Research Article

What are the Effects of Nonpoint Source Pollution on Paterson's Aquifer?

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Abstract

The purpose of this study was to build a functioning model aquifer similar to New Jersey Paterson's natural aquifer, and then demonstrate if this aquifer can filter 90% of the nonpoint source pollution such as road salt and fertilizer. The result for salinity show approximately 50% of the road salt filtered by the aquifer.

Keywords: Nonpoint source pollution; Paterson's Aquifer; Salinity; Fertilizer

1. Introduction

An aquifer is an underground formation that contains ground water. Most aquifers consist of materials such as rock, sand, and gravel that have a lot of space where water can accumulate. Aquifers are an important water source for many cities and for agriculture. Water in an aquifer is stored in the pores flows from one pore space to another. The ability of rock or soil to allow water to flow through it is called permeability. Porosity and permeability are important characteristics of Aquifers. Materials such as gravel that allow the flow of water are permeable. Materials such as clay or granite that do not allow the flow of water are impermeable. The most productive aquifers usually form in permeable materials, such as sandstone, limestone, or layers of sand and gravel. Water is filtered and purified as it travels underground. When surface water travels down through permeable layers of rock and soil, it reaches a recharge zone. This recharge zone is environmentally sensitive to any pollution because the pollution can also enter the aquifer and contaminate the underground water. We research and designed an aquifer similar to Paterson's natural aquifer. We wanted to see if nonpoint source pollution was filtered out before it reaches the underground water supply of the aquifers in Paterson.

2. Material and Methods

2.1 Materials and reagents

- Potting soil
- Modeling clay
- Road salt
- Water: Type I deionized (DI) water
- Liquid fertilizer-miracle grow
- Sand-(1)50 lb. bag of play sand
- Gravel-aquarium and pea.

2.2 Equipment

- Styrofoam cup
- 2-18 in pieces of clear plastic tubing
- Coffee filter paper
- 10 gallon clear glass fish tank
- Conductivity meter
- 4 plastic 10ml bottles to drip water from the aquifer
- 1 lb. of modeling clay
- 2 lbs. of white play sand
- 1 lbs. of aquarium gravel (natural color)
- Miracle Grow liquid fertilizer green color
- ½ cup road salt
- Watering container
- Salinity meter.

3. Experiment

1. To one side of the container place one 18 inch tube, allowing approximately 1/4 of an inch clearance with the bottom of the container. Fasten the tubing directly against to the long side of the container with a piece of tape. This represents a well function to test ground water.
2. Pour a layer of white sand completely covering the bottom of the clear plastic container, making it approximately 1" deep. Pour water into the sand, wetting it completely, with no standing water on top of sand. Water is absorbed in the sand, and will remain around the sand particles as it is stored in the ground and ultimately in the aquifer.
3. Flatten the modeling clay (like a pancake) The clay represents a “confining layer” that keeps water from passing through it. Pour a small amount of water onto the clay. Pour a small amount of water on top of the clay, and should only flow into the sand below in areas not covered by the clay.
4. Use the aquarium rocks to form the next layer of earth. Place the rocks over the sand and clay, covering the entire container. On the opposite side of the tank, place the second 18 inch tubing into this layer leaving a ¼ of an inch clearance above the clay level. Pour water into your aquifer until the water reaches the aquarium rocks. A “surface” supply of water (a small lake) will form. This will give a view of both the ground and surface water supplies which can be used for drinking water purposes.
5. Next, place the two inches of white sand on top of the gravel. Then place two inches of soil/silt on top of the two inches of white sand and pour water until the water reaches the middle of the soil/silt level.
6. Use ½ cup of the green miracle grow fertilizer to sprinkle over the top layer of soil/silt. Then, with the watering container, pour water over the road salt to simulate rain. This represents fertilizers used in cities. Let the fertilizer and rain water filter through the aquifer. Observe the green liquid fertilizer as it filters through the aquifer layers. This is one way pollution that can spread throughout the aquifer over time. Siphon the water from both tubes to get a flow of water into each plastic bottle.
7. Test the water for evidence of green liquid miracle grow fertilizer.

8. Use a ½ cup road salt and sprinkle over the soil/silt layer. Then, with the watering container, pour water over the road salt to simulate rain. This represents road salt used in cities. Let the road salt and rain water filter through the aquifer. Observe the road salt as it filters through the aquifer layers. Again, siphon the water from both tubes to get a flow of water into each plastic bottle.
9. Test the water for evidence of salt using a salinity meter.

4. Results and Discussion

The purpose of this study was to build a functioning model aquifer similar to Paterson's natural aquifer, and then demonstrate the filtering ability of the model. The hypothesis states, "if the model aquifer is constructed similar to Paterson's natural aquifer, then it will 90% of the non-point source pollution." Further research states that clay soil has a high alkalinity of 8.5, which increases the salinity of soil. "Alkali soil is a type of soil having high concentration of sodium." In addition, the ingredients in modeling clay contain salt as its second ingredient. This is probably why the ground water is high in salinity. The results for the fertilizer show that as the dark green 'miracle grow liquid fertilizer' filtered slowly through the soil and sand it began to dissolve and become much lighter color. When the liquid fertilizer reached the gravel layer most of the liquid fertilizer had disappeared. The ground water layer had no visible color of the liquid green fertilizer. This part of the experiment supported our hypothesis, which states, "if the model aquifer is constructed similar to Paterson's natural aquifer, then it will filter 90% of the non-point source pollution." The model aquifer was able to filter 90% of the liquid fertilizer.

	Paterson tap water (ppm)	**Surface water (ppm)**	**Aquifer water (ppm)**	**Ground water (ppm)**
Salinity	300	12560	6480	8180

Table 1: Results for Salinity.

	Surface soil layer	**Sand layer**	**Gravel layer**	**Ground water sand layer**
Fertilizer color	dark green	light green	slight green	no green

Table 2: Results for Fertilizer color.

5. Conclusion

The purpose of this experiment was to build a functioning model aquifer similar to Paterson' s natural aquifer. The hypothesis states, "if the model aquifer is constructed similar to Paterson's natural aquifer, then it will filter 90% of the non-point source pollution". The results of the demonstration supported the hypothesis regarding filtering fertilizer. When the ground/tap water was tested no fertilizer was present. Therefore, 100% of the miracle grow liquid fertilizer was filtered through the aquifer before it reached the ground/tap water. However, the results of the demonstration did not support the hypothesis regarding road salt. When the ground/tap water was tested salt was present. A significant increase in the salinity of the water was noted. Only 50% of the original road salt applied to the surface level of the model aquifer was filtered through the aquifer when it reaches the ground/tap water. Therefore, this model aquifer did not have the ability to completely filter the road salt that was applied to the surface level (Table1 and Table 2).

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