

## ABCWUA Water Resource Education Activity

<b>Activity Title:</b>	<b>Dirty to Drinkable: Nature’s Purification by Percolation</b>
<b>Description</b>	Students will learn about the natural filtering ability of soil by creating their own groundwater models.
<b>Objectives</b>	Students will: <ul style="list-style-type: none"> <li>• learn how soil cleans water as it passes through to the aquifer.</li> <li>• the processes used by the local water utility authority to clean the river water.</li> </ul>
<b>Grade Level</b>	5 <sup>th</sup> -12 <sup>th</sup>
<b>NM Content Standards</b>	<u>Science for grades 5-8</u> Strand 1, Standard I; BM I, grade 5 (PS 1 & 5), grade 6 (PS 2 & 3), Grade 7 (PS 2), grade 8 (PS 1) Strand II, Standard II, BM I, grade 5 (PS 4), grade 6 (PS 1), grade 7 (PS 4 & 5), grade 8 (PS 1 & 3) Strand II, Standard III, BM II, grade 5 (PS 3), grade 7 (PS 2 & 3), grade 8 (PS 2) Strand III, Standard I, BM I, grade 5 (PS 1 & 2), grade 6 (PS 1), grade 7 (PS 3) , grade 8 (PS 3) <u>Science grades 9-12</u> Strand I, Standard I, BM I, PS 1 Strand II, Standard II, BM I, PS 1, 3 & 4 Strand III, Standard I, BM I, PS 9, 12, 13 & 15
<b>Materials Needed</b>	<b>Materials (per student or group)</b> <ul style="list-style-type: none"> <li>• one one-liter bottle that is cut in half (top and bottom)</li> <li>• 2 clear plastic cups</li> <li>• 1 coffee filter</li> <li>• ½ cup sand</li> <li>• 2” ball of clay</li> <li>• ½ cup gravel</li> <li>• 1 tablespoon powdered alum</li> <li>• one gallon water made “dirty” with 1 tblsp. cocoa powder, or actual dirty water</li> </ul>
<b>Background Info</b>	Soil is composed of sand, silt, organic compounds, minerals and living organisms. This composition will affect the rate at which water can travel through it. The permeability rate is the time it takes for water to pass through a given material. A percolation test is based on this rate and is used by communities to determine whether a septic system can be used or not. Soil overlaying the water table provides the primary protection against ground water pollution. Bacteria,

sediment and other insoluble forms of contamination become trapped within the soil pores. Some chemicals are absorbed or react chemically with soil, thereby preventing or slowing the migration of these pollutants into the ground water. Plants and soil microorganisms use some potential pollutants, such as nitrogen, as nutrients for growth, therefore filtering these chemical out from the layers below.

Because soil is composed of many different substances, it carries electron charges. These charges have the ability to take out substances dissolved in water as it passes through. This "cat ion exchange" is one way this occurs. Positive ions get exchanged within the soil just like calcium and magnesium are taken out of "hard" water with a salt containing water softener. Water treatment plants use this filtering ability of soil by having freshwater pass through a column of sand and gravel and then have the remains settle out. Sand and gravel filters have been shown to filter 90-95% of materials dissolved in the water supply. It is this ability that scientists used to create separation distances or setback zones from the water supply. Septic tanks, livestock yards, septic leach fields, petroleum tanks, pesticide and fertilizer storage and handling, and manure stacks all have required distances between the ground and the water supply. If contaminants are kept to a minimum, the filtering effect of soil will filter out most dangerous chemicals. The problem encountered by most systems is that the amount and content of the pollution exceeds the filtering capability of soil.

Up to now, 100% of the Albuquerque area's drinking water has come from an aquifer that is deep underground, and the water is brought to the surface through a system of over 90 groundwater wells. The problem is that we have been pumping it out faster than it's being replenished naturally. In our area, it takes a long time for rain and river water to seep down and replenish the aquifer. To make matters more difficult, we live in a high desert ecosystem where droughts are common, everyone wants and needs water, and the population keeps growing.

By Fall 2008, the Albuquerque area will begin to use surface water (the Rio Grande) to reduce our aquifer pumping so the aquifer can begin to recover on its own. The aquifer will remain an important reserve to draw on during drought. Most students do not realize where their drinking water comes from or how dirty water is purified to drinking water standards.

<b>Procedure</b>	<p><b>Introducing the Activity</b></p> <p>Set up the sand-gravel filter as a demonstration. Pour out a sample of the dirty river water into a clear plastic cup. Ask the students if they would drink this. Why not? Explain that over 40% of Americans get their water from the ground. Here in Albuquerque, 100% of our drinking water has always come from the ground. We call the location of the ground water an aquifer.</p> <p>How is that water purified naturally? Does soil play a role in cleaning the water? What is the relationship between groundwater quality and the purifying nature of soil? What types of activities about the surface affect the groundwater?</p> <p><b>Procedure</b></p> <ol style="list-style-type: none"><li>1. Each student or group is to have one filtration set-up: one 1-liter bottle cut horizontally in half, sand, gravel, clay, alum, coffee filter and dirty water poured in a clear cup.</li><li>2. Place the filter in the top of the bottle, which has been turned upside down and nested into the bottom portion of the bottle.</li><li>3. Students are to mix a small amount of alum with the dirty water. Explain that the alum attracts particles in a process called flocculation. The alum helps the particles settle quickly. The large particles settle either by sinking to the bottom or they can be filtered more easily because they are now larger.</li><li>4. Students are to build their filter with a small amount each of sand, gravel and clay, in any order. Explain that the sand and gravel are normally found below the ground's surface and that we have some layers of clay in some areas underground. Clay becomes a "confining" layer because it prevents percolation and inhibits recharge of the aquifer. Confine means to keep something in the same place.</li><li>5. Students are to pour the dirty river water mixed with alum slowly over the filter. As the water seeps down, call attention to the slowness of the process and that it takes a long time for natural percolation to take place. Discuss with the students that soils have the capacity to filter certain chemicals out, while others pass through, and that the soil may look clean but still be unsanitary. Do not drink!</li><li>6. Finally, explain that by the summer of 2008, for the</li></ol>

	<p>first time ever, our local source of drinking water will change from 100% aquifer to primarily river (surface) water. This is because we have been pumping aquifer water much faster than it can be replenished naturally. The new water treatment plant will clean the river water very quickly and at a reasonable price. The process used will be very similar to what you just observed.</p>
<b>Evaluation/Extension</b>	<p>Classes will be invited to visit the new water treatment plant to see how purification takes place in a six stage process:</p> <p>First: The water is pumped into large open settling basins, where almost all of the sand and sediment fall to the bottom. The sediment is then trucked away, recycled or sent to a landfill.</p> <p>Second: The lighter particles that didn't sink are mixed with fine sand and powdered iron to make them heavier. This is called "flocculation".</p> <p>Third: These heavy particles pass to another settlement tank where they slowly drift to the bottom. The sand and iron additives are now separated and re-used. The leftover sludge is removed, dried and hauled to a landfill. (Actiflo)</p> <p>Fourth: Should bacteria and other tiny organisms still be alive, a combination of ozone and hydrogen peroxide is used to kill them.</p> <p>Fifth: Finally, any remaining undesirable materials are captured by a granular-activated carbon and sand filter. The river water is now clean and safe to drink. The carbon and sand filter is cleaned by backwashing.</p> <p>Sixth: Sodium hypochlorite is added to the water to keep it pure as it is sent to our homes and businesses.</p>