Hi, I'm Hailey Dennis and I'm Emily May. Our project is... FILTRATION STATION! The purpose of our experiment was to test different types of filters to determine which one cleans dirty water the best by reducing the number of total dissolved solids.

Hypothesis

We think the filter that has the greatest number of mediums will do the best job of reducing total dissolved solids (our carbon, sand, gravel, cotton ball #3 filter).

Background Information

There are both natural and man-made filters to clean water. Cat tails and other wetland plants will remove 90-95% of toxins and heavy metals in water. Wetlands act like a giant sponge and help to reduce overland flooding that is a threat to safe well water. Wetlands can also supply people and livestock with water. Source: Oak Hammock Marsh Presentation 2020. You would find man made filters in water treatment plants or in outdoor survival kits (ex- Life Straw). Good quality man made filters usually include a membrane and might include the process of reverse osmosis.

We chose to filter dirty water through different designs of sand, gravel, carbon, and cotton ball mediums because this filtration method most closely resembles the natural filtration that happens in yards when rain water or melt water sinks through

the various soil levels and is eventually collected in wells.

Water filters containing permanganate green sand generally remove minerals such as iron, manganese, and dissolved solids which can be damaging to appliances and plumbing fixtures. Water in our area generally is high in manganese (source: Diamond Water Works staff). This experiment does not explore water disinfection.

Definitions:

Filtration: The process by which solid particles in a liquid or gaseous fluid are removed by the use of a filter medium that permits the fluid to pass through but retains the solid particles.

Total Dissolved Solids: (TDS)This represents the total concentration of dissolved substances in water. TDS is made up of inorganic salts, as well as a small amount of organic matter (such as dirt).

Reverse Osmosis: (RO) is a water treatment method used to remove dissolved inorganic chemicals and suspended particulate matter from a water supply. Water, under pressure, is forced through a semipermeable membrane that removes molecules larger than the pores of the membrane. This is a process commonly used to cleanse water but we didn't use it our experiment.

Semipermeable membrane: It is a thin flexible layer that only

certain molecules can pass through but is still strong enough to protect what is inside or underneath.

Oxidization: This is the loss of electrons during a reaction by a molecule, atom, or ion. This occurs when the oxidization state of a molecule, atom, or ion is increased. Oxidization of water is commonly done through aeration (adding air bubbles to the water). In this experiment the water that passed through the kitchen tap with a screen was oxidized.

Water softener: This is any substance that lessens the hardness of water, usually by precipitating or absorbing calcium and magnesium ions.

Variables

Independent Variable (changed): Type of water filter design used. 3 filters have been constructed.

Dependent Variable (measured): We will assist a staff member at Diamond Water works to test water samples for iron and total dissolved solids.

Controlled Variable (stays the same): All the same: source of sand and fish tank gravel, size of pop bottles, number and size of cotton balls, hole size in bottom of pop bottle (same drill bit used), source of activated carbon, temperature of materials, amount of materials in each filter, same water source (although from 2 different taps in the same house), and same amount of

water submitted for testing (500ml)

Materials

3 two liter pop bottles, cleaned play sand, cotton balls, activated carbon from 2 Brita filters, fish tank gravel, black dirt, Brookdale tap water (unsoftened), measuring cups for sand and water, gravel, and water, 1/4 teaspoon for measuring black dirt, labeled collection containers, drill, funnel, and gorilla tape.

Method

1. Pop bottle #1: fill with cleaned sand, then cotton balls.

2. Pop bottle #2: fill with sand and gravel mix, then sand, and lastly cotton balls.

3. Pop bottle #3: fill sand/gravel mix, sand, activated carbon (what was contained in 2 Brita filters), then sand, and lastly cotton balls.

4. Drill hole in bottom of each pop bottle. Tape pop bottles upside down to legs of kitchen table with gorilla tape. Initial flush was with 10 cups of water for each filter. Discard flush water. Mix 1/4 tsp dirt to 1 cup water ratio. We waited 10 seconds for dirt to settle and then poured 2 cups of dirty water very slowly into each filter through funnel and collect results for Trial 1. Next, 3 cups of flush water drained through each filter. Discard flush water. Same ratio of dirt to water used and same amount (2 cups) poured through each filter for trial two.

For trial 1 and 2, glass measuring cup was washed out between uses. Results were inconclusive after the first two trials so we ran a third trial of just tap water (no dirt added) through each filter after another 3-cup flush and had those samples tested for TDS.

Observations

We noticed that the tap water was light yellow when held up to natural light and it was clear after being filtered through each of the three filters. We were surprised that our flush water was clear and clean looking because we expected that it could look a bit dirty. Filter #3 always took the longest to filter the water, possibly due to having the greatest number of mediums to pass through.

Brookdale Tap Water taken from a kitchen tap(unsoftened) Trial 1	TDS	Iron
Unfiltered/Dirty Water	603	0 ppm
Filter 1	592	0 ppm
Filter 2	570	0 ppm
Filter 3	604	0 ppm

Brookdale Tap Water taken from a bathtub (unsoftened) Trial 2	TDS	Iron
Bathtub Tap Water (without added dirt)	550	2 ppm
Unfiltered/Dirty Water	578	2 ppm
Filter 1	550	2 ppm
Filter 2	557	2 ppm
Filter 3	668	2 ppm

Brookdale Tap Water taken from Bathtub (unsoftened) Trial 3	TDS	Iron
Unfiltered/Dirty Water	482	2 ppm
Filter 1	415	2 ppm
Filter 2	484	2 ppm
Filter 3	538	2 ppm

Conclusion

The filter that performed the best (2/3 times) was filter #1. The filter that performed the poorest (3/3 times) was filter #3 which we did not expect as it had the most number of mediums. Filter #3 TDS scores were actually higher than the dirty water suggesting that the initial 10 cup flush might not have been enough to clean the filter. There was a 68 ppm difference in TDS between tap water samples in Trial 2 and 3 which was surprising since they were both taken from the same bathtub tap on different days. In trial #3, the TDS values were the lowest for all the filters because we did not add dirt to the water. Running more trials would have provided more data for comparison.

We learned from Diamond Water Works staff that the reason the iron levels differed in the trials was because some of the tap water we used was from the kitchen tap where there was a screen and some of the water came from the bathtub where there was no screen. The screen oxidized the iron which made testing for it difficult as the yellow iron color disappeared from the oxidized sample and the iron test could not detect it even though we know that it is still there.

We also learned that carbon only helps to reduce odor and improve taste. Therefore, having carbon as part of our filtration designs was not helpful to reduce TDS values.

Application

We believe that access to clean drinking water is a right and not a commodity to be sold which puts the world's poorest people at risk of not being able to afford it. For millions of people, there is no such thing as piped water in their houses. In some cities, water is plentiful in wealthy neighborhoods but not in poorer neighborhoods. Those who cannot afford to pay, drink contaminated water and many become ill. Source: Arato, R. (2005). *World of Water: Essential to Life*. Crabtree.

We feel that people anywhere could use these inexpensive and readily available materials to make similar water filters to remove dirt and minerals from their water. If people had a way of disinfecting this filtered water, they could have safe useable water available to them at no or little cost.

Extra Background Information for Lab Book

We know that many people in Canada and the world struggle to access clean drinking water and that clean water is essential to good health. Supplying local households with clean water from their private wells is also interesting as we both have wells in our yards. Climate change is causing our ice glaciers to melt into

the ocean and areas of drought are threats to fresh water supplies. World population growth and pollution are other threats to having enough clean water for everyone. Source: Barnham, K. (2008). *Environment Action! Save Water*. Crabtree.

We learned about two other methods of cleaning water in our research. One method that can be used by people who live near the Arctic Ocean to remove salt from drinking water involves freezing very salty water and then letting the ice partially melt. Since there is little room between the ice crystals for salt and most of the salt stays in the water, the ice can be melted and consumed. Ingram, J. (1992). *Real Live Science: Top Scientists Present Amazing Activities Any Kid Can Do.* Grey de Pencier Books. pg. 27. Another option to remove mud from water involves uses capillary action to move water from a higher bowl to a lower bowl. The mud particles in the dirty water in the higher bowl cannot travel down the handkerchief to the lower bowl so the lower bowl only collects clear water. Walpole, B. (1988). *175 Science Experiments to Amuse and Amaze Your Friends: Experiments! Tricks! Things to Make*! Random House. pg. 43.

We hope you were influenced to next time...**THINK BEFORE YOU DRINK!**