# NITRATE-NITROGEN LEVELS IN WELL WATER FROM THE LITTLE RIVER/ROOTY CREEK WATERSHED IN EAST CENTRAL GEORGIA

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**Abstract.** The 99,912 ha Little River/Rooty Creek watershed lies in the heart of Georgia's dairy industry. Surface and ground water contamination from agricultural activities is of great concern in the watershed. This study shows that ground water quality in the watershed is not generally affected by nitrate-nitrogen (nitrate-N) from typical nonpoint sources. However, there are nitrate-N "hotspots", primarily around dairies, that exceed the EPA's Maximum Contaminant Level (MCL) for nitrate-N in drinking water. Farmers with high nitrate-N levels in their well water should complete the Farm*A*Syst worksheets, implement the recommended wellhead protection measures and use Best Management Practices to control and prevent ground water contamination.

## INTRODUCTION

The watershed's streams are listed in Georgia's Nonpoint Assessment and Management Plan as being threatened to meet their designated "fishing stream" classification (U.S. Environmental Protection Division, 1989). Nutrient and bacteria derived from animal waste and applied nutrients, along with cropland-produced sediment, have been documented by the U.S. Environmental Protection Agency (EPA) in the watershed's streams and small rivers (HUA Work Plan, 1991). However, the impact of agriculture on ground water from animal waste was not known.

The majority of rural residents throughout the project area depend on ground water for their domestic water needs. Few homeowners have mineral tests (including nitrate-N) performed on their water, so no base data on ground water quality existed.

Furthermore, five areas totalling over 17,600 ha are significant recharge areas for localized aquifers (HUA Workplan, 1991). All of these recharge areas contain some potential agricultural pollutants.

### Nitrate-Nitrogen Health Hazards

Excess nitrate-N in well water samples is an indication that animal waste, commercial fertilizer or human waste is leaching into the ground water. Nitrate-N at levels above 3 mg/L are considered introduced by human activity (Nielson and Lee, 1987). The EPA has set the maximum contaminant level (MCL) for nitrate-N in drinking water at 10 mg/L. When infants less than six months old or the very elderly drink water with levels of nitrate-N greater than 10 mg/L, methemoglobinemia or "blue-baby syndrome" may occur. Simply put, vital tissues such as the brain, receive blood with less oxygen than normal. This may cause brain damage or even death (Nugent et al., 1988)

Cattle are also at risk from ingesting water with high levels of nitrate-N. Water with nitrate-N levels between 20-40 mg/L are harmful to cattle over a long period of time. Nitrate-N concentrations over 40 mg/L put cattle at risk of nitrate toxicity and death (Harris and Beede, 1993).

### Justification Of Study

Across the United States, agriculture has been identified as a contributor of surface and water pollution. Depending on the source, it contributes up to 70% of all nonpoint source pollution across the nation (Chesters and Schierow, 1985; Meyers et al., 1985; Phipps and Crosson, 1986; USDA, 1987). The obvious question is: How much of this nonpoint source pollution is making its way into the aquifer beneath the Little River/Rooty Creek watershed?

### Water Quality Project

The Little River/Rooty Creek Agricultural Nonpoint Source Hydrological Unit Area is one of 74 five-year federal water quality projects across the nation. It encompasses the watershed. The overall purpose of the water quality project is to increase the voluntary farmer adoption of Best Management Practices (BMPs) that will protect and improve surface and ground water quality while maintaining agricultural productivity and profitability.

BMPs are conservation techniques used to control or prevent agriculturally-caused nonpoint source pollution. BMPs implemented in the watershed include sediment retention ponds, terracing, permanent pasture, nutrient management plans for manure and commercial fertilizer application, composting poultry mortality and litter, and pump-out of animal waste lagoons.

Implementing BMPs specific to each farm's water quality problem(s) is expected to achieve a 65-75% reduction in agriculturally-caused nonpoint source pollution at the completion of the project. Cost-share money is available to farmers who qualify to implement BMPs from Consolidated Farm Services Agency (formerly the ASCS).

### Description of Watershed

The 99,912 ha Little River/Rooty Creek watershed includes portions of Jasper, Morgan, Newton, Putnam and Walton counties in the Piedmont region of east-central Georgia. There is an estimated rural non-farm population of 6,020 and a farm population of 790.

Morgan and Putnam Counties lead the state in numbers of dairy cattle with a combined total of over 18,000 head. Morgan County leads the state with over 30,000 head of beef and dairy cattle (Georgia Agricultural Statistics Service, 1993). These animals excrete an estimated 386,000 Mg of manure annually. Within the project there are 80 dairies, 70 beef cattle farms and over 3 million chickens and turkeys.

Major crops grown in the watershed include corn for silage, bermudagrass for hay and pasture, and small grains.

### Private Well Characteristics

The Piedmont region of Georgia is characterized as having deep clay soil on top of granite rock aquifers. The average depth of the clay soil is 18 m (Lineback, 1991).

Wells dug or bored in the clay less than 18 m, not in the aquifer, are considered shallow wells. Typically these wells have a casing diameter of either 609 mm or 914 mm.

Deep wells are greater than 18 m deep and are drilled into the aquifer. These wells generally have 152 mm diameter well casings. On the average, wells in the Piedmont flow between 3.7 - 37.8 L per minute. This is very slow compared to south Georgia wells that can flow over 7570 L per minute.

## METHODS

### Purpose of Study

The purpose of this study is to determine the extent of nitrate-N contamination of ground water throughout the watershed resulting from agricultural activities. To achieve this, a goal was set to analyze 25% of the farmers' private potable water supply for nitrate-N levels in the watershed.

### Well Sampling

Wells were sampled at random throughout the watershed. Samples from non-farm wells were generated through solicitation in a weekly newspaper column that covers the majority of the watershed and at county events such as the fair. At this time, well samples have been drawn from all areas of the watershed.

Well sampling procedures were followed as outlined by Tyson and Harrison (1993). The line was purged of standing water and samples were collected in 10 mL plastic bottles as close to the well as possible. Collected well samples were sent to the University of Georgia Agricultural Services Laboratory in Athens to be analyzed.

From 1 June 1991 through 30 September 1994, 284 well samples were taken in the project area and analyzed for nitrate-N levels. These samples represent over 88% of the dairies and 58% of poultry operations in the project area, plus a significant number of non-farm wells. Also included are well samples from swine and beef operations.

## CONCLUSIONS

Well test results indicate that the ground water in the project area is relatively free of serious nitrate-N contamination (Table 1). However, there are "hotspots" of nitrate-N contamination in ground water throughout the project area.

These results are consistent with other major ground water quality studies conducted on aquifers across the United States by the EPA (1990) and the U.S. Geologic Survey (1991). These studies found that the majority of principal aquifers sampled had median nitrate-N levels well below 10 mg/L (U.S. Department of Agriculture, 1991). However, the studies identified "hotspots" within some aquifers where nitrate-N levels exceeded the EPA's MCL. Some of this contamination has been linked to agricultural activity.

Likewise, some of the nitrate-N contamination of ground water in the project area can be linked to agricultural activity. Of the 35 well samples in Table 1 exceeding EPA's nitrate-N standard, 29 came from dairies and two from poultry operations. The remaining four samples came from non-farm wells.

A study of nine of these dairies to determine the sources of nitrate-N in well water found that unpaved loafing areas, rather than animal waste lagoons or septic systems were the most likely source of ground water nitrate-N contamination (Drommerhausen et al., 1994).

Of the 284 well samples taken in the project area, 140 (49%) came from wells greater than 18 m deep and had less than 10 mg/L nitrate-N concentration. Forty-four well samples (15%) were 18 m or less and had less than 10 mg/L nitrate-N concentration. It should be pointed out that 65 samples were taken from wells whose depth was not known. Therefore, 249 (87%) of the 284 well samples had nitrate-N concentrations of less than 10 mg/L.

**Table 1. Nitrate-N Levels in 284 Wells in the Little River/Rooty Creek Water Quality Project.**

| Range of $NO_3$-N | Number of Samples | % of Total |
|---|---|---|
| < 3.0 mg/L | 177 | 62 |
| 3.01 - 9.99 mg/L | 72 | 25 |
| > 10.0 mg/L | 35 | 12 |

**Table 2. Well Samples Exceeding 10 mg/L nitrate-N level.**

| | Well depth-m | | |
|---|---|---|---|
| | <18 | 18-61 | >61 |
| Non-farm | 1 | 2 | 1 |
| Poultry | 2 | 0 | 0 |
| Dairy | 4 | 7 | 18 |
| Total | 7 | 9 | 19 |

The majority of wells with nitrate-N levels at or above 10 mg/L are deep wells (Table 2). These wells are primarily on dairy farms. Visual inspection revealed they are in close proximity to septic drain fields, cattle loafing areas or are influenced by surface water runoff. Upon questioning farmers about how old these wells are, each indicated they were put in before 1985 (before the Georgia legislature passed the "Water Well Standards Act of 1985"). Therefore, it may be these wells were not properly installed, resulting in cracked casings or other defects which would allow nitrate-N contaminated water to mix with ground water.

## SUMMARY AND RECOMMENDATIONS

Although there is a high animal density in the project area, generally the ground water is free of widespread nitrate-N contamination. However, there are "hotspots" where high nitrate-N levels exceed the EPA's MCL in wells throughout the project area. These "hotspots" are primarily deep wells installed before 1985 on dairy farms. Visual inspection of these wells, indicate they are being influenced by effluent from cattle loafing areas, surface water runoff and in only a few cases, septic drain fields. Some may be contaminated from all three sources.

The results of this study point to the need to teach farmers how to protect their wells from contaminants. It is recommended that all farmers, especially those with wells high in nitrate-N, complete the Farmstead Assessment System (commonly refered to as Farm*A*Syst) program.

Farm*A*Syst is a series of 12 worksheets that helps the farmer assess how effectively farmstead practices (structures and activities) protect drinking water. The strength of this program is that the farmer develops an action plan to reduce the risks identified from the worksheets at the completion of the program.

Farm*A*Syst was developed by staff from Region 5 EPA, the University of Minnesota Extension Service and the University of Wisconsin Extension Service. It is a nationally recognized wellhead protection program. Eighteen states have developed and completed their own Farm*A*Syst programs. The remaining states are at various stages of material and program development (Jäckson et al., 1994). In concert with Farm*A*Syst, it is recommended that BMPs be put in place around the dairies to control and manage animal waste. These BMPs include many previously mentioned, including using "cow carpet" in heavy use areas, rotational grazing, using a nutrient management plan when spreading manure and surface water diversion into settling basins.

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