is your temperature too hot, too cold, or just right? You can ask an adult to help you find average temperatures for the water location (lake, creek) that you sampled.

2. Electrical conductivity : Did you test fresh water or salt water? Did you test running water or stagnant water? After winter rains, we can expect some water bodies to have lower conductivity compared to their summer measurements due to evaporation of water.

3. Were your measurements in the typical ranges provided above? Why or why not?

4. TDS : Were your measurements in the typical ranges provided above? Why or why not?

Dissolved Oxygen

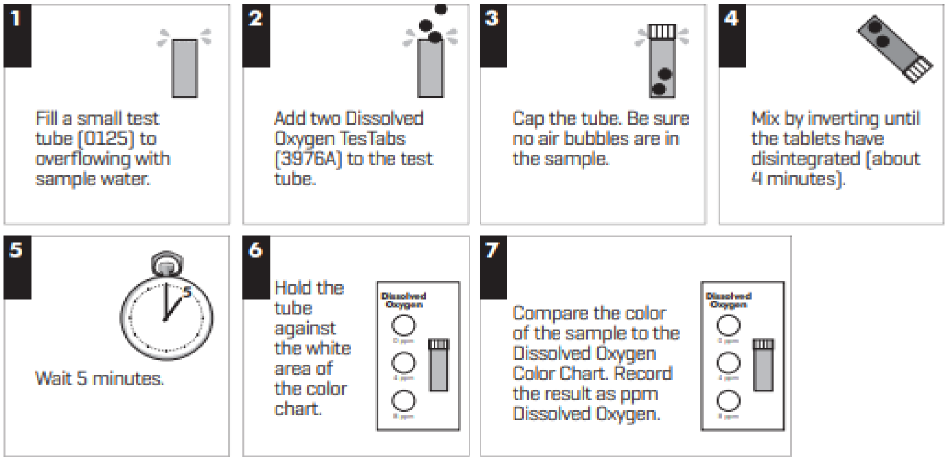
Dissolved oxygen measures the amount of oxygen that is in water and is available to living organisms. Oxygen is important for aquatic plants and animals. Low dissolved oxygen is a sign of pollution, and low dissolved oxygen is harmful to the fish and other aquatic organisms.

Typical values:

5-6 ppm: Sufficient for most species
<3 ppm: Stressful to most aquatic species
<2 ppm: Fatal to most species

Dissolved Oxygen

Dissolved Oxygen Procedure



Data Entry:

Water Sample #1:

Dissolved oxygen ______________ ______________ ______________

Water Sample #2:

Dissolved oxygen ______________ ______________ ______________

Water Sample #3:

Dissolved oxygen ______________ ______________ ______________

Water Sample #4:

Dissolved oxygen ______________ ______________ ______________

What do results mean?

1) Low dissolved oxygen is typically harmful to aquatic life. How did you values compare to the ranges provided above?

2) Were values lower or higher than what you expected? Why or why not?

3) Did values change for different sample samples? Why do you think this is?

Test Strips Galore

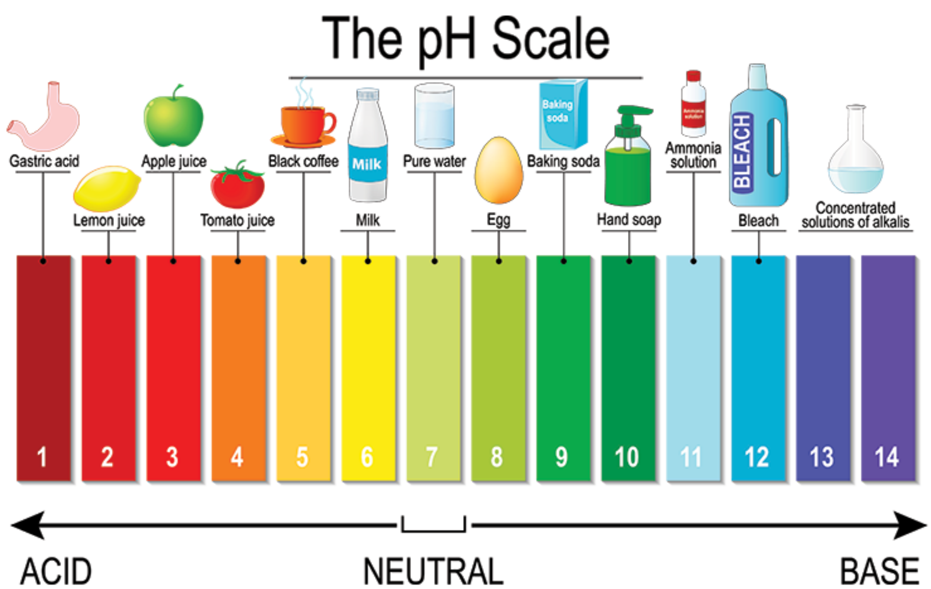
Test strips are a quick and reliable way to take multiple measurements.

1) pH

pH is a measurement of how acidic or basic water (or a liquid) is. The scale goes from 0 – 14, with 0 being very acidic, and 14 being very basic. Most water is right around pH 6 – 8. pH is important for water quality because most life needs a pH of 6 – 8 for survival. pH can be impacted by pollution.

Typical values:

- Surface water systems: 6.5 – 8.5 pH
- Groundwater systems 6 – 8.5 pH
- Common bottled water: 6.5 – 7.5 pH
- Tap water: varies, but around 7.5 pH
- Rainfall: 5.6 pH



2) Hardness

Have you ever taken a shower and it feels like the soap is still on you? Or have you noticed "spots" on your dishes after they have been cleaned in the dishwasher? This relates to hardness, or the amount of calcium carbonate and magnesium in water. Drinking water is an important contribution of these minerals to your diet, and generally hard water is considered safe. Hard water is typically found in desert environments where mineral buildup is high.

Hardness is important for water quality, because depending if the water is "soft" or "hard", some chemicals can be more or less toxic.

Typical values:

- Soft water: 0 to 60 mg/L (milligrams per liter) as calcium carbonate

Test Strips Galore

3) Chlorine

Chlorine is added to our drinking water supply to kill harmful bacteria and keep us safe. However, for some species, such as fish, chlorine can be toxic. Chlorine can enter lakes and rivers from swimming pools, or sewage treatment facilities. To keep aquatic organisms safe, chlorine is a common water quality measurement.

Typical values:

- Safe drinking water level: 4 mg/L
- Municipal tap water: 1.5 to 2.0 mg/L
- Lethal to fish at: 0.1-0.3 mg/L

4) Lead

Lead is more commonly a human health drinking water issue, rather than for environmental samples. There is no safe level for lead exposure for humans. Lead is more commonly measured in blood to determine if human exposure has happened. **However, in the environment, lead is naturally present**

Typical values:

- Soil concentrations in the US: 50 and 400 mg/L
- Safe levels for aquatic freshwater organisms: 0.0025 – 0.065 mg/L

5) Iron

Iron is a metal that is also found in the environment. Iron is typically not a concern; however, it can impart an unpleasant taste in drinking water. High levels can be toxic to aquatic organisms.

Typical values:

- Safe level in drinking water: 0.3 mg/1
- Safe level for aquatic freshwater organisms: 1.0 mg/L

6) Copper

Copper is a complex nutrient because at low levels, it is essential for life. But at high concentrations, it is toxic. Copper is found in the earth's crust. Copper may enter water bodies through mining, and other operations, but is also naturally present in water bodies since it is found in the earth's crust.

Typical values:

- Average value for lakes and rivers: 10 mg/L

7) Nitrate and Nitrite

Nitrate and nitrite are made up of nitrogen, which is an important component of our proteins. However, high concentrations can be toxic to infants, pregnant women, and aquatic organisms. Nitrogen, as nitrate and nitrite, enters the environment most commonly through application of fertilizers.

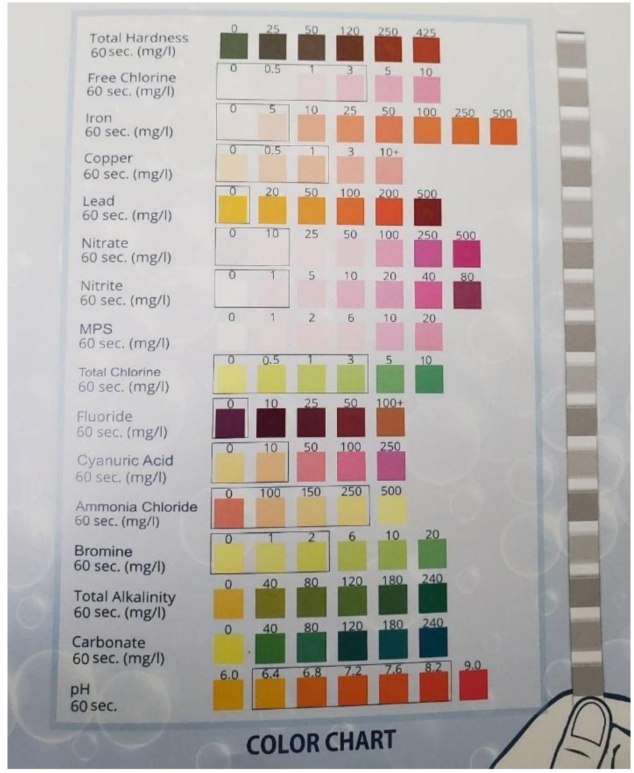
Typical values:

- Safe level in drinking water for nitrate: 10 mg/L
- Safe level in drinking water for nitrite: 1 mg/L
- Nitrate levels in groundwater: 1 – 9 mg/L; for nitrite: 0.3 mg/L
- Nitrate levels in streams: 01 – 18 mg/L

Test Strips Galore

Directions:

1) Remove a strip from the sealable bag. Immediately seal the bag tightly.
2) Immerse the reagent area of the strip in water sample for two seconds. You can dip the strip in a test tube or use a pipette provided in your kit. Do not shake of excess water from the strip.
3) Hold the strip horizontally for 30 -50 seconds and compare results against the color chart provided below.
4) Read the results within 30 seconds in good light for most accurate results.



Data Entry:

Water Sample #1:

pH

Hardness

Chlorine

Lead

Copper

Nitrate

Nitrite

Water Sample #2:

pH

Hardness

Chlorine

Lead

Copper

Nitrate

Nitrite

Water Sample #3:

pH

Hardness

Chlorine

Lead

Copper

Nitrate

Nitrite

Water Sample #4:

pH

Hardness

Chlorine

Lead

Copper

Nitrate

Nitrite

Test Strips Galore

What do results mean?

Your test strips provide the following ranges:

pH: 6-9
Total Hardness: 0-425PPM
Free Chlorine: 0-10PPM
Iron: 0-500PPM
Copper: 0-10PPM
Lead: 0-500PPM
Nitrate: 0-500PPM
Nitrite: 0-80PPM
Total Chlorine: 0-10PPM

PPM is a unit called parts per million. It is a tiny unit of measurement and is equivalent to t is equivalent to about 32 seconds out of a year. The point is to understand that even very small amounts of some compounds can be hazardous to people and the environment.

1. **Which samples had the highest values for each test?**

- **pH: _____________**
- **Hardness: _____________**
- **Chlorine: _____________**
- **Lead: _____________**
- **Copper: _____________**
- **Nitrate: _____________**
- **Nitrite: _____________**

2. **Did you expect this? Why or why not?**

3. **Were any of the tests in the hazardous to aquatic life range? Which samples? Why do you think that is?**

Phosphate

Phosphate is a compound that contains phosphorus. Phosphorus is important for animal growth, but too much phosphorus can cause negative impacts to people and the environment. For example, too much phosphorus in a water body can lead to an explosion of algal growth. Too many algae will deplete all of the oxygen in a water body, and cause “anoxia”, or environments with no oxygen. This is bad for fish and other aquatic organisms.

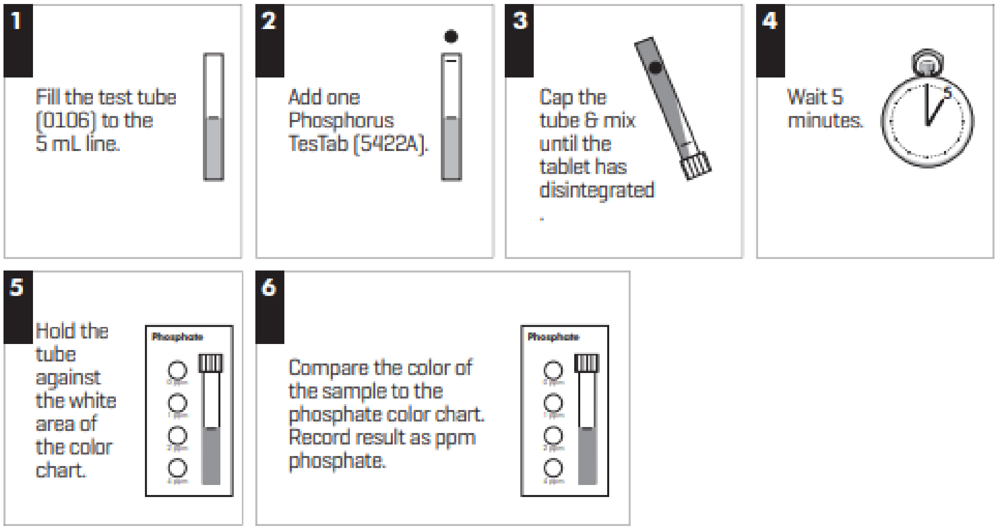
Phosphate comes from natural sources like uneaten food, decaying plants or animals, but may also come from fertilizers and household items like detergents.

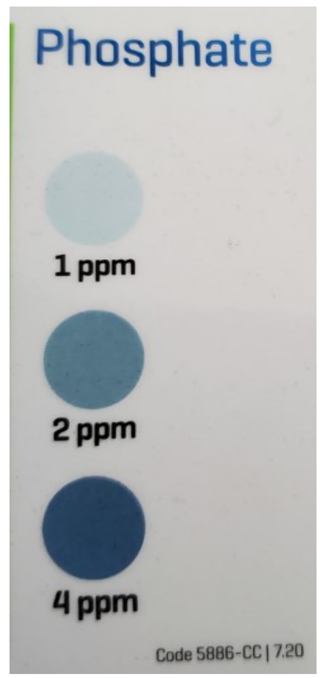
Typical values:

- Tap water and reservoir / lake water: 0.08-0.09 mg/L
- River water: 0.11-0.37 mg/L
- Values > 1 mg/L: favorable for algae growth
- 2 -3 mg/L: algae growth likely to occur

Directions

Phosphate Procedure





Data Entry:

Water Sample #1:

Phosphate _____________ _____________ _____________

Water Sample #2:

Phosphate _____________ _____________ _____________

Phosphate

What do results mean?

1) Were your values similar to those typically seen in tap water or local water bodies? (Compare to values above) Why or why not?

2) What are some phosphorus sources that might be impacting the water bodies were you took samples?

3) Do you think phosphorus increases or decreases in a water body after rain? After drought? After irrigation of farms? Why or why not?

Bacteria

Bacteria are living organisms that are too small to see with our eyes. Bacteria are everywhere – air, food, water, even on you! Most bacteria are either not harmful, or in many cases, are beneficial! It is important to test water, like tap water, swimming pools, and rivers and streams, to understand if harmful bacteria are present. This keeps humans and the environment safe.

Harmful bacteria are found in dog poop, and these bacteria can easily enter water bodies. This is why it is important to clean up dog poop!

Typical values:

- No detectable coliform bacteria in drinking water.
- "Coliform" bacteria" are bacteria from poop. It is not ok to have these in drinking water. However, your test may show bacteria in your drinking water because there are also non-harmful bacteria present. These species are safe for you.
- Water that you have contact with (like swimming): <200 colonies/100 mL
- Water that you fish or boat in: <1,000 colonies/100 mL

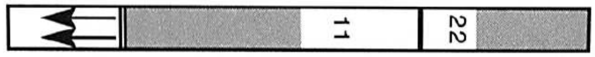
Your test strips will show a positive result if bacteria are present. Remember, not all bacteria are harmful.

Bacteria

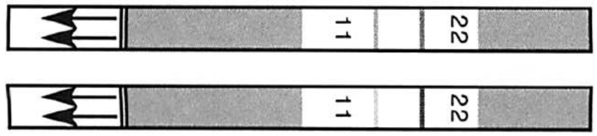
Directions:

1) Do not open until immediately prior to use.
2) Open foil pouch and remove contents.
3) Use a clean dropper, and place exactly one dropper-full of your water sample into the vial.
4) Gently swirl. Let stand for 7 minutes.
5) Swirl again and return to a flat surface.
6) Place test strip in vial with arrows pointing down.
7) Wait 10 minutes. Do not disturb the test. Watch for reddish lines beginning to appear.

Negative: Only one line, next to number 2, is present.



Positive: Line 1 and Line 2 are present. Line 1 may be lighter in intensity or equal in intensity to line 2.



If only line 2 is present, test is NEGATIVE
If line 1 and line 2 are present, test is POSITIVE

Note: If no lines appear, your result is not valid and you should try again with a new pouch.

Data Entry:

Water Sample #1:

Bacteria: ______________ ______________ ______________

What do results mean?

1. Did your sample have bacteria?

2. Where do you think the bacteria came from?

3. What type of water sample would you expect to have the most bacteria?

Conclusion

Congratulations Citizen Scientist! You are now an expert at water quality in the Bay Area. Remember, you can email the program leaders if you have questions. Contact info is above, in the Intro section.

1) We have a few final questions for you to think about:

2)Which sample had the highest salinity? Why?

3) Which samples had the best and worst water quality? Why?

4) Do you think water quality changes throughout the year at one location? Why or why not?

5) How would water quality impact an endangered species, like salmon?

6) You can ask an adult to help you answer these questions. The internet will be a helpful tool.

Yeye You Made It!

Remember!!!

- If you need help during the experiment you can contact us at : **office@calacs.org, aliciaataylor@gmail.com,** and **jssheth@syr.edu**

- You can help your local scientist understand the regional water quality by inputting your data at : **https://docs.google.com/forms/d/11hAaF9PzBKki8P7YpHXxBn5JwibaWnXi5fj-hnQjxgQ/edit?ts=60920d62**

- Also remember that you can find the video detailing all the experiments at calacs.org or svacs.org! The video is found on the homepage of both websites. Search for "Water Quality Kit Citizen Science".

Water Quality

Citizen Science | Project Kit

To get involved in more projects, contact your local ACS section TODAY at

office@calacs.org, aliciaataylor@gmail.com, or jssheth@syr.edu!

BAY AREA SCIENCE

ACS Local Section California

ACS Local Section Silicon Valley