RRB-88-72

AQUIFER VULNERABILITY STUDIES, ANNAPOLIS VALLEY, NOVA SCOTIA: A DISCUSSION PAPER

by

R.E. Jackson

National Water Research Institute
Canada Centre for Inland Waters
Burlington, Ontario, L7R 4A6

August 1988
NWRI Contribution #88-91

EXECUTIVE SUMMARY

The few studies that have been undertaken so far of the migration and fate of pesticides in Canadian ground waters have been post mortem or reactive (e.g., Priddle et al., 1987, 1988). However, under the new Guidelines for Registration of Pesticides in Canada: Environmental Chemistry and Fate of Agriculture Canada (1987) both laboratory and field tests are required to determine the environmental behavior of pesticides under Canadian conditions. One particular concern is the fate of pesticides which have been shown in laboratory tests to be very mobile and therefore considered "leachers". Such pesticides pose a threat to ground waters due to their solubility, persistence and toxicity, e.g., aldicarb, atrazine, dichloropropane/ene, dinoseb and carbofuran.

The Guidelines contain protocols for field tests, however, these are not defined in detail nor are they binding on the proponent. Consequently, it is proposed that Agriculture Canada and Environment Canada conduct demonstration field studies at the Sheffield Farm, near Kentville, Nova Scotia to determine how the leaching potential of pesticides might be meaningfully evaluated and therefore how ground waters can be protected.

RÉSUMÉ

Les quelques études entreprises jusqu'à présent sur la migration et l'évolution des pesticides dans les eaux souterraines du Canada ont été effectuées après des déversements ou des cas connus de contamination (p. ex., Priddle et al., 1987, 1988). Toutefois, les nouvelles Lignes directrices sur l'homologation des pesticides au Canada : caractéristiques chimiques et évolution dans l'environnement, publiées par Agriculture Canada (1987), exigent la tenue d'essais en laboratoire et sur le terrain pour déterminer l'évolution des pesticides dans l'environnement compte tenu des conditions qui règnent au Canada. Il s'agit d'abord d'étudier l'évolution des pesticides qui sont apparus très mobiles en laboratoire et qui sont, par conséquent, considérés comme des "agents d'infiltration". Ce genre de pesticides constituent une menace pour les eaux souterraines à cause de sa solubilité, de sa persistance et de sa toxicité, comme les produits suivants : aldicarbe, atrazine, dichloropropane/ène, dinosèbe et carbofuran.

Les lignes directrices contiennent des méthodes d'essai sur le terrain, mais sans les décrire en détail et sans les imposer aux promoteurs. En conséquence, il est proposé qu'Agriculture Canada et Environnement Canada effectuent des études de démonstration sur le terrain à la ferme Sheffield, près de Kentville en Nouvelle-Écosse, pour déterminer dans quelle mesure le potentiel d'infiltration des pesticides peut être évalué et, par conséquent, de quelle façon protéger les eaux souterraines.

THE SHEFFIELD FARM SITE

The Sheffield Farm site is located 5 km north of the Kentville Agriculture Experiment Station in the Annapolis-Cornwallis Valley of Nova Scotia (see Figure 1). The farm has a cool, humid climate with a total annual precipitation of 1116 mm of which 227 mm is snowfall. Most precipitation falls between October and February. The summer growing season is characterized by average daily maximum temperatures of 16.1°C in May to 24.9°C in July. Monthly precipitation during these 3 months averages 73 mm (Langille, 1987).

The Farm is located on the floor of the Annapolis-Cornwallis valley and is bisected by a drainage channel (see Figure 2). The soils of the Farm have developed from glaciofluvial, fluviomarine and till deposits. These overlie the Triassic Wolfville rocks (see Figure 3), which are mainly poorly sorted and cross stratified sandstones and conglomerates with intraformational claystone and siltstone (Trescott, 1968).

A large part of the Farm is covered with well drained sandy loams of the Cornwallis and Somerset soil series, as shown on Figure 4. Such soils are frequently used for potato, berry, tobacco and orchard crops; the aquifers beneath these permeable soils are vulnerable to contamination by pesticide and fertilizer residues. As such, the soils provide attractive sites in which to conduct experimental applications of pesticides and fertilizers to crops in order to assess the migration and fate of the residues with respect to ground waters.

Figure 5 shows the field numbering system used on the Sheffield Farm. Three field areas have been identified as potential sites for pesticide application:

1. field area B1/C1 (Somerset),
2. field area B4 (Somerset), and
3. field area E4/E5/E6/D5/D6 (Cornwallis).

During August and September 1988, reconnaissance hydrogeological studies were carried out in the three field areas identified above. These included detailed coring of the soil materials to bedrock using a solid stem auger and a split spoon sampler, installation of 19 5-cm piezometers (i.e., monitoring wells) in the completed holes, and hydraulic and chemical testing of the piezometers. It is proposed that additional instrumentation be installed during 1989 in those sites that appear suitable for field experiments and that experimental applications of pesticides to crops begin in the Spring of 1990.

PROPOSED EXPERIMENTS

There are several field experiments which could profitablly be undertaken with the cooperation of Agriculture Canada. Three will be briefly discussed here.

Results of a four-year long monitoring program of aldicarb contamination of the ground waters in the sandstone aquifer of Prince

Edward Island have suggested that contamination has arisen because of inadvisable agricultural practices. It is common practice to apply the seed potatoes together with the pesticide (Temik) and fertilizer during the early Spring. Because Temik is a systemic pesticide, it relies on the presence of a well-developed root zone for plant uptake. However, this is clearly impossible at this point in time when no root zone could have developed.

Furthermore, the acidity and coldness of the soil waters after snowmelt in May would inhibit the degradation of aldicarb to less toxic degradation products. Finally, the oxidation of ammonium nitrate fertilizer would produce an acid soil water which would increase the persistence of aldicarb. Consequently, it is American practice to apply aldicarb only after plant emergence, i.e., in late June, when the soil is drier, considerably warmer, and less acid.

Therefore, it is proposed that separate plots of potatoes be cultivated at Sheffield Farm, e.g., in the B1/C1 field area, and that fertilizers and aldicarb be applied (1) at seeding and (2) after emergence to identical plots. This experiment should provide information on the safe use of this very toxic insecticide. Furthermore, it should indicate how fertilizer residues may contaminate ground waters.

A second experiment might concern the use of insecticides or fumigants (e.g., dichloropropane/ene) that have been detected in ground waters beneath berry fields in British Columbia. A third could involve the application of atrazine to corn crops. In each case the intent of the study would be to understand the migration and fate of

the pesticide with respect to plant uptake, hydrologic transport through the unsaturated zone, sorption and transformation in both the saturated and unsaturated zones of the ground water flow systems and, finally, the fate of the pesticide once it has reached the water table and enters the saturated zone of the flow system.

REFERENCES

Langille, D.R. 1987. Soils of the Kentville Research Station and Sheffield Farm. Research Branch, Agriculture Canada, Kentville.

Trescott, P.C. 1968. Groundwater Resources and Hydrogeology of the Annapolis-Cornwallis Valley, Nova Scotia. Memoir 6, Nova Scotia Department of Mines, Halifax, Nova Scotia.

Priddle, M.W., R.E. Jackson, K.S. Novakowski, S. Denhoed, B.W. Graham, R.J. Patterson, D. Chaput, and D. Jardine. 1987. Migration and fate of aldicarb in the sandstone aquifer of Prince Edward Island. Water Poll. Res. J. Canada, 22(1);173-185.

Priddle, M.W., R.E. Jackson, A.S. Crowe, and J.P. Mutch. 1988. Aldicarb and nitrogen residues in a sandstone aquifer. In: Proceedings of NWWA Conference on Agricultural Impacts on Ground Water, Des Moines, Iowa, March 1988.

Figure 1

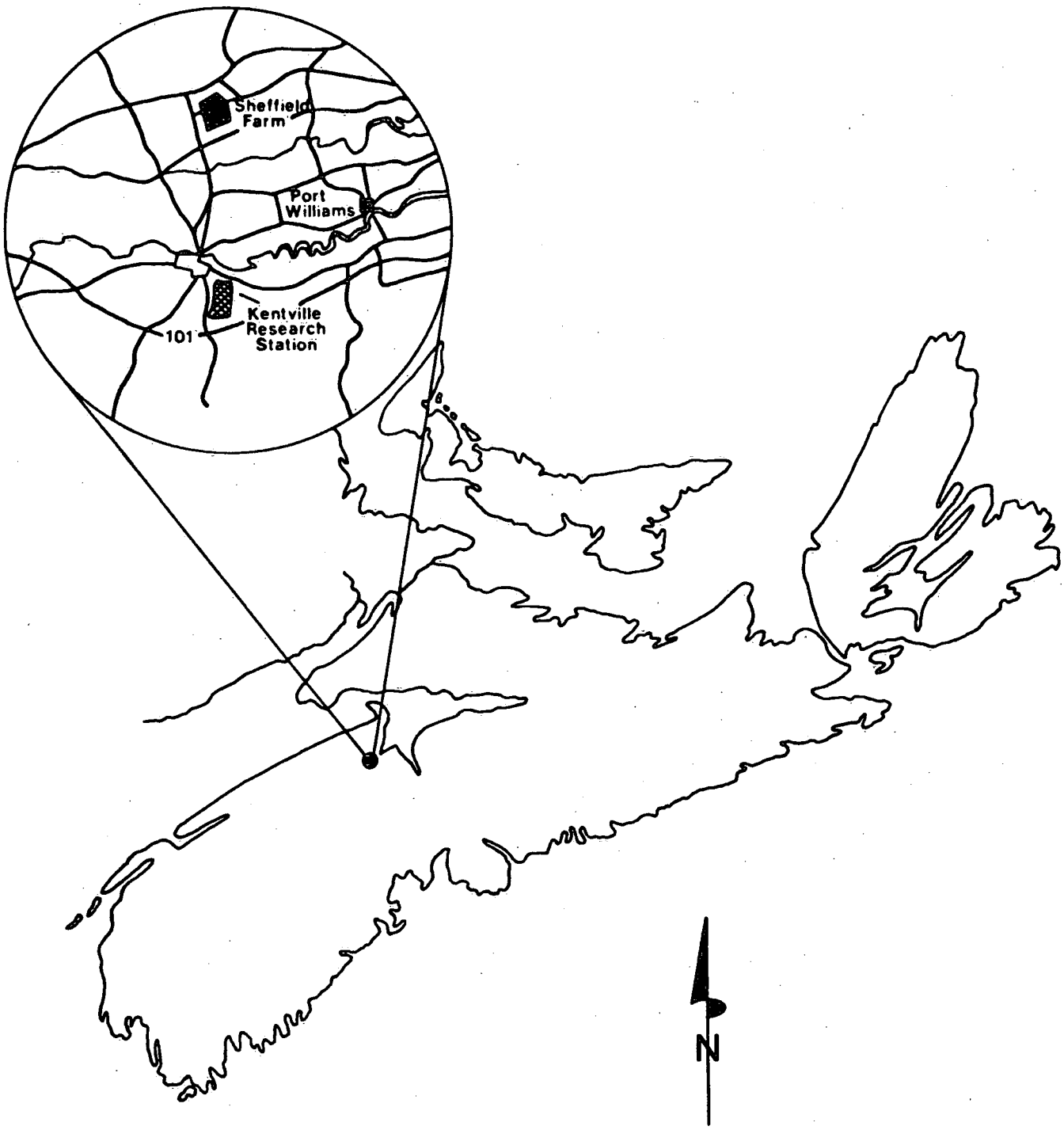
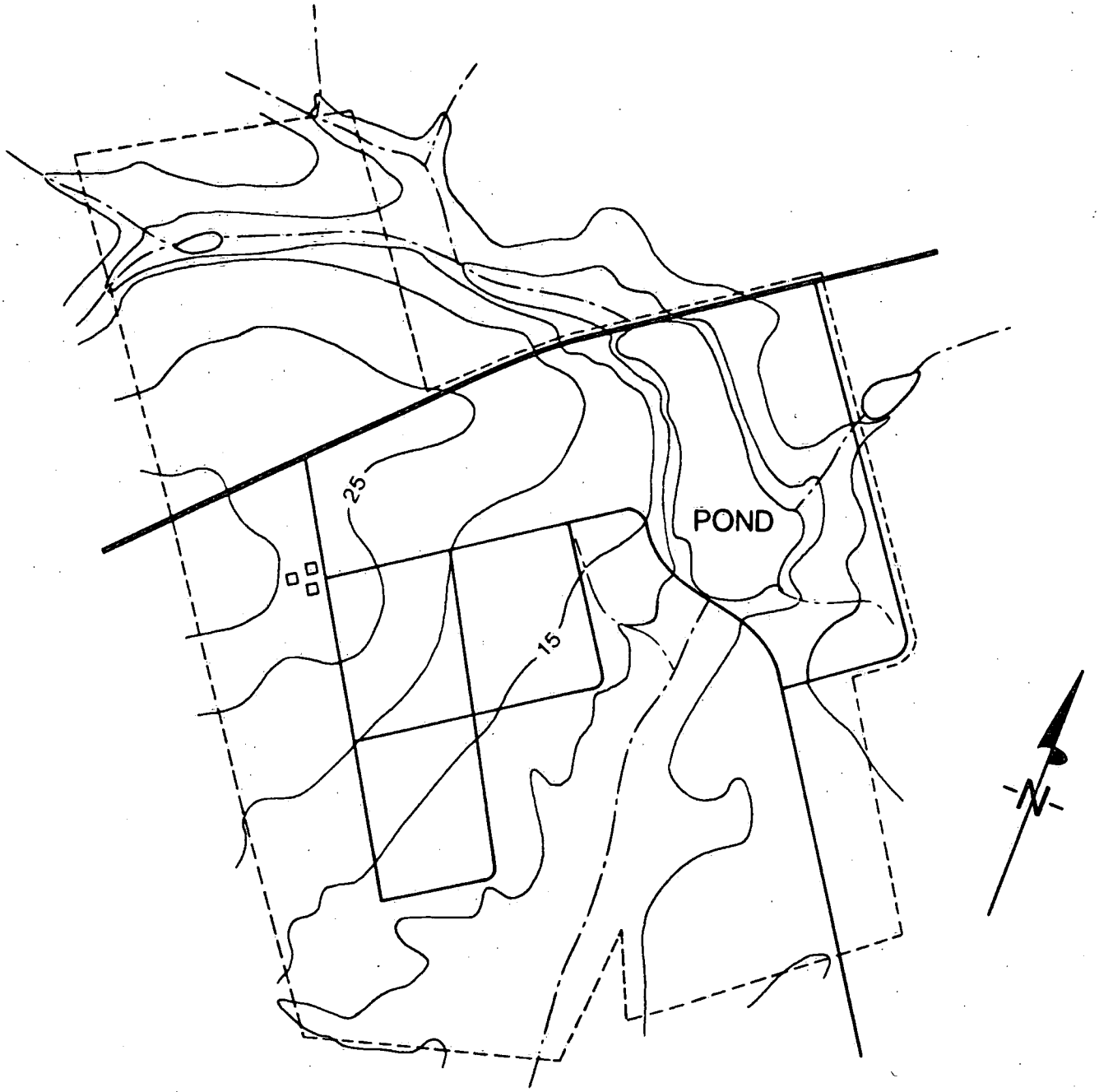

Sheffield Farm
Port Williams
Kentville Research Station
101
N

Figure 2

SHEFFIELD FARM - SHEFFIELD MILLS (Nova Scotia)



LEGEND:

Stream

Road

Boundary

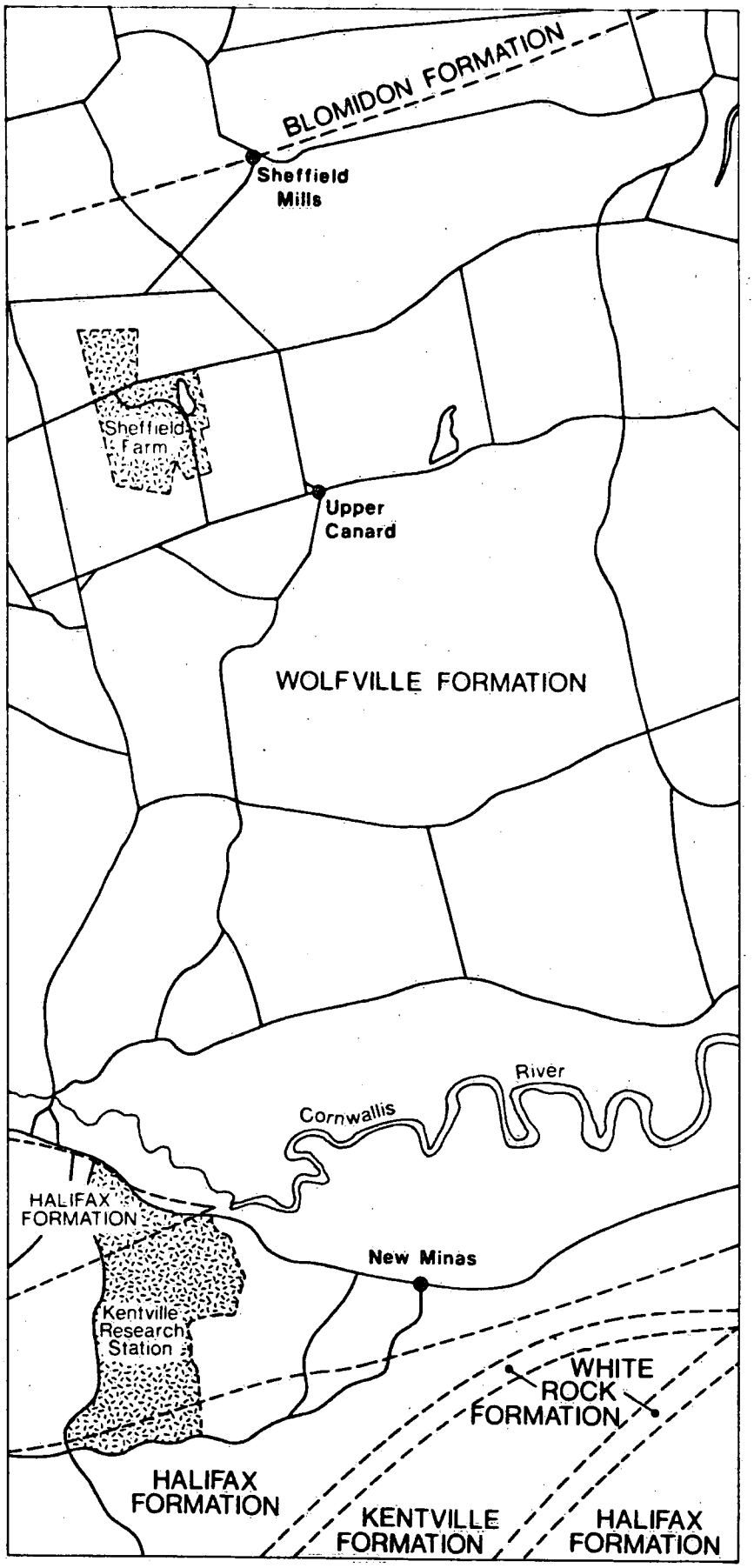
Contour Line —25—

Scale 1:10,000

200 0 200 400 600

Contour Interval - 5m

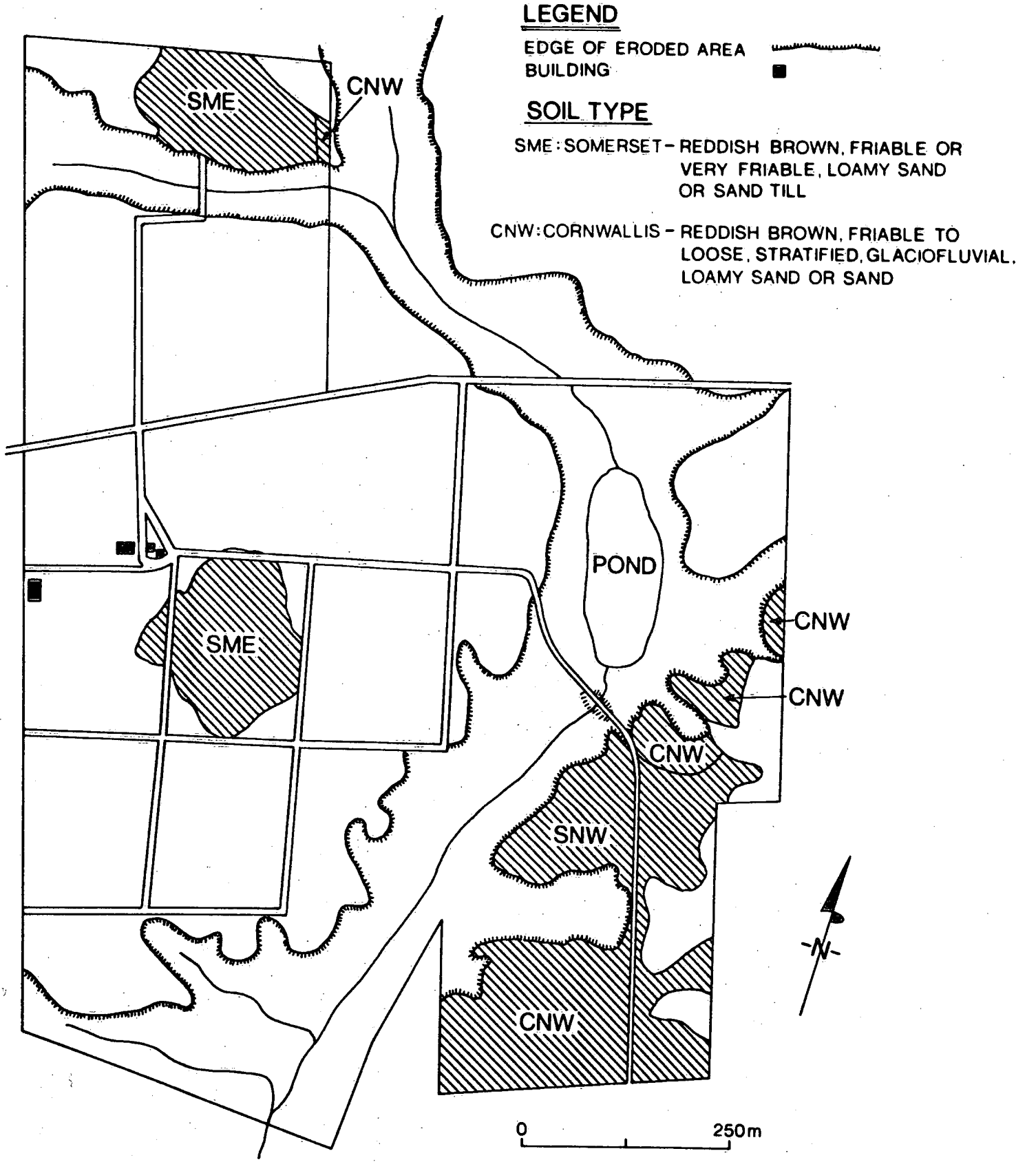
Figure 3

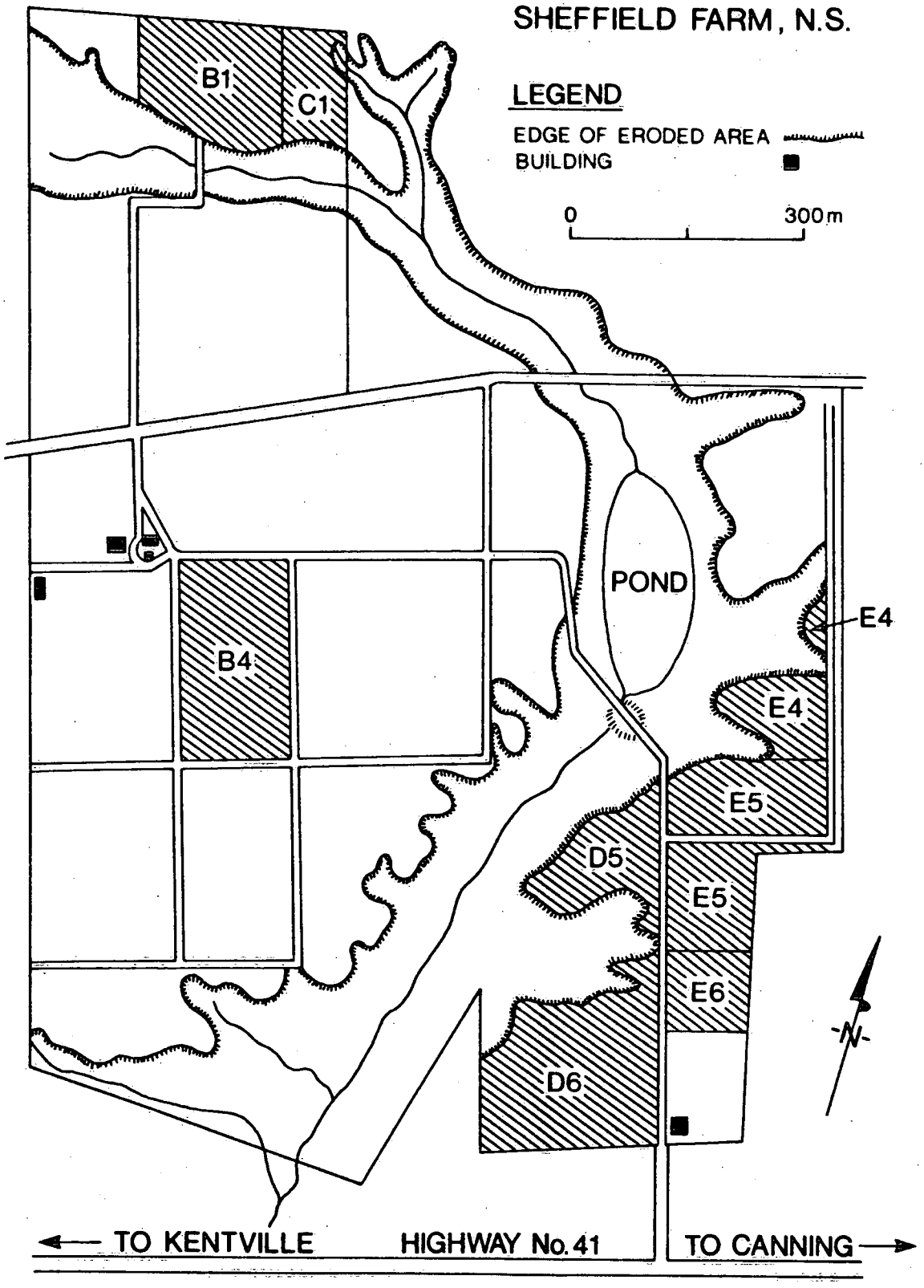


------ FORMATION BOUNDARY

APPROXIMATE SCALE 1:77,500

SHEFFIELD FARM, N.S.




SHEFFIELD FARM, N.S.
LEGEND
EDGE OF ERODED AREA
BUILDING
0
300m
B1
C1
B4
POND
E4
E4
E5
D5
E5
E6
D6
N
TO KENTVILLE
HIGHWAY No. 41
TO CANNING