What is Residence Time?

Residence time is a broadly useful concept that expresses how fast something moves through a system in equilibrium. It is the average time a substance spends within a specified region of space, such as a reservoir. For example, the residence time of water stored in deep groundwater, as part of the water cycle, is about 10,000 years. A common method for determining residence times is to calculate how long it would take for a region of space to become filled with a substance.

What is Recharge?

Recharge refers to the replenishment of an aquifer's groundwater. An aquifer is a layer of underground sand, gravel or spongy rock where water collects. Natural recharge takes place when rainfall, streamflow, or melting snow percolate into the ground.

Artificial recharge occcurs when water is put into special basins or is directed into modified stream channels and allowed to sink into the ground. Artificial recharge also can take place when water is pumped directly in the aquifer through special wells.

Tucson has two sources of water available for recharge, wastewater effluent and Central Arizona Project (CAP) water.

Why Recharge?

Recharge takes advantage of water supplies available now and stores them for future use. Pilot recharge studies must be done in advance of developing large-scale recharge facilities to determine recharge rates and quantities, water quality changes, the ability of the aquifer to store and release recharged water, and costs of recharging the water and pumping it for use.

Where is Recharge Taking Place?

The City is pursuing several recharge projects using CAP water or wastewater effluent. Several CAP recharge projects are in the planning or construction stages. Two examples are the Central Avra Valley Storage and Recovery Project west of Tucson near Sandario Road and Mile Wide Road, and the Pima Mine Road Recharge Project south of the city near the Santa Cruz River channel.

Recharge also helps provide treated wastewater to the City's reclaimed water system. The reclaimed water system delivers treated wastewater for irrigating parks, golf courses, and schools. Up to 6,500 acre-feet of water can be held in storage each year. (One acre-foot equals about 326,000 gallons.) The water is recovered and used during the summer months when demand for reclaimed water is at its peak. A planned educational and recreational wetlands project will provide additional storage capacity to the recharge facility.

Recharge helps to preserve and restore our water supplies and is important to our community's water future.

What does water flow really look like?

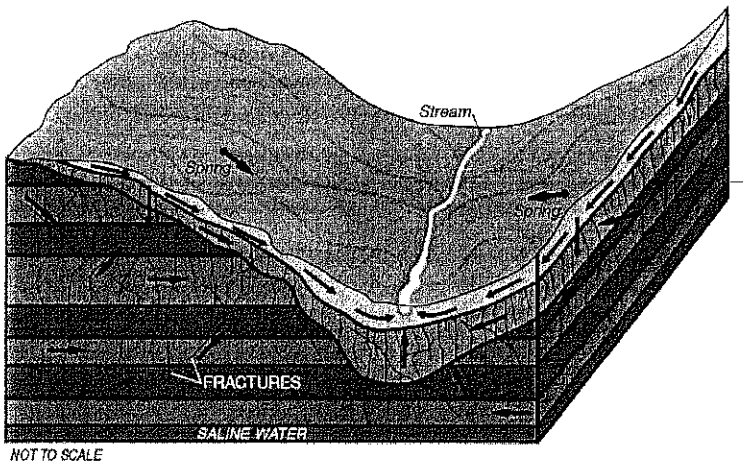
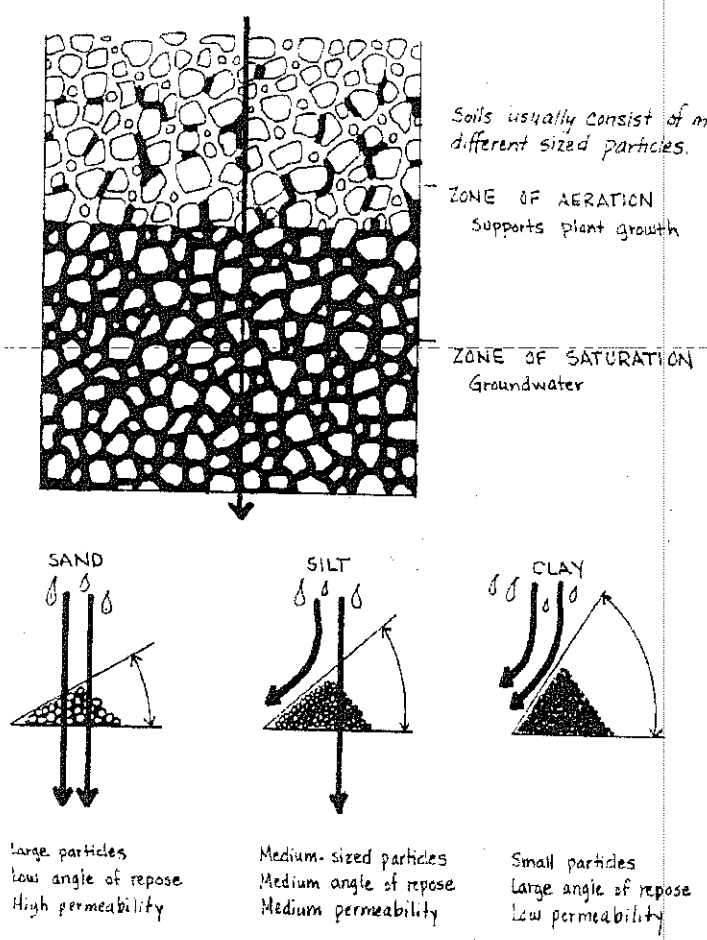


Figure 5. Conceptual ground-water flow in a fractured-rock setting (modified from Harlow and LeCain, 1991).



The Hidden Resource - Groundwater

Every day Americans rely on a resource that is "hidden" in its natural surroundings. Hidden beneath layers of soil and rock is the Earth's largest freshwater supply: groundwater. The estimated supply of groundwater in the lower 48 states is 65 quadrillion gallons or about 4 times the amount of water in the Great Lakes. It is the source of water for about half of the U.S. residents and nearly 97 percent of the rural population.

Groundwater originates as precipitation. It seeps into the ground, filling the spaces and pores between soil particles or the fractures and fissures in rocks. The underground area where all the pores and spaces are filled with water is called the saturated zone. Different geological formations hold varying amounts of water, but those that yield water in usable quantities are called aquifers. Usually, groundwater flows slowly through an aquifer; the rate can be as little as half an inch per year. The flow can be considerably faster in limestone caverns, volcanic lava tubes, or large rock formations where groundwater may resemble underground streams.

As water travels through the soil and rock, it picks up water-soluble materials and carries them along. Some of the materials in groundwater occur naturally, but many constituents in groundwater are the result of human land use activities. Different soils have different capacities to filter and absorb wastes. However, once groundwater is contaminated, it is difficult and may be impossible to clean up. When possible, cleanup is very expensive and may require many years.

In many geological formations, groundwater moves so slowly that contamination can remain undiscovered for years until the contaminated groundwater is brought to the surface by springs or wells. During that time, the pollutants can spread and contaminate large volumes of otherwise usable groundwater.

Potential sources of contaminants that threaten groundwater in the United States include the following:

- ~23 million septic systems
- ~390 million tons of municipal and industrial waste in 6,000 landfills
- ~1.7 million active oil and gas wells and ~1million abandoned wells
- ~72,000 active coal and mineral mines; ~60,500 oil and gas; ~1,500 metal mines; ~5,000 coal; ~6,000 active non-metal
- ~1.1 billion pounds of pesticides used each year; 660 million pounds of Alachlor and

Atrazine used per year

- ~50 million tons of fertilizer used each year
- ~306 million gallons of improperly disposed motor oil
- ~1.2 million underground storage tanks
- ~7.4 million tons of deicing salts applied to highways each winter; Snow Belt states receive 100 metric tons per road mile during the winter

KEEPING IT SAFE

Everyone has a role to play in keeping our water supplies safe. Everyday activities affect water quality. By being cautious about the use of hazardous substances - pesticides, fertilizers, herbicides, paints, fuels - and the disposal of all types of waste, every citizen can help keep our water resources safe and clean.

Consider some of the following alternatives to hazardous household chemicals and products:

- Use lotions or gels instead of aerosol sprays.
- Use rechargeable batteries.
- Use 1 part vinegar to 32 parts water to wash floors.
- Use a mixture of salt and lemon juice to clean copper.
- Use dry cornstarch or baking soda as a rug cleaner.
- Use non-phosphate detergents.
- Use cedar chips as an alternative to moth balls.
- Use 2 tablespoons of vinegar to 1 quart of water as a window cleaner.

KEEPING IT PROTECTED

An estimated 90 billion gallons of liquid from landfills and 100 billion gallons from liquid impoundments annually leak into groundwater in the United States.

Listed below are some of the ways to make sure that future generations will have clean, safe groundwater supplies.

- Have your septic tank pumped out every three to five years.
- Do not store pesticides, fertilizers, and herbicides near a well.
- Make sure abandoned wells are properly filled in and sealed.
- Store home-heating oil in an above-ground storage tank where leaks can be easily detected.
- Use fertilizers and pesticides on lawns and gardens sparingly and follow all label directions for mixing, use, and disposal of empty containers.
- Report chemical or toxic spills on land, in the air, or in the water by calling the 24-hour National Response Center toll-free at 800-424-8802.
- Do not pour toxic or hazardous substances into sinks or toilets, on the ground, or into sinkholes.
- Collect used motor oil and recycle it at used-oil collection centers or service stations.
- Cover your wellhead with a cap and grade the soil around the wellhead so that runoff water is diverted away from the well.
- Test your well water for bacteria and nitrates once a year.