# Water Quality Laboratory

## Instructions for Part 1: Subjective, Qualitative data

1. You will conduct some primary research on water flavor and quality. All water samples provided in this laboratory are safe for human consumption. The water sources are: 2 types of bottled water, tap water, Britta filtered water, and distilled water.
2. On the first day of this laboratory, you are in charge of obtaining subjective or qualitative information about the water samples. Form a group of 4 people. No more than four people per group, no fewer than three people per group.
3. Select one individual to be the "taste tester". The rest of the group will work as the:
    a. Sample Preparer*
    b. Sample Administrator*
    c. Data Recorder

    *If the group only has three people, the sample preparer cannot be the same person as the sample administrator.
4. Record who is assigned to which role in the appropriate area of the lab assignment.
5. The class will discuss the criteria for smell and taste. The Data Recorder should note the final criteria on the lab assignment.
6. Form two hypotheses about which type of water tastes the best and worst and write them on the assignment.
7. Instruct the taste tester to take the waiver form, leave the classroom and wait in the hallway for their name to be called (you have to make sure you know their name). While they are waiting, they should read the waiver and sign it.
8. In the meantime....Sample Preparer's tasks:
    I. Obtain 5 cups (ones that the taste tester will drink out of), marker, and tape (if needed)
    II. Label the cups Sample 1, Sample 2, Sample 3, Sample 4, Sample 5
    III. Record on the data sheet which water sample will be placed in each cup. Mix up the order – the rest of the group SHOULD NOT know which sample is which! The goal of this step is to have a randomized order of sampling for each group. For example one possible set up **could** be:
        Sample 1 – Water sample B
        Sample 2 – Water sample A
        Sample 3 – Water sample C
        Sample 4 – Water sample E
        Sample 5 – Water sample D
    IV. Add enough of the water sample to the appropriate cup so that the taste tester can take a few sips of water.
    V. Provide the 5 samples to the Sample Administrator and call the taste tester back into the classroom.
8. Sample Administrator's tasks (once the samples are prepared):
    a. Call the taste tester back into the room. Collect the waiver sheet and greet the taste-tester. Explain what will happen (this means you need to have already read the instructions).
    b. Give each sample to the taste tester one at a time. Instruct them to (1) smell the water sample and score it based on the set criteria, (2) taste the water sample and rank it based on the set criteria. The data recorder will record the data.
    c. Repeat with each of the 5 samples in the order given to you by the sample preparer.
    d. After all 5 samples have been tasted, ask the taste tester to rank the samples as "best" tasting and "worst" tasting.
9. Data recorder's tasks:
    I. Record the data from the tests on the appropriate area of the data sheets.
    II. AFTER all the samples have been administered and the data recorded, reveal which sample is "A", "B", "C", "D", or "E" and write that on the taste & smell test data sheet.
10. At some point, (probably the next class day) the instructor will also reveal the true sources of each water after the objective, quantitative data has been recorded . When that happens, write the true sources of the water on the data sheet.

## Instructions for Part 2: Objective, Quantitative Data

For this section, each group will obtain objective, quantitative data about **ONE** CHEMICAL in each of the water samples. After each group collects the data for their sample, the class will share the data.

1. Read about the sources of the 6 chemicals that we will be testing for in the water samples. Think about "Why would the concentration of these chemicals be different in various water sources?"

### *pH*

In general, water with a low pH (< 6.5) could be acidic, soft, and corrosive. Therefore, the water could contain metal ions such as iron, manganese, copper, lead, and zinc, or, in other words, elevated levels of toxic metals. This can cause premature damage to metal piping, and have associated aesthetic problems such as a metallic or sour taste, staining of laundry, and the characteristic "blue-green" staining of sinks and drains. More importantly, there are health risks associated with these toxins. Water with a pH > 8.5 could indicate that the water is hard. Hard water does not pose a health risk, but can cause aesthetic problems. These problems include an alkali taste to the water (making that morning coffee taste bitter!), formation of a deposit on dishes, utensils, and laundry basins, difficulty in getting soaps and detergents to lather, and formation of insoluble precipitates on clothing.

### *Chlorine*

Chlorine is used to kill bacteria and other microbes in drinking water supplies and public swimming pools. Prior to the chlorination of municipal water supplies, contaminated public drinking water was a common source of disease. Microscopic waterborne pathogens causing cholera, typhoid fever, dysentery and Hepatitis A killed thousands of people every year. Today, we take the safety of drinking water for granted. Modern chlorination and filtration of water prevents the spread of these diseases. For more interesting reading about water chlorination and water safety, check out this link: http://www.americanchemistry.com/s_chlorine/sec_content.asp?CID=2183&DID=9227&CTYPEID=109

### *Nitrate*

Drinking water high in nitrate is potentially harmful to human and animal health. Nitrate ($NO_3^-$) is a naturally occurring form of nitrogen (N) which is very mobile in water. It is essential for plant growth and is often added to soil to improve productivity. Water moving down through soil after rainfall or irrigation carries dissolved nitrate with it to ground water. Sources of nitrogen and nitrates may include runoff or seepage from fertilized agricultural lands, municipal and industrial waste water, refuse dumps, animal feedlots, septic tanks and private sewage disposal systems, urban drainage and decaying plant debris. Geologic formations and direction of ground water flow also may influence nitrate concentration.

### *Copper*

Levels of copper found naturally in ground water and surface water are generally very low; about 4 micrograms of copper in one liter of water (4 ug/1) or less. However, drinking water may contain higher levels of a dissolved form of copper. High levels of copper occur if corrosive water comes in contact with copper plumbing and copper-containing fixtures in the water distribution system. If corrosive water remains motionless in the plumbing system for six hours or more, copper levels may exceed 1,000 ug/l. The level of copper in drinking water increases with the corrosivity of the water and the length of time it remains in contact with the plumbing.

### *Iron*

Iron is not hazardous to health, but it is considered a secondary or aesthetic contaminant. Dissolved iron gives water a disagreeable taste. When the iron combines with tea, coffee and other beverages, it produces an inky, black appearance and a harsh, unacceptable taste. Vegetables cooked in water containing excessive iron turn dark and look unappealing. The source of iron may be from the corrosion of iron or steel pipes or other components of the plumbing where the acidity of the water, measured as pH, is below 6.5

### *Phosphate*

Natural waters have a phosphorus concentration of approximately 0.02 parts per million (ppm) which is a limiting factor for plant growth. On the other hand, large concentrations of this nutrient can accelerate plant growth. Manmade sources of phosphate include human sewage, agricultural run-off from crops, sewage from animal feedlots, pulp and paper industry, vegetable and fruit processing, chemical and fertilizer manufacturing, and detergents

2. Form and record hypotheses about the chemical levels in the various water sources on the assignment.

3. Obtain the following items:

   Water Samples ("A", "B", "C", "D", or "E") **Note: pour the samples into another container, DO NOT put the glass pipette into the main container**
   Test tablets for pH, chlorine, iron, nitrate, copper, OR phosphate (your group will be assigned one of these)
   5 test tubes
   green pipette pump
   10mL glass pipette
   Indicator cards

4. Label the test tubes as follows: A, B, C, D, E
5. Add the appropriate volume of the designated water sample to each test tube depending on which chemical you were assigned:
   pH – 10mL
   chlorine – 5mL
   iron – 5mL
   nitrate – 5mL
   copper – 10mL
   phosphate – 5mL
6. Add one test tablet to each tube, cover tube with Parafilm, and gently shake or invert to mix.
7. Wait about 5 minutes.
8. Use the color indicator cards and record the concentration of the chemical in the water on the data sheet. If it is between two of the values on the indicator cards you can say "less then ____, but greater than ____".
9. Share your data with the other group assigned to the same chemical and calculate an average or consensus.
10. Share the average values of the chemical with the class, and record the other groups' data on your chart.
11. Clean up
12. Discuss the questions with the rest of the group. These questions may require people to look up some information on their own time outside of class! Please note that there are some questions that will be completed and submitted as a group and some that are completed and submitted individually.

**Data Sheet:**

**Part 1: Subjective, Qualitative data**

Taste Tester_____
Sample Preparer_____
Sample Administrator_____
Data Recorder_____

Smell and tastel will be ranked using the following descriptive terms: *good* or *bad*. Determine as a class what criteria will produce a *good* or *bad* ranking.

Good Smell: _____

Bad Smell: _____

Good Taste: _____

Bad Taste: _____

Which type of water tastes the best?
*Hypothesis:*

Which type of water tastes the worst?
*Hypothesis:*

| Sample Preparation | Actual water samples (from instructor) |
|---|---|
| Sample 1 = | Sample A = |
| Sample 2 = | Sample B = |
| Sample 3 = | Sample C = |
| Sample 4 = | Sample D = |
| Sample 5 = | Sample E = |

**Smell & Taste Test**

Water Sample 1 _____

1. Smell: good bad
2. Taste: good bad

Water Sample 2 _____

1. Smell: good bad
2. Taste: good bad

Water Sample 3 _____

1. Smell: good bad
2. Taste: good bad

Water Sample 4 _____

1. Smell: good bad
2. Taste: good bad

Water Sample 5 _____

1. Smell: good bad
2. Taste: good bad

"Best smelling" sample: _____

"Worst smelling" sample: _____

"Best tasting" sample: _____

"Worst tasting" sample: _____

**Part 2: Objective, Quantitative Data**

*Hypotheses:* Which sample will have the lowest pH? Why?

Which sample will have the highest quantity of chlorine? Why?

Which sample will have the highest quantity of nitrate? Why?

Which sample will have the highest quantity of copper? Why?

Which sample will have the highest quantity of iron? Why?

Which sample will have the highest quantity of phosphate? Why?

Chemical test assigned to group _____

| | A | B | C | D | E |
|---|---|---|---|---|---|
| "Our group" | | | | | |
| "Other group" | | | | | |
| Average | | | | | |

Class Average Data:

| | pH | Chlorine | Nitrate | Copper | Iron | Phosphate |
|---|---|---|---|---|---|---|
| A | | | | | | |
| B | | | | | | |
| C | | | | | | |
| D | | | | | | |
| E | | | | | | |

**Questions to complete with your group:**

1. Describe the general set up of a double-blind, randomized study.

2. Describe how **this** water quality study was both double-blind and randomized:

3. What was the subjective data that was collected in these experiments?

4. Would this subjective data change if we had different people acting as the "taste testers"? Support your answer.

5. Are there significant taste or smell differences between the various sources of water? If so, why do you think this might be the case?

6. What was the quantitative data that was collected in these experiments?

7. Would this quantitative data change if different people were the "scientists"? Support your answer.

8. Are there significant differences in pH, chlorine, nitrate, copper, iron, and phosphate concentrations between the various sources of water? If so, why do you think this might be the case?

9. Was there any association with the quantitative and qualitative data? For example did most people find water that had a low pH tasted better?

10. What are two conclusions you could make from the data we collected as a class.

11. Examine some of the "cartoons" on display - what are your groups' reactions to these cartoons? Do you think these cartoons are "scientifically accurate" or "inaccurate" and why?

12. How can we make society more aware of the environmental problems associated with bottled water? List at least 5 ways.

13. Are there times or places that bottled water might be essential? Are there times or places when bottled water is not essential?

**Tasks & Questions to complete individually:**

Read about how to read a water quality report: http://www.dwrf.info/what-s-my-water-quality/

- Visit the SFPUC website and read about San Francisco's water: http://sfwater.org/detail.cfm/MC_ID/13/MSC_ID/166/MTO_ID/299/C_ID/5027
- Read the 2009 water quality report for the city of San Francisco: http://sfwater.org/Files/FactSheets/2009WQB_table.pdf

1. Who sets the limits of certain chemicals in tap water?

2. Where does the City of San Francisco's water come from?

3. According to the water quality report, does San Francisco have "clean" water? Why or why not?

4. According to EWG (http://www.ewg.org/tap-water/rating-big-city-water) where does San Francisco's drinking water rank nationally?

5. Who regulates the limits or levels of certain chemicals in bottled water (http://www.allaboutwater.org/regulations.html)?

6. What are some differences between tap water and bottled water quality control procedures?

7. Read the International Bottled Water Association's response to "The Truth About Bottled Water": http://www.bottledwater.org/news/ibwa-rebuts-misleading-and-factually-incorrect-video-about-bottled-water What do you think about the two sides? Which one do you "believe" and why?