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THE EFFECT OF ANIMAL WASTE ON WATER QUALITY IN NOVA SCOTIA

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INTRODUCTION

Public concern in Nova Scotia has grown in recent years over the extent of groundwater and surface water contamination due to agricultural practices. The main concerns are eutrophication of streams and nitrate pollution of drinking water as over 50 percent of the population in the Province receives it's drinking water from wells (Eaton et al. 1986). A recent study conducted in an extensive farming area in Nova Scotia revealed that twelve percent of the wells tested had nitrate levels in excess of the Canadian drinking water standard of 10 $mg \cdot l^{-1}$ (Government of Nova Scotia 1990). The sources of nitrate were not identified in the study.

Today's modern farming practices require effective management techniques which maximize the benefits of agricultural wastes. The demand for efficiency, the potential savings of fertilizer costs and environmental awareness has rejuvenated an interest in livestock manure as a resource rather than a burden. This organic by-product is a soil amendment and source of plant nutrients which is important to most of the soils in Nova Scotia as they are generally low in natural fertility and organic matter.

The shallow soils and humid climate of Nova Scotia results in high water tables in the spring and fall which requires effective subsurface drainage to maximize crop production on these soils. Surface runoff and subsurface drainage discharge following manure application is a potential pollutant to groundwater and streams. The objective of this study is to quantify the impact of manure application on surface and ground water quality.

MATERIALS AND METHODS

Site Description

The study is being conducted on a 5.4 ha field in Streets Ridge, Nova Scotia, Canada. The field has a uniform 4% slope and the soil is classified as a Queens which is characterized by a fine loam surface layer (0-36 cm) over a highly compacted basil till. The site was previously used for a subsurface drainage research project and has an existing drainage system with three replicates of drains installed at 3, 6 and 12 meter spacings (Madani et al. 1992). Three drain spacing plots along with the accompanying buffer drains were combined into one plot by joining all the drains into one line. The field now has three plots with a drain line from each plot being connected to a tipping bucket in a propane heated outflow building to allow for continuous drain flow measurements (Figure 1).

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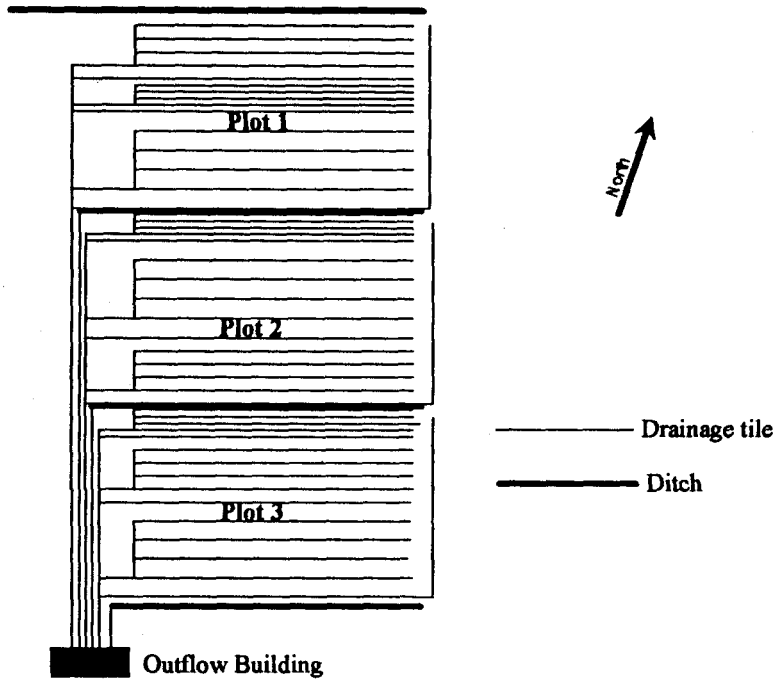

Figure 1. Layout of the plots, ditches and drainage tile at the site.

Shallow ditches were excavated at the bottom of each plot to collect surface runoff. At the southwest end of each ditch, two hickenbottom surface inlets were installed. These surface inlets were connected to existing lines which run to the outflow building and are connected to tipping buckets.

Manure Treatments

Solid beef manure from a nearby farm was spread on the plots. Plot 2 had manure spread at a rate of 35,000 $kg \cdot ha^{-1}$ and plot 3 had manure spread at a rate of 70,000 $kg \cdot ha^{-1}$. There was no manure spread on plot 1. The manure application rates were determined from a manure nutrient analysis (Table 1) and were designed to provide 103 kg and 206 kg of available nitrogen per ha for plots 2 and 3, respectively. The application rates of the broadcast manure spreaders were calibrated by weighing the spreaders full and empty with portable wheel scales and determining the area to be covered with each load. The manure was incorporated into the soil immediately after spreading and the field was then seeded with timothy.

Table 1. Manure analysis (100% dry basis).

Dry matter (%)	Total N (%)	Total P_2O_5 (%)	Total K_2O (%)	Ca (%)	Mg (%)
26.2	1.80	0.28	1.33	0.60	0.26

Outflow Sampling

A total of 66 drain water samples and 15 surface runoff samples were collected manually from the tipping buckets between May 21 and August 24, 1993. The samples were analyzed for nitrate, potassium, phosphorus and 9 other elements by the Analytical Services Laboratory of the Nova Scotia Department of Agriculture and Marketing.

PRELIMINARY RESULTS

Higher rates of subsurface drainage outflows generally resulted in more nutrients leaching through the soil profile with nitrate and potassium concentrations in the range of (N: 5-21 $mg \cdot l^{-1}$, K: 3-6 $mg \cdot l^{-1}$) at high outflows and (N:2-5 $mg \cdot l^{-1}$, K: 1-2 $mg \cdot l^{-1}$) at low outflows. The elements had consistent readings for all ranges of flows except for iron which had increased levels with high outflows.

Surface runoff water had lower nitrate levels than those found in the subsurface drain outflow, whereas potassium levels were higher in the runoff water.

Table 2 shows the average and range of nutrients in the drain outflow and surface runoff water samples collected.

Table 2. Average and range of nutrients in outflow and runoff water samples (mg/l).

	Drain outflow			Surface runoff		
	N	P	K	N	P	K
Average	6.45	0.12	2.17	6.26	0.21	8.09
Minimum	1.56	0.00	0.81	1.71	0.00	0.94
Maximum	21.90	0.44	6.87	10.9	0.60	16.44

Drain outflows from plot 3 (120 kg N/ha) contained only marginally higher levels of nitrate than plots 1 and 2. There was little difference among the potassium and phosphorus measured in the outflow water for the three plots (Table 3).

Table 3. Total nutrients lost from each plot through drain outflow and surface runoff from May 21 to August 24 (kg).

	Drain outflow			Surface runoff		
Plot	N	P	K	N	P	K
1	1.83	0.037	0.40	0.54	0.016	0.44
2	1.86	0.029	0.42	0.55	0.011	0.41
3	2.02	0.024	0.40	0.54	0.021	0.72

Surface runoff water from plot 3 had considerably higher potassium and phosphorus levels than plots 1 and 2 however nitrate measured in the surface runoff water was the same for all three plots.

A total of 7.32 kg of N, 0.136 kg of P and 2.81 kg of K were lost from the 5.4 ha field through subsurface drain outflow and surface runoff over the period from May 21 to August 24, 1993.

Monitoring of the site will continue over the next two years with manure application each spring.

REFERENCES

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