THE AMERICAN WELL OWNER

✯ INFORMATION AND ADVICE ABOUT GROUND WATER, WELLS AND WATER SYSTEMS ✯

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Independent Authority on Ground Water

Safe Yield Concepts for Home Wells

MESSAGE FROM THE PUBLISHER

The articles in this issue of *THE AMERICAN WELL OWNER* deal with water quantity and water quality in well supply. Arsenic is a still a topical issue because of the change in the Maximum Contaminant Level (MCL) for arsenic in public water supplies that came into effect earlier this year. Private well owners need to find out if they have any arsenic in their well water, and if so, how much. Only a small number of wells might need to install equipment to reduce arsenic levels. You won't know until you test! Although bedrock wells have received publicity with regard to possible arsenic content, wells in sands or gravels may also have levels of arsenic that need attention. If you have a problem with arsenic it can easily be fixed. "Doing the science" by having a water test should be the first step.

The water quantity article involves a concern about the capability of aquifers to supply water to increasing numbers of new homes. When demand is greater than supply there is always potential for conflict. While in most places ground water resources can sustain home well demands, there are circumstances where water availability is a limiting constraint on development. The last straw can break the back of the proverbial camel, and just one more well can in some instances cross over the safe margins for sustainable supply. Good science and objective measurement of resource potential should precede local planning decisions regarding well-based development. "Doing the math" by estimating recharge and storage should be the first step. Housing density decisions should prioritize leaving adequate open vegetated space to allow for aquifer recharge. It is in nobody's interest to jeopardize sustainability of supply to existing well users by allowing "just one more" sub-division.

Andrew Stone

American Ground Water Trust

Well yield is often given two meanings. The first is "how much water will be delivered" usually stated as gallons per minute. A second meaning is "for how long will the aquifer be able to provide water to the well for the pump to deliver?" In other words, "how much water is available?" or, "at what rate can I pump the well and for how long?"

In a discussion of safe yield we have to consider the characteristics of the aquifer (the saturated rock formations where ground water is stored). Wells are engineered holes (usually drilled) that access the water stored in an aquifer. When a well is pumped, water is first drawn from storage in the well column. As the water level in the well drops because of the pumping then "new" water is drawn into the well from the surrounding aquifer. If the well is pumped for a long time then the rate of inflow to the well could become a limiting factor to the yield of water at the surface. For example, if the well pump is delivering 5 gallons per minute but the aquifer is only supplying 4 gallons per minute to the well column, then before too long the level of water in the well will be lowered right to the pump. In some cases there may be plenty of water stored in surrounding rocks but during drilling the well column may have only intersected a few small fractures. In such cases the low flow rate into the well is not necessarily an indication of how much water is in storage.

Average water use in homes is around 75 gallons per person (inside use only). A family of four will need about 300 gallons a day. With a 5 gallon per minute pump, the total needs of the family are supplied by one hour

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Helping communities, residents, businesses and farms, that use water wells, maintain safe, reliable, cost-effective water supplies and ensure a sustainable local environment.

of pumping, or about 4% of a 24 hour day. During the other 23 hours (96% of the day) the aquifer can recover from the pumping and will be replenished from the surrounding rocks and from slow infiltration seepage from above.

One problem that can occur with increased housing development is that each additional well is drawing from the same ground water storage (aquifer). Even although virtually all water used inside the home may be returned to the ground via on-site septic systems, extensive garden and lawn irrigation from nearby homes can have an impact on available ground water storage.

The storage capability of an aquifer is related to its size (geometry) and to the porosity of the rocks. For example sandy deposits may have up to 25% of their volume filled with water. Consolidated rocks such as granite may have 1%. [see box below for an example of storage calculation]

Your Water Bank Account

What happens if there is additional pumping or if there is a period of drought with no replenishment to the aquifer from rainfall or snowmelt?

If you continue to draw money from a bank account that is not receiving any deposits, the length of time you can keep drawing money will depend on how much money you draw and how much money there is in the account! It is just the same with pumping from a water well.

HOW MUCH WATER IN ONE ACRE OF AQUIFER?

Consider an aquifer extending over an area of <u>one acre</u> with a saturated thickness of <u>100 feet</u>.

[One acre = 43,560 square feet. 1 cubic foot = 7.481 gallons]

Volume of aquifer in cubic feet is 100 x 43,560 = 4,356,000 cubic feet of saturated aquifer

Sand aquifer at 25% porosity would hold 4,356,000 x 25% = 1,089,000 cubic feet of water

Gallons of water in a 1 acre sand aquifer with 25% porosity with a saturated thickness of 100 feet:

1,089,000 x 7.481 (gallons) = 8,146,809 million gallons

For an aquifer of the same dimensions with 1% porosity, the water in storage would be 325,872 gallons

Average annual household use at 300 gallons per day is 109,500 gallons

The calculation above is an oversimplification, because in reality porosity is not uniform throughout an aquifer and not all the water in an aquifer would be available to flow to a well. The calculation does not take any account of recharge from rainfall. As an example:

RECHARGE

If 20% of an annual average rainfall of 30 inches per year infiltrates down to the aquifer then the annual recharge to ground water over one acre will be 162,936 gallons.

The actual amount that recharges to ground water depends on the intensity, duration and frequency of precipitation and land-cover type of the ground surface (pervious or impervious). "Good soaking rains" are the most effective. Short summer showers will often produce no ground water recharge.

If we go back to the banking comparison, the one acre aquifer in the storage calculation has an annual "income" of 162,936 gallons and the family of four is "withdrawing" 109,500 gallons per year (although much of this is being returned directly via the septic system).
Even if an aquifer has a high storage, many people believe that the expected average amount of recharge is most important in considering the safe yield of an aquifer and the number of wells that should be allowed.

There are many factors to consider:

- The amount and reliability of recharge to the aquifer **(income)**

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- The volume of water in storage in the aquifer and accessible to the well(s) **(savings account)**
- The average and peak daily demands on the well **(how may times you go to the ATM)**

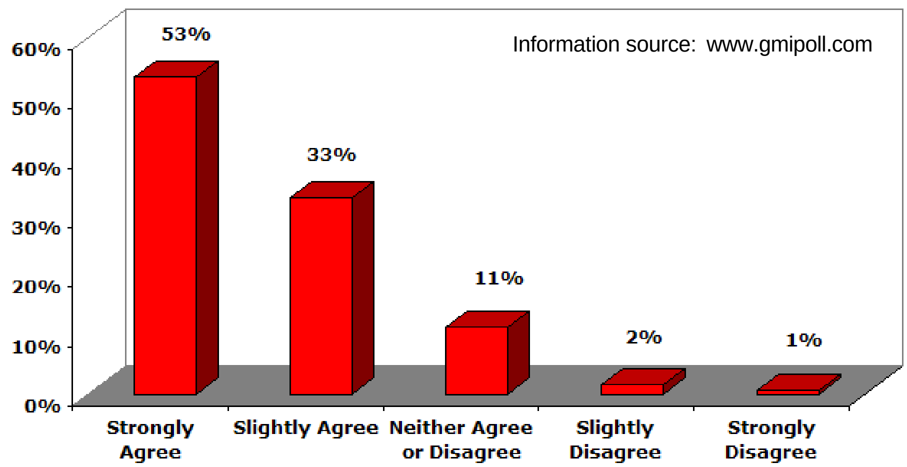
With nearby development there is likely to be several homes, or other water users, making withdrawals from the shared account!

With increasing build-out and development, land use is changing and paved areas, storm drainage and roofs may reduce ground water recharge potential. More homes mean more wells and so there is likely to be greater demands on aquifers. While the hydrologic impact of individual wells is very small, planners and zoning authorities need to be mindful of the importance of keeping development within the limits of ground water sustainability. "Doing the math" for ground water storage based on local knowledge of geology and well contractors' experience with well performance and reliability should be a first step in planning decisions. Encouraging best management practices for all development, and maintaining appropriately large vegetated areas for recharge in sub-divisions is important for the tens of thousands of communities where safe yield of well water is a prized and cherished asset for over 15 million families in America's rural and suburban homes.

PROTECTION OF THE ENVIRONMENT—QUALITY OF LIFE

According to a recent poll by Global Market Insite, Inc., 90% of Americans are somewhat or very concerned about the future of the environment, with many expressing concern about pressures on natural resources. The graph below shows that there is a strong connection between perceptions of the quality of life and protection of the environment. Well owners in particular have a very strong vested interest in maintaining the quality of nation's reserves of ground water for environmental and economic purposes.

THERE IS A CONNECTION BETWEEN THE PROTECTION OF THE ENVIRONMENT AND MY QUALITY OF LIFE: How much do you agree with this statement?

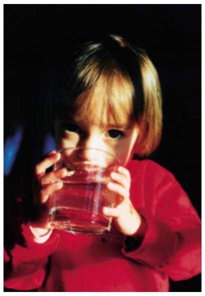


TESTING FOR ARSENIC IN GROUND WATER. . . continued from back page

a whole house treatment for all water used could cost between $2,000 to $3,600 or $235 to $450 to put a device on a single faucet. No single test will analyze a water sample for all constituents. If arsenic is suspected, then the laboratory must be asked to conduct a specific test for arsenic. Most certified labs test for "Total Arsenic" using either an EPA-approved atomic adsorption spectrophotometry (i.e., AAS) method or a type of mass spectrometry (i.e., MS or ICP-MS) method. Currently, there is no generally accepted (standard) method to test for arsenic species at the water source or to preserve the sample for later laboratory analysis of the species type. However, some laboratories or state environmental quality departments have portable test units with flow-through columns of adsorptive material that can separate the As(V) species from the water sample so that any remaining arsenic detected by a subsequent "total" arsenic test can be considered the amount of As(III) in the water.

When choosing a laboratory to analyze a water sample it is important to select a company that has a current "accreditation" through the state's environmental or health agency. A list of approved laboratories may be listed on the Internet by the regulating State administrative agency. Alternatively, the state agency may be contacted through the state listings in most phone books or by contacting your local health department for a referral.

The Trust has prepared a pamphlet "Arsenic in Ground Water." This is available to homeowners for $2.50 (including postage) and is a good investment in objective information to aid well-owner understanding of the issue and provide guidance towards a solution. Visit www.agwt.org and click on the "Arsenic" button. For a comprehensive package of well information (including the arsenic pamphlet) a "Well Owner Kit" is recommended. See the ***Ground Water Info Store*** on the Trust's web site.



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Testing For Arsenic in Ground Water

The results of a water quality test can rule-out or confirm water problems. Many health-related water quality issues, including the presence of arsenic (chemical symbol - As), cannot be recognized without a water test. It is important for the test to determine the level of arsenic and its chemical form (i.e., species) in order to use the right treatment/ removal process. The As(III) species is more difficult to remove or reduce than the oxidized As(V) species. Water quality information is needed to enable a treatment professional to design a system that will operate at the highest efficiency with the lowest maintenance cost while ensuring that the treated-water is safe. Most well water systems will not need water treatment unless arsenic is detected above the United States Environmental Protection Agency's (EPA) Maximum Contaminant Level (MCL) of 10 parts per billion.

There are several treatment options available for domestic wells with arsenic. The cost will depend on the level of arsenic and the flow rate of water (gallons per minute) to be treated. According to the New Jersey State Department of Environmental Protection,

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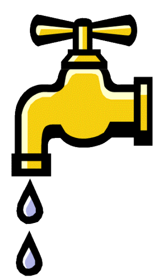
To provide a basic water quality profile,[1] laboratory tests for the following are recommended for new water wells:

Bacteria[2]	Sodium
Nitrate[2]	Fluoride
pH (acidity)	Total dissolved solids (TDS)
Iron	Sulfate
Manganese	Tannin[3]
Lead and Copper	Arsenic
Hardness	Phosphate[3]
Alkalinity	Silica[3]
Chloride	



[1]The water quality profile of a well should be retested every 3 to 5 years to monitor for possible changes. Testing for radon, fuel, industrial chemicals or pesticides may also be appropriate based on the surrounding local geology and land use conditions.

[2]A homeowners should test for bacteria on an annual basis. In commercial agricultural areas, a nitrate test should also be completed annually.

[3]Analysis for these elements is recommended if an adsorption-type treatment system for arsenic is contemplated. These elements may compete with arsenic for adsorption sites on the treatment media.