Nitrate

Nitrate is the most widespread anthropogenic chemical in ground water. Nitrate is the anthropogenic chemical that most frequently exceeds its drinking water criteria. Nitrate is the most widely studied chemical in ground water. Much of GWMAP's efforts in the past few years have focused on nitrate. Since there is no lack of information on nitrate in journals and on the web, I thought it would be more interesting to test your knowledge of nitrate with a quiz. First, a little information (not needed for the quiz). The quiz follows the background info and the answers are available in an attached document at the end of the quiz.

Background

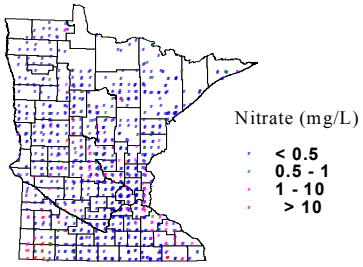
Humans have dramatically altered the nitrogen cycle, primarily by converting reduced forms of nitrogen into oxidized forms. Oxidized forms include nitrous oxides, which are a concern in air, and nitrate, which is a concern in water. Nitrate is the chemical that most frequently exceeds drinking water criteria. It is mobile, and in oxygenated environments, it is persistent. The primary sources of oxidized nitrogen include oxidation of organic matter following soil tillage, use of inorganic fertilizers, and automobiles. Other sources include land application of manure, atmospheric deposition, and various industrial sources.

Health effects of nitrate are somewhat contentious. Methemoglobinemia (blue-baby syndrome) has been documented in infants 0 to 3 months in age and in young livestock. Not many cases are reported anymore. Some researchers feel methemoglobinemia cases generally go unreported, while other researchers question many of the cases that are reported. Other health effects are less well understood. Some researchers support a link between nitrate and cancer, while others do not. Other environmental effects of nitrate include eutrophication of surface water and development of hypoxic areas in surface water. For more information on these topics, see the following links.

- Methemoglobinemia:http://www.tricity.wsu.edu/aenews/Oct98AENews/aenewsoctober98.htm#anchor545063; http://www.nap.edu/books/0309051401/html/516.html; http://www.cgfi.com/pdf/ENVIRONMENTAL%20HEALTH%20PERSPECTIVES%20BLUE%20BABY.PDF
- Cancer http://www.uihealthcare.com/news/news/2001/04/30drinkingwater.html; http://infoventures.com/cancer/canlit/eti1195a.html
- Hypoxia http://www.nos.noaa.gov/products/pubs_hypox.html
- Eutrophication http://www.orst.edu/instruction/bi301/eutrophi.htm

GWMAP Studies

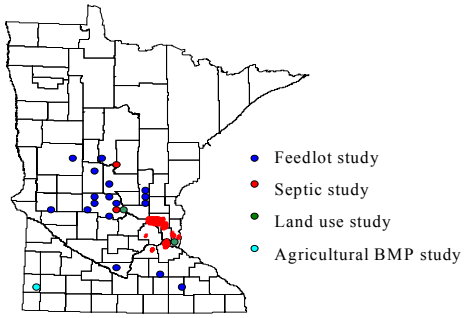
Most GWMAP studies have focused on nitrate in ground water. We sampled nitrate as part of the statewide baseline study from 1992 to 1996. In this study, we sampled 954 private drinking water wells in a variety of aquifers throughout the state. The statewide distribution of nitrate is shown below.



Since 1996, we have conducted

- land use studies in St. Cloud and Cottage Grove;
- studies of nonsewered communities in Lakeland, Baxter, St. Joseph's, and several communities in the Metro Area,
- studies adjacent to feedlots; and
- studies of BMPs in agricultural areas.

The location of these studies is shown in the following figure.



Quiz

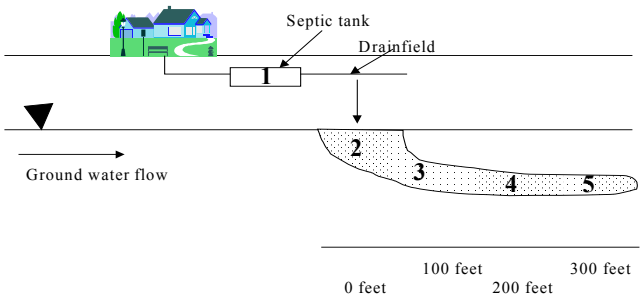
1. Associate the following values with the appropriate question.

5, 0.5, 6, 3.4, 10, 26, 18, 15, 0, 1.0, 1.5

- Nitrate HRL
- % private wells in MN > HRL
- % private wells in sensitive aquifers > HRL
- % private wells in agricultural areas, sensitive aquifers, > HRL
- Documented methemoglobinemia deaths in MN, 1990-1999
- Typical nitrate concentration in ground water, nonsewered residential
- Typical nitrate concentration in ground water, sewered residential
- Typical nitrate concentration in ground water, sewered commercial
- Typical nitrate concentration in ground water, nonirrigated row crop
- Typical nitrate concentration in ground water, irrigated row crop
- Typical nitrate concentration in ground water, forested

2. Examine the following illustration and concentrations. Assign a reasonable concentration (mg/L) to the corresponding numbers. You may use concentrations more than once. Assume there is oxygen throughout the plume. Assume background concentration is 0 mg/L.

Concentrations: 0, 5, 10, 15, 20, 25

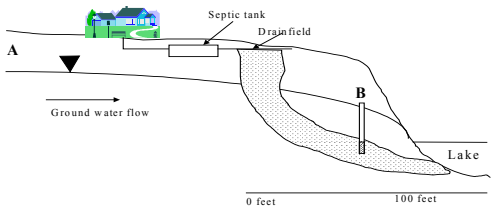


Number	**Concentration (mg/L)**
1	
2	
3	
4	
5	

3. Considering the following measurements, is the aquifer vulnerable to contamination (yes, no, maybe)

Measurement	**Vulnerable?**
Oxygen < 0.5 mg/L	
Redox potential > 300 mV	
Total iron < 0.10 mg/L	
Organic nitrogen > 1.0 mg/L	
Organic carbon > 5 mg/L	
TCE is degraded	
BTEX are degraded	

4. Examine the illustration. Rank the following management strategies, from most (1) to least (6) effective in decreasing risk of nitrate impacting the lake.

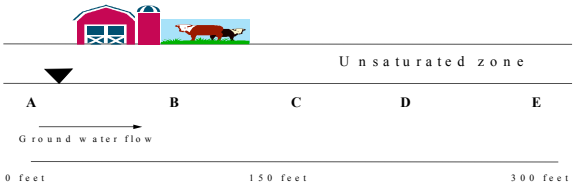


Strategy	**Effect**
Plant trees over area affected by plume	
Put in a beach to enhance recharge and dilution of plume	
Install rip-rap along lake shore	
Move septic system back to Point A	
Install a withdrawal well at Point B and intercept plume	
Maintain septic system	

Eat less

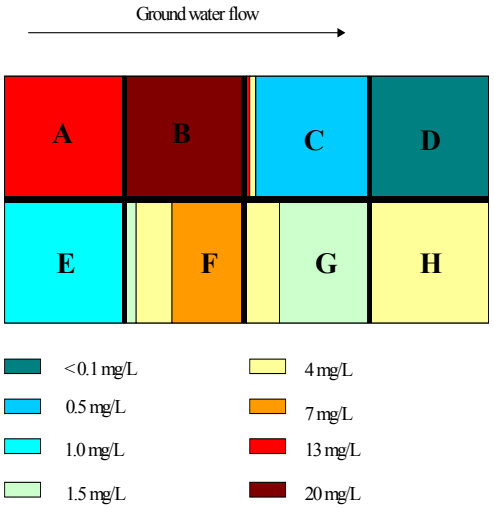
5. Examine the illustration. Assign appropriate concentrations (mg/L) to the letters, using the following values.

Total nitrogen (mg/L): 6, 25, 25, 40, 140
Nitrate-nitrogen (mg/L): < 0.01, 0.1, 5, 25, 25



Letter	Total N concentration	Nitrate-N concentration
A		
B		
C		
D		
E		

6. Examine the illustration. Assign the appropriate land use to each box. Consider the predominant color within a box. There may be different colors within a box. These are designed to illustrate the transition in nitrate concentration from one land use to the other.



Land uses:

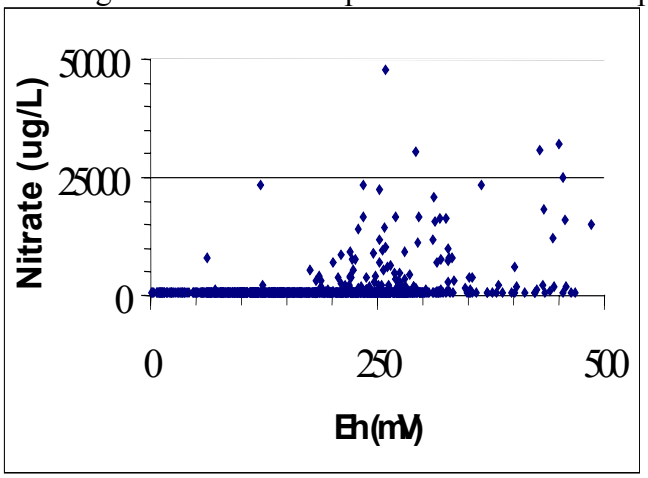
- Irrigated potatoes
- Irrigated corn
- Forest
- Grassland
- Nonsewered residential
- Sewered residential

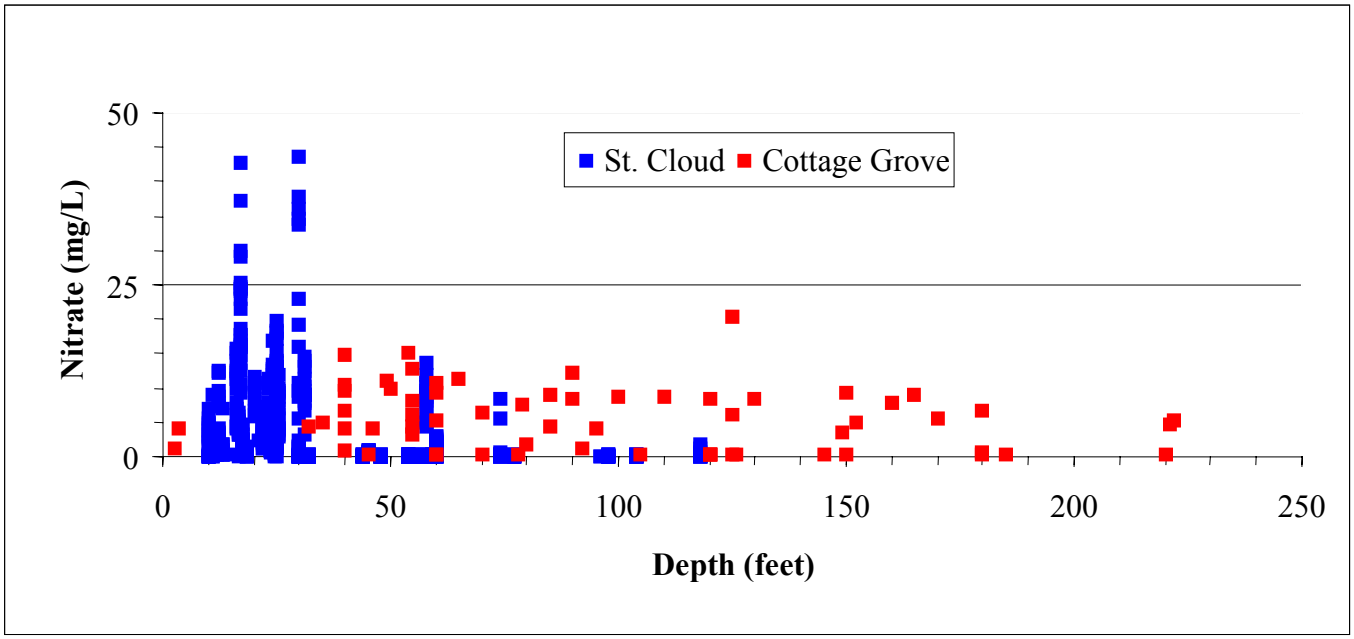
- Wetland
- Alfalfa-corn rotation

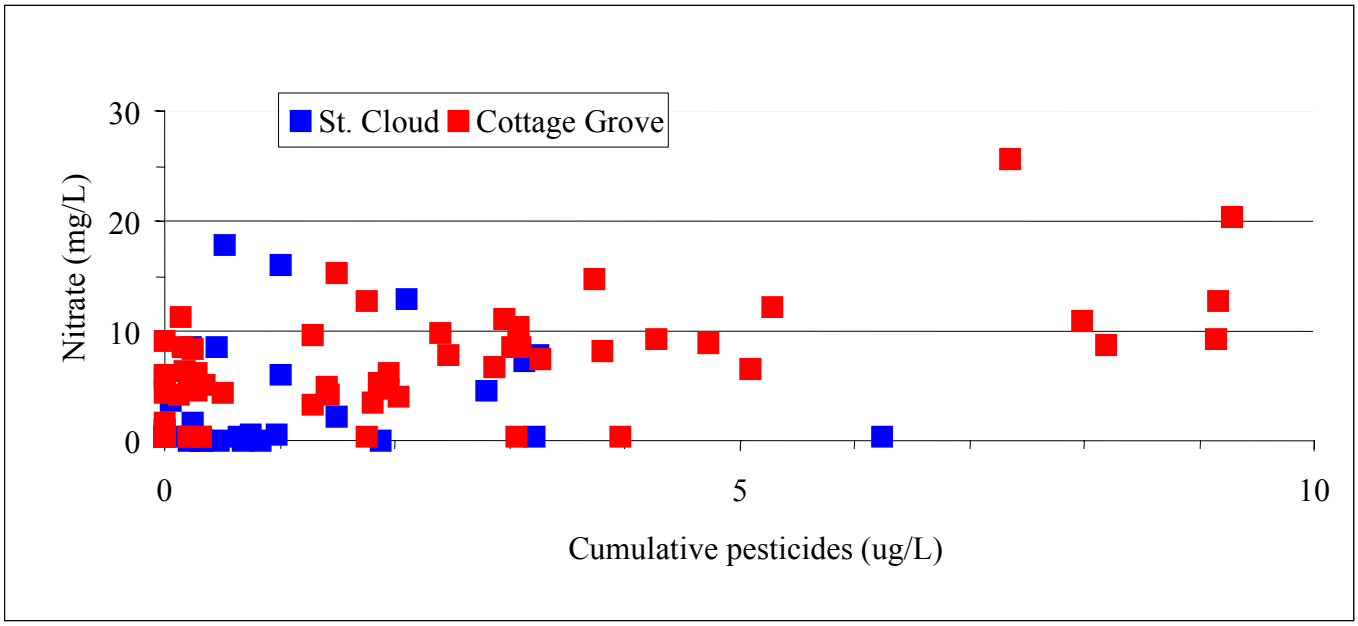
Box	Land Use
A	
B	
C	
D	
E	
F	
G	
H	

Bonus Question

Each figure shows a concept. Describe the concept.







Answers to Quiz Problems