Ground Water Model Activities

East Maui Watershed Partnership
Adapted from Utah State University and University of Wisconsin Ground Water Project
Ages 7th-Adult

INTRODUCTION

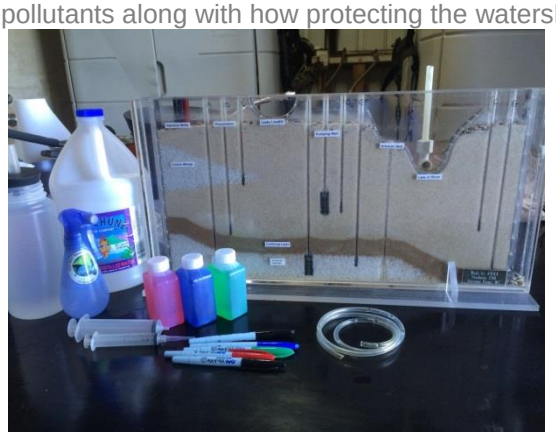
What is groundwater?

Water contained in saturated soil and rock materials below the surface of the earth. It is not NEW water, but is recycled water through the hydraulic cycle. The source of groundwater is precipitation in the form of rain or snow that falls on the earth's surface and soaks into the ground. This water passes through different saturation zones in the earth down gradient until it reaches a point where it discharges at the surface as a lake, stream, or wetland, or it is withdrawn from a well.

TASK(S)

Groundwater Model

This is an interactive classroom tool that is designed to show the flow of water and toxins through different gradients. The model is a simulated cut-away section of the earth. It shows the make-up of the ground beneath the surface and allows for demonstrations of groundwater principles. It can be used in front of the classroom and demonstrates flow through confined and unconfined aquifers as well as the effects of pumping these aquifers. This model is used in conjunction with a PowerPoint slide show and short video that introduces hydrology and the specific of Maui's ground water and pollutants along with how protecting the watershed helps groundwater recharge.



Concepts that can be demonstrated:

- Aquifers
- Groundwater Flow
- Water Table
- Wells
- Contamination Effects

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ACTIVITY/PROCESS

1. Aquifers

Purpose

To teach basic groundwater concepts including aquifer, groundwater flow, and water table.

Background:

People often erroneously believe that groundwater travels hundreds of miles underground. They also believe that the water they drink has been underground for thousands of years. In fact, groundwater drawn from shallow wells usually enters the ground within a few miles of the well and has been in the ground for only a few years or tens of years.

Groundwater is stored in the pore spaces of saturated soil, between sand, grains, and inside crack and fractures in rock. An underground unit of soil, sand, gravel, or fractured rock which can yield a significant quantity of groundwater to wells is called an AQUIFER.

GROUNDWATER FLOWS through interconnected pore spaces in aquifers. Groundwater may flow at different rates in different types of aquifers. Aquifers are not always uniform either horizontally or vertically because of differences in composition or in properties. You'll notice in the model that some aquifers are fine sand and some are coarse sand or gravel. Aquifers may be separated by layers which do not transmit much water. These layers are called confining layers (aquitards). If a confining layer exits above an aquifer which is fully saturated and under positive pressure, this aquifer is called an *artesian* aquifer. Aquifers without a confining layer above them are called unconfined aquifers or WATER TABLE aquifers.

2. Flow Concepts

Purpose

To teach basic groundwater concepts including the relationship between groundwater and surface water, saturated and unsaturated zones, piezometer, and recharge area.

Background:

Groundwater is not new water; it is "recycled" water that is related to all the other water on earth by a process called the hydrologic cycle. The hydrologic cycle describes the **INTER-RELATIONSHIP OF GROUNDWATER WITH SURFACE WATER**, such as lakes and streams, and the water found in the atmosphere, such as clouds, snow, and rain. When rain falls on the surface of the ground, some of it runs off the land into lakes and streams. This is considered run-off. When it soaks into the ground, it is referred to as infiltration. The water soaking into the ground may first go throughout an unsaturated zone, where some may be taken up by plants and "lost" to evapotranspiration. The **UNSATURATED ZONE** contains spaces between the soil particles, some of which are filled with air and the rest with the water that soaks in. Soils in the unsaturated zone are able to hold water in small pores against the force of gravity because of surface tension or cohesion, which is the attraction that water molecules

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have for one another. Water in larger pores is more subject to the force of gravity and is the source of water that moves downward to become groundwater. Below the unsaturated zone, the water reaches a zone in the sand and gravel where all the cracks and spaces in the soil or rock are filled with water. This is the **SATURATED ZONE**. Water in the saturated zone is groundwater. The top of the saturated zone is called the water table. In the model, the dye in the observation wells (piezometers) sits at the same elevation as the water table.

Topography influences the rate of groundwater recharge as well. Groundwater recharge areas are usually located in upland areas. Water may then flow down-gradient until it reaches an area where it can come to the surface of the ground, called a discharge area. Groundwater discharge areas are normally low areas such as lakes, rivers, and wetlands. Groundwater often feeds lakes and streams. The place where groundwater becomes surface water is a discharge area. When groundwater simply bubbles up at the surface of the ground, that discharge area is called a spring. The stream in the model is an example of the inter-relationship of groundwater and surface water, where the groundwater enters the stream in the form of a spring.

3. Wells

Purpose

To teach basic groundwater concepts including aquifer, groundwater flow, and water table.

Background:

In the model, the dye in the observation wells (piezometers) sits at the same elevation as the water table. PIEZOMETERS are wells installed to monitor water level and water quality. Groundwater is withdrawn from the ground through WELLS for use in our homes, farms, and industries. Wells are drilled or driven into water-bearing underground zones called aquifers. A screen is placed at the bottom of the well to keep soil from being pumped out along with the water. In the case of bedrock wells, there is not always a screen used. A pump is used to withdraw water from the well. When a well is drilled to penetrate any aquifer, water will enter the well casing. In an unconfined aquifer, the water level will stabilize in the well at the top of the saturated zone, which is called the water table. In a confined aquifer, when water in the well rises above the top of the aquifer, potentially resulting in the flow of water above the surface of the ground, a flowing well or ARTESIAN WELL may result.

4. Groundwater Contamination

Purpose

To teach basic groundwater concepts including aquifer, groundwater flow, and water table.

Background:

What properties of water make it unique? Water can dissolve more substances in greater quantities than any other liquid; however, this natural ability to dissolve and carry materials allows it to be easily contaminated by human activities as well.

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Human activities at or near the land surface can contaminate groundwater by moving through the unsaturated zone to the water table. Contamination can continue to move within the saturated zone, and discharge at the stream outlet. Human activities which may contaminate groundwater include over fertilization, misuse of pesticides, oil spills, leaky landfills, leaky septic systems, and leaky underground storage tanks.

There are direct routes of groundwater pollution. Abandoned wells can be contaminated by human activities at or near the land surface. Remember that pumping water from wells draws water toward it from all directions. Since wells create a cone of depression around them as they draw water, they can also draw contaminants toward them from any direction: above, below, or even the area that would normally be considered "downstream".

MATERIALS

Groundwater Flow Demonstration Model Kit
PowerPoint Presentation
Distilled Water

GLOSSARY

Aquifer - Areas underground where groundwater exists in sufficient quantities to supply wells or springs.

Artesian Well – a confined aquifer containing groundwater under positive pressure.

Condensation - The process by which a vapor becomes a liquid.

Cone of Depression – Occurs in an aquifer when groundwater is pumped from a well.

Contamination (Water) - Damage to the quality of water sources by sewage, industrial waste, or other matter.

Disinfection - A process whereby most microorganisms in or on a substance are killed; there is a high probability that pathogenic (disease causing) bacteria are killed in the process but depending on the process, destruction of viruses is not as certain.

Distillation - The separation of different substances in a solution by boiling off those of low boiling point first. For example, water can be distilled and the steam condensed back into a liquid that is almost pure water. The impurities (minerals) remain in the concentrated residue.

Diatomaceous Earth - An earthy deposit formed mainly of diatoms (one-celled marine life forms) that are pulverized and resemble sandy flour.

Erosion - The wearing away of the land surface by wind, water, ice, or other geologic agents. Erosion occurs naturally from weather or runoff but is often intensified by human land use practices.

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Evaporation - The process by which water becomes a vapor at a temperature below the boiling point.

Filtration - A mechanical process which involves moving water through a material, usually sand, designed to catch and remove particles.

Groundwater - Water found under the ground, in aquifers and between soil particles.

Groundwater Recharge - Water that moves below the root zone as “deep percolation” and eventually joins the groundwater.

Hard Water - Water containing excessive amounts of calcium and magnesium ions which prevents soap from lathering and produces scale and incrustation.

Hydrologic Cycle (Water Cycle) - The cycle of water movement from the atmosphere to the earth and back to the atmosphere through precipitation, runoff, infiltration, percolation, storage, evaporation, transpiration, and condensation.

Infiltration - The gradual downward flow of water from the surface into the soil.

Irrigation - The controlled application of water for agricultural purposes through human-made systems to supply water requirements not satisfied by rainfall.

Leaching - The process by which soluble materials in the soil, such as nutrients, pesticide chemicals, or contaminants, are washed into a lower layer of soil or are dissolved and carried away by water.

Piezometers – a device used to measure liquid pressure of groundwater at a specific point.

Spring – where water flows naturally from an aquifer to the earth’s surface.

Well – Excavation structure to access groundwater in underground aquifers.