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Nitrates and Our Groundwater

Nitrate contamination of the world's groundwater supply poses a serious human health threat. High nitrate levels found in drinking water have been proven to be the cause for numerous health conditions across the world. If we intend to provide for the future survival of man and life on planet earth, we must take action now to assure the quality of one of our most precious resources, our groundwater supply.

Groundwater is defined as the water stored in the open spaces within underground rocks and unconsolidated material (Plumb 2). The primary source of water in underground aquifers is precipitation that infiltrates the ground and moves through the soil and pore spaces of rocks. There are also other possible sources that add water to the underground aquifer, including water infiltrating from lakes and streams, recharge ponds, and wastewater treatment systems. As groundwater moves through the soil, sediment, and rocks, many of its impurities are filtered out, however, not all soils and rocks are good filters. Soils all have different drainage characteristics, thus soils with a higher amount of sand and gravel are going to filter liquids down to the aquifer at a faster rate than soils comprised of more silty, finer sorted particles. In some cases, pollutants are not always removed from the water by the filtering affect of the soil before they reach the groundwater supply.

Clean groundwater is very important to all of us, even though it’s a resource that we usually take for granted. Groundwater makes up about twenty-two percent of the world’s supply of fresh water (Groundwater). Right now, groundwater accounts for twenty percent of all the water used annually in the United States (Groundwater). On a national average, a little more than

sixty-five percent of the groundwater in the United States each year goes to agriculture, mainly for irrigation, with industrial use second, and domestic use third (Groundwater).

The single largest consumer of water in the United States is agriculture. In dry areas, farmers must irrigate their land in order to grow crops. It is estimated that in the United States more than one-hundred billion gallons of fresh water are used each day for the irrigation of cropland (Groundwater). People also use billions of gallons of groundwater. The average person in the United States requires more than fifty gallons of water each day for personal and household uses. These uses include drinking, washing, preparing meals, and removing waste. A bath in a bathtub, for instance, uses approximately twenty-five gallons of water, and a shower uses about fifteen gallons per minute of water while the shower runs. Just to sustain human tissue requires about two and a half quarts of water per day. Most people drink about a quart of water per day, and get the rest of their required water from food content. Most of the foods we eat are comprised mostly of water: for example, eggs are about seventy-four percent water, watermelon is ninety-two percent, and a piece of lean meat is about seventy percent. It is easy to understand how important our water supply is to all of us, and how important it is for us to protect it.

Since agriculture is the leading user of our groundwater, perhaps it is fitting, that it is also the biggest contributor of contaminating nitrates that infiltrate our water supply each year. Nitrates are inorganic compounds that occur in a number of conditions in the environment, both naturally and synthetically (Plumb 2). Nitrate (NO_3) is composed of one atom of nitrogen (N) and three atoms of oxygen (O). Agriculture and livestock production account for eighty percent of all nitrogen added to the environment. Industrial fertilizers make up fifty-three percent and animal manure makes up twenty-seven percent of this total (Groundwater) .

Just how do these nitrates get from the farmers' fields into our water supply? There are two primary reasons that nitrate contaminates reach our underground water supply and make it unsafe. The number one reason is farmers' bad habits of consistently over-fertilizing by applying excess nitrogen to the soil. In 1995 America's agricultural producers added thirty-six billion pounds of nitrogen into the environment; twenty-three billion pounds of supplemental industrial nitrogen and thirteen billion pounds of extra nitrogen in the form of animal manure ("Nitrogen in Private" 1). It is estimated that twenty percent of this nitrogen was not used by the crops it was intended. This accounts for about seven or eight billion pounds of excess nitrogen remaining in the environment in 1995 ("Nitrogen in Private" 1). Much of the excess nitrogen eventually enters the reservoirs, rivers, and groundwater that supply us with our drinking water. Over fertilization of lawns has also been known to cause excess nitrogen to enter our drinking water supply. The number two reason that nitrate contaminants reach our groundwater supply runs parallel with the first. Over-irrigation causes the leaching of these nitrates past the plants root zone where they can be taken in by crops and used effectively. Today's farmers not only need to know when it is time to irrigate, they also need to know how much and for how long. When the two problems of over-fertilization and over-irrigation are added together, the potential for harmful nitrate contamination of our water supply is disturbingly high.

The question now is just how harmful are nitrates in our drinking water? Nitrate levels that exceed the Environmental Protection Agency and United States Public Health Service standard level of ten parts per million can cause a number of health conditions. The most severe condition is known as methemoglobinemia, or blue baby syndrome. Infants who are six months old or younger have the greatest risk of developing methemoglobinemia, because they consume a large amount of fluids in relationship to their body weight (Plumb 5). Their stomachs also have a

low acidity which creates an ideal environment for bacteria to convert nitrate to nitrite. The nitrite then reacts with hemoglobin, the proteins responsible for transporting oxygen in the body, converting them to methemoglobin, a form that is incapable of carrying oxygen. As a result, the victim suffers from oxygen deprivation, or more commonly stated, the individual slowly suffocates. Symptoms of methemoglobinemia include anoxic appearance, shortness of breath, nausea, vomiting, diarrhea, lethargy, and in more extreme cases, the loss of consciousness and even death (Plumb 6). Approximately eight to ten percent of blue baby syndrome cases result in death of the infant (Plumb 6).

Although, methemoglobinemia is the most immediate life-threatening effect of nitrate exposure, there are a number of equally serious longer-term, chronic implications. Deborah Plumb, a health consultant, said, "In numerous studies, exposure to high levels of nitrate in drinking water has been linked to a variety of effects ranging from hypertrophy [enlargement of the thyroid] to fifteen types of cancer, two kinds of birth defects, and even hypertension" (8). Since 1976 there have been a number of different epidemeology studies conducted in eleven different countries that show a definite relationship between increasing rates of stomach cancer and increasing nitrate intake (Plumb 9). The facts speak for themselves; increasing levels of nitrates in our groundwater are slowly poisoning our society.

Nitrate contamination also has harmful effects in the environment. The primary effect is the killing of fish and other aquatic life. When rivers and lakes become contaminated, algae starts to bloom. When the algae dies, the oxygen is sucked out of the water, killing the aquatic life. One of the primary examples of this is the Gulf of Mexico shrimping industry which has felt the detrimental effects of nitrate contamination from nitrogen fertilizer runoff in the Midwest (Beeman "Nitrogen-Reduction" 4).

What must be done to prevent unnecessary contamination of our groundwater? Farmers will and must be allowed to continue to use nitrogen fertilizer. "The use of fertilizers has made it possible for farmers to reach and maintain high levels of production, providing a safe and bountiful food supply" (Iowa Nutrient 6). Farmers do not, however, need to overuse their fertilizers. By following certain guidelines, farmers can safely and effectively apply nitrogen fertilizer. First, they must establish realistic yield goals for their crop's nitrogen requirements which are based on their three- to five-year yield records and annual soil tests (USDA 6). After establishing their yield goals, they need to account for all other outside nitrogen sources, such as residual soil nitrates and legume supplied nitrates, with annual soil tests (Iowa Nutrient 30). With this acquired information, the farmers can then apply their nitrogen fertilizer in the proper amounts. The fertilizer needs to be applied in the spring to minimize environmental loss (Iowa Nutrient 4). Conservation tillage, terraces, contour farming, strip cropping, and irrigation water management should also be used to minimize nitrogen movement and leaching (Groundwater). To help farmers guard against excess fertilizer application, they can now purchase insurance to protect themselves from any monetary loss due to low yields caused by insufficient nitrogen application ("Nitrogen Pollution" 4). When farmers use these practices, they will not only help to keep our water safe from contamination, they will probably enjoy the same yields as before and spend less money on fertilizer, thus increasing their net profits.

All of us must also take action to protect ourselves from nitrate contamination. The best way to do this is by continually checking the water we drink. For those in cities, this is already taken care of by the water department, but those who are in rural areas must test their water on their own. Larger cities, such as Des Moines, Iowa, use nitrate removal systems, which cost over four million dollars, to purify their contaminated water (Beeman "Nitrogen-Reduction" 4).

Nitrate contamination can be corrected in rural areas with reverse osmosis, ion exchange, and distillation units (Plumb 10). Most simple filters do not remove nitrates. Boiling contaminated water will also not remove nitrates, and will actually cause more water to evaporate leaving a higher concentration of nitrate.

Nitrate contamination poses a serious health threat to all of us. Each of us uses a little more than fifty gallons of fresh water every day. If we allow all of our fresh water to be contaminated beyond use, our world will no longer be a pleasant environment to live in. We must all act now to maintain a fresh water system that will be capable of sustaining us, and our many generations into the future.