Earth's Secret Filter

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Background, Purpose and Hypothesis:

In Kitchener-Waterloo Ontario, 75% of the drinking water comes from underground aquifers. As the population of our cities increases, and as our cities grow along with industrial businesses, there is a greater need to be careful about protecting our underground water from contamination. Many of the surrounding communities consist of farmland and because of the abundant use of pesticides and chemicals the contamination to our aquifers is a cause for concern.

The **purpose** of this project was to examine the different filtering abilities of soils. Experiments were conducted in order to demonstrate our soil's natural ability to filter certain contaminants as well as to determine which *types* of soils work best in filtering out possible contaminants that may enter into the soil and down into the water table.

The **hypothesis** made was that the *type* of soil does have an effect on the amount and concentration of contaminants potentially reaching the water table.

Procedure

In setting out to prove the hypothesis that different soil types have different filtering abilities of contaminants, several different filters were constructed:

1. A filter consisting of sand and gravel
2. A filter consisting of sand, soil and gravel
3. A filter consisting of sand, clay and gravel
4. A filter consisting of sand, crushed limestone and gravel

5. A soil filter
6. A soil and vegetation filter

The following contaminants were assembled: Acidic Vinegar Solution (to simulate acid rain with a pH level of 4), Red Kool-Aid Solution (colour contaminant), Salt Solution (to simulate road salt—with a specific gravity of 1.080), Car Anti-freeze and Turbid Water.

Before starting with the experiments, the contaminant samples were measured and the observations were recorded. The type of contaminant determined the kind of measurement that was used. The pH of the acidic vinegar solution was measured using the pH paper, the intensity of the colour of Kool-Aid was measured visually and the specific gravity of the salt and antifreeze solutions was measured using a hydrometer. Each of these characteristics was noted before the experiments were conducted.

Each experiment started with pouring a measured amount of a single contaminant through the various filters and collecting samples once it had passed through the filter. The samples that passed through the filter were then analyzed in the same manner (pH, specific gravity, intensity of colour etc.) and the results were recorded. The noted results from the collected sample were then compared to the original sample and the observations were recorded. Photographs were also taken of the contaminant solutions prior to being passed through the filter and afterwards in order to show the difference in the colour intensity of the Kool-Aid contaminant.

In the first experiment, a sample of the turbid water was poured through the sand, soil and clay filters. The samples that passed through the filters were checked visually for clarity and compared with a sample of the original turbid water. In the second experiment a sample of Kool-Aid was poured through the sand, soil and clay filters. The Kool-Aid sample represented common contaminants diluted in the surface water. Again, the samples that went through the filters were visually examined for colour loss and then compared to the colour of the original Kool-Aid sample. In the third experiment, I tried to simulate acid rain by pouring a sample of an acidic vinegar solution through a filter that had a layer of crushed limestone between layers of gravel and clay. The pH of the vinegar solution that passed through this filter was measured with the pH paper and recorded. The fourth experiment simulated salty runoff water from the roads. The salt solution was poured through a sand filter and collected. The specific gravity of the solution after it passed through the filter was measured and recorded. The soil's ability to deal with common pollutants as car antifreeze was tested in my experiment number 5. As in the previous experiment, the specific gravity of the sample was measured, recorded and compared to the original sample. I noted that in this experiment it took about 24 hours for a sample of antifreeze to go through the clay filter.

In order to determine whether vegetation played a role in helping to reduce a colour of a contaminant, the same amount of Kool-Aid was poured through a filter consisting only of soil and then through a filter that contained soil and vegetation. The results of this were recorded and analyzed.

Results/Observations and Conclusions

The best types of soils that help to filter contaminants before they have the ability to reach the water table are those soils that are medium and fine-textured. The coarse textured soils (gravely) are the worst in terms of removing contaminants from the soil; however, they are great for draining surface water and helping to replenish underground aquifers. The experiments that I conducted all proved this theory. Sand is a coarse material and because of its porosity, water moves through it quite rapidly and the water (and the contaminants found in the water) does not have an opportunity to make contact with the sand particles and moves through quickly. The results from the experiments prove that contamination reduction is not very great when sand is used as a filter. The red colourant contaminant and the salt contaminant both were not greatly reduced by being passed through a sand filter.

A filter that was very effective in reducing the concentration of the red colourant contaminant, the turbid water and the salt contaminant was the soil filter. Soil has many properties which make it a very effective filter and protector of our groundwater. The decomposed matter and the porosity of the soil as well as any vegetation found in the soil can help to filter out more of the contaminant that may be present in the water. All of the experiments that I conducted proved that enriched soil is an extremely good filter of pollutants.

The clay filter also proved to be very effective in reducing the colourant, salt solution and antifreeze contamination, proving as well, that these types of soils, if found over water tables will help to filter out common contaminants. It was observed that it took significantly longer to filter the same amount of contaminant through a clay filter than the sand filter. This is due to the fact that clay's fine particles are close together and do not allow water to flow through quickly. Lower permeability of clay provides for better filtration ability.

Soil composition can also affect its ability to reduce concentration of certain chemicals. Addition of limestone to a simple clay filter helped greatly in reducing the acidity of the filtered water.

I was surprised by my last experiment and the improved filtering ability of soil when there is an actual plant (vegetation) in the soil. This experiment proved that living things in the soil will also help to filter contaminants.

My project and the experiments conducted prove that soil and the soil types are extremely important in protecting the quality of our underground water supply. The soil plays an extremely important role in helping to filter out some of the contaminants prior to them reaching the water table. The soil acts like a sponge in trapping the contaminants. I believe that enriching the soils with vegetation and other matter will also help to protect the underground water from contaminants. Perhaps planting more vegetation in the soils located on top of our water tables will help in the reduction of contamination into our underground water supply.

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