AGRICULTURAL LAND USES, LIVESTOCK AND SOILS

OF

THE CANADIAN GREAT LAKES BASIN

(south of latitude 45° N)

A REPORT OF THE ACTIVITIES OF
THE ENGINEERING RESEARCH SERVICE AND THE SOIL RESEARCH INSTITUTE
AS PART OF AGRICULTURE CANADA'S CONTRIBUTION TO THE IMPLEMENTATION
OF THE GREAT LAKES WATER QUALITY AGREEMENT
1973 - 1974

prepared, in part, for

TASK C (CANADIAN SECTION) INTERNATIONAL REFERENCE GROUP ON GREAT
LAKES POLLUTION FROM LAND USE ACTIVITIES

JUNE 1974

PARTICIPANTS

D. R. Coote
Engineering Research Service, Ottawa

E. M. MacDonald
Soil Research Institute, Ottawa

C. J. Wall
Soil Research Institute
Ontario Soil Survey Unit, Guelph

SUPPORT STAFF

E. M. Cole

J. M. Cossette

R. J. Dewe

D. G. Harder

F. J. MacCallum

J. D. McRae

M. D. Rigby

J. C. Slot

L. van Vliet

ACKNOWLEDGEMENTS: The following list includes others who have contributed materially to this report, and for whose assistance the participants wish to express their sincere appreciation: (Contributions within this report are identified by footnotes)

Dr. C. Acton
Agriculture Canada,
Ontario Soil Survey Unit, Guelph

Dr. T. Dickinson
School of Engineering,
University of Guelph, Guelph

Support Staff: A. Scott

Dr. M. Kaplansky
Data Processing Division,
Agriculture Canada, Ottawa

Mr. L. Philpotts
Economics Branch,
Agriculture Canada, Ottawa

Support Staff: R. LaFrance

Mr. R.A. Ryerson
Canada Centre for Remote Sensing,
Energy, Mines and Resources, Ottawa

In addition to those individuals mentioned above, the participants wish to express their appreciation to the Staff of the Soil Research Institute, including the Cartography Unit, and the Engineering Research Service for their advice and assistance.

The projects described in this report were made possible by funds supplied directly to the Research Branch, Agriculture Canada, by the Treasury Board for implementation of the Great Lakes Water Quality Agreement.

TABLE OF CONTENTS

TABLE OF CONTENTS

(continued)

LIST OF TABLES

LIST OF FIGURES AND MAPS

continued

INTRODUCTION

The Creat Lakes Water Quality Agreement, 1972, was based on the findings and recommendations of an International Joint Commission (I.J.G.) study of the pollution problems in Lake Erie, Lake Ontario and the international section of the St. Lawrence River. Two articles of this Agreement have particular significance for agriculture and agricultural research:

- Article VI requested that the International Joint Commission inquire into and report on "pollution of the boundary waters of the Great Lakes System from agricultural, forestry and other land use activities, in accordance with the terms of reference attached to this agreement".
- Article V was directed primarily to the regulatory agencies and requested the development and implementation of programmes and other measures directed towards achievement of the established water quality objectives. One section of this article dealt with the abatement and control of pollution from agricultural, forestry and other land use activities, and included:
  - measures for the control of pest control products to limit inputs into the Great Lakes System.
  - measures for abatement and control of pollution from animal husbandry operations.
  - measures governing the disposal of solid wastes.
  - measures to abate and control inputs of nutrients and sediments.

The International Joint Commission (I.J.C.) established the International Reference Group on Great Lakes Pollution from Land Use Activities to plan and implement the study requested by Article VI. Implementation of Article V, federally, is the responsibility of the Interdepartmental Committee on Water Programmes (I.C.W.), Central Sub-Committee.

Agriculture Canada (C.D.A.) is participating in both programmes. In December 1972, with I.C.W. funds, a C.D.A. Task Force for Implementation of the Creat Lakes Water Quality Programme was established with the directive to survey published material on agricultural pollution of the Lower Creat Lakes, to survey ongoing work on this problem, to determine limitations in knowledge and deficiencies in existing research programmes, and finally, to develop plans for research programmes to fill in any deficiencies. A report was prepared by the Task Force as a working document, and considered two major areas of concern:

I Pesticides

II Fertilizer Nutrients and Animal Husbandry Operations.

In the 73/74 fiscal year, Engineering Research Service and the Soil Research Institute were involved in several I.C.W. supported programmes. These were carried out as a contribution to the I.C.W. implementation of Article V of the Agreement; as a contribution to the planning of the I.J.C. programme; or as an implementation of those recommendations of Section II of the Task Force Report that would contribute to either of these programmes.

Recommendation 2, Section II of the Task Force Report, proposed monitoring of agricultural watersheds for contributions of nutrients and other pollutants to water, with selection of sites based on soil, land use and hydrological data. In addition, it was recommended that the proposed programme should be integrated with other larger watershed studies through participation of the C.D.A. Research Branch in the proposed watershed studies (Task C) of the International Reference Group on Creat Lakes Pollution from Land Use Activities. Agriculture Canada has participated in the development of the Task C watershed study plan through representation on the Task C Technical Committee and its Agricultural Sub-Committee. In order to complete the study plan and to select sites according to prescribed criteria, the following programmes were carried out and are included in this report:

1) Land Use Inventory
2) Soil potential for pollutant transfer
3) Soil erosion
4) Background data collection for the Agricultural Sub-Committee

The soil erosion study also followed Recommendation 5 of the Task Force Report. This called for mapping of the susceptability to erosion of the soils of Southern Ontario, and characterization of the erodibility of these soils.

A programme was commenced as per Recommendation 4 of the Task Force Report to study the direct runoff of pollutants from manure storage areas and to maintain surveillance of runoff from open feedlots. The recommendation stressed the need for this data to enable the development of design requirements for control facilities. This study will contribute to the I.C.W. programme.

In support of Article V, the need for a livestock operations inventory was established by the Department of the Environment (D.O.E.). This was carried out as a joint D.O.E./C.D.A. contribution to implementation of the Great Lakes Quality Agreement.

SUMMARY

I. The Agricultural Sub-Committee of the International Reference Group on Great Lakes Pollution from Land Use Activities - Task C Technical Committee, has required certain information on which to base its collective selection of sites for Preliminary Agricultural Watershed Studies. Some of this information was provided by the following projects:

> Classification and mapping of the soils according to "Soil Potential for Pollutant Transfer": This is an estimate of the influence of soil physical characteristics on the surface hydrology of different soil landscapes. Soil information including texture, depth, drainage class and slope have been used to group many of the soils of Southern Ontario into 5 major groups and 14 subgroups. The subgroups were mapped in detail at 1:250,000, and generalized for presentation at 1:500,000 and 1:1,000,000.

> An Agricultural Land Use Inventory: This is a cartographic presentation of selected data from the 1971 Agricultural Census, Statistics Canada. Data for livestock, crops and fertilizer and manure nutrients per unit area are presented on maps of 1:500,000 or 1:1,000,000 by photographically reducing maps produced by the computer at a scale of 1:250,000. The smallest unit of area is that of an "Enumeration Area" (Census). Some of these are subject to editing to maintain confidentiality of individual farmers. Symbols are printed which represent seven levels of density within the range encountered for each characteristic.

In addition to the material provided by these projects, data obtained from activity II below, and data on climatic variability were utilized to identify distinct "agricultural regions" within the Lower Great Lakes Basin. Twenty-one agricultural regions were identified, i.e., regions defined as an area of similar soils, in the same climatic zone, upon which an identifiable agricultural land use or combination of land uses exists. Representative watersheds for each of these regions were selected for consideration by the Agricultural Sub-Committee. Extensive use was made of aerial photographs and soil and topographic maps to select and characterize these small watersheds. Individual drainage, land use, soil and livestock maps were prepared for each small watershed. (Engineering Research Service and Soil Research Institute).

II. Soil erosion within the Canadian Great Lakes Basin was determined by application of a soil loss prediction equation. The soil loss equation employed provides estimates of average annual rainfall induced erosion losses by consideration of soil erodibility, land use, rainfall and slope parameters. A map has been prepared (scale 1:500,000) that indicates the areal distribution of predicted soil erosion losses from the predominant soil and agricultural regions of Southern Ontario. The predicted soil erosion losses ranged from 0 to 15 tons/ac./yr. Watersheds located in regions of highest soil erosion loss from agricultural land included the Thames, Sydenham and Humber Rivers (Soil Research Institute, Ontario Soil Survey Unit).

III. Two beef feedlots and two manure storage areas have been instrumented so that a record of rainfall and runoff can be obtained. Samples are collected and analysed for nutrients and solids. The preliminary data reveal a wide range in all values obtained. The study has been underway for approximately 5 months, and is continuing. A progress report is available under separate cover. (Engineering Research Service).

IV. An inventory of large livestock operations in Southern Ontario has been carried out utilizing aerial photographs. Eleven categories of livestock have been recognized. Farms with less than 75 dairy cows, 150 beef steers or 300 hogs, and other farms smaller than a comparable size have been omitted. More than 4,500 farms have been recorded, and an area of over 25,000 square miles has been surveyed during this inventory. Farm size, distance to roads, streams and houses, and major and minor watersheds in which each is located have been recorded for all large farms identified. (Engineering Research Service and Soil Research Institute).

PREPARATION OF BACKGROUND INFORMATION FOR AGRICULTURAL REGION IDENTIFICATION AND WATERSHED SELECTION

D. R. Coote
Engineering Research Service

E. M. MacDonald
Soil Research Institute

Soil Series Groupings: Dr. C. Acton, Soil Survey Unit, C.D.A. Guelph

Mapping: J. M. Cossette and J. D. McRae, Soil Research Institute

Photo reductions: Photo Mechanical Unit, S.R.I. Cartography

Computer mapping: Dr. M. Kaplansky, Data Processing, C.D.A., Ottawa

PREPARATION OF BACKGROUND INFORMATION FOR AGRICULTURAL REGION IDENTIFICATION AND WATERSHED SELECTION

INTRODUCTION AND DISCUSSION

An Agricultural Sub-Committee holds responsibility for the preparation and implementation of a study plan to integrate the requirements of the agricultural watershed study with those of the remainder of the International Reference Group on Great Lakes Pollution from Land Use Activities - Task C studies.

The approach taken by the Agricultural Sub-Committee was to identify agricultural regions within which representative agricultural watersheds or sub-watersheds would be chosen. This approach was intended to allow measurements to be made of water quality and quantity parameters in streams which were known to have flowed from specific types of agricultural land uses and facilities. The following factors were identified by the Sub-Committee for consideration, and data was obtained and prepared for presentation to the Committee:

1. Land Use - (1) crops
   (2) livestock
2. Soils - differences likely to be relevant to agricultural pollution
3. Climate - significant variability within the Canadian Great Lakes Basin

The preparation of data for watershed selection was aimed at enabling the Agricultural Sub-Committee to identify areas within which the agricultural land use pattern is reasonably uniform.

Mapping of the soil potential for pollutant transfer permitted the primary division of the Basin into five major soil groups, and approximately four additional inseparable complexes. Climatic variability defined broad differences in cropping practices across the Basin. However, inspection of crop distribution maps indicated that soils grouped together and which fall in a similar climatic zone also can vary widely in the type and density of crops grown in two or more areas. Thus a further division of the Basin was made from inspection of crop distribution maps superimposed on the soil maps. Livestock distribution differences are controlled by economic factors and crop distribution so that a degree of interdependence exists between the livestock and crop distributions. Livestock distribution was therefore considered to be of secondary significance. The inspection of all maps, simultaneously, permitted the general definition of agricultural areas. Additional segregation of areas was achieved by considering the production of specialized crops such as tobacco, fruits and vegetables. The 21 main agricultural regions are shown on Map I.1.

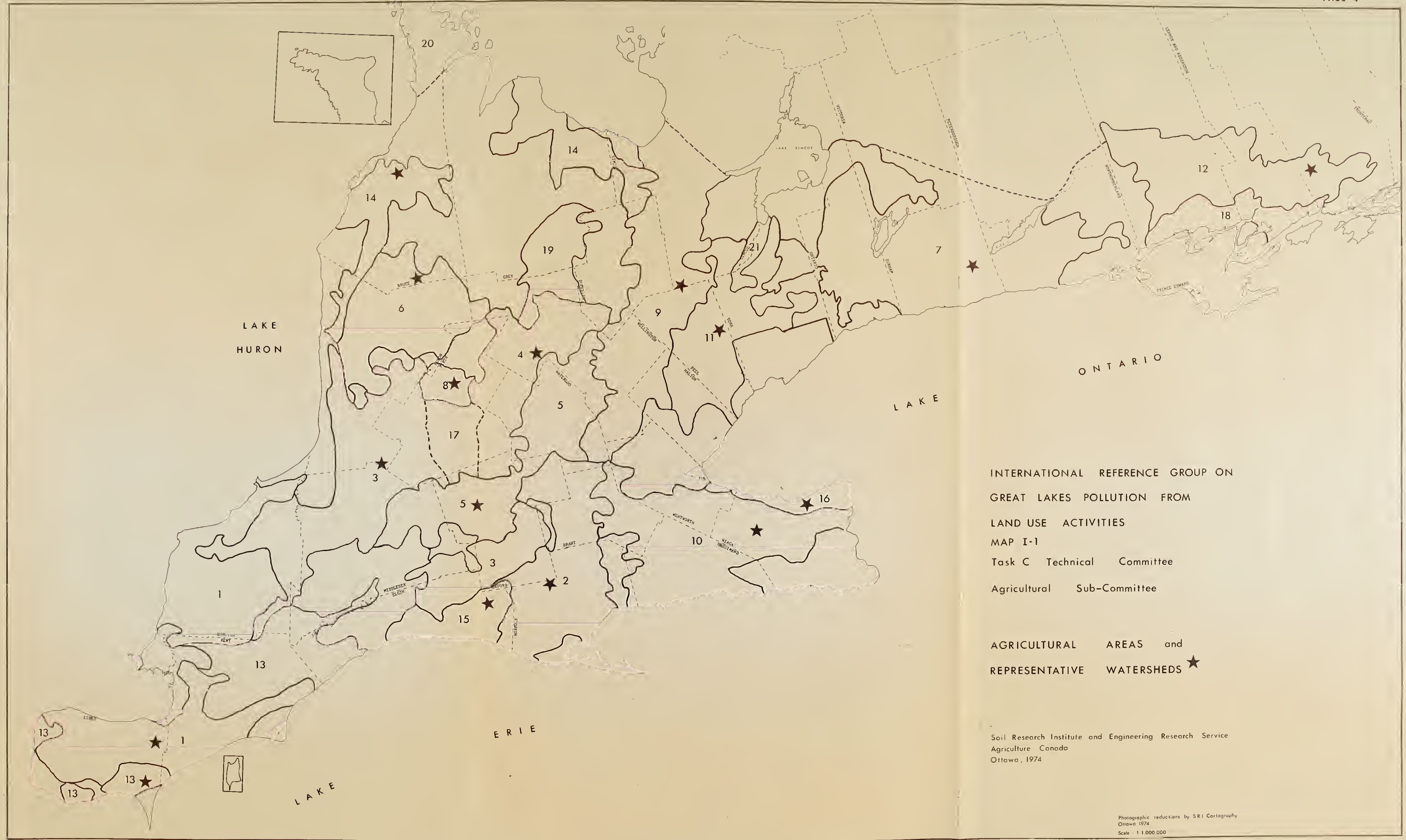
The preparation of maps showing the soil groupings and complexes enabled estimates to be made of the area of each, so that a consideration of the pollution potential was coupled with a knowledge of the extent of coverage of the Basin of each soil group. Existing stream sediment load data also indicated regions in which studies of high and low sediment loads would be most valuable. A relative ranking of area priorities was therefore possible.

An "agricultural area" sometimes consisted of a number of small, scattered areas in which similarities existed which allowed the formation of a single unit for representation purposes. It was usually possible to single out the "average" or the largest of these scattered areas as a starting point for a search of watersheds. If no watershed was found, the search moved to the next "average" or the next largest area.

River or stream patterns could be seen on 1:250,000 topographic maps by overlaying the outlines of the soil groupings. This done, the river was studied on the 1:50,000 topographic maps for suitable sites. At this point, reference was made to the locations of existing water flow measuring stations of both the Ontario Ministry of the Environment and the Federal Inland Waters Directorate. Any site on which an existing or past gauging station was located was given precedence. The watershed areas above each possible gauging site were inspected for urban areas, new highway construction, large highways, etc., and rejected if excessive non-agricultural activities were found.

Finally, air photos were used where ever possible to obtain an up-to-date land use inventory of the possible study watershed, and crop and livestock production noted. Where suitable air photos were not available, crop information was obtained from the Canada Land Inventory maps at 1:50,000 scale. A final selection of alternative sites was made by the entire Agricultural Sub-Committee.

A brief description of each of the regions shown on Map I.1, with the locations of the representative sub-basins, where applicable, can be found in Appendix I, starting on page 90.


LAKE HURON
LAKE ONTARIO
LAKE ERIE
INTERNATIONAL REFERENCE GROUP ON
GREAT LAKES POLLUTION FROM
LAND USE ACTIVITIES
MAP I-1
Task C Technical Committee
Agricultural Sub-Committee
AGRICULTURAL AREAS and
REPRESENTATIVE WATERSHEDS ★
Soil Research Institute and Engineering Research Service
Agriculture Canada
Ottawa, 1974
Photographic reductions by SRI Cartography
Ottawa 1974
Scale - 1:1,000,000
BRUCE
GREY
WATERLOO
WELLINGTON
PEEL
HALTON
YORK
WENTWORTH
BRANT
OXFORD
MIDDLESEX
ELGIN
NORFOLK
KENT
ESSEX
VICTORIA
DURHAM
PETERBOROUGH
PRINCE EDWARD
LAKE SIMCOE

1. CLIMATIC ZONES

Identification of climatic zones with significant differences in relation to the pollution potential of an agricultural region was required for selection of unique agricultural regions.

As a first approach, the area of the Canadian Lower Great Lakes Basin was divided into 10 climatic zones. These zones were grouped on several parameters including rainfall, length of frost-free period, growing degree-days, etc. They were as follows:

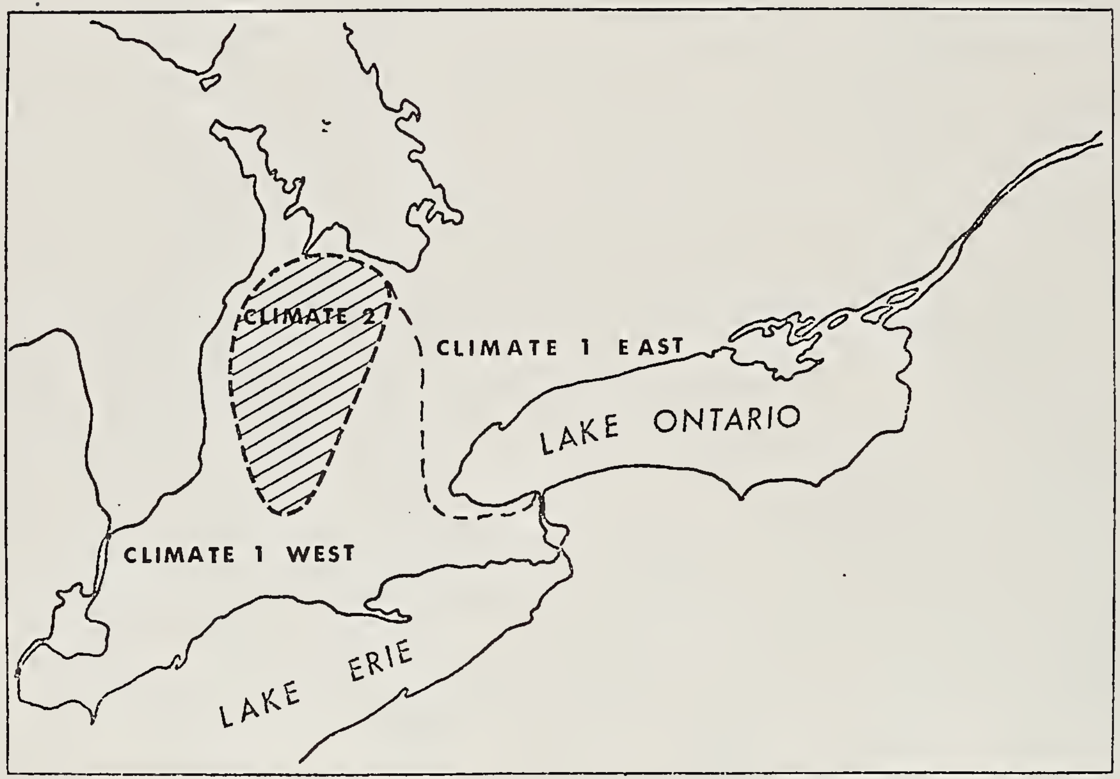
1. Leamington
2. Kent and Essex
3. Lake Erie counties
4. South Slopes
5. Huron Slopes
6. Dundalk Uplands
7. Niagara Fruit Belt
8. Lake Ontario Shore
9. Simcoe and Kawartha Lakes
10. Prince Edward County

Climatic information was obtained from the Canada Land Inventory, Climates of Canada for Agriculture, C.L.I. Report No.3, 1966, and the Climate of Southern Ontario, Brown, McKay and Chapman, D.O.T., Climatological Study #5, 1968.

Subsequently, it was concluded that this number of climatic zones lacked sufficient individual significance for this study*.

A broader distinction was made between the climatic zones of the region. Recognition was given to the higher snowfall, rainfall and runoff, and lower degree-days and shorter growing season of the central uplands (Climate 2). This was in contrast with the climate of the rest of the region which is lower in elevation, closer to, and more influenced by, the Great Lakes (Climate 1). A distinction was also made between that part of climatic zone 1 which was east compared to that which was west of the Niagara Escarpment. (See Map I.2).

*Personal cummunication, D. M. Brown, Department of Land Resource Science, University of Guelph.



Map I.2 Climatic Zones for Definition of Agricultural Regions

2. SOIL POTENTIAL FOR POLLUTANT TRANSFER TO WATER SYSTEMS

The selection of sites for watershed studies will inevitably be based on a number of criteria depending on the objectives of the watershed study. In the case of the Agricultural Watershed Study, which is a part of the Pilot Watershed Study of the International Reference Group on Great Lakes Pollution from Land Use Activities, the selection of a set of watersheds was based on their overall representativeness of the agricultural pollution potential of the Canadian Lower Great Lakes Basin.

One of the primary concerns with agricultural sources of pollutants are the non-point sources such as land drainage (surface runoff, subsurface drain and ditch effluent) and deep percolation contributions to ground water. The factors which affect the potential of an agricultural area to contribute to these non-point sources include the soil texture, soil drainage characteristics, soil depth, topography, climate, crop production, livestock production and the management of cropping and livestock activities.

This report describes the approach which was taken in order to simplify the presentation of the soil-related pollution potential characteristics of an agricultural area.

In the following interpretive system, many Southern Ontario soils have been grouped into categories on the basis of their potential for pollutant transfer to either surface waters (streams, small lakes or ponds) or ground water. Two basically different pollutants are inferred, namely, (1) sediment arising from erosion of lands under agricultural use, being transferred by surface runoff, and (2) chemicals arising from the use of fertilizers, herbicides, pesticides, or barnyard manure in agricultural practices, which involve either surface transfer or move through the ground water system.

There are five major groups specified, each group having certain unique properties which affect differently the potential of those soils to contribute pollutants to surface waters or ground water. The relative ranking of the groups has no particular significance with regard to the severity of potential for pollutant transfer. For example, the soils in Group 1 present a greater potential hazard to pollutant transfer than the soils in Group 4, but no greater than Group 3.

1. High potential to contribute to surface water; low to ground water.
2. Moderate potential to contribute to surface water and ground water.
3. Low potential to contribute to surface water and high potential to contribute to ground water.
4. Low potential to contribute to either surface or ground water.
5. High potential to contribute to both surface and ground water.

Soil factors which were considered to result in a soil type being placed into one of the five groups listed above include some of the following (sub-groups based on textural class; a-fine, b-medium, c-coarse):

1.a) Soils with high percentages of clay size particles throughout the profile which have low infiltration rates, but which are classified as either well or imperfectly drained. This implies a high degree of surface runoff, and therefore a potential to contribute soluble and particulate forms of pollutants to surface drains, ditches and streams.

b) Medium textured soils which have low infiltration rates, but which are well or imperfectly drained will also have a potential for surface water pollution if pollutant material is available in the soil environment for transport by surface runoff.
Medium textured soils which have moderate infiltration rates may occur on slopes exceeding 6%. Soils of this type which are well drained are likely to experience runoff as well as infiltration. A potential for contributions of pollutants, including sediments, to surface water systems will exist with these soils.

c) Coarse textured (sandy) soils which have fine textured layers at a shallow depth, which are on sloping topography (slopes exceeding 3%), and which are also well or imperfectly drained; such soils create a condition where lateral flow of water over the fine textured layer may occur. This lateral movement of water will usually re-appear at the surface at a point lower down the slope, or where the coarse textured soil becomes more shallow over the fine textured material. The lateral movement of water out of the soil is also implied by the well or imperfectly drained classification of these soils. Direct horizontal drainage into drains or ditches may also occur.

d) Organic soils which have been artificially drained for crop production will often have water pumped from a ditch network into a nearby stream or lake. This water may contain dissolved pollutant materials. These soils must be considered as potential surface water pollution sources because of these artificial drainage practices.

e) Certain of the soils which do not fit the descriptions a) through d) above may also possess the potential for the transfer of contaminants to surface water. Miscellaneous land types such as escarpment, bottom land and recent alluvium are often located in such a way as to contribute water over the surface or laterally directly to a stream or river.

2.b) Some soils which are medium textured throughout the profile and which occur on slopes of less than 6%, and which are classified into the imperfectly drained class may be expected to contribute water to a moderate degree to both surface and ground water systems. Dissolved materials will be transferred to both these systems, and particulate or suspended matter will also move into surface water systems.

3.b) Medium textured soil profiles which are poorly drained may have a high potential to contribute dissolved material to ground water. Runoff is low or very reduced, and water has to pass through the profile to ultimate drainage into ground water.

c) The most common conditions under which water will percolate to ground water are the deep sandy and gravelly profiles. These soils have very rapid infiltration rates and permeabilities, and are usually well drained.

d) Shallow soils overlying limestone bedrock are also considered as possessing the potential for ground water pollution. The fractured rock permits the rapid transfer of water and dissolved material to ground water.

4.b) Certain soils can be considered as having a low potential for the transfer of pollutants to water systems; these include the medium textured, well drained soils on slopes less than 6%.

c) Other soils in the group include the sandy textured soils overlying clay, where slopes are less than 3% and lateral water movement over the clay materials is at a minimum.

5.a)and b) Fine and medium textured soils which are poorly drained may possess the potential to transfer sediment and dissolved materials to surface water and also dissolved material to ground water. These soils often receive runoff water from higher elevations but, because of their location, runoff does not leave them rapidly enough to keep these soils imperfectly or well drained. Though fine textured, water does move through these soils in large enough quantities to pose a potential ground water pollution problem.

c) Bedrock, Rockland and other rock outcrop situations are potential conditions where any available pollutants might be transferred to either surface or ground water.

Table I.1 is a summary of the soil grouping criteria as outlined above. Table I.2 lists many Southern Ontario soils according to their grouping in the system described.

Map I.3 shows the generalized distribution of the soil pollution transfer potential in the Canadian Lower Great Lakes Basin. The mapping procedure which has preceded this map included the photographing of all of the soil maps of the Ontario Soil Survey of the counties included in this area. Two soil maps which have not been published but which are in single, original copy form were also photographed*. These photographs were reduced or enlarged to the common scale of 1:250,000 and composited to match the Canada Land Inventory Soil Capability maps. The soil groups were color coded and the maps colored. Generalized overlays were then produced, photographed and reduced to 1:500,000 and 1:1,000,000. (see Map I.3).

* Thanks are expressed to Dr. D. Hoffman and Dr. C. Acton for loan of maps of Brant and Waterloo Counties respectively.

Table I.1 Summary of Criteria for Grouping of Soils by Potential for Pollutant Transfer

Group 1. Soils with high potential for transfer of pollutants to surface water systems (streams and small lakes) and low potential for transfer to ground water:

1.a. Fine textured profiles, low infiltration rate

PROFILE TEXTURE	SLOPE	DRAINAGE CLASS
clays, clay loams	all	good, imperfect
silty clays	"	" "
silty clay loams	"	" "

1.b. Medium textured profiles, low infiltration rate

loams, silt loams	>6%	well drained
loams, silt loams	all	good, imperfect

1.c. Coarse textured profiles

sands or sandy loams over clay	>3%	good, imperfect

1.d. Organic soils

	all	tile drained or pumped

1.e. Miscellaneous land types

bottom land
alluvium
escarpment

Group 2. Soils with moderate potential for transfer of pollutants to surface water and ground water:

2.b. Medium textured profiles

loams, silt loams	<6%	mainly imperfect

Group 3. Soils with high potential for transfer of pollutants to ground water, but low potential to surface water:

3.b. Medium textured profiles

PROFILE TEXTURE	SLOPE	DRAINAGE CLASS
fine sandy loams	all	mainly poor
gravelly loams	"	" "
loam over gravel	"	" "
3.c. Coarse textured profiles		
deep sands and sandy loams	"	" "
sands or sandy loams over gravel	"	" "
3.d. Shallow soils overlying bedrock		
	"	" "

Group 4. Soils with low potential for transfer of pollutants to either surface or ground water:

4.b. Medium textured profiles

loams, silt loams	6%	mainly well
4.c. Coarse textured soils		
sands or sandy loams over clay	3%	all

Group 5. Soils with high potential for transfer of pollutants to both surface water systems and ground water:

5.a. Fine textured profiles

clays, clay loams	all	poor
silty clays	"	"
silty clay loams	"	"
5.b. Medium textured profiles		
loams, silt loams	"	"

5.c. Rock outcrop

Table I.2 Tentative groupings of some Southern Ontario Soils

1. Soils with high potential for contribution of pollutants to surface water systems, and low potential for contribution to ground water.

1a. Fine textured soils, low infiltration rate, well and imperfectly drained.

Alberton SiCL
Brantford CL, SiCL
Brockport CL
Caistor CL, C, Sandspot phase
Cashel C
Chinquacoury CL
Cooksville C
Craigleith CL
Dunedin CL, C
Elderslie SiCL, CL
Elmbrook CL, C
Cananoque C
Haldimand CL, SiCL, C
Huron CL
Kemble CL, SiC
King CL, Steep phase
Lockport CL
Lambton
Landsdowne C
Lindsay C, Steep phase
Lovering CL, SiCL
Medonte SiCL
Monaghan CL
Oneida L, CL
Peel CL, C
Perth CL, SiCL, C
Renfrew CL
Rideau CL
Saugeen CL, SiCL
Schomberg CL, SiCL, Steep phase
Smithfille L, SiCL
Smithfield CL
Solmesville CL
South Bay C
Thames CL
Vincent CL, SiCL
Waupoos C
Niagara C

1b. Medium textured soils, low infiltration rate, well and imperfectly drained.

Alberton SiL
Brantford L, SiL
Caistor L
Chinquacoury L, SiL
Elderslie SiL
Haldimand L, SiL
Huron L, CL, SiL
Kemble SiL
King SiL
Lambton L, SiL
Magnetawan SiL
Medonte SiL
Monaghan SiL
Oneida SiL
Perth L, SiL, SL
Saugeen SiL
Schomberg SiL
Smithville SiL
Smithfield SiL
South Bay SL
St. Clements SL
Tavistock FSL, SiL, L
Vincent SiL
Wellesley SL

Medium textured soils on slopes exceeding 6%, well drained.

Bennington L, SiL
Bondhead L, SL
Brant FSL, SiL, L
Darlington SL, L
Deloro L
Dummer L
Eldorado SL, L, L-steep
Freeport SL
Galesburg L, SL
Crenville L
Cuelph SL, L
Cuerin SL-steep
Harkaway L, SiL
Harriston L, L-steep, SiL
Honeywood vFSL, SiL, FSL
Leith SiL
Miami L, SiL, CL, CL
Newburgh SiL, FSL
Newcastle SiL, CL
Norham SiL
Osprey SL, L
Otonabee SL, L, L-steep
Seely's Bay SiL
Vasey -steep phase
Woburn SL, L
Wooler SiL

1c. Coarse textured soils overlying fine textures on slopes exceeding 3%, well and imperfectly drained.

Berrien S, LS
Bookton FSL, SL
Dalton SL
Dundonald SL
Edenvale SL
Winona SL, FSL

1d. Organic Soils, if artificially drained.

Muck
Peat

1e. Miscellaneous land types and recent alluvium soils.

Alluvium
Boomer L
Bottom Land
Donald L
Elmira L
Escarpment
Grand L
Hawkesville L
Haysville L
Macton L
Martin S

2. Soils with moderate potential for contribution to both surface water and ground water.

2b. Medium textured soils on slopes <6%, mainly imperfectly drained.

Battersea SiL
Bennington L, SiL, FSL, vFSL
Beverly SiL, FSL, L
Codrington SiL
Conestogo L
Embro SiL
Emily L
Guerin L, SL
Heidelberg FSL
Kossuth SL
Listowel L, SiL
London L, SiL
Matilda L
Matson SiL
Milliken SL, L
Murray SiL
Otonabee SL, L
Piccadilly FSL
Tuscola FSL, L, SiL
Whitby L
Wiarton L, SiL
Pelham L

3. Soils with high potential for contribution to ground water and low potential for contribution to surface water.

3 b. Medium textured soils, mainly poorly drained.

Bainsville SiL
Colwood FSL, L, SiL
Crombie SiL, FSL
Fox FSL
Hinchingbrooke L, SiL
Killean L
Lily L
Lyons L
Maryhill L
Mill SL
Parkhill L, SiL
Petherwick SiL
Stockdale SiL

3 c. Coarse textured soils.

Alliston SL, FSL
Ayr SL
Bamford SL
Bancroft SL
Brady S, SL, GL
Bridgman S
Brighton S, SL, GS, GSL
Brisbane L
Burford GL, Co.L, L
Caledon FSL, L, GL, SL
Camilla SL, FSL, SiL
Colborne SL
Cramahe GSL, GL
Donnybrook SL
Dumfries L, SL
Eastport G, S
Flamboro SL
Font SL
Fonthill SL, L
Floradale L
Fox S, LS, GL, SL
Foxboro FSL
Gilford GL, SL
Grimsby FSL, SL
Granby SL, S
Gwilliambury SL, GSL
Harrow L
Hillsburg SL, FSL
Kenabeek SL
Kirkland SL
Lisbon SL
Mannheim L
Mallard SL
Monteagle SL
Oshtemo LS, S
Percy FSL
Pike Lake L
Plainfield S
Pontypool S, SL, GS
Rubicon SL
Sargent SL, L, GSL
Springvale SL
St.Jacobs L
Sullivan S, SL
Tecumseth S, SL
Teeswater SiL
Tennyson SL
Tioga S, FSL, LS-steep
Trent FSL
Vineland SL, FSL
Watrin S
Wendigo S, LS
White Lake GSL
Wyevall GSL
Pelham SL

3 d. Shallow soils overlying bedrock.

Ameliasburg CL
Athol SL
Burnbrae L
Farmington L, CL
Gerow CL
Brook L
Breypen L
Hillier CL
Shasawandah L
Trafalgar C, SiCL
Whitfield FSL

4. Soils with low potential for contribution to both surface water and ground water.

4 b. Medium textured soils, mainly well drained, slopes <6%.

Ancaster SiL
Bondhead SL, L
Brant FSL, SiL, L
Darlington SL, L
Deloro L
Dummer L
Eldorado SL, L
Freeport SL
Grenville L
Guelph SL, L
Harkaway L, SiL
Harriston L, SiL
Honeywood SiL, VFSL, FSL
Leith SiCL
Miami L, SiL, GL
Newburgh FSL, SiL
Newcastle SiL, CL
Norham SiL
Ontario L
Osprey L, SL
Seely's Bay SiL
Vasey L, SL
Waterloo SL, FSL
Woburn L, SL
Wooler SiL

4 c. Coarse textured soils overlying fine textures, slopes <3%.

Berrien S, LS, SL, FSL
Bookton FSL, SL
Brookston CL, Sandspot phase*
Dalton SL
Dundonald SL
Edenvale SL
Winona SL, FSL

* If surrounded by sand

5. Soils with high potential for contribution to both surface water and ground water.

5a. Fine textured soils, poorly drained.

Atherley CL, SiCL
Blackwell C
Brookston CL, C, Sandspot phase*
Chesley CL, SiCL
Clyde CL, C
Ferndale CL
Jeddo C, CL
Lindsay CL, C
Lincoln CL
Malton C
Minesing Marly C
Mississauga CL
Morley SiCL, C
Moscow C
Napanee C
Sidney C
Simcoe CL, C, SiCL
Toledo SiCL, C, CL
Welland C

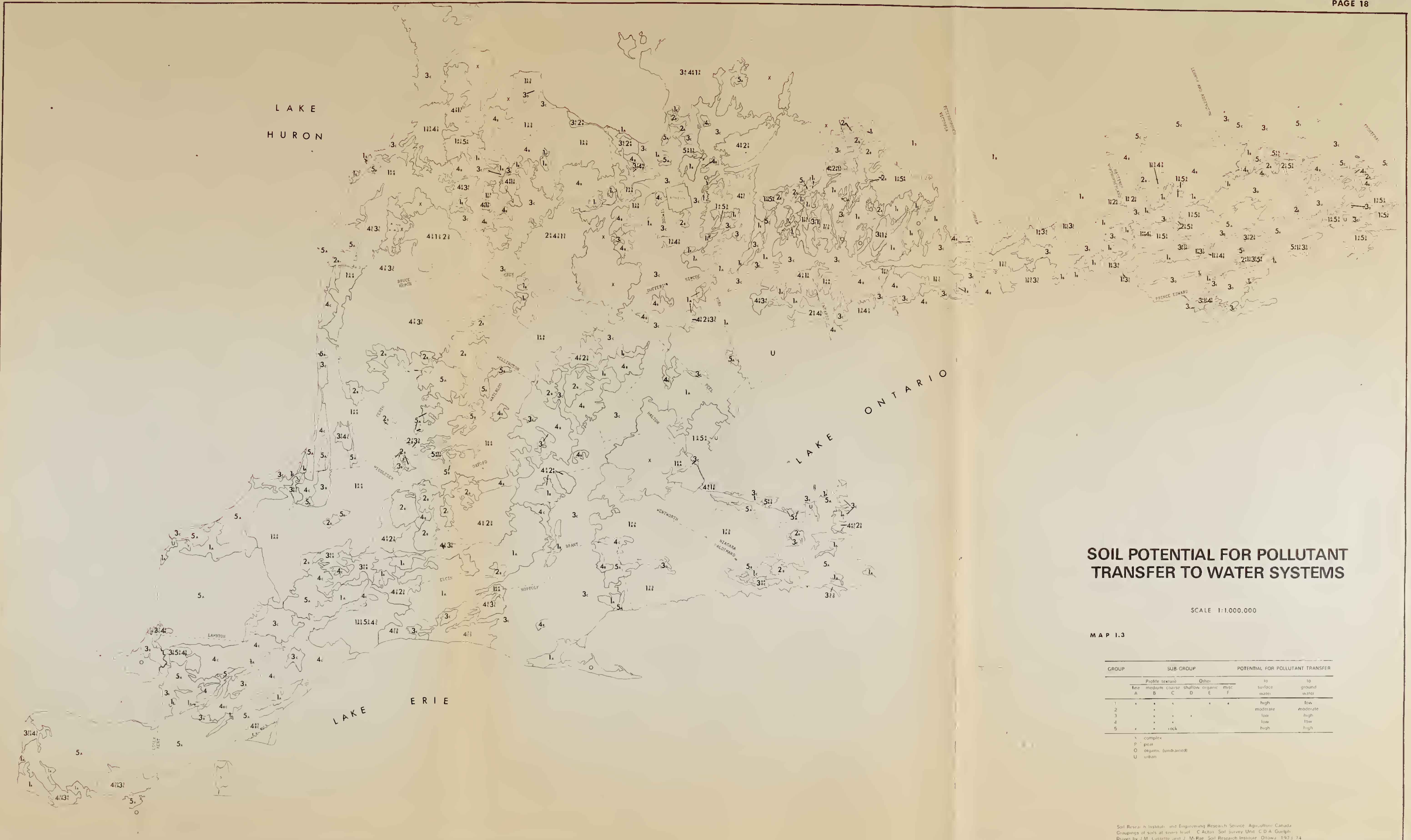
* If surrounded by clay

5b. Medium-textured soils, poorly drained.

Brookston SiL
Chelsey SiL
Clyde L
Dorking SiL
Ferndale SiL
Jeddo SL, L
Maplewood FSL, L, SiL
Minesing SiL
Morley L, SC
Toledo SiL
Wauseon SL, FSL
Wilmot SL

5c. Rock outcrop.

Rockland
Bedrock
All lithic soil phases.



SOIL POTENTIAL FOR POLLUTANT TRANSFER TO WATER SYSTEMS

SCALE 1:1,000,000

MAP 1.3

GROUP	SUB-GROUP						POTENTIAL FOR POLLUTANT TRANSFER	
	Profile texture			Other			to surface water	to ground water
	fine A	medium B	coarse C	shallow D	organic E	misc F		
1	•	•	•		•	•	high	low
2		•					moderate	moderate
3		x	•	•			low	high
4		x	•				low	low
5	x	•	rock				high	high

x complex
P peat
O organic (undrained)
U urban

Soil Research Institute and Engineering Research Service Agriculture Canada
Groupings of soils at series level C Acton Soil Survey Unit C D A Guelph
Drawn by J M Cossette and J McRae Soil Research Institute Ottawa 1973 74
Base map Ontario Soil Survey Photographic reductions S R I Cartography Ottawa

3. AGRICULTURAL LAND USE INVENTORY

INTRODUCTION

An agricultural land use inventory for Southern Ontario[1] was implemented by Agriculture Canada (Soil Research Institute and Engineering Research Service) during the 1973/74 fiscal year. The project was initiated to supply some of the agricultural data required by the proposed study of the International Reference Group on Great Lakes Pollution from Land Use Activities. The agricultural portion of the proposed Watershed Studies (Task C) required crop and livestock data for the identification of distinct agricultural regions, and subsequently, for the selection of agricultural watersheds. The Land Use Inventory (Task B) of the Reference Group Study identified the need for data on nutrient inputs from fertilizer usage and livestock operations.

The inventory carried out in support of these tasks consisted of a cartographic presentation of data from the 1971 Census of Agriculture, Statistics Canada, pertaining to livestock type, crop acreage and fertilized acreage (see Agricultural Land Use maps, pgs. 24 - 47)

1. The agricultural land use inventory covered the Canadian Great Lakes Basin south of latitude 45°N.

METHODOLOGY

COMPUTER METHODOLOGY[1] :

The Agricultural Characteristics maps were produced on a line printer using the SYMAP package available from Harvard University. Because of the volume of data involved, a separate map at a scale of 1:250,000 was produced for each of the thirty-two counties studied. These were then pieced together and photo reduced.

Proximal mapping was used, in which the symbolism for each character location is determined by the symbolism applicable to the nearest data point through an interpolation routine. Data is available for each county at the Enumeration Area (EA) level. The data points are located at the centroids of population of each EA. Urban EA's appear as blank areas, while rural EA's for which data has been suppressed are assumed to be similar to their neighbours.

The raw input data consisted of four files: the results of the 1971 Census of Agriculture; the UTM coordinates of the centroids of population of each EA; the area of each EA; and the UTM coordinates of the vertices of a simplified outline of each county. Since the first two files contain data for all areas of Canada and are grouped by Enumeration District, data from the first three files for the thirty-two counties of Southern Ontario was extracted and arranged by county on one tape. A programme acting as a front end to SYMAP using this tape calculates the actual data point values and the location of the EA. Card packages of county outlines produced from the fourth file were used directly as input to SYMAP to set the boundaries of the map being produced.

In order to minimize problems arising from printer intensity differences all maps were run off-line at the same time using a fresh ribbon whenever possible.

DATA:

Area:

Data for total area of the enumeration areas was provided by Statistics Canada.

Crops and Livestock:

Data for livestock types and numbers, crop acreages, fertilized acreages, and improved acreages was obtained from the 1971 Census of Agriculture (Statistics Canada) on an enumeration area basis. The data obtained from Statistics Canada was subject to the editing out of those enumeration areas with less than ten farms, and in certain other cases where suppression of data was necessary to maintain confidentiality. In cases where data for an agricultural enumeration area was suppressed, the average value of the surrounding enumeration areas was used.

---

[1] The computer programming described in this part of the report was carried out by Dr. M. Kaplansky, who also supplied the following summary of this work.

Nutrients:

In the Report of the CDA Task Force For Implementation of the Great Lakes Water Quality Programme, March 1973, township census data had been converted to express livestock manure and fertilizer nutrient distribution. Similarly, conversion of enumeration area data to express nutrient inputs has been carried out:

1. Density of Manure Nutrients:

   Annual N and P (expressed as P_2O_5) values in fresh manure from each kind of animal had been calculated by the CDA Task Force for Implementation of the Great Lakes Water Quality Programme, 1973. These values were adapted for use in this study to give the following annual production values per animal for N and P:

Table I.3 Annual Manure Nitrogen and Phosphorus Production

Kind of Animal	N(lb/anim-yr)	P_2O_5(lb/anim-yr)
Milk Cows	140	65
Bulls	140	65
Beef Cows	70	32
Calves	30	11
Steers	58	36
Heifers	58	36
Hogs (Pigs & Sows)	23	14
Sheep (Ewes & Lambs)	15	9
Horses	95	33
Hens	1.5	1.0
Pullets	0.5	0.3
Other Poultry	1.2	0.1
Mink	0.8	2.4

The total N and P (as P_2O_5) produced per enumeration area was calculated from the 1971 Census data and the coefficients listed above. These values were then expressed as density in terms of acres of improved farmland and total acres of all land. These densities were then mapped using the described computer mapping technique.

2. Density of Fertilizer Nutrients:

Recommended Rates of Fertilizer Application:

In the Report of the CDA Task Force for Implementation of the Great Lakes Water Quality Programme, March 1973, recommended rates of fertilizer application had been assigned for the major crops as follows:

Table I.4 Recommended Fertilizer Application Rates

CROP	Recommended N-Application (lbs/acre)	Recommended P_2O_5 Application (lbs/acre)
Corn (grain & silage)	100	60
Soybeans	10	40
Wheat	50	60
Oats	20	20
Barley	30	30
Potatoes	70	150
Tobacco	25	140
Tree Fruits	200	60
Small Fruits	85	60
Vegetables	100	120
Tame hay	50	40
Alfalfa hay	0	40
Improved pasture	50	40
Others	50	50

Fertilized Acres:

(a) The fertilized acreage from the 1971 Census of Agriculture on an enumeration area bases were used for the following crops: wheat, oats, barley, potatoes, tree fruits, small fruits and vegetables.

(b) For corn and soybeans, all acres reported as "grown" were assumed to be fertilized, and for these crops the data for acres grown was used as "fertilized acres" in the calculations.

(c) The ratio of "alfalfa hay grown" to "total hay grown" was calculated for each enumeration area. It was assumed that a similar relationship existed for hay fertilized, and this ratio was used to proportion the fertilized acres for total hay into "fertilized acres for alfalfa hay" and "fertilized acres for tame hay".

(d) The 1971 Census of Agriculture contains a category of "other fertilized acres" which includes the fertilized acres of corn for silage and soybeans. For this project, fertilized acres for soybeans and corn for silage had been estimated as described above, and the reported "other fertilized acres" were adjusted accordingly.

For each crop, the recommended fertilizer application rate and the fertilized acre statistics for each enumeration area were used to calculate the total fertilizer nutrient input per enumeration area. These input figures were expressed as density on an improved farmland acre bases, and mapped using the previously described computer mapping technique.

3. Density of total Nutrients:
   The data from the calculation of manure nutrients and fertilizer nutrients was summed to give total nutrient inputs. These total nutrient inputs were expressed as density based on total acres of all land, and on acres or improved farmland and were mapped as previously described.

PRESENTATION:

The computer produced maps were of individual counties at the scale of 1:250,000. These were combined and reduced to give individual maps at the scale of 1:500,000 and 1:1,000,000[1] which covered that portion of the Canadian Great Lakes Basin south of latitude 45°N.

ITEMS TO BE NOTED

1. The land use maps for crops and livestock types, as well as some of the nutrient input maps, are expressed in terms of improved farmland acres. These maps should be used in conjunction with the map showing improved farmland as a per cent of all land, especially if densities in relation to total area are being considered rather than identification of the use of agricultural land.

2. The symbols for the different mapping levels should always be identified. Visual densities cannot be used for all of the maps, especially at the scale of 1:1,000,000 due to variability in printing quality.

1. Photo reductions supervised by R. St.John, Photo Mechanical Unit, S.R.I. Cartography

AGRICULTURAL CHARACTERISTICS

Map no.

Land

1. Improved farmland (area as percent of all land)

Crops

2. Corn
3. Soybeams
4. Small grains
5. Total hay
6. Vegetables and small fruits
7. Tree fruits
8. Tobacco

Livestock (number per improved farmland acre)

9. Total cattle
10. Milk cows and heifers
11. Beef cattle
12. Hogs
13. Poultry

Nutrients (estimated pounds per improved farmland acre)

14. Manure nitrogen
15. Manure phosphorus
16. Fertilizer nitrogen
17. Fertilizer phosphorus
18. Total nitrogen (manure plus fertilizer)
19. Total phosphorus (manure plus fertilizer)

Nutrients (estimated pounds per acre of all land)

20. Manure nitrogen
21. Manure phosphorus
22. Total nitrogen (manure plus fertilizer)
23. Total phosphorus (manure plus fertilizer)

AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*

MAP 1 Scale 1:1,000,000

IMPROVED FARMLAND

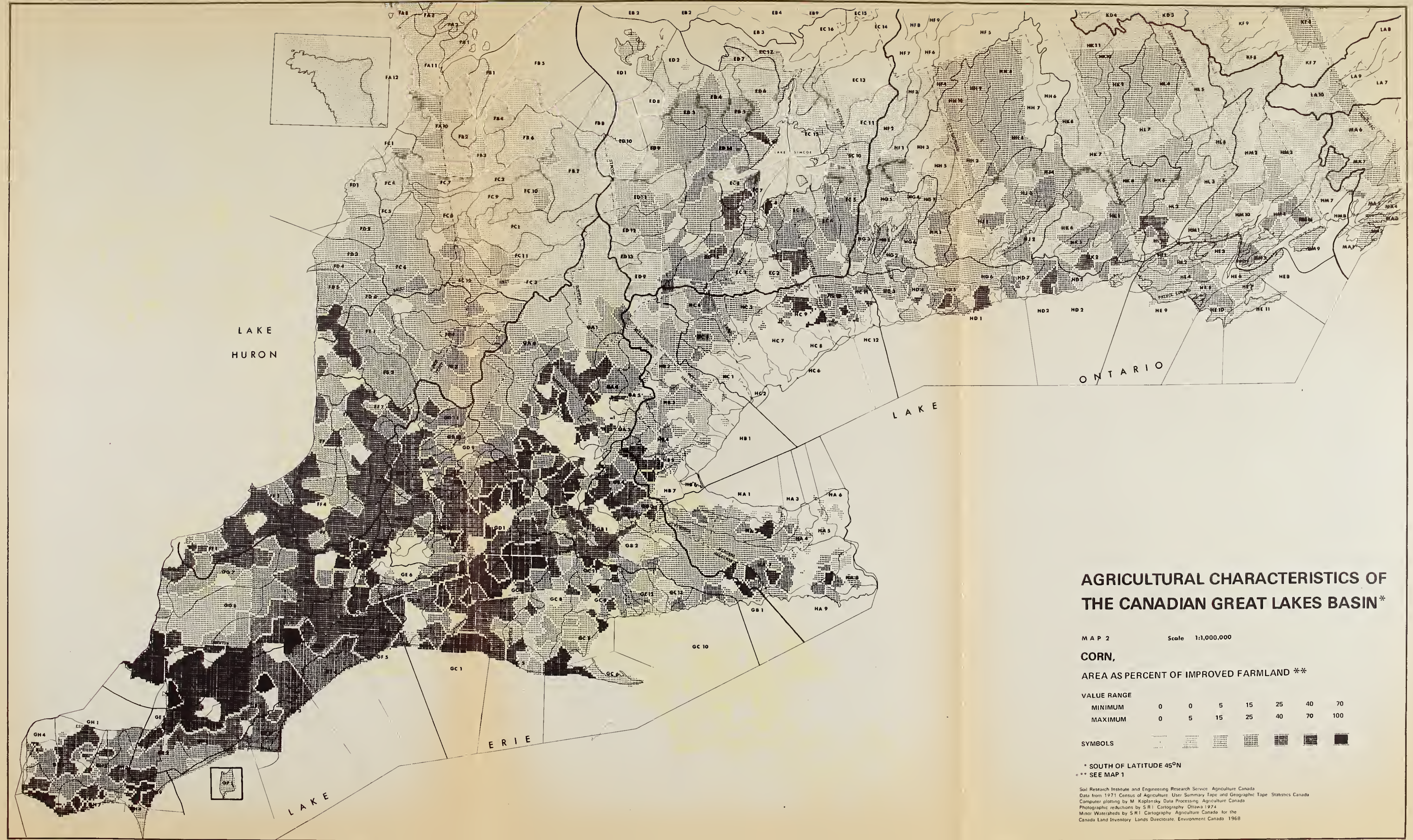
AREA AS PERCENT OF ALL LAND

VALUE RANGE							
MINIMUM	0	0	10	30	50	70	90
MAXIMUM	0	10	30	50	70	90	100

SYMBOLS

* SOUTH OF LATITUDE 45°N

Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M. Kaplansky Data Processing Agriculture Canada
Photographic reductions by S.R.I. Cartography Ottawa
Minor Watersheds by S.R.I. Cartography Agriculture Canada for the
Canada Land Inventory Lands Directorate Environment Canada 1968


LAKE HURON
LAKE ONTARIO
LAKE ERIE
AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*
MAP 2
Scale 1:1,000,000
CORN,
AREA AS PERCENT OF IMPROVED FARMLAND **
VALUE RANGE
MINIMUM 0 0 5 15 25 40 70
MAXIMUM 0 5 15 25 40 70 100
SYMBOLS
* SOUTH OF LATITUDE 45°N
** SEE MAP 1
Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M Kaplansky Data Processing Agriculture Canada
Photographic reductions by S R I Cartography Ottawa 1974
Minor Watersheds by S R I Cartography Agriculture Canada for the
Canada Land Inventory Lands Directorate, Environment Canada 1968

AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*

MAP 3 Scale 1:1,000,000

SOYBEANS

AREA AS PERCENT OF IMPROVED FARMLAND **

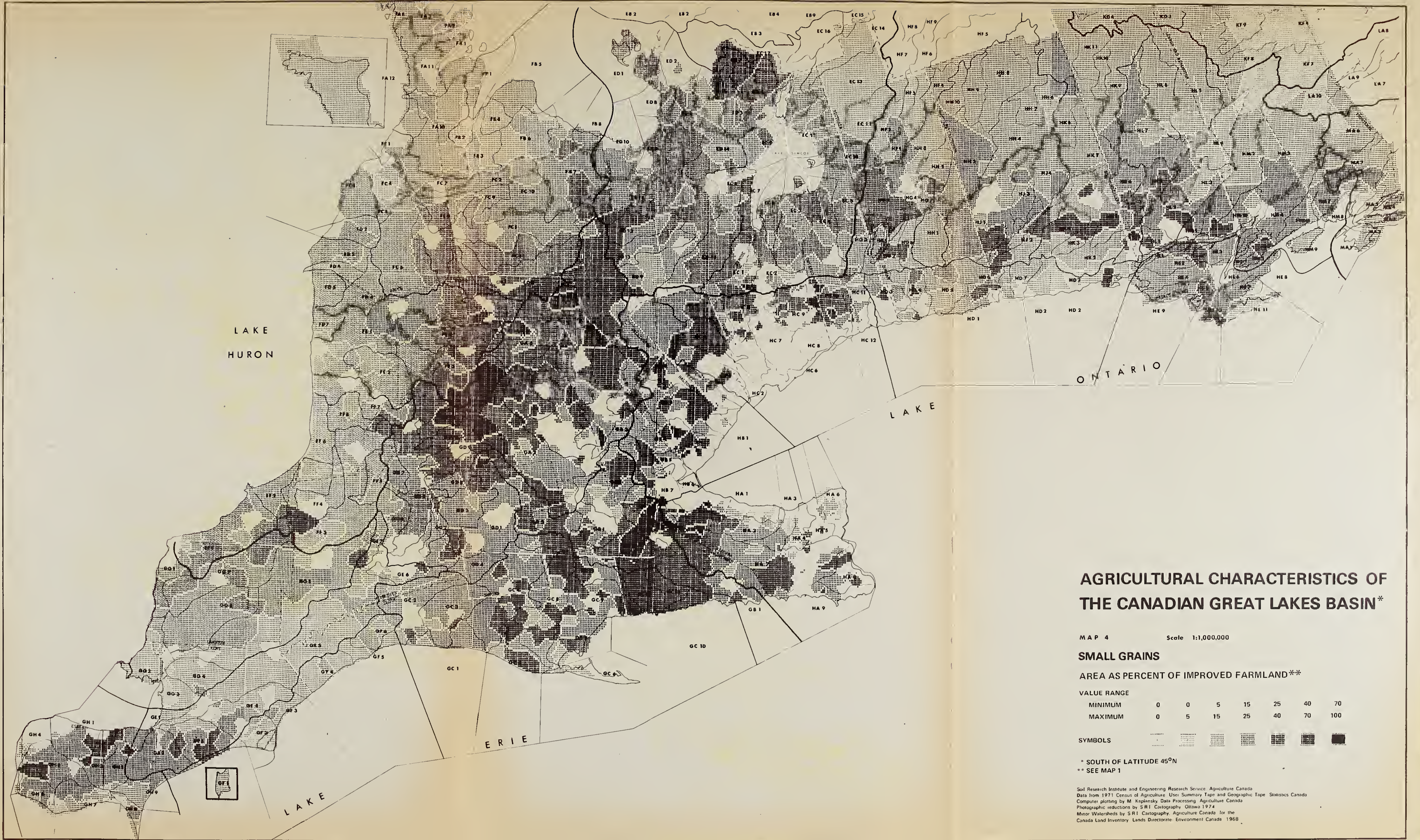
VALUE RANGE

MINIMUM	0	0	5	15	25	40	70
MAXIMUM	0	5	15	25	40	70	100

SYMBOLS

* SOUTH OF LATITUDE 45°N
** SEE MAP 1

Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape, Statistics Canada
Computer plotting by M Kaplansky Data Processing Agriculture Canada
Photographic reductions by S R I Cartography Ottawa 1974
Minor Watersheds by S R I Cartography Agriculture Canada for the
Canada Land Inventory Lands Directorate Environment Canada 1968



AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*

MAP 4 Scale 1:1,000,000

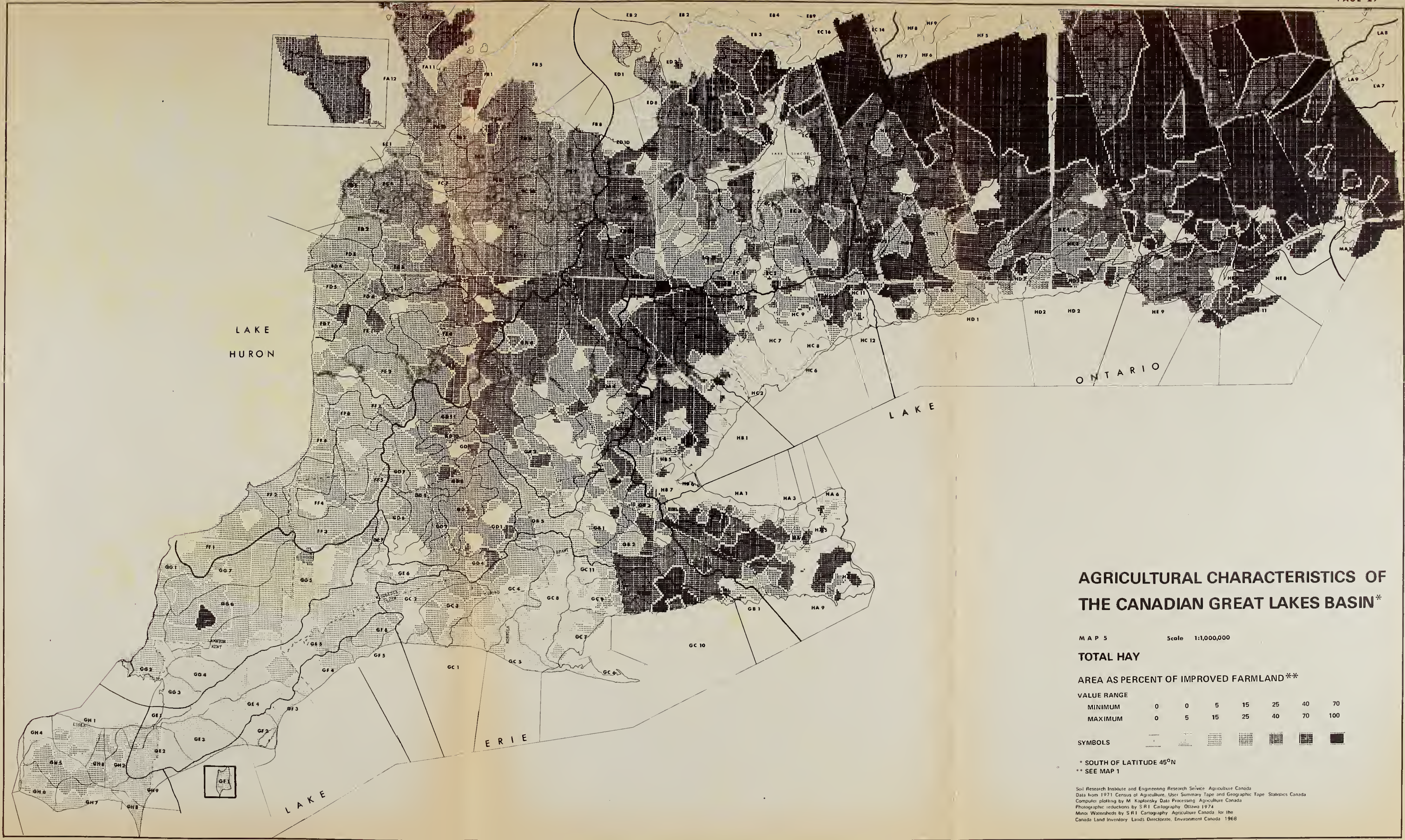
SMALL GRAINS

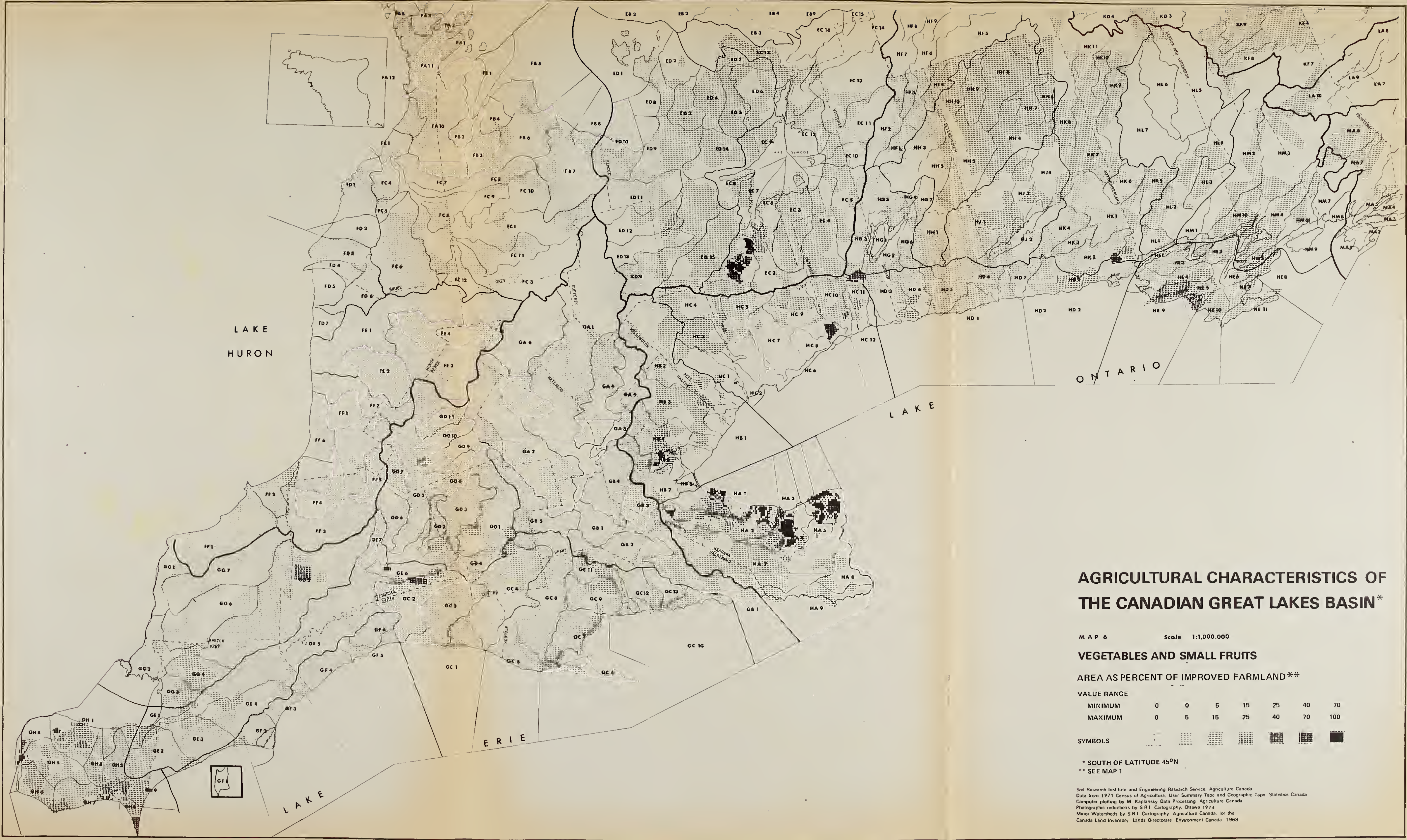
AREA AS PERCENT OF IMPROVED FARMLAND**

VALUE RANGE							
MINIMUM	0	0	5	15	25	40	70
MAXIMUM	0	5	15	25	40	70	100
SYMBOLS							

* SOUTH OF LATITUDE 45°N
** SEE MAP 1

Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M Kaplansky Data Processing Agriculture Canada
Photographic reductions by S R I Cartography Ottawa 1974
Minor Watersheds by S R I Cartography, Agriculture Canada for the
Canada Land Inventory Lands Directorate Environment Canada 1968


LAKE HURON
LAKE ONTARIO
LAKE ERIE
AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*
MAP 5 Scale 1:1,000,000
TOTAL HAY
AREA AS PERCENT OF IMPROVED FARMLAND**
VALUE RANGE
MINIMUM 0 0 5 15 25 40 70
MAXIMUM 0 5 15 25 40 70 100
SYMBOLS
* SOUTH OF LATITUDE 45°N
** SEE MAP 1
Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture, User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M Kaplansky Data Processing Agriculture Canada
Photographic reductions by S R I Cartography Ottawa 1974
Minor Watersheds by S R I Cartography Agriculture Canada for the
Canada Land Inventory Lands Directorate, Environment Canada 1968



AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*

MAP 6 Scale 1:1,000,000

VEGETABLES AND SMALL FRUITS

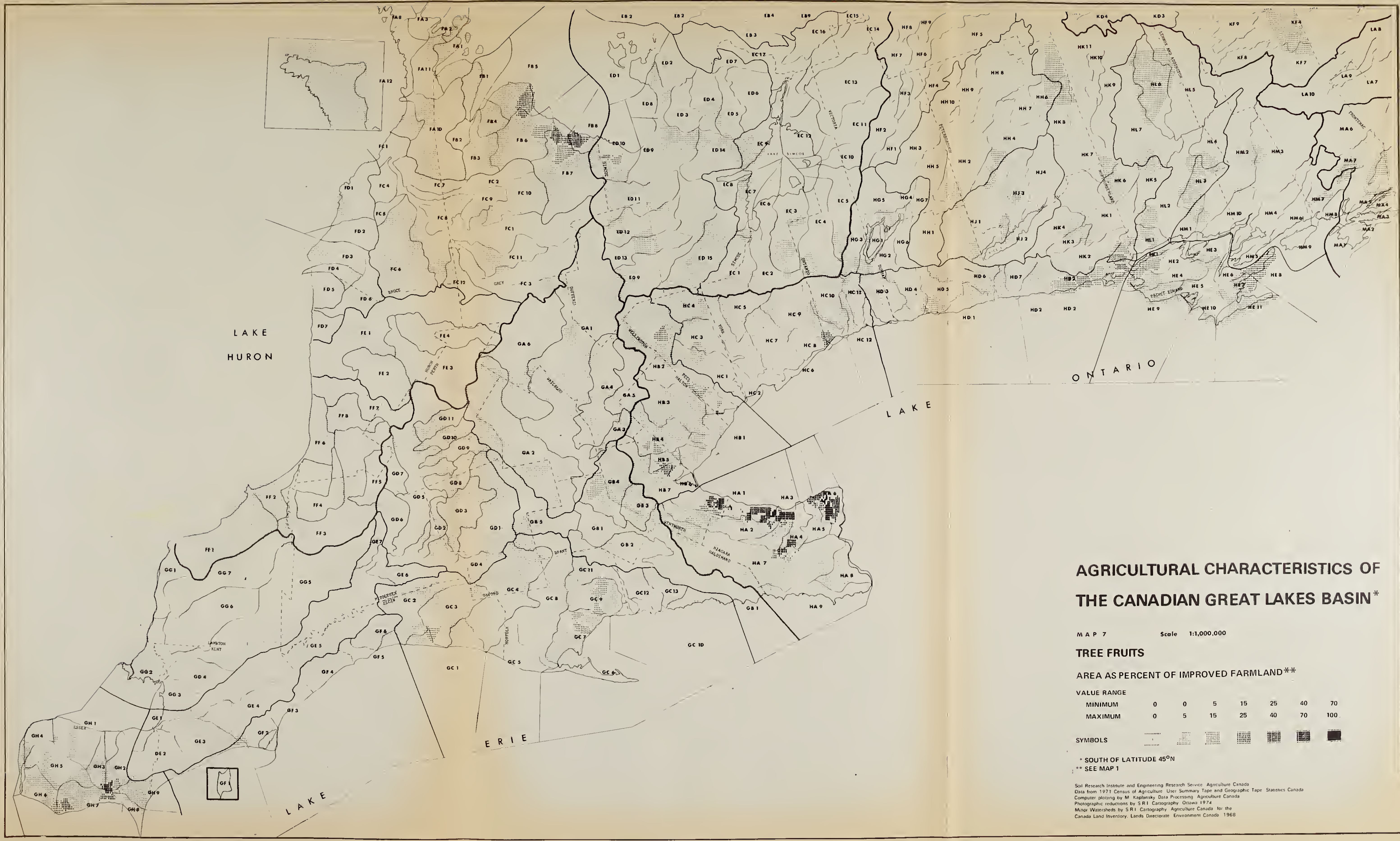
AREA AS PERCENT OF IMPROVED FARMLAND**

VALUE RANGE							
MINIMUM	0	0	5	15	25	40	70
MAXIMUM	0	5	15	25	40	70	100

SYMBOLS

* SOUTH OF LATITUDE 45°N
** SEE MAP 1

Soil Research Institute and Engineering Research Service, Agriculture Canada
Data from 1971 Census of Agriculture, User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M Kaplansky Data Processing Agriculture Canada
Photographic reductions by S R I Cartography, Ottawa 1974
Minor Watersheds by S R I Cartography Agriculture Canada, for the
Canada Land Inventory Lands Directorate Environment Canada 1968



AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*

MAP 7 Scale 1:1,000,000

TREE FRUITS

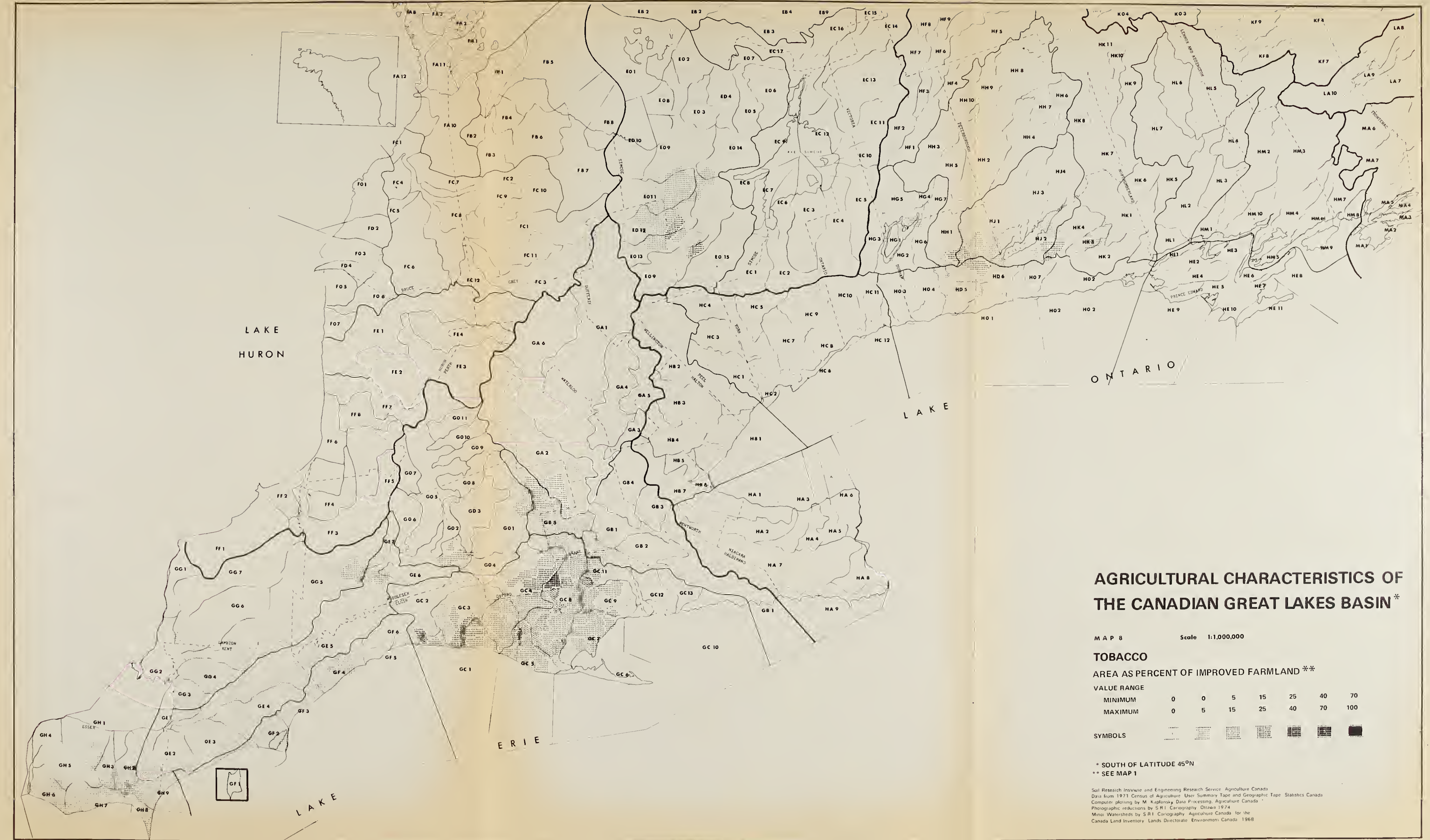
AREA AS PERCENT OF IMPROVED FARMLAND**

VALUE RANGE							
MINIMUM	0	0	5	15	25	40	70
MAXIMUM	0	5	15	25	40	70	100

SYMBOLS

* SOUTH OF LATITUDE 45°N
** SEE MAP 1

Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M. Kaplansky Data Processing Agriculture Canada
Photographic reductions by S R I Cartography Ottawa 1974
Minor Watersheds by S R I Cartography Agriculture Canada for the
Canada Land Inventory, Lands Directorate Environment Canada 1968



AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*

MAP 8 Scale 1:1,000,000

TOBACCO

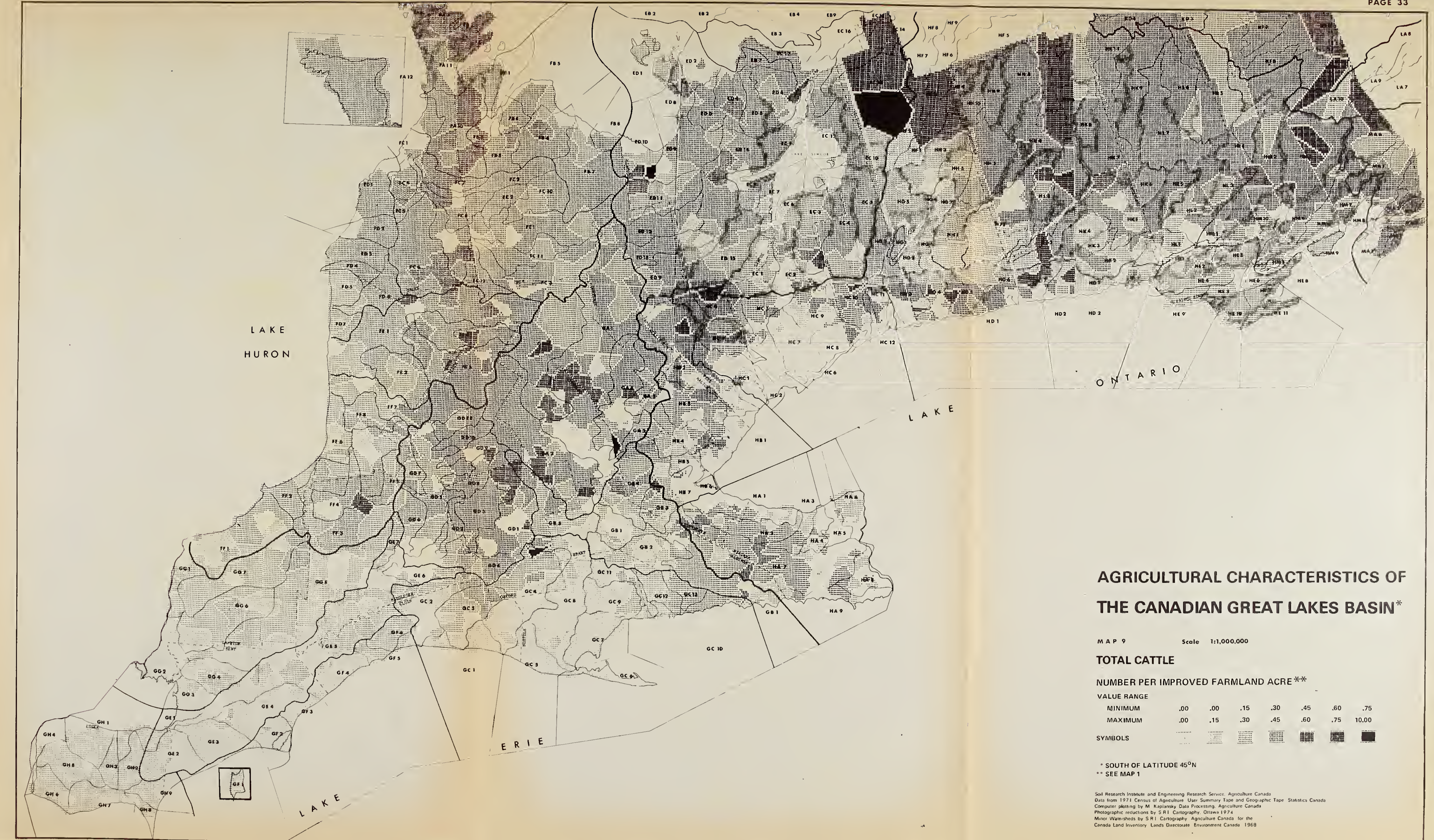
AREA AS PERCENT OF IMPROVED FARMLAND **

VALUE RANGE							
MINIMUM	0	0	5	15	25	40	70
MAXIMUM	0	5	15	25	40	70	100

SYMBOLS

* SOUTH OF LATITUDE 45°N
** SEE MAP 1

Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M. Kaplansky Data Processing, Agriculture Canada
Photographic reductions by S.R.I. Cartography Ottawa 1974
Minor Watersheds by S.R.I. Cartography Agriculture Canada for the
Canada Land Inventory Lands Directorate Environment Canada 1968



AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*

MAP 9 Scale 1:1,000,000

TOTAL CATTLE

NUMBER PER IMPROVED FARMLAND ACRE**

VALUE RANGE

MINIMUM	.00	.00	.15	.30	.45	.60	.75
MAXIMUM	.00	.15	.30	.45	.60	.75	10.00

SYMBOLS

* SOUTH OF LATITUDE 45°N
** SEE MAP 1

Soil Research Institute and Engineering Research Service, Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M. Kaplansky Data Processing, Agriculture Canada
Photographic reductions by S.R.I. Cartography, Ottawa 1974
Minor Watersheds by S.R.I. Cartography Agriculture Canada for the
Canada Land Inventory Lands Directorate Environment Canada 1968

AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*

MAP 10 Scale 1:1,000,000

MILK COWS AND HEIFERS

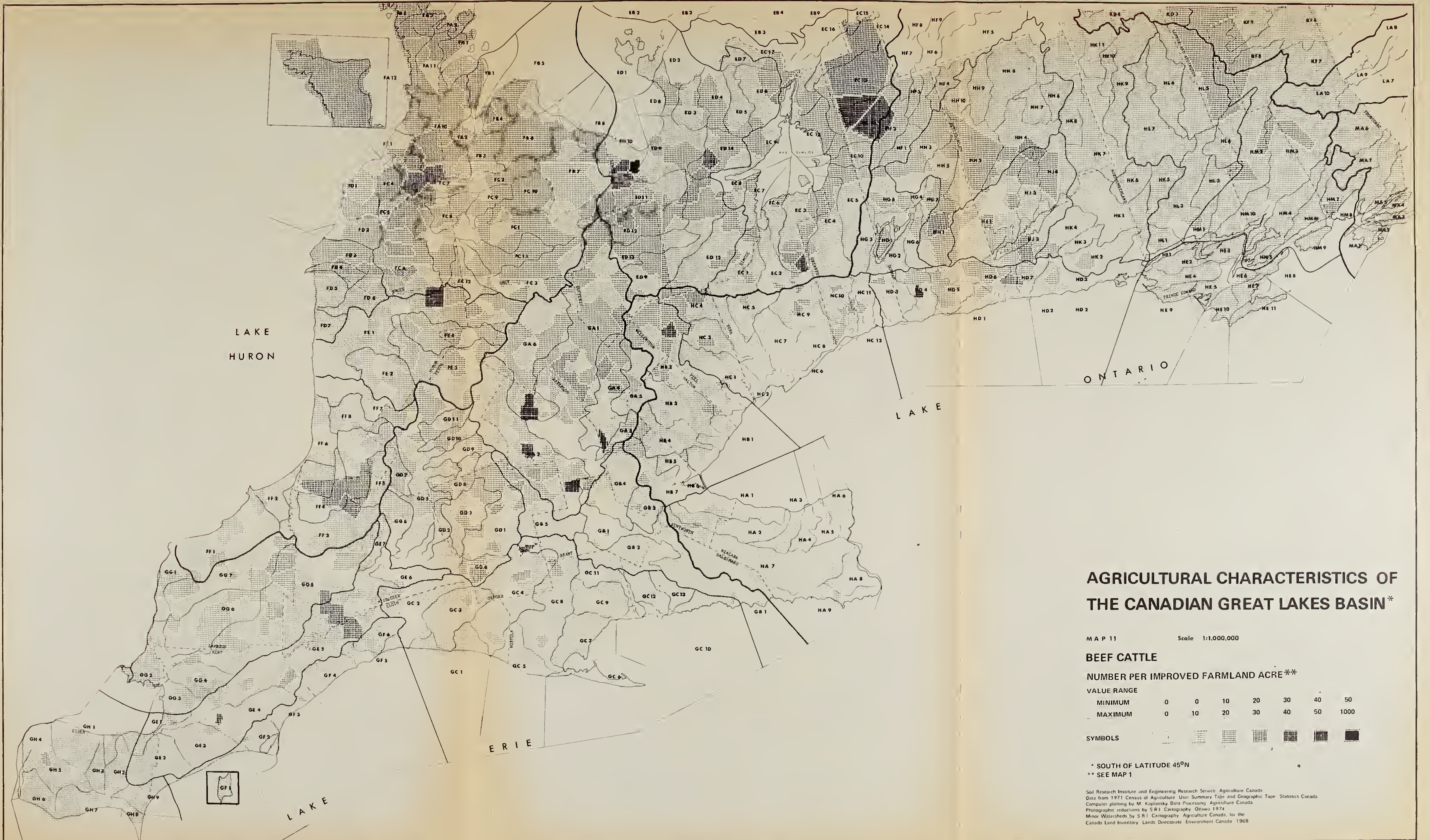
NUMBER PER IMPROVED FARMLAND ACRE**

VALUE RANGE

MINIMUM	.00	.00	.05	.10	.15	.20	.25
MAXIMUM	.00	.05	.10	.15	.20	.25	10.00
SYMBOLS							

* SOUTH OF LATITUDE 45°N
** SEE MAP 1

Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M. Kaplansky Data Processing Agriculture Canada
Photographic reductions by S.R.I. Cartography Ottawa 1974
Minor Watersheds by S.R.I. Cartography Agriculture Canada for the
Canada Land Inventory Lands Directorate Environment Canada 1968



AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*

MAP 11 Scale 1:1,000,000

BEEF CATTLE

NUMBER PER IMPROVED FARMLAND ACRE**

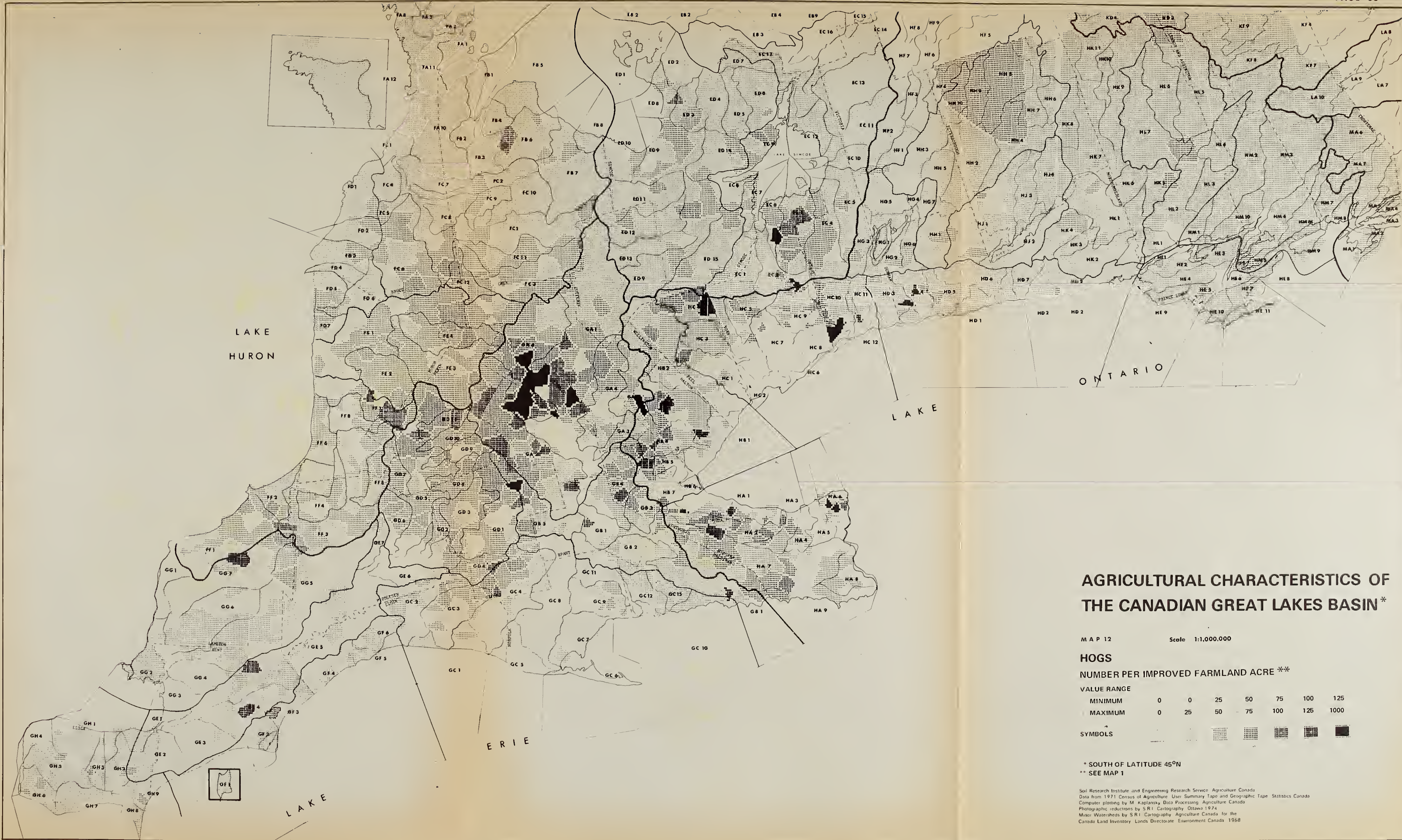
VALUE RANGE

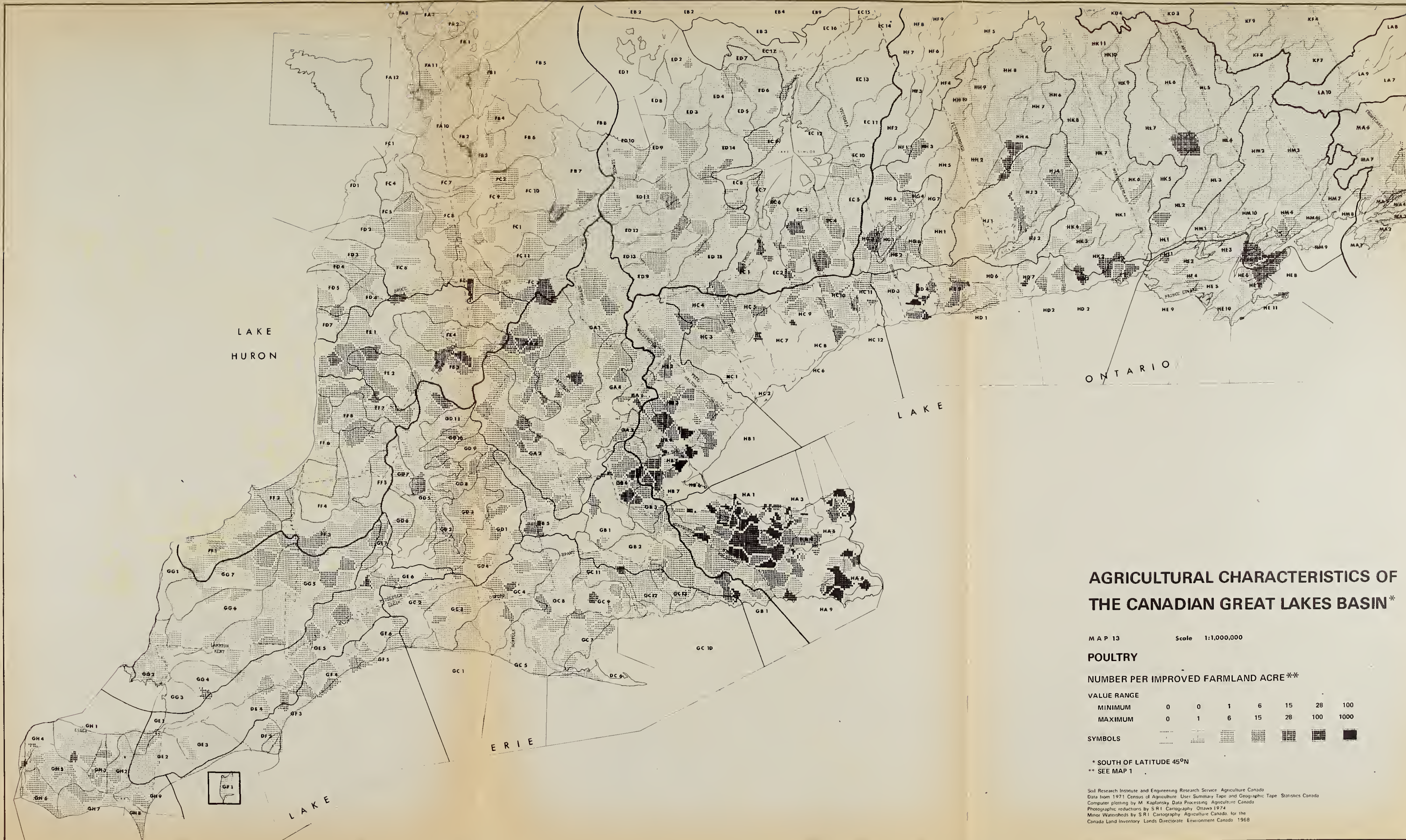
MINIMUM	0	0	10	20	30	40	50
MAXIMUM	0	10	20	30	40	50	1000

SYMBOLS

* SOUTH OF LATITUDE 45°N
** SEE MAP 1

Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M Kaplansky Data Processing Agriculture Canada
Photographic reductions by S R I Cartography Ottawa 1974
Minor Watersheds by S R I Cartography Agriculture Canada, for the
Canada Land Inventory Lands Directorate Environment Canada 1968


LAKE HURON
LAKE ONTARIO
LAKE ERIE
AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*
MAP 12
Scale 1:1,000,000
HOGS
NUMBER PER IMPROVED FARMLAND ACRE **
VALUE RANGE
MINIMUM 0 0 25 50 75 100 125
MAXIMUM 0 25 50 75 100 125 1000
SYMBOLS
* SOUTH OF LATITUDE 45°N
** SEE MAP 1
Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M Kaplansky Data Processing Agriculture Canada
Photographic reductions by S R I Cartography Ottawa 1974
Minor Watersheds by S R I Cartography Agriculture Canada for the
Canada Land Inventory Lands Directorate Environment Canada 1968



AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*

MAP 13 Scale 1:1,000,000

POULTRY

NUMBER PER IMPROVED FARMLAND ACRE**

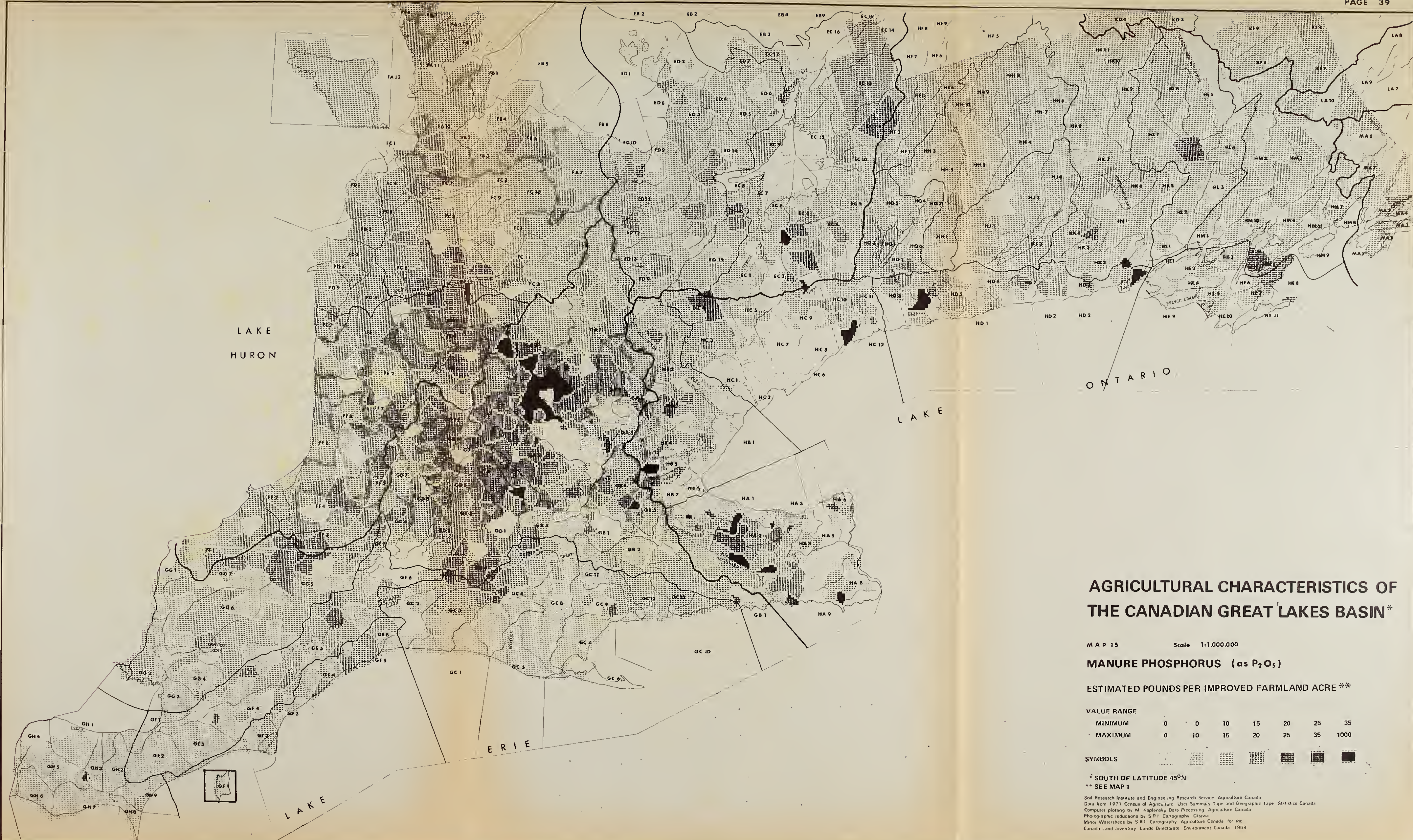
VALUE RANGE							
MINIMUM	0	0	1	6	15	28	100
MAXIMUM	0	1	6	15	28	100	1000

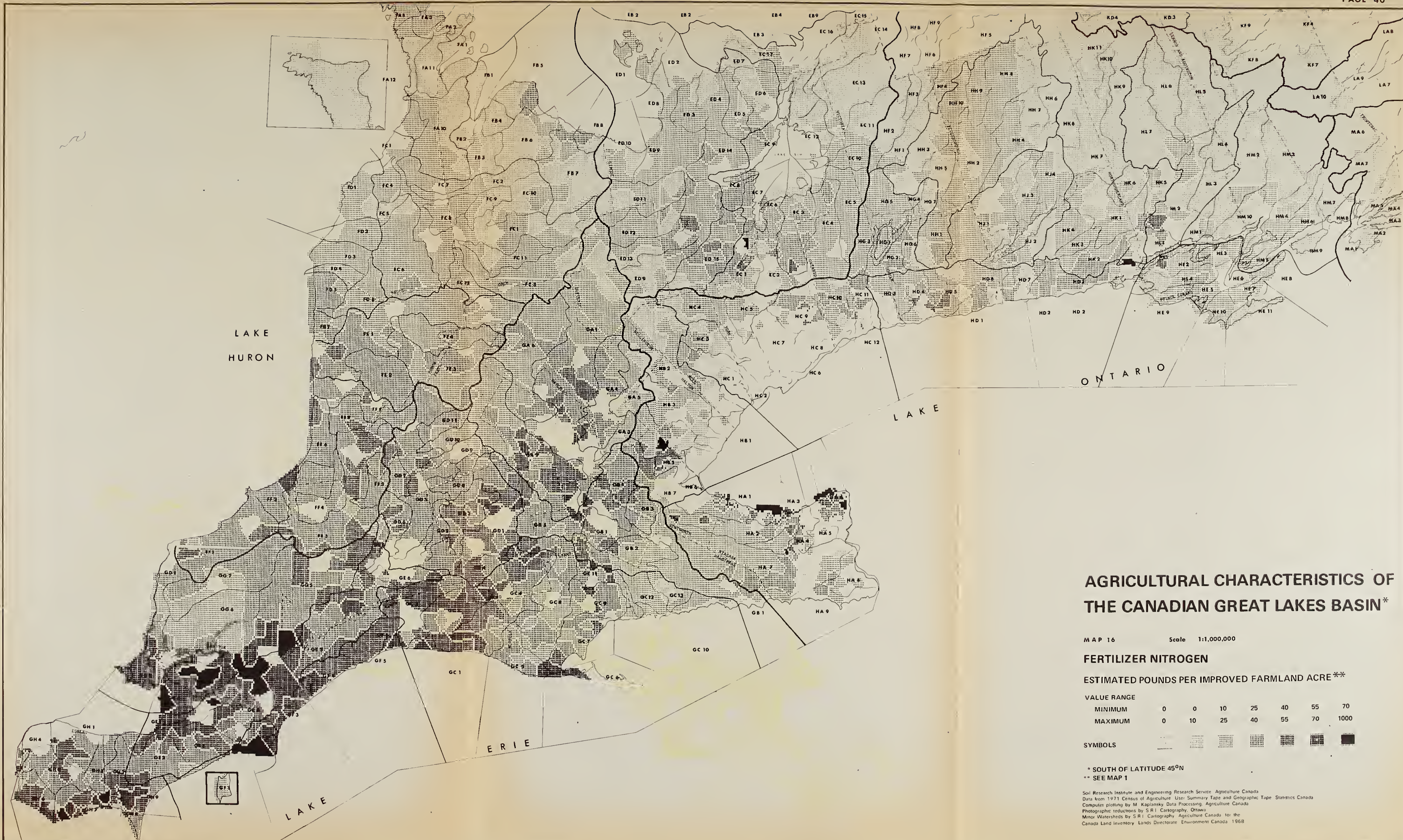
SYMBOLS

* SOUTH OF LATITUDE 45°N
** SEE MAP 1

Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M Kaplansky Data Processing Agriculture Canada
Photographic reductions by S R I Cartography Ottawa 1974
Minor Watersheds by S R I Cartography Agriculture Canada, for the
Canada Land Inventory Lands Directorate Environment Canada 1968


LAKE HURON
LAKE ONTARIO
LAKE ERIE
AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*
MAP 14
Scale 1:1,000,000
MANURE NITROGEN
ESTIMATED POUNDS PER IMPROVED FARMLAND ACRE **
VALUE RANGE
MINIMUM 0 0 10 25 40 55 70
MAXIMUM 0 10 25 40 55 70 1000
SYMBOLS
* SOUTH OF LATITUDE 45°N
** SEE MAP 1
Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M. Kaplansky Data Processing Agriculture Canada
Photographic reductions by S.R.I. Cartography Ottawa
Minor Watersheds by S.R.I. Cartography Agriculture Canada for the
Canada Land Inventory Lands Directorate Environment Canada 1968


LAKE HURON
LAKE ONTARIO
LAKE ERIE
AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*
MAP 15
Scale 1:1,000,000
MANURE PHOSPHORUS (as P_2O_5)
ESTIMATED POUNDS PER IMPROVED FARMLAND ACRE **
VALUE RANGE
MINIMUM 0 0 10 15 20 25 35
MAXIMUM 0 10 15 20 25 35 1000
SYMBOLS
* SOUTH OF LATITUDE 45°N
** SEE MAP 1
Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M Kaplansky Data Processing Agriculture Canada
Photographic reductions by S R I Cartography Ottawa
Minor Watersheds by S R I Cartography Agriculture Canada for the
Canada Land Inventory Lands Directorate Environment Canada 1968



AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*

MAP 16 Scale 1:1,000,000

FERTILIZER NITROGEN

ESTIMATED POUNDS PER IMPROVED FARMLAND ACRE**

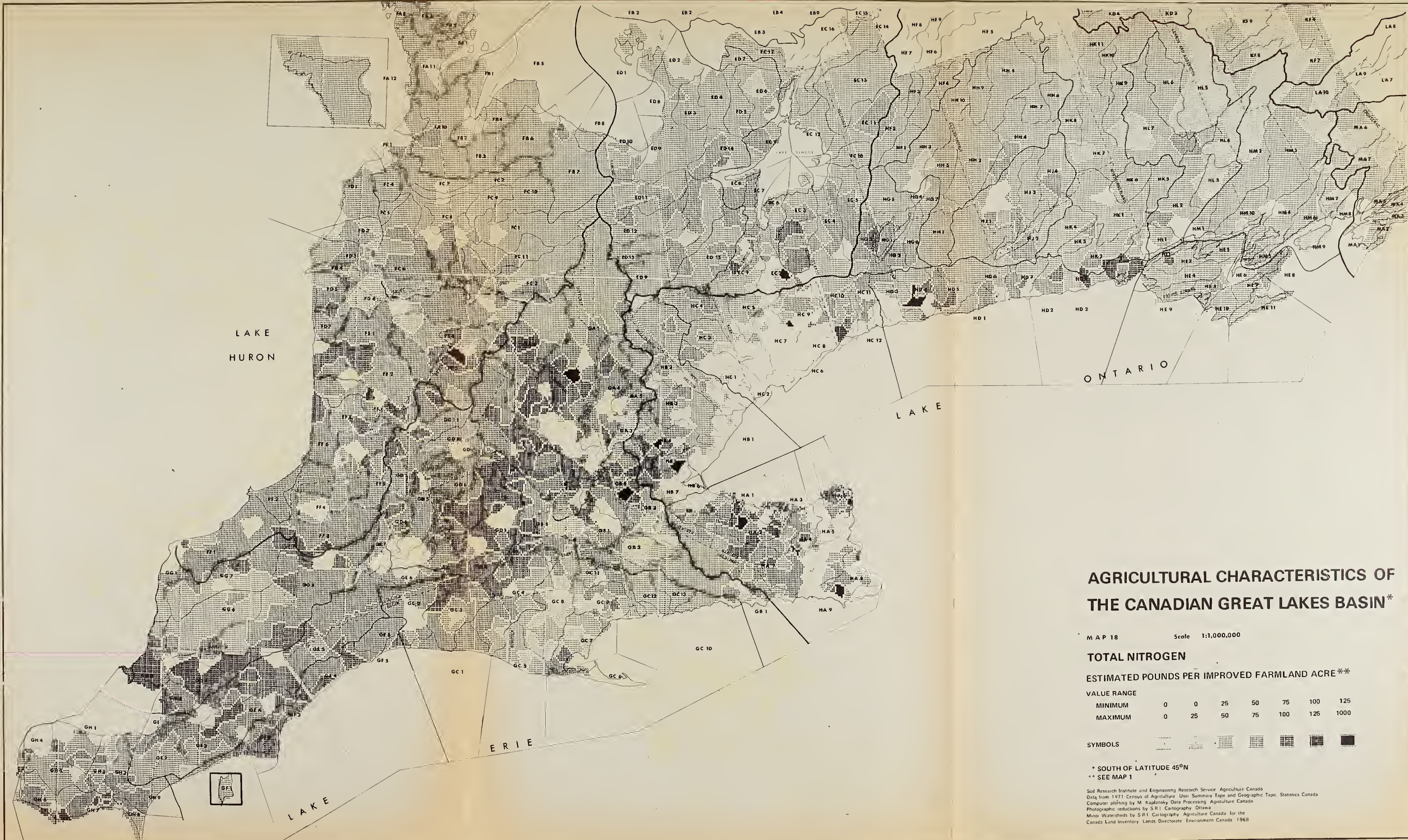
VALUE RANGE							
MINIMUM	0	0	10	25	40	55	70
MAXIMUM	0	10	25	40	55	70	1000

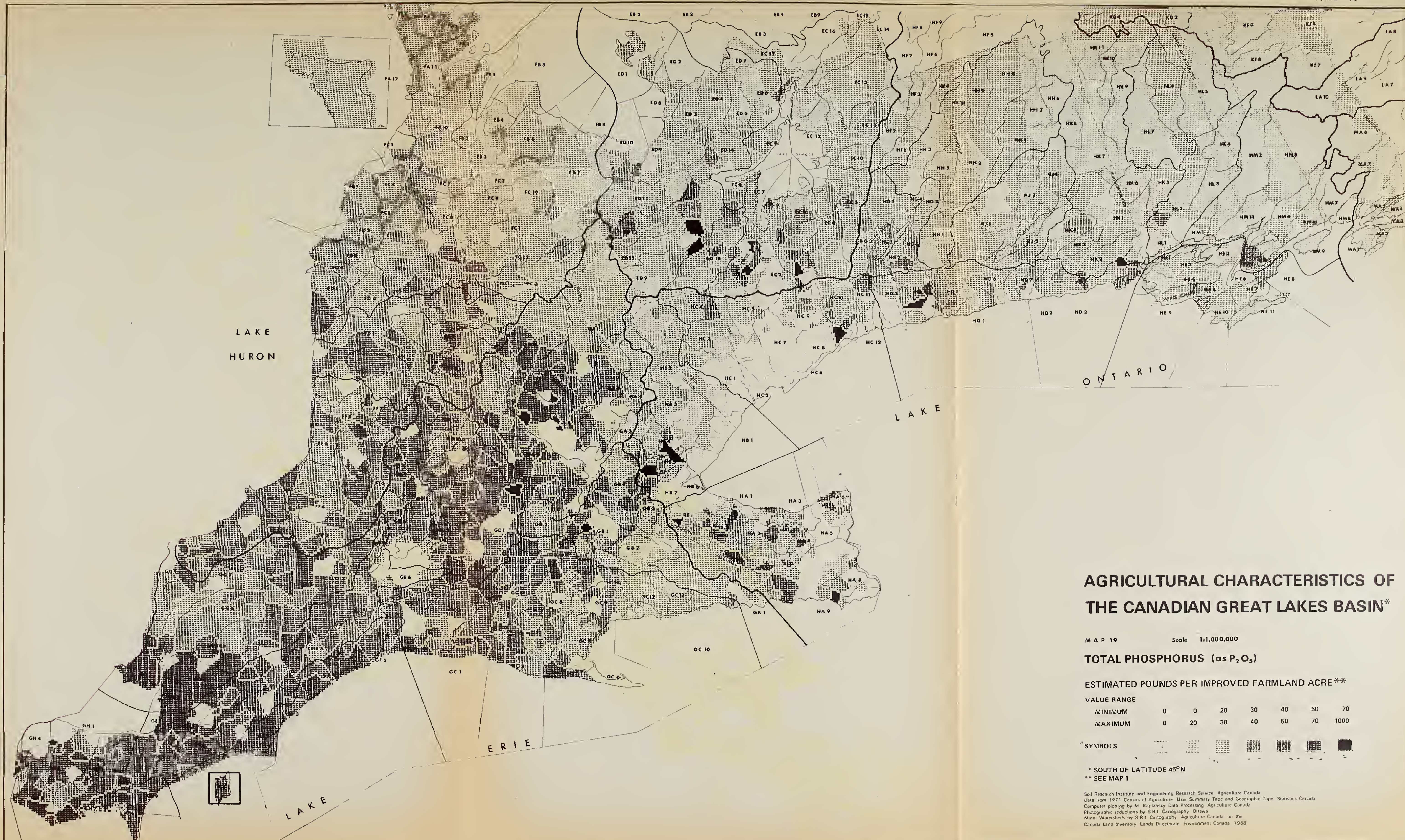
SYMBOLS

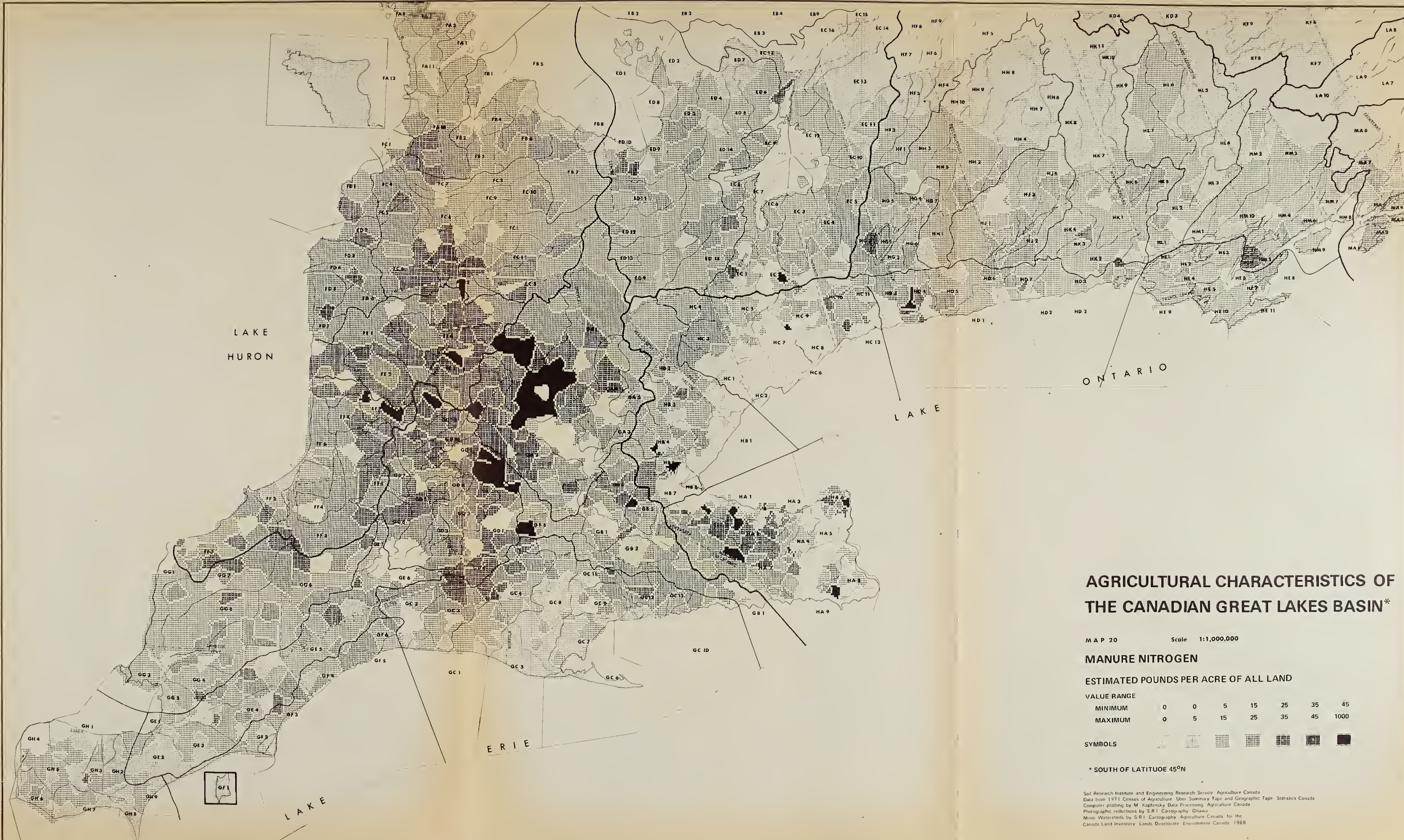
* SOUTH OF LATITUDE 45°N
** SEE MAP 1

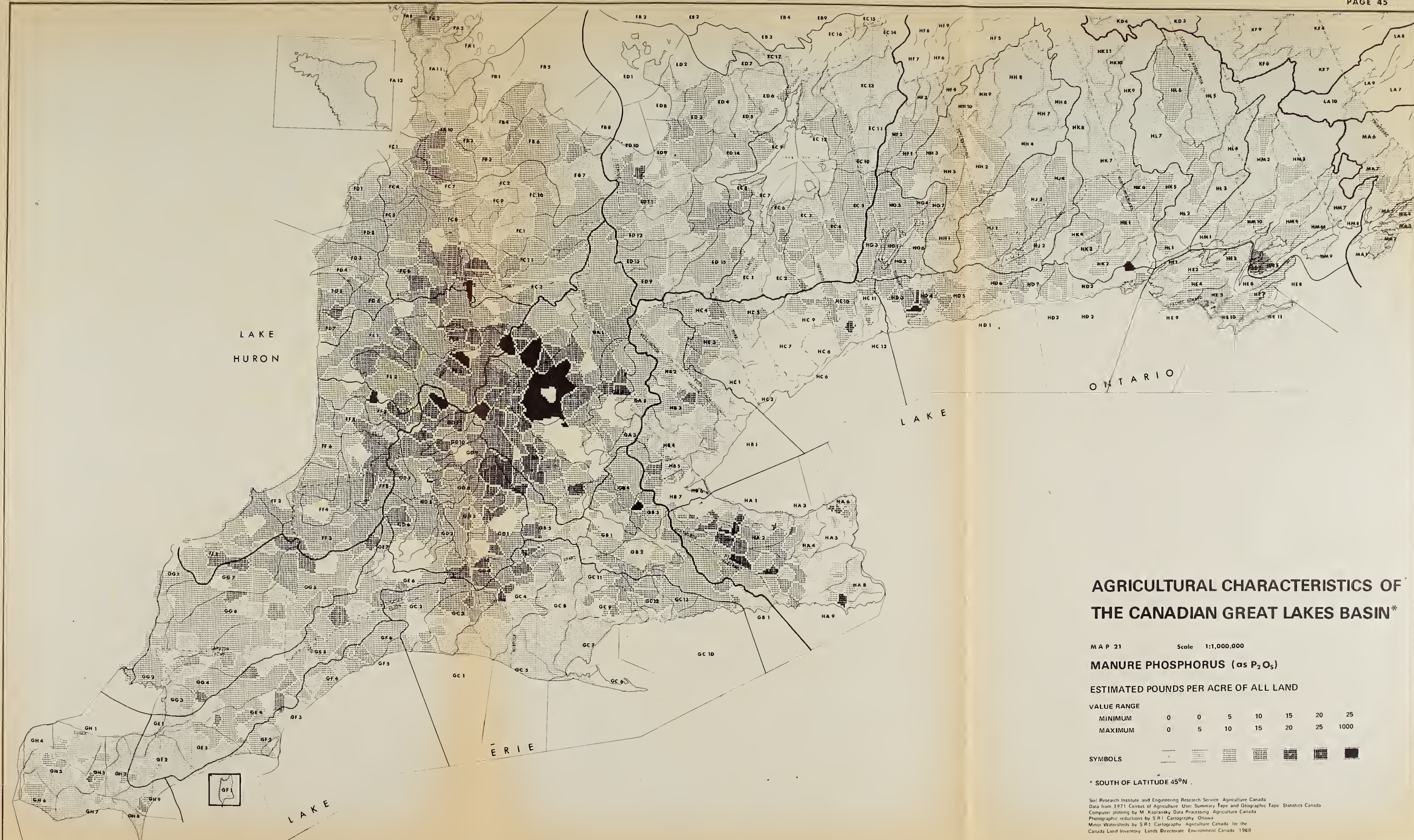
Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M Kaplansky Data Processing, Agriculture Canada
Photographic reductions by S R I Cartography, Ottawa
Minor Watersheds by S R I Cartography Agriculture Canada for the
Canada Land Inventory Lands Directorate Environment Canada 1968


LAKE HURON
LAKE ONTARIO
LAKE ERIE
AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*
MAP 17
Scale 1:1,000,000
FERTILIZER PHOSPHORUS (as P_2O_5)
ESTIMATED POUNDS PER IMPROVED FARMLAND ACRE **
VALUE RANGE
MINIMUM 0 0 10 20 30 40 50
MAXIMUM 0 10 20 30 40 50 1000
SYMBOLS
* SOUTH OF LATITUDE 45°N
** SEE MAP 1
Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M Kaplansky Data Processing Agriculture Canada
Photographic reductions by S R I Cartography Ottawa
Minor Watersheds by S R I Cartography Agriculture Canada for the
Canada Land Inventory Lands Directorate Environment Canada 1968


LAKE HURON
LAKE ONTARIO
LAKE ERIE
AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*
MAP 18
Scale 1:1,000,000
TOTAL NITROGEN
ESTIMATED POUNDS PER IMPROVED FARMLAND ACRE**
VALUE RANGE
MINIMUM 0 0 25 50 75 100 125
MAXIMUM 0 25 50 75 100 125 1000
SYMBOLS
* SOUTH OF LATITUDE 45°N
** SEE MAP 1
Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape, Statistics Canada
Computer plotting by M Kaplansky Data Processing Agriculture Canada
Photographic reductions by S R I Cartography Ottawa
Minor Watersheds by S R I Cartography Agriculture Canada for the
Canada Land Inventory Lands Directorate Environment Canada 1968


LAKE HURON
LAKE ONTARIO
LAKE ERIE
AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*
MAP 19
Scale 1:1,000,000
TOTAL PHOSPHORUS (as P_2O_5)
ESTIMATED POUNDS PER IMPROVED FARMLAND ACRE**
VALUE RANGE
MINIMUM 0 0 20 30 40 50 70
MAXIMUM 0 20 30 40 50 70 1000
SYMBOLS
* SOUTH OF LATITUDE 45°N
** SEE MAP 1
Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M Kaplansky Data Processing Agriculture Canada
Photographic reductions by S R I Cartography Ottawa
Minor Watersheds by S R I Cartography Agriculture Canada for the
Canada Land Inventory Lands Directorate Environment Canada 1968


LAKE
HURON
LAKE
ONTARIO
LAKE
ERIE
AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*
MAP 20
Scale 1:1,000,000
MANURE NITROGEN
ESTIMATED POUNDS PER ACRE OF ALL LAND
VALUE RANGE
MINIMUM 0 0 5 15 25 35 45
MAXIMUM 0 5 15 25 35 45 1000
SYMBOLS
* SOUTH OF LATITUOE 45°N
Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M Kaplansky Data Processing Agriculture Canada
Photographic reductions by S R I Cartography Ottawa
Minor Watersheds by S R I Cartography Agriculture Canada for the
Canada Land Inventory Lands Directorate Environment Canada 1968



AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*

MAP 21 Scale 1:1,000,000

MANURE PHOSPHORUS (as P_2O_5)

ESTIMATED POUNDS PER ACRE OF ALL LAND

VALUE RANGE							
MINIMUM	0	0	5	10	15	20	25
MAXIMUM	0	5	10	15	20	25	1000

SYMBOLS

* SOUTH OF LATITUDE 45°N .

Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M Kaplansky Data Processing Agriculture Canada
Photographic reductions by S R I Cartography Ottawa
Minor Watersheds by S R I Cartography Agriculture Canada for the
Canada Land Inventory Lands Directorate Environment Canada 1968


LAKE HURON
ONTARIO
LAKE
ERIE
LAKE
AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*
MAP 22
Scale 1:1,000,000
TOTAL NITROGEN
ESTIMATED POUNDS PER ACRE OF ALL LAND
VALUE RANGE
MINIMUM 0 0 10 30 50 70 90
MAXIMUM 0 10 30 50 70 90 100
SYMBOLS
* SOUTH OF LATITUDE 45°N
Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M Kaplansky Data Processing Agriculture Canada
Photographic reductions by S R I Cartography Ottawa
Minor Watersheds by S R I Cartography Agriculture Canada for the
Canada Land Inventory Lands Directorate Environment Canada 1968


LAKE HURON
LAKE ONTARIO
LAKE ERIE
AGRICULTURAL CHARACTERISTICS OF THE CANADIAN GREAT LAKES BASIN*
MAP 23
Scale 1:1,000,000
TOTAL PHOSPHORUS (as P_2O_5)
ESTIMATED POUNDS PER ACRE OF ALL LAND
VALUE RANGE
MINIMUM 0 0 10 20 30 40 50
MAXIMUM 0 10 20 30 40 50 1000
SYMBOLS
* SOUTH OF LATITUDE 45°N
Soil Research Institute and Engineering Research Service Agriculture Canada
Data from 1971 Census of Agriculture User Summary Tape and Geographic Tape Statistics Canada
Computer plotting by M Kaplansky Data Processing Agriculture Canada
Photographic reductions by S R I Cartography Ottawa
Minor Watersheds by S R I Cartography Agriculture Canada for the
Canada Land Inventory Lands Directorate Environment Canada 1968

SOIL EROSION AND FLUVIAL SEDIMENTATION IN SOUTHERN ONTARIO

Report on Preliminary Investigations

G. J. Wall
Ontario Soil Survey Unit,
Agriculture Canada, Guelph

W. T. Dickinson
School of Engineering
University of Guelph

Data compilation: L. van Vliet
J. C. Slot
A. Scott

INTRODUCTION

Funds have recently been provided to the Ontario Soil Survey Unit, Guelph, to survey the extent and degree of soil erosion in Southern Ontario. Concurrent with these investigations, Dr. T. Dickinson, School of Agricultural Engineering, University of Guelph has assessed all available fluvial suspended sediment data for Southern Ontario streams in order to obtain some estimate of suspended sediment outputs to the Great Lakes. The purpose of this report is to summarize the results of these studies and attempt to relate these estimates of soil erosion to fluvial sediment data.

ASSESSMENT OF SHEET EROSION FROM AGRICULTURAL LAND

In an attempt to obtain quantitative estimates of soil erosion losses from agricultural land in the short period of time allotted for this study, it was deemed necessary to evaluate the utility of a soil loss prediction equation. The universal soil loss equation developed by Wischmeier and Smith (1965) was selected for use in the study. This equation expresses field soil loss in tons per acre as a function of rainfall characteristics, storm temporal distribution, soil, topography, surface cover, crop sequence, productivity, tillage, residue management and erosion-control practices. It enables the computation of long term average sheet erosion losses from agricultural land in Southern Ontario.

The soil loss equation is $A = RKLSCP$ (Wischmeier and Smith, 1965) where

A - is the computed soil loss per unit area

R - the rainfall factor, is the number of erosion-index units in a normal year's rain.

K - the soil erodibility factor, is the erosion rate per unit of erosion index for a specific soil in cultivated continuous fallow.

L - the slope-length factor.

S - the slope gradient factor.

C - the cropping-management factor, is the ratio of soil loss from a field with specified cropping and management to that from the fallow condition.

P - the erosion-control practice factor, is the ratio of soil loss with contouring, stripcropping, or terracing to that with straight-row farming, up-and-down slope.

The universal soil loss equation was developed in central and eastern U.S.A. and is the result of over 8,000 plot years of basic erosion-plot data collected over a period of 20 years. The extension field plot measurements that are available to date indicate that soil loss predictions are sufficiently accurate to provide reliable guides for conservation farm planning. The major limitation of the universal soil loss equation is lack of sufficient research data for evaluation of some of the factors. For example, it is not possible to employ the soil loss equation to predict specific storm or specific year soil losses because additional data such as antecedent moisture content, soil surface conditions, etc. must be taken into consideration for these predictions.

Prior to application of the universal soil loss equation in Ontario, it was necessary to determine the regional distribution of the rainfall factor (R) as well as to compute erodibility values (K) for soil materials. Slope gradient, slope length, and cropping factors used in the soil loss equation required no special adaptation for use in Ontario.

The rainfall erosion index (R) is the longtime average yearly total of the storm EI values (total kinetic energy of the storm times its maximum 30 minute intensity). Previous research indicated that storm losses from cultivated fields were directly proportional to this factor (EI) when factors other than rainfall were held constant. Data for the computation of the R values for Southern Ontario were obtained from the Atmospheric Environmental Service, Environment Canada. Computed R values ranged from 50 to 100 in Southern Ontario (Figure II.1). Wischmeier and Smith (1965) reported R values in the U.S.A. that ranged from 600 in the south to as low as 50 in the northern states.

The erodibility factor K of the soil loss equation is used to assess the relative erodibility of soil materials on the basis of inherent soil properties. Soil properties that influence erodibility by water are (1) those that affect the infiltration rate, permeability, and total water holding capacity, and (2) those that resist the dispersion, splashing, abrasion, and transporting forces of the rainfall and runoff (Wischmeier and Smith, 1965). In the soil loss equation, the K value is a quantitative value, experimentally determined from erosion plot studies. Time constraints rendered it impossible to determine K values for Ontario soil materials in this same manner.

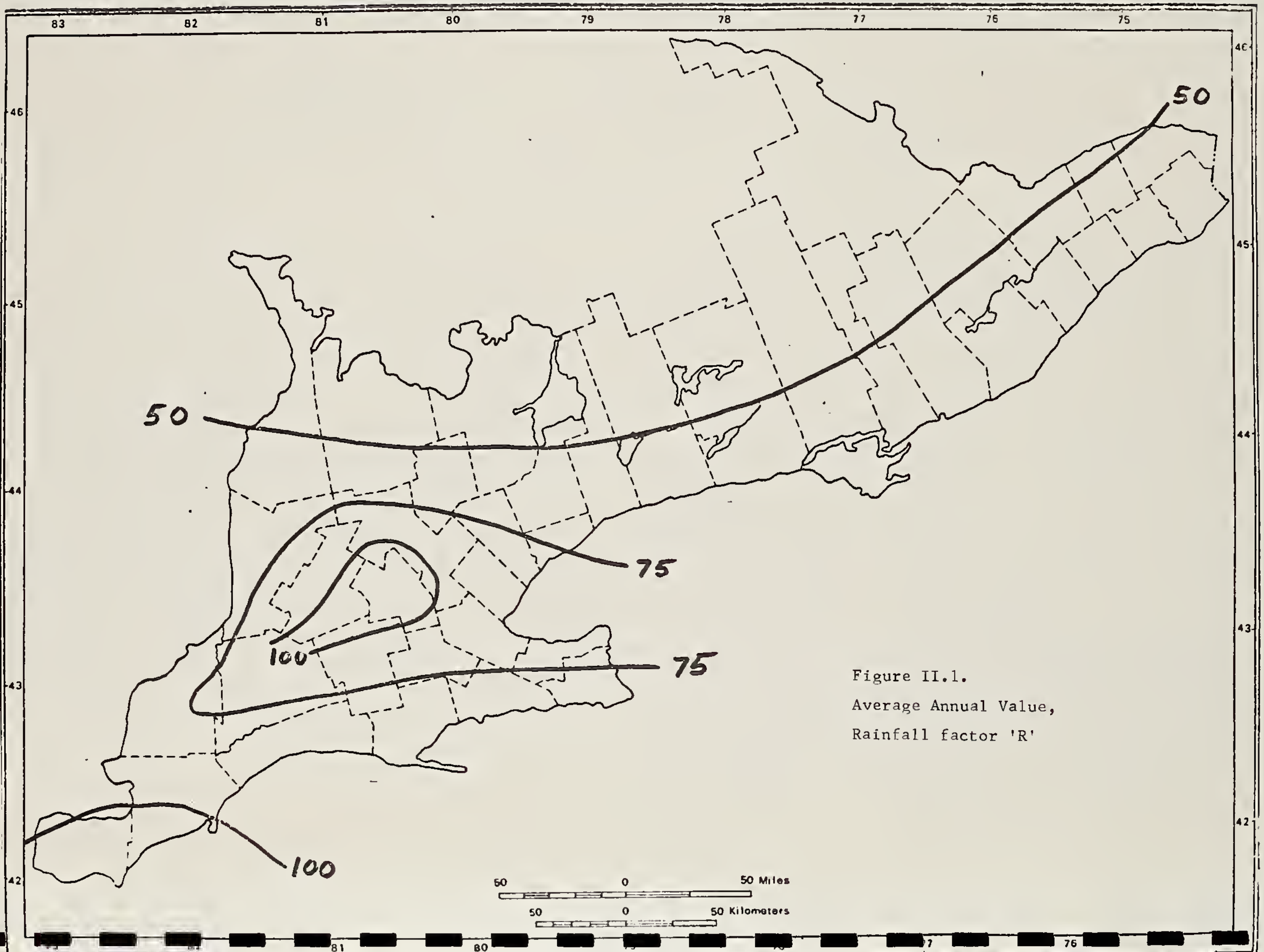


Figure II.1.
Average Annual Value,
Rainfall factor 'R'

Wischmeier et al.(1971) have published a convenient soil erodibility nomograph for the computation of K factors (Figure II.2). Only five soil parameters need to be known: percent silt, percent sand, organic matter content, structure and permeability. Statistical confidence limits for the nomograph method of K computation revealed that 95 of 100 estimates of K should be within $\pm$0.02 of the true K value (Wischmeier et al.(1971)).

The soil erodibility nomograph was used for the computation of K values for soil types found in Southern Ontario. The only major difficulty encountered in the use of the soil erodibility nomograph was with the silt fraction of the particle size parameter. Wischmeier et al.(1971) have redefined the silt fraction (2-50 μm) to include the very fine sand (50-100 μm) since research data indicated that the very fine sand behaved more like silt than like the larger sand in terms of erodibility. Unfortunately, the very fine sand content of most soil series in Ontario was not available and it was necessary to compute K values from the soil erodibility nomograph using the uncorrected silt fraction (2-50 μm).

Soil information required for the determination of K factors were obtained from published Ontario soil survey reports as well as from personal communication with individuals of the Ontario Soil Survey Unit, Guelph. The generalized distribution of K factor values in Southern Ontario is depicted in a map by grouping K values into four classes ($<$20, 20-30, 30-40, $>$40) and indicating the distribution of each class (Figure II.3). Maximum inherent soil erodibility is reflected by the highest K value.

Crops, crop rotations, cultivation practices and yield information for the predominant agricultural systems in Southern Ontario were determined from personal communication with O.M.A.F. soils and crop specialists. This information was used to compute the cropping and management factor, C of the soil loss equation. Slope gradient and slope length factors that were needed for the soil loss equation were obtained from soil survey reports and topographic sheets. The erosion control factor, P, of the soil loss equation was not used in this study since the occurrence of stripcropping, contouring or terracing in Ontario was assumed to be minimal.

Figure II.4 is a map of Southern Ontario that depicts average annual sheet erosion losses from agricultural land as predicted by the universal soil loss equation. The computed values reflect erosion losses from the predominant soil types in combination with the predominant crop, yield levels and management practices associated with these soils. Therefore, erosion losses from small acreages of highly erodible soil materials, streambanks, urban centers, or poorly managed agricultural land were not considered in the soil erosion loss computations indicated in Figure II.4. The highest predicted average annual sheet erosion losses occurred in the Thames, Sydenham, Ausable and Humber watersheds.

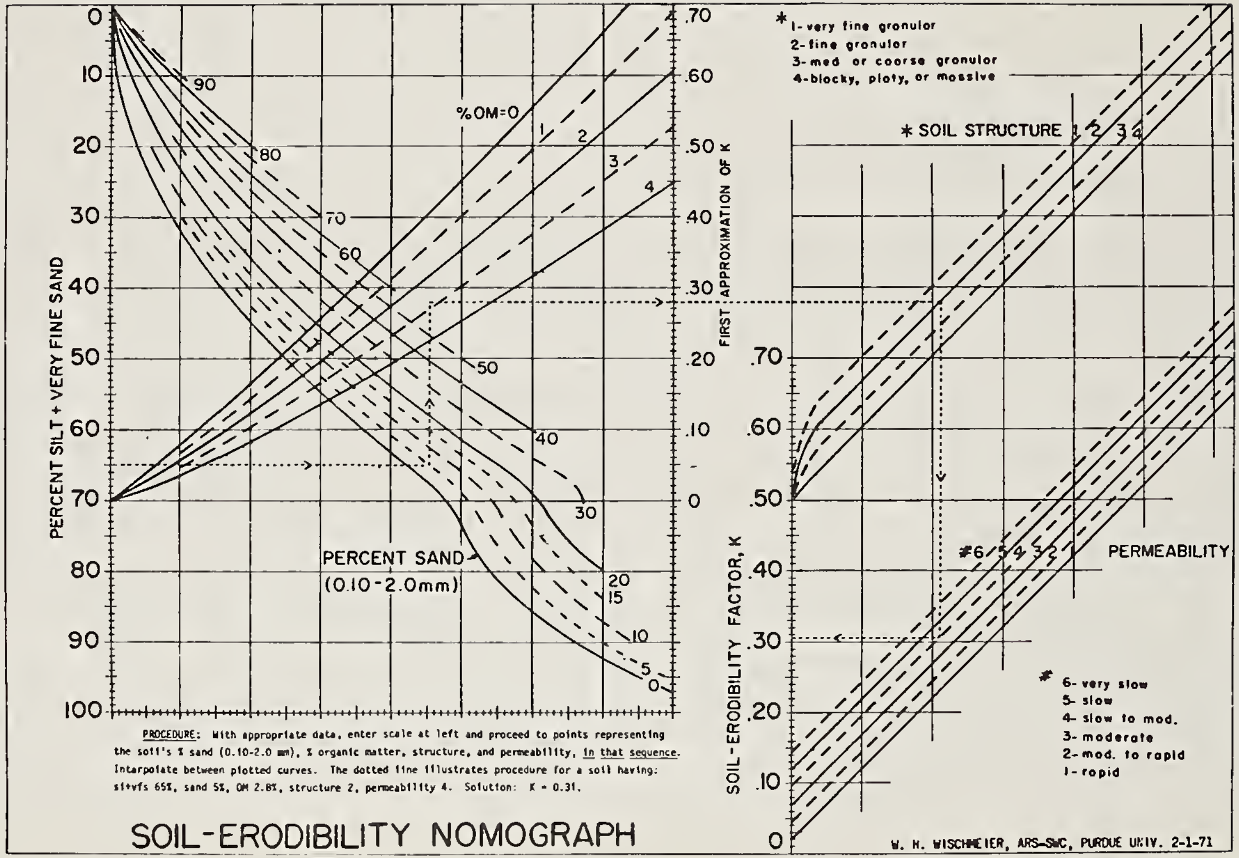


Figure II.2 Nomograph for computation of 'K' factors

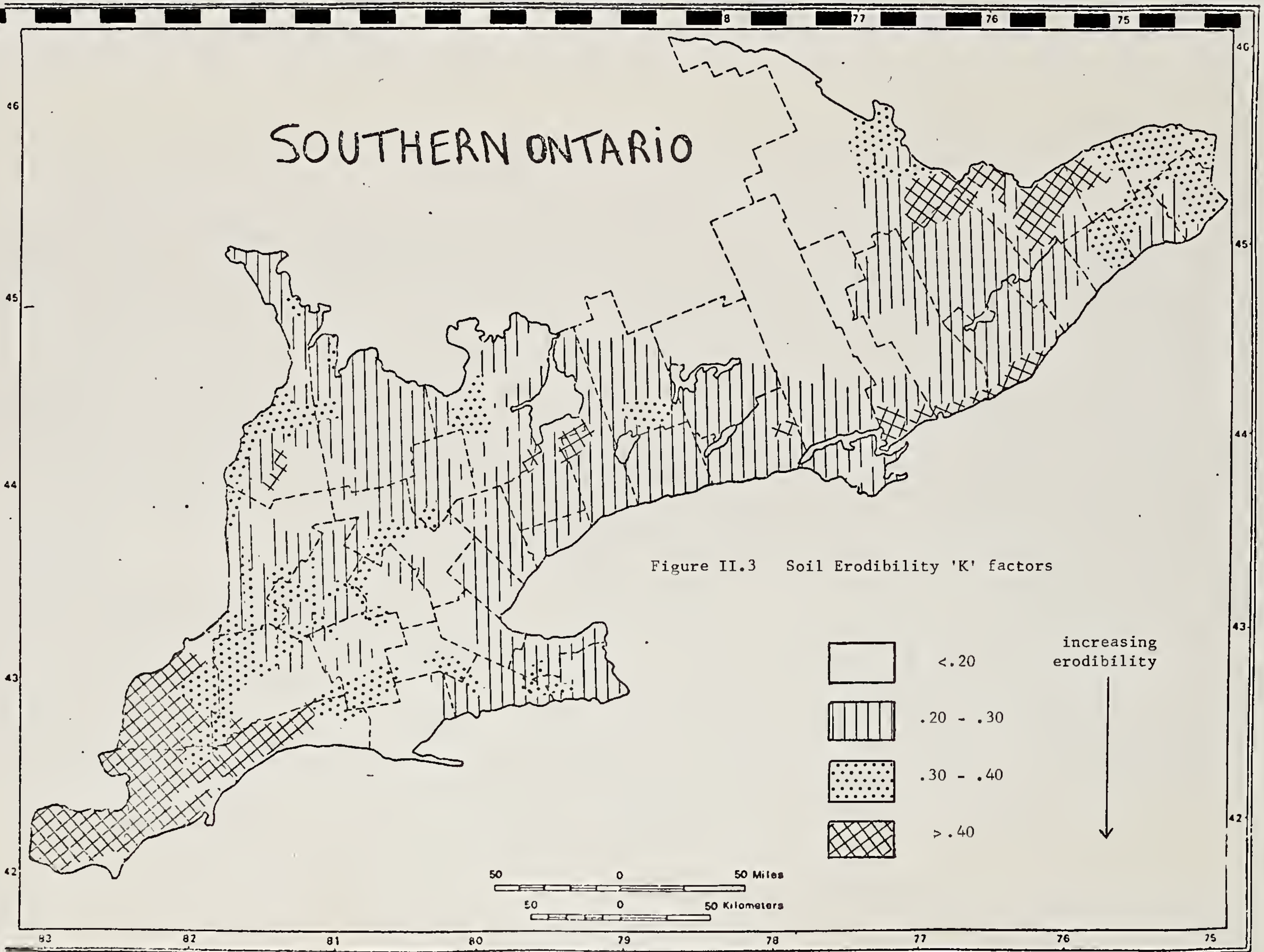
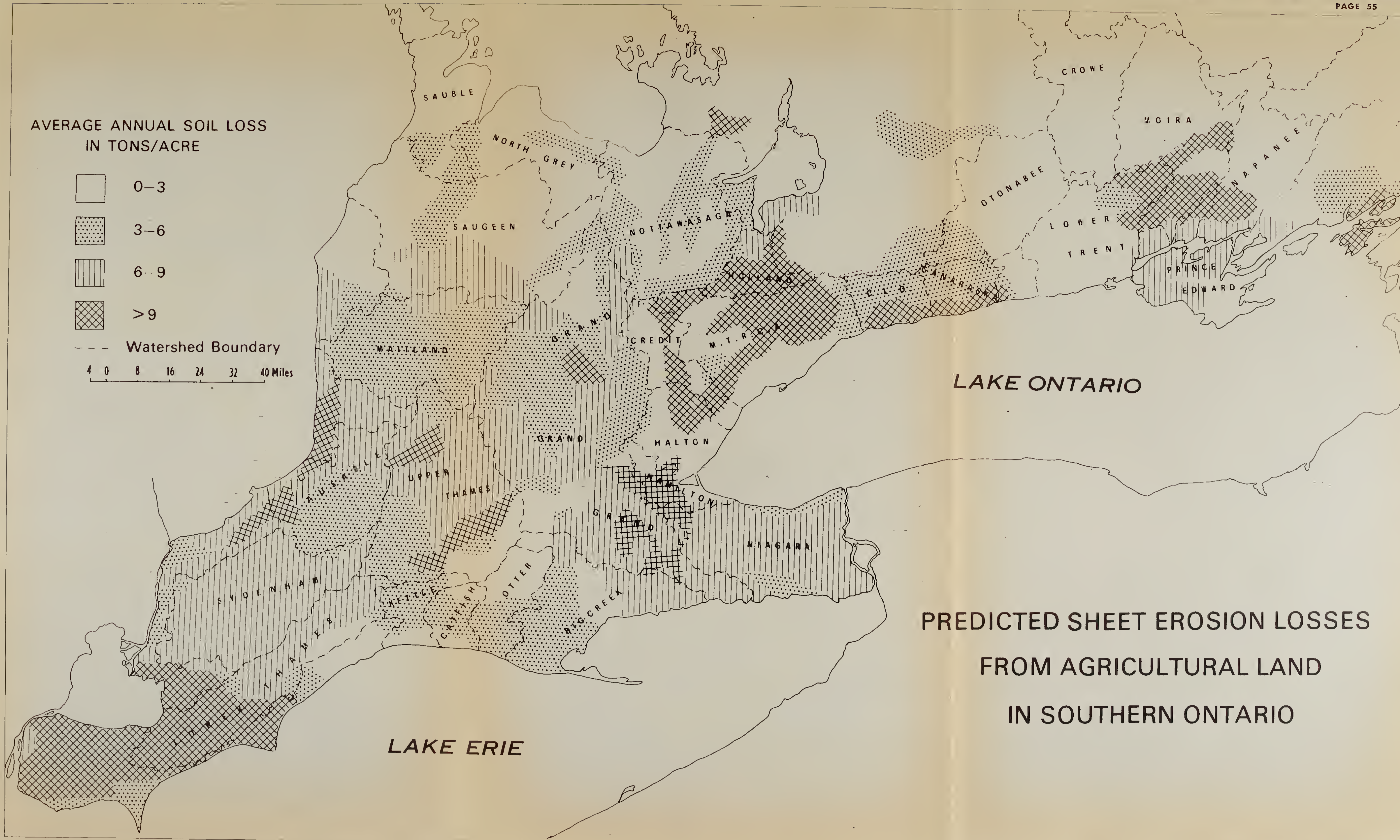


Figure II.3 Soil Erodibility 'K' factors



PREDICTED SHEET EROSION LOSSES FROM AGRICULTURAL LAND IN SOUTHERN ONTARIO

ASSESSMENT OF FLUVIAL SEDIMENT DATA

The universal soil loss equation is a useful tool for the prediction of sheet erosion losses but provides no reliable data for the prediction of fluvial sediment loads. In an attempt to locate watersheds with high sediment outputs to the Great Lakes from south-western Ontario streams all available fluvial sediment data was assessed. Two main sources of fluvial sediment data were located: (1) Water Quality Branch, Ministry of the Environment and (2) the Water Survey of Cañada, Inland Water Directorate, Department of the Environment. Data obtained from the Water Quality Branch, Ministry of the Environment may be characterized as follows: grab sample obtained from stream segment of greatest flow, time oriented sampling, general lack of discharge data, and total solids and suspended solids analysis. The periodicity of this data as well as the lack of discharge information renders the Water Quality Branch suspended sediment measurements unsuitable for the assessment of fluvial sediment outputs to the Great Lakes.

Fluvial sediment data available from the Water Survey of Canada may be characterized as follows: depth integrated sampling related to the entire stream cross-section, flow oriented sampling intervals, daily discharge measurements, and suspended sediment analysis. While the quality of this data seems adequate for the prediction of fluvial sediment outputs to the Great Lakes, data are only available for six streams in Southwestern Ontario. Table II.1 depicts the streams, basin size, and average annual suspended sediment loads for which Water Survey of Canada data are available in southwestern Ontario. Big Otter Creek and the Humber River have the largest suspended sediment loads.

Table II.1 - Streams, Basin Size and Average Annual Suspended Sediment loads from Water Survey of Canada Data

River	Gauge Location	Size(mi^2)	Annual Suspended Sediment tons/acre
Big Otter Creek	Vienna	269	.5
Big Creek	Walsingham	228	.2
Canagagigue Creek	Elmira	42	.2
Humber River	Elder Mills	117	.3
Humber River	Weston	309	.3
Thames River (Upper)	Ingersoll	200	<.1
Maitland River	Donneybrook	680	<.1

SUMMARY

The universal soil loss equation was used to obtain estimates of soil erosion losses from agricultural land in Southern Ontario. The results of this study revealed that soil erosion losses of 0 to 15 tons/ac/yr. may be anticipated from the predominant agricultural regions in the Province. The aerial distribution of the magnitude of predicted sheet erosion losses from agricultural land is shown in Figure II.4.

Sediments eroded from agricultural land may not be transported great distances. Deposition of sediments often occurs locally, or more specifically, in the same field as the initial erosion as a result of slope, crop, drainage or cultivation changes. However, some percentage of the eroded material will reach major streams with ultimate deposition into the Great Lakes.

Water Survey of Canada data for six streams in Southwestern Ontario indicated suspended sediment yields of 0.1 to 0.5 tons/ac/yr. These values are in agreement with estimates of the average annual fluvial suspended sediment yields of 0.4 tons/ac/yr. for major streams of the North American continent (Holeman, 1968). The origin of fluvial sediments is generally attributed to agricultural, urban and streambank sources. But, the partitioning of the total fluvial sediment load into the relative contributions of agricultural, urban and streambank sources remains a matter of speculation.

Additional funding has been received to obtain detailed estimates of soil erosion losses from 15 agricultural watersheds in Southern Ontario. This data will be used to compare predicted soil erosion losses with actual measured fluvial suspended sediment outputs from the agricultural watersheds. It is anticipated that this information will provide an appreciation of sediment delivery ratios from agricultural land to streams in the different physiographic and agricultural regions of Southern Ontario as well as assisting in the extrapolation of soil erosion data for the entire Great Lakes Basin.

ACKNOWLEDGMENTS

The authors wish to express appreciation to Messrs. L. van Vliet, J. Slot and A. Scott for much of the data compilation associated with this project.

REFERENCES CITED

Holeman, J.N. 1968. The sediment yield of major rivers of the world. Water Resources Research 4:737-747.

Wischmeier, W.H. and D.D. Smith, 1965. Predicting rainfall-erosion losses from cropland east of the Rocky Mountains. Agriculture Handbook No. 282, A.R.S., U.S.D.A.

Wischmeier, W.H., Johnson, C.B. and B.V. Cross, 1971. A soil erodibility nomograph for farmland and construction sites. J. Soil and Water Conservation 26:189-193.

A SELECTIVE INVENTORY OF LARCE LIVESTOCK OPERATIONS

SOUTHERN ONTARIO

(by aerial photograph interpretation)

D. R. Coote
Engineering Research Service

E. M. MacDonald
Soil Research Institute

M. Dwyer Rigby
Soil Research Institute

Photo interpretation: J. M. Cossette
R. J. Dewe
D. G. Harder
F. J. MacCallum
J. D. McRae
M. D. Rigby

Drafting: R. LaFrance(Economics Branch, Agriculture Canada)

Consultation throughout project - photo interpretation, programme development and implementation:
Mr. L. E. Philpotts
Economics Branch
Agriculture Canada, Ottawa

Technique development and initial staff training:
Mr. R. A. Ryerson
Canada Centre for Remote Sensing
Dept. of Energy, Mines and Resources, Ottawa

Implemented and supervised by Agriculture Canada as part of the Agriculture Canada - Environment Canada contribution to implementation of the Creat Lakes Water Quality Agreement.

INTRODUCTION

Effective implementation of the Great Lakes Water Quality Agreement must be based on factual, up-to-date information. Agricultural land use is one of the land uses identified in the Agreement as requiring study in relation to the present environmental situation. Southern Ontario is Canada's highest agricultural producing area as well as her largest internal marketplace for these same goods. Livestock production, particularly that of the ever-increasing confinement facility operations, plays no small role in the economy of this region. Indeed, it is an increasing land use phenomenon and the management of livestock waste is becoming a factor of immediate concern.

Article V of the Great Lakes Water Quality Agreement, Section (d) dealt with measures for abatement and control of pollution from agricultural land use activities, with specific mention of livestock operations as follows:

Article V (d)

> (ii) "measures for the abatement and control of pollution from animal husbandry operations, including encouragement to appropriate regulatory agencies to adopt regulations governing site selection and disposal of liquid and solid wastes in order to minimize loss of pollutants to receiving waters".

The need for an up-to-date inventory or comprehensive survey concerned with the location and type of livestock operations in the Great Lakes Basin was recognized. This data is required to formulate programmes and control measures pertaining to pollution from animal husbandry operations. A joint Agriculture Canada/Environment Canada project was initiated to meet this need. This livestock operation survey was adapted to meet some of the requirements of Task B (Land Use Inventory) and Task C (Watershed Studies) of the International Reference Group on Great Lakes Pollution from Land Use Activities. This project utilized aerial photograph interpretation as the inventory method. Livestock operations in Southern Ontario were located, classified as to type and size of animal population, and assessed as to mode of waste management practiced.

PROJECT OBJECTIVES

The data gleaned from this particular inventory was required to fulfil objectives relating to the management of livestock waste as concerned with location, type and size of animal population, type of waste product and storage of same, relationship of waste to water and soil, and its odour aesthetic pollution potential. Specific project goals may be considered to be:

- calculation and recording of livestock operations;
  a) type of operation (species of animal)
  b) animal population (size)

- analysis of the population's confinement in terms of the locational relationship of this phase of the operation to natural waters;

- identification of the type of management of the population's organic waste;
  a) type of waste produced
  b) storage of wastes
  c) disposal of wastes

- designation of an operation in respect to
  a) location of the confinement facility or shelter structure and the waste product in relation to the potential pollutant transfer capability classification of the soil in the immediate area
  b) location of the livestock population within an individual watershed and related drainage system of the Great Lakes Basin
  c) location of the operation relative to its proximity to road traffic and urban living conditions (aesthetic pollution, health hazard)

- calculation and assessment of the above factors combined in such a way as to relate livestock operations (species, populations and confinement facilities) to geographical locations in watersheds, soil types, and counties of the Ontario sector of the Great Lakes Basin.

- calculation and assessment of the above factors so as to determine areas where effluent or waste products from livestock operations may play a relatively significant role as a pollutant source. This information should contribute to study development in the Great Lakes Basin.

METHODOLOGY

DESIGN:

This inventory of Southern Ontario's livestock operations was carried out as an aerial photograph interpretation analysis using existing photography. The total survey area was covered by black and white panchromatic 1:15,840 scale photography taken during the summers of 1966, 1971 or 1972. (See Map IV-1. See Appendix IV-1)

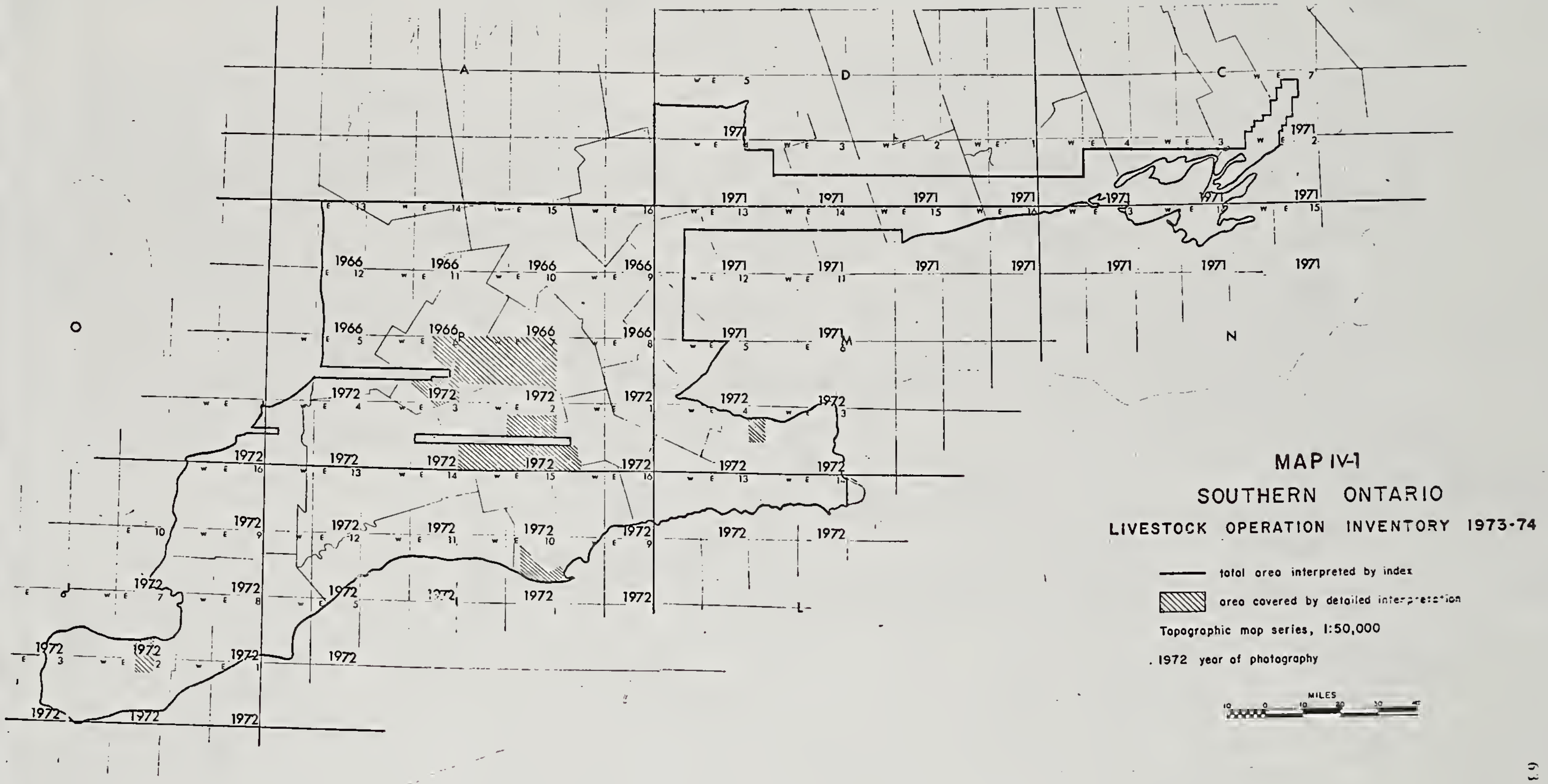
The entire programme was designed to apply a rapid surveillance technique requiring minimum manpower to a large area of agricultural land in order to analyze the region for the presence of active livestock operations. Detection of problems or potential problems associated with environmental pollution was regarded as the end result of the analysis. The basic premise for the study was concurred to be a survey or inventory of livestock operations and the management of their waste in the Southern Ontario section of the Great Lakes Drainage Basin.

Contact 9" x 9" prints from 1971 and 1972 flights were ordered from, and processed by, the Aerial Photography Department of the Ontario Ministry of Natural Resources. Copies of 1966 photography were not obtained. Interpretation of this material was done using the Ontario Ministry of Natural Resources library prints.

1:50,000 National Topographic Series maps and mylar overlays containing Enumeration District and Enumeration Area information were used for plotting the geographic location of livestock operations and for designating the watershed in which each operation occurred. (This portion of the study will not be published but is available for government use).

An information sheet, including a unique numerical designation for each interpreted livestock operation, was developed (see Appendix IV-2). This sheet, designed as the basis for a computer printout programme, gave provision for photograph, geographical, municipal, and watershed designation. Livestock type, size, type of confinement, waste type and mode of storage, slope of immediate terrain, distance from surface water flow, roads and urban developments were recorded directly on the information sheets. Provision for other aspects of specific interest concerning each interpreted operation was covered by a comments section at the bottom of the one page information sheet.

Background material, such as publications providing information on livestock operations and their management, proved very useful particularly during the early stages of the project (see References). Statistics Canada information regarding the livestock population of Southern Ontario was often referred to (see References).



MAP IV-1
SOUTHERN ONTARIO
LIVESTOCK OPERATION INVENTORY 1973-74

IMPLEMENTATION:

The projected 5 month programme[1/] required aerial photograph study and individual livestock operation interpretation using Abrams (CF-8) pocket stereoscopes or Abrams (CB-1) 2X - 4X stereoscopes. Individual building measurements were subsequently made using a Bausch & Lomb (81 - 34 - 35) measuring magnifier and the 0.005 section of the (81 - 34 - 36) general purpose scale.

Farm unit designation[2/], the unique numerical number registered on the information sheet, plus a symbol designating the type of livestock present, was recorded on each photograph and on the Mylar overlay of the corresponding 1:50,000 topographic map sheet. (1971 and 1972 photographs were marked, 1966 photographs, which did not become the property of the Department of Agriculture but remained in the library of the Ministry of Natural Resources, were not marked).

In early November, a special two-day training period was given to aerial photograph interpreters hired for this project. Each interpreter was provided with a training package which was referred to throughout the introductory session (see references). Land use, agricultural practices, aerial photograph interpretation, measuring techniques and procedures were discussed. The training session included reading assignments, examination of photographs, example situations of land slopes and livestock operation types, and a set of test photographs for study and examination. Implementation of developed methodology, as adapted to meet the requirements of this project, provided a firm basis on which to develop the programme.

1/ Programme implementation and supervision came under the auspices of the Engineering Research Service and the Soil Research Institute of Agriculture Canada. Mr. R.A. Ryerson of the Canada Centre for Remote Sensing developed the techniques used in this particular analysis and was responsible for the initial staff training session. Mr. L.E. Philpotts of the Economics Branch of Agriculture Canada developed the measurement charts for the individual operations, took part in the ground checking exercise and was available for consultation regarding actual photograph interpretation throughout the project. Mr. C. Acton, Soil Survey Unit, Agriculture Canada, Guelph, supplied some training session photographs on which slope had been marked.

2/ 'Farm' as used here and elsewhere in this report refers to an active livestock operation as interpreted and located in a specific geographic location.

A set of tables was developed which became the basis for population computations, once the livestock species and confinement management techniques of the operation had been interpreted (see Appendix IV-3).

A two-day field trip (December 10-11, 1973) clarified many of the problems and early questions encountered by the interpretive staff. The first day involved visits to, and discussions with, livestock operators in the Guelph area (see appendix IV-4). The second day was devoted to field checking farm units which the staff had previously interpreted and recorded.

Interpretation procedures changed as the programme developed: During the initial six weeks, November - December 1973, all farm units which an individual interpreter believed to house livestock were studied, interpreted, and subsequently measured and recorded. Minor operations were found to be taking up the bulk of the interpretation time and energy, particularly when this energy was expended at "guestimating" very small numbers of animals. In early January 1974, the programme was modified so that, in general, only size class 3 livestock operations, and smaller size operations which were found close to water courses or lakes, or within urban areas, would be recorded (see Map IV-1. See footnote to table IV-1. See appendix IV-2). The project thus became a locational inventory and waste management survey related to the relatively large agricultural operations in which livestock production was a major enterprise. The bulk of the study, approximately 90% of the geographical area and 65% of the livestock operations recorded, was handled during the last three months of the time allotted to this five-month project (November 1, 1973 to March 31, 1974). Map IV-1 shows the area done in detail and outlines the total area covered by the project. Approximately 1,650 operations were interpreted and recorded during the initial detailed phase.

All 1971 and 1972 photographs were filed and stored in numerical order according to flightlines. Interpreters worked individually on 1:50,000 map sheets and Mylar overlays and the corresponding flightlines. Once all photographs relating to a map sheet had been interpreted, farm units designated and recorded on photographs, and Mylar overlays and information sheets completed, the Mylar overlays were forwarded to the Economics Branch for final drafting[3/]. A computer printout was compiled from the numerically unique information sheets and became the source of the data presented in the subsequent sections of this report.

3/ Mr. R. LaFrance of the Economics Branch did the final drafting of the serial numbers and type symbols on the Mylar map overlays.

The total project, including this report, took the equivalent of 3 full time personnel 5 months to complete. During that time approximately 10,500 photographs, covering in excess of 26,000 square miles, were handled. In total some 4,540 agricultural units were recorded in detail according to the information sheet data requirements. These operations were located in 144 minor watersheds of 25 river basins of the Canadian Creat Lakes Basin. They represent a relatively complete survey of the larger livestock operations of Southern Ontario including their location, animal species, waste management, and relationship to surface water flow, roads and urban development.

The inventory represents a survey of Southern Ontario livestock operations at a particular point in time as follows (see Map IV-1, see appendix IV-1);

- summer of 1966 for the area north and west of Moffat, Ontario (5 miles east of Cuelph)
- summer of 1971 north and east of Moffat, Ontario
- summer of 1972 for any location south of a line from Bayfield on Lake Huron to Port Credit on Lake Ontario

The resultant material provides information on only those operations which were active at the time of photography.

All data have been organized so that the original material can be easily secured, checked and used in subsequent studies. Such subsequent programmes might use the information according to the time it was obtained, use it as a basis on which to compare changes through time, or use it in a specific problem analysis. Future projects to which this data would contribute could include:

- watershed studies relating water quality and the presence of livestock operations;
- assessment of livestock waste management practices in relation to water quality;
- identification and study of areas or regions which are representative of particular types of livestock operations and management characteristics;
- changes and/or trends in livestock operations and management practices through time, as related to sequential aerial photography.

DISCUSSION

RESULTS:

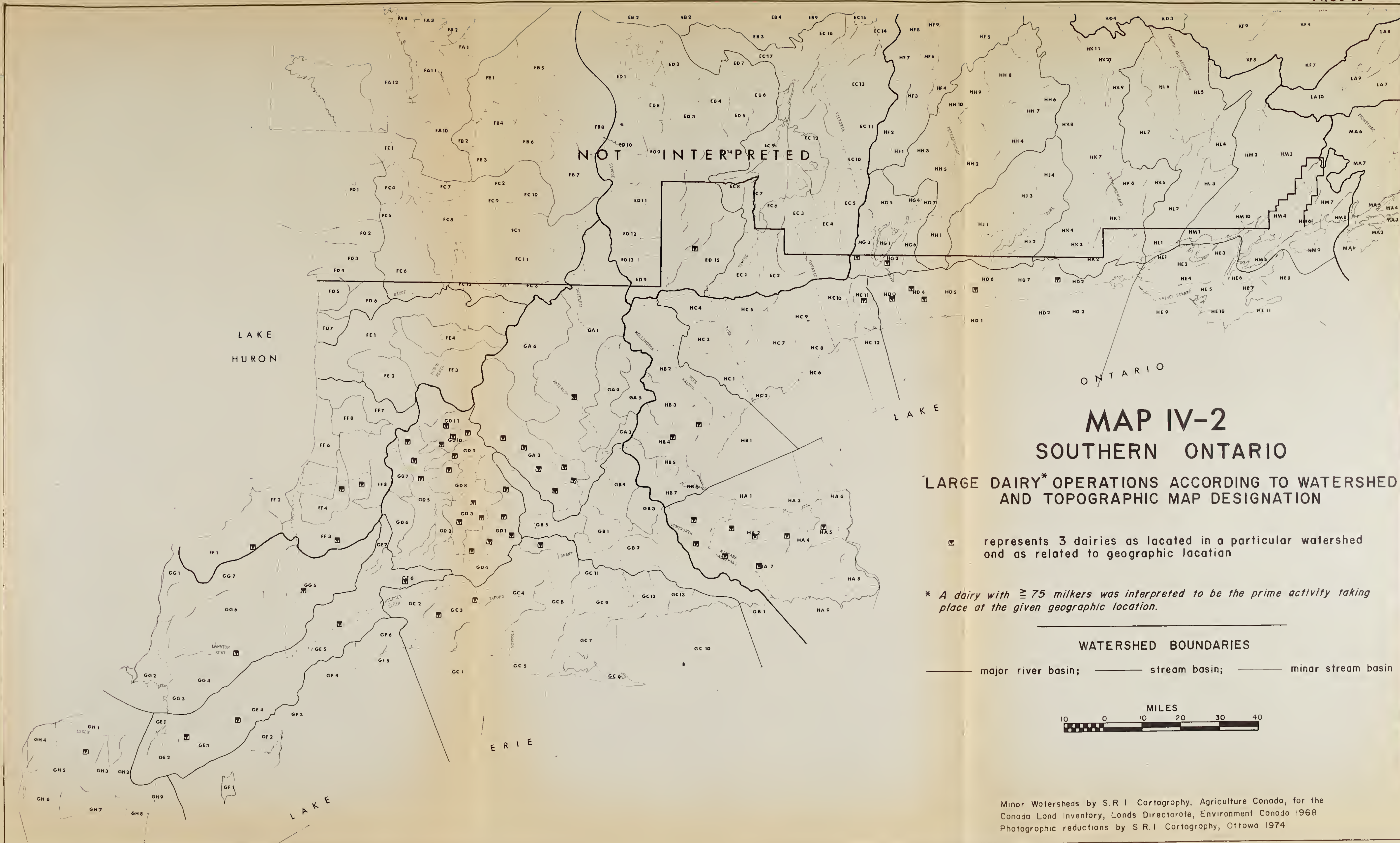
The distribution of livestock operations recorded in this inventory follows the general pattern evident from the Census Data maps presented in Section I of this report. The relevant livestock maps appear in Section I. Livestock distribution is largely controlled by factors involving producer - market relations and by crop production.[4/]

Results of this study serve not simply as an inventory of livestock operations according to their size and geographic locations, but also reveal characteristics of, and possible pollution implications for, such operations. Information regarding animal population and shelter type or confinement practices, slope of the land in the immediate vicinity of the buildings, proximity of livestock buildings to surface drainage channels, roads and residential dwellings, and waste management practices carried out at a given location have been directly recorded from aerial photographs. Both the data pertaining to size, type and geographic location of the livestock operation, and the specific information related to the characteristics of the operations, have been recorded on a computer print-out (see Appendix IV-5). This data can be used and analysed in numerous ways.

The total study, understood as one of an inventory nature, provides a relatively clear picture of the presence of livestock operations in Southern Ontario. Map IV-1 outlines the total area covered in the project and the areas initially studied in detail, and shows the year of photography upon which the interpretation was based. Maps IV-2, IV-3, IV-4, and IV-5 provide a generalized view of the presence of large scale (or size class 3 - for definitions see Appendix IV-2) operations. Approximately 2,631 of the 4,540 livestock operations recorded were of this size class. A further 20% of the number of large operations were medium sized close to streams, road or houses, and were also recorded.

A relatively clear picture of the general location of large livestock operations and the relationship between them and other agricultural aspects of Southern Ontario is obtained by study of these maps in conjunction with the material in footnote 4 and maps from Section I.

4/ See Section I of this report - computer maps showing Agricultural Characteristics of the Canadian Great Lakes Basin. Note particularly maps of improved farmland as % of total land, and map showing acreages of corn, small grains and hay as % of improved land. See also ARDA, Canada Land Inventory, Soil Capability for Agriculture, maps and accompanying text for 1:250,000 map sheets 30 L,M,N ; 31 C,D ; 40 I,J,P.



MAP IV-2
SOUTHERN ONTARIO

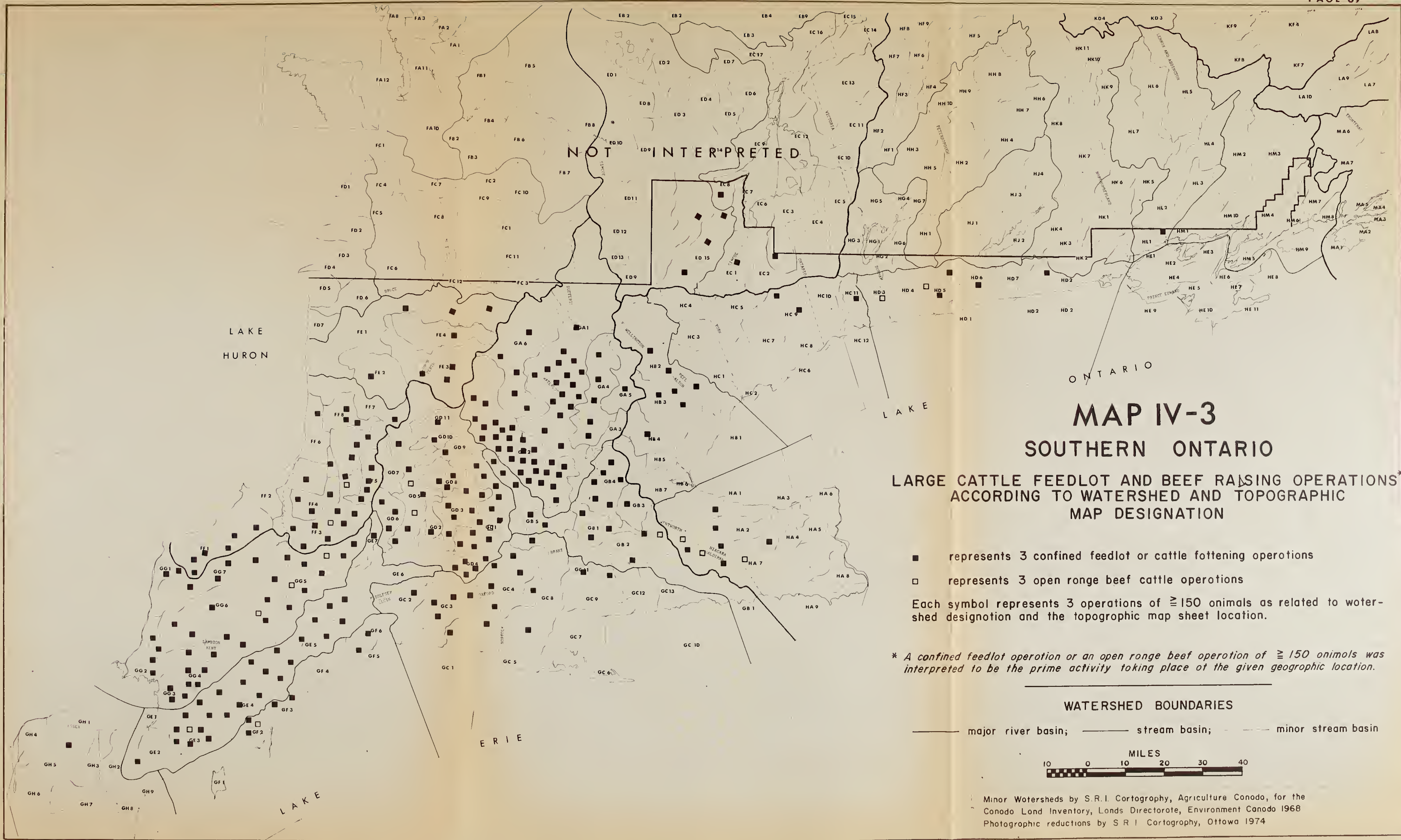
LARGE DAIRY* OPERATIONS ACCORDING TO WATERSHED AND TOPOGRAPHIC MAP DESIGNATION

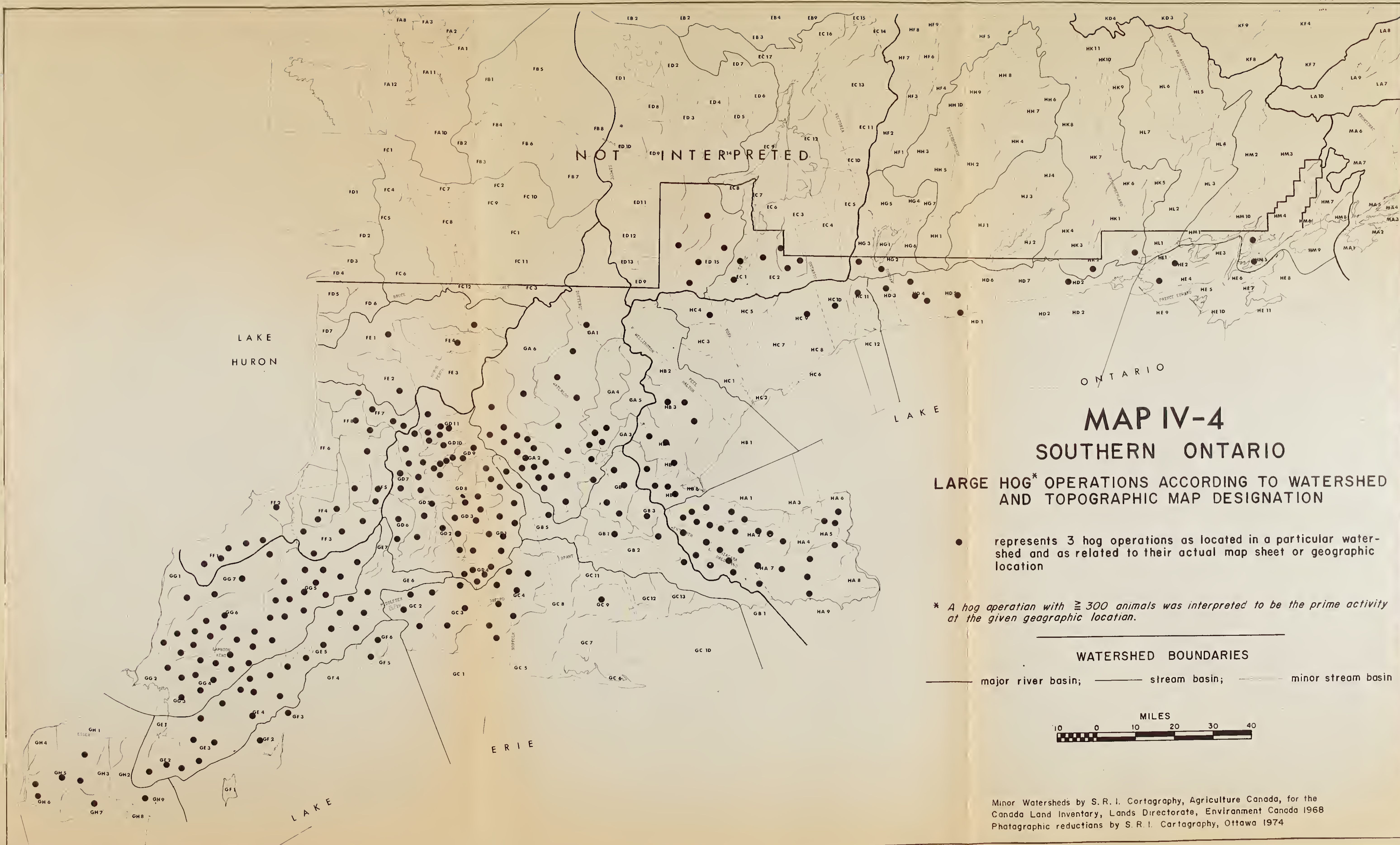
represents 3 dairies as located in a particular watershed and as related to geographic location

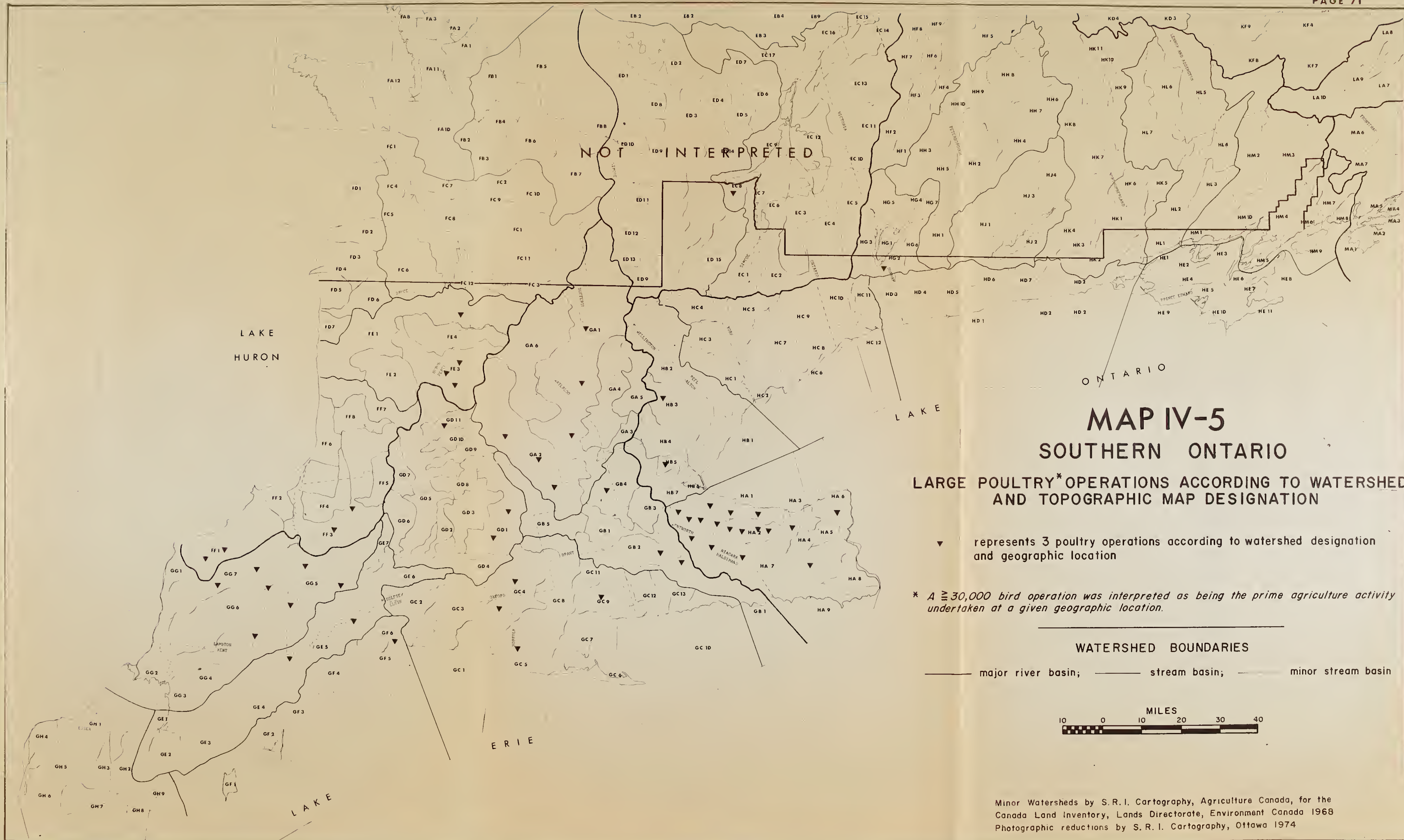
* *A dairy with ≧ 75 milkers was interpreted to be the prime activity taking place at the given geographic location.*

WATERSHED BOUNDARIES

Minor Watersheds by S.R.I. Cartography, Agriculture Canada, for the Canada Land Inventory, Lands Directorate, Environment Canada 1968
Photographic reductions by S.R.I. Cartography, Ottawa 1974


MAP IV-3
SOUTHERN ONTARIO
LARGE CATTLE FEEDLOT AND BEEF RAISING OPERATIONS*
ACCORDING TO WATERSHED AND TOPOGRAPHIC
MAP DESIGNATION
■ represents 3 confined feedlot or cattle fattening operations
□ represents 3 open range beef cattle operations
Each symbol represents 3 operations of ≧150 animals as related to watershed designation and the topographic map sheet location.
* A confined feedlot operation or an open range beef operation of ≧150 animals was interpreted to be the prime activity taking place at the given geographic location.
WATERSHED BOUNDARIES
major river basin; stream basin; minor stream basin
MILES
10 0 10 20 30 40
Minor Watersheds by S.R.I. Cartography, Agriculture Canada, for the Canada Land Inventory, Lands Directorate, Environment Canada 1968
Photographic reductions by S.R.I. Cartography, Ottawa 1974
NOT INTERPRETED
LAKE HURON
LAKE ONTARIO
LAKE ERIE


MAP IV-4
SOUTHERN ONTARIO
LARGE HOG* OPERATIONS ACCORDING TO WATERSHED AND TOPOGRAPHIC MAP DESIGNATION
● represents 3 hog operations as located in a particular watershed and as related to their actual map sheet or geographic location
* A hog operation with ≧ 300 animals was interpreted to be the prime activity at the given geographic location.
WATERSHED BOUNDARIES
major river basin; stream basin; minor stream basin
MILES
10 0 10 20 30 40
Minor Watersheds by S. R. I. Cartography, Agriculture Canada, for the Canada Land Inventory, Lands Directorate, Environment Canada 1968
Photographic reductions by S. R. I. Cartography, Ottawa 1974
NOT INTERPRETED
LAKE HURON
LAKE ERIE
LAKE ONTARIO



MAP IV-5
SOUTHERN ONTARIO
LARGE POULTRY* OPERATIONS ACCORDING TO WATERSHED AND TOPOGRAPHIC MAP DESIGNATION

▼ represents 3 poultry operations according to watershed designation and geographic location

* *A ≧ 30,000 bird operation was interpreted as being the prime agriculture activity undertaken at a given geographic location.*

WATERSHED BOUNDARIES

major river basin; stream basin; minor stream basin

MILES
10 0 10 20 30 40

Minor Watersheds by S.R.I. Cartography, Agriculture Canada, for the Canada Land Inventory, Lands Directorate, Environment Canada 1968
Photographic reductions by S.R.I. Cartography, Ottawa 1974

As an indication of possible pollution implications from livestock wastes, this study allows some aspects of the environmental pollution potential of Southern Ontario livestock operations to be looked at directly. Other aspects require special data retrieval and presentation and/or use of it together with other material noted throughout this report:

- Waste management practices and potential pollution of water by livestock operations are elements for which this project provides direct information (e.g. manure storage types were recorded as well as proximity of the operation to surface waters)

- Relationships of livestock operations to soil in terms of the potential of the soil in the immediate vicinity to transfer pollutants to water systems can be analysed in terms of the geographic locations of operations as related to the soil groups which have been classified according to the pollutant transfer capability. Soil types at each location may be found by checking published Soil Survey maps (see References) while Soil Potential for Pollutant Transfer may be checked by studying the map developed for this purpose (Section I, map I-3).

- Existing practices for the management of livestock wastes have been recorded where possible. Work with this part of the data could provide some valuable information concerning these characteristics, and provide a basis for a study of trends in the use of different practices.

The full potential for the use of the data as it exists, and for its development for use in future studies, remains to be investigated. In order to demonstrate a possible interpretation of the results and to provide some insight into the usefulness of the data obtained, two minor watersheds (GA-2, Nith River and GA-4, Speed River) have been looked at in greater detail.

Study of maps IV-2, IV-3, IV-4, and IV-5[5/] showed that the central region in which the Grand River Basin is located tends to contain the highest overall concentration of large livestock operations, with the exception of poultry producers. The two minor watersheds chosen for a more detailed examination of the data were therefore selected from this basin. All

---

[5/] The base of these maps is the Watershed System map initially developed for the Canada Land Inventory, Environment Canada, 1968, and prepared by the Cartography Unit, Soil Research Institute, Agriculture Canada.

five livestock types generally recorded are found in these watersheds[6/]. Both watersheds were partly covered by recent photography (1972) and partly covered by older photography (1966). The majority of the area of one was covered as a detailed (all farms) inventory, while the entire area of the other was covered only as a selective inventory of large operations, or those close to water courses or residences.

<u>Nith River Basin (GA-2) and Speed River Basin (GA-4)</u>

Examination of the data from these two watersheds provides an example of

1) Interpretation from 1966 photos and 1972 photos:

   Photography taken in the summer of 1972 covers the southern two-thirds of the Nith River Basin (GA-2), and the southern one-quarter of the Speed River Basin (GA-4). Operations in the northern sections of both these basins were interpreted from 1966 photography (see maps IV-6, IV-7, IV-8 and IV-9).

2) Detailed inventory - (all interpreted livestock operations were interpreted and recorded regardless of size):

   Approximately two-thirds of the Nith River Basin was interpreted in 'detail'. The detailed inventory was done for the portion of the basin which was covered by 1972 photography. None of the Speed River Basin was done in detail. All of the Speed River Basin was covered as a 'selective inventory', as was the northern part of the Nith River Basin, i.e. that portion covered by 1966 photography (see maps IV-6, IV-7, IV-8 and IV-9).

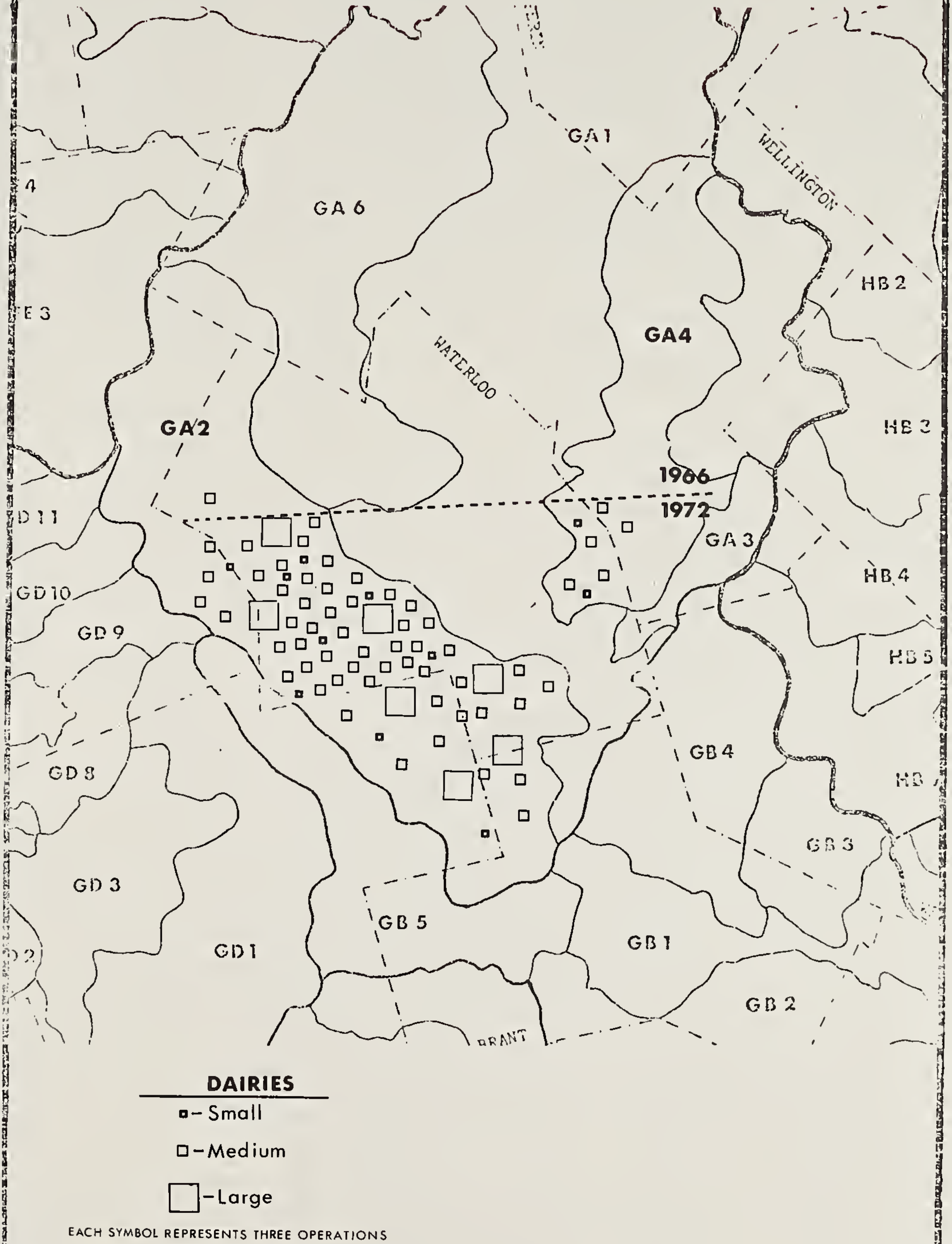
Tables IV-1 and IV-2 provide 'inventory' information as to the type, size and general location of interpreted livestock operations in the Nith and Speed River Basins respectively. Some of this material is graphically presented on Maps IV-6, IV-7, IV-8 and IV-9. These presentations, together with the tables, illustrate:

- Numerical relationships between different sized operations[7/] of the same livestock type (Nith River Basin)[8/]:

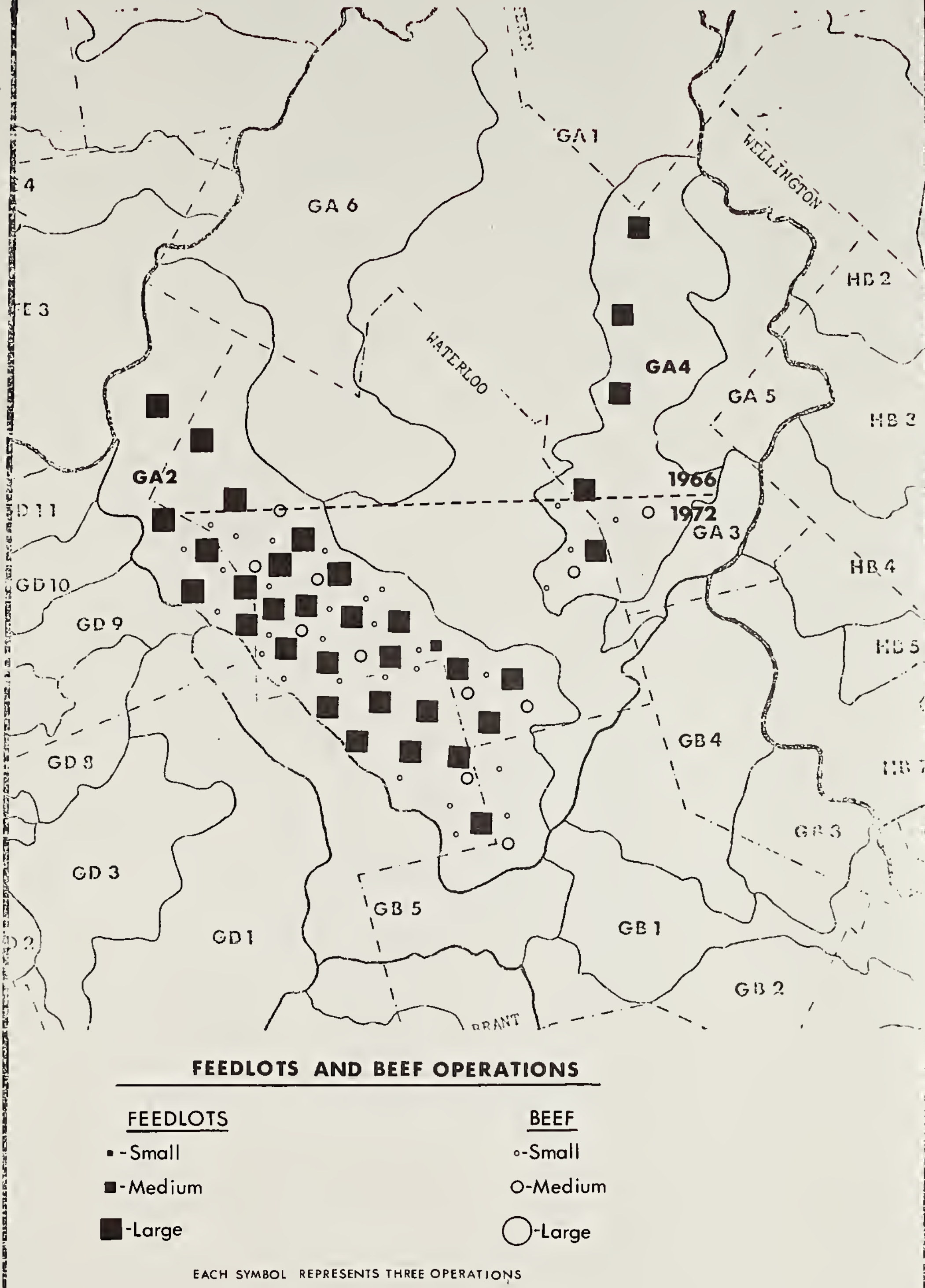
6/ This project generally interpreted, calculated numbers for, and recorded livestock operations as predominately dairy, beef, steers, hogs, and poultry. Throughout the study 'beef' was used to refer to non-dairy cow/calf operations, whereas 'steers' was used to refer to or designate feedlots or confined facility beef cattle operations. 'Pigs' referred to either sow or feeder operations, and usually to an integrated mixture of sows and/or feeders at one farm site.

7/ The number of livestock within each size class range for each livestock type reflects approximately equivalent manure nutrient production; however, the ranges of manure nutrient production within each size class were arbitrarily chosen.

8/ This observation is based only on 1972 photo data for Watershed GA-2, since, in this case, all size classes were recorded.



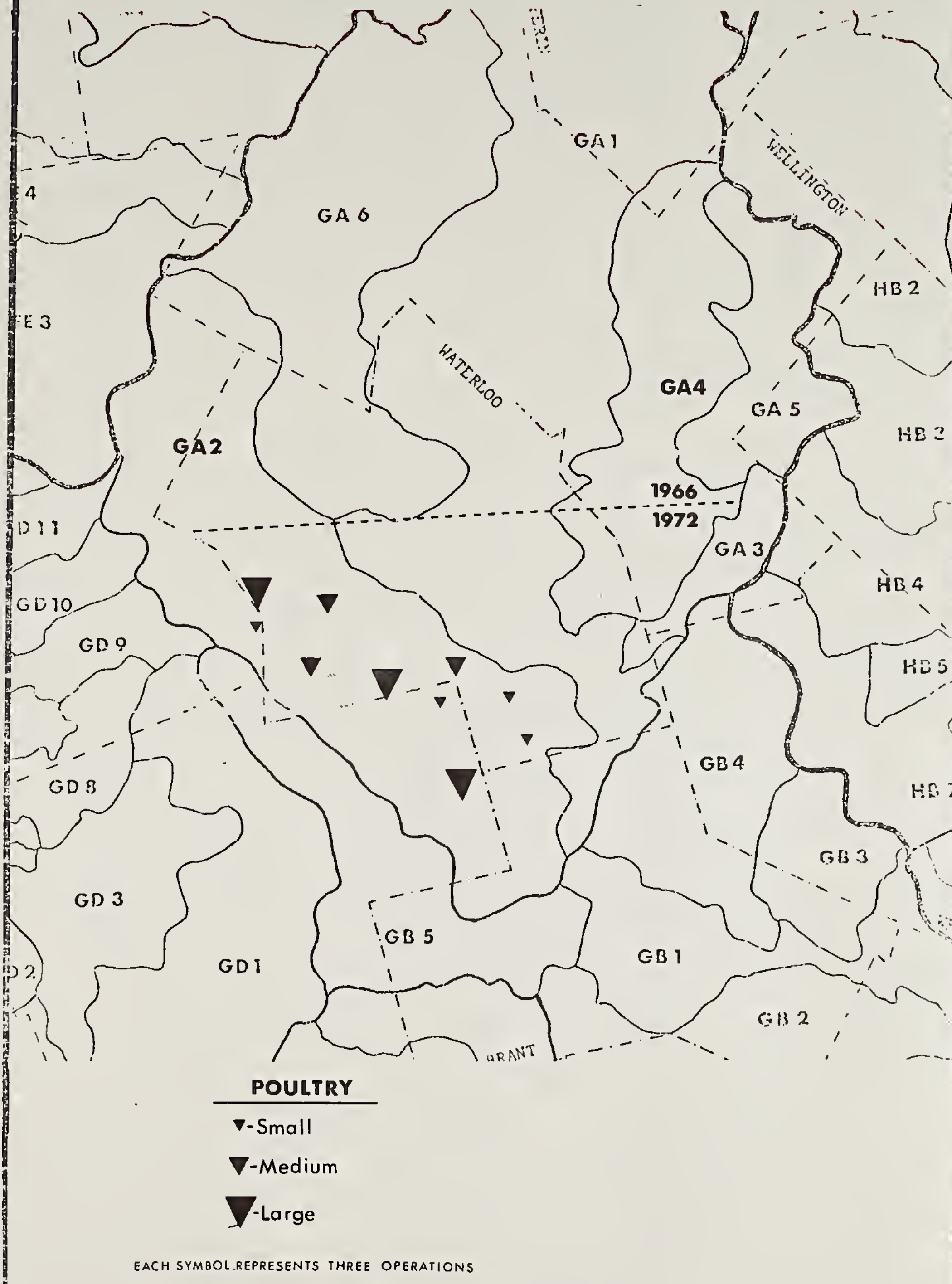
Map IV-6 Watersheds GA-2 (Nith River Basin) and GA-4 (Speed River Basin) - Dairy Operations



Map IV-7 Watersheds GA-2 (Nith River Basin) and GA-4 (Speed River Basin) - Feedlots and Beef Operations

EACH SYMBOL REPRESENTS THREE OPERATIONS

Map IV-8 Watersheds GA-2 (Nith River Basin) and GA-4 (Speed River Basin) - Pig Operations



Map IV-9 Watersheds GA-2 (Nith River Basin) and GA-4 (Speed River Basin) - Poultry Operations

- Dairy farms (Map IV-6) - Medium size dairy farms, that is those having between 25 and 74 cows, dominate the dairy industry in this watershed. The distribution of total numbers of animals between small, medium and large in this area was 7%, 69% and 24% respectively.
- Feedlot and Beef operations (Map IV-7) - Feedlot (steer) operations fall almost entirely into the "large" or class 3 category of greater than 150 cattle. Of the feedlot population, 98% was found in large operations. Conversely, beef operations (beef cow/calf) are either medium (50 - 149) or small (<50), with the latter being the dominant size class. However, 55% of the total number of these animals were in "small" operations, and 38% in "medium".
- Pigs (Map IV-8) - Pig operations vary widely in size, but large scale operations (>300 pigs) and medium sized farms (100 - 300 pigs) tend to dominate. Again, however, almost 80% of the total number of pigs appear to be housed in the "large" operations, and 18% in the "medium".

- Distribution of livestock operations of different types and sizes:
  - The area of the Nith River Basin (GA-2) covered by 1972 photography contains a uniform distribution of large dairy, feedlot and pig operations, with essentially no dominant type for the region, but there are few large poultry operations. The area of the Speed River Basin (GA-4) covered by 1972 photography has no large poultry or dairy farms, and pig operations are dominant in this region.

- Relationships between data from 1966 and 1972 photography:
  - Comparison between 1966 and 1972 photography can only be made with large sized operations, since only selective inventory coverage was done on 1966 photographs. In 1966 very few livestock farms of size class three were present in this area, and those that were present were either beef feedlots or, to a lesser extent, pigs. The data implies that there has been a considerable increase in the size of most livestock operations since 1966, but no estimate of any changes in the total numbers of livestock can be made. The date of photography must always be considered when making inferences from the data contained in this report.

TABLE IV-1 INTERPRETED LIVESTOCK OPERATIONS* - WATERSHED GA-2 (in southern 2/3 of this basin, <u>all</u> livestock operations were recorded)

	Large Total Units	Number	Map Sheet Designation **	Enumeration District Designation ***	Medium Total Units	Number	Map Sheet Designation **	Enumeration District Designation ***	Small Total Unit	Number	Map Sheet Designation **	Enumeration District Designation ***
Dairy	22	2,328	P/2 (1) P/7 (13) P/8 (8)	550 (4) 555 (8) 576 (8) 579 (2)	167	6,697	P/1 (8) P/2 (2) P/7 (138) P/8 (19)	502 (9) 550 (15) 555 (124) 576 (14) 579 (5)	31	663	P/1 (4) P/7 (26) P/8 (1)	502 (2) 550 (3) 555 (23) 579 (3)
Beef	2	370	P/8 (2)	555 (2)	27	1,898	P/1 (3) P/7 (17) P/8 (7)	502 (4) 550 (1) 555 (17) 576 (5)	83	2,764	P/1 (10) P/7 (63) P/8 (10)	502 (7) 550 (10) 555 (59) 576 (7)
Feedlot Cattle	84	26,914	P/1 (7) P/2 (1) P/7 (55) P/8 (16) P/10(4)	502 (12) 550 (16) 555 (41) 576 (11) 579 (4)	5	575	P/1 (1) P/7 (1) P/8 (3)	550 (2) 555 (1) 576 (2)			N I L	
Hogs	53	28,678	P/1 (5) P/7 (39) P/8 (5) P/10(4)	502 (5) 550 (11) 555 (30) 576 (3) 579 (4)	33	6,669	P/1 (7) P/7 (23) P/8 (2) P/10(1)	502 (4) 550 (4) 555 (19) 576 (2) 579 (4)	14	850	P/7 (2) P/8 (12)	550 (1) 555 (1) 576 (11) 579 (1)
Poultry	9	>300,000	P/2 (1) P/7 (7) P/8 (1)	550 (2) 555 (5) 576 (1) 579 (1)	10	~250,000	P/7 (9) P/10(1)	555 (10)	14	~140,000	P/7 (14)	550 (2) 555 (11) 579 (1)

* Size Class	Large	Medium	Small	Units
Dairy	≥ 75	25- 74	< 25	Milk cows
Beef	≥ 150	50-149	< 50	Cows/calves
Feedlot Cattle	≥ 150	50-149	< 50	Fattening beef
Hogs	≥ 300	100-299	< 100	Breeding and/or fattening hogs
Poultry	≥ 30,000	10,000-30,000	< 10,000	Birds

** Refers to NTS 1:50,000 map sheets on which operations are located.
*** Refers to Enumeration Districts compiled by Statistics Canada for survey and data collection purposes.
All numbers in brackets () refer to actual number of operations recorded.

TABLE IV-2 INTERPRETED LIVESTOCK OPERATIONS* - WATERSHED GA-4 (Selective survey only)

Type of Operation	Large Total	Number	Map** Sheet Designation	Enumeration*** District Designation	Medium Total	Number	Map Sheet Designation	Enumeration District Designation	Small Total	Number	Map Sheet Designation	Enumeration District Designation
Dairy	NIL	Nil			13	490	P/8 (13)	578 (3) 576 (10)	9	195	P/8 (9)	576 (6) 578 (3)
Beef Cattle	NIL	Nil			6	395	P/8 (6)	578 (3) 576 (3)	13	580	P/8 (12) P/1 (1)	502 (1) 576 (9) 578 (3)
Feedlot Cattle	16	4,893	P/7 (1) P/8 (5) P/9 (9) P/16(1)	576 (3) 578 (12) 579 (1)	1	100	P/8 (1)	576 (1)	NIL	Nil		
Hogs	13	8,615	P/7 (1) P/8 (11) P/16(1)	576 (5) 578 (7) 579 (1)	3	673	P/8 (2) P/9 (1)	576 (1) 578 (2)	NIL	Nil		
Poultry	1	30,000	P/16 (1)	579 (1)	NIL	Nil			1	8,700	P/8 (1)	578 (1)

*, **, *** - See Notes Below Table I.

All numbers in brackets, (), refer to real number of operations recorded.

Tables IV-3 and IV-4 represent an example of data concerned with the characteristics of, and possible pollution implications for, livestock operations as interpreted from aerial photography. Characteristics noted directly include type of confinement, range of slope in immediate vicinity of buildings, and type of manure storage. Animal population per operation according to size class is presented as an average of data recorded as interpreted. Distances of buildings or confinement facilities from the nearest runoff channel, the nearest stream or lake, the nearest municipal road, and the nearest settlement of four or more houses are presented as numbers of operations within a range of distance.

- Proximity of livestock operation facilities to water channels, municipal roads and residential areas provide information which can be of value in assessing the present or potential water, air or aesthetic pollution problem associated with a particular livstock farm.

- Comparison of the livestock operation location data (Maps IV-6 IV-7, IV-8 and IV-9) and the soil potential for pollutant transfer to water systems data (See Section I) provides information concerning the relationship of livestock wastes and potential pollution problems. For example, although the livestock distribution is uniform for the portion of the Nith River Basin covered by 1972 photography, the soil potential for pollution transfer varies from Group 3 (high potential to transfer pollutants to ground water, low potential to surface water) to Group 1 (high potential to transfer pollutants to surface water and low potential to ground water). Possible pollution implications for livestock farms in the two soil areas may be quite different.

- Information as to the type of confinement or shelter facility and the type of manure storage can be used to note present management practices and trends in specific areas or as related to agricultural regions of Southern Ontario. For example, it is of interest to note that in the southern part of the Nith River basin, in 1972 there were no dairy farms which had adopted the liquid manure storage facility, although this type of storage is becoming more common in Ontario.

TABLE IV-3 CHARACTERISTICS* OF LIVESTOCK OPERATIONS - WATERSHED GA-2 (in southern 2/3 of this basin, all livestock operations were recorded)

Livestock Operation and Size Class	Average** Size of Operation No. Animals	Distance from Run-off Channel feet	Distance Stream or Lake feet	Confinement	Average** Slope Vicinity of Buildings %	Manure Storage Type	Proximity of Road feet	Proximity of Urban Area feet
Dairy - Large (22)	105.8	<100 (9) 100-500 (7) >500 (6)	<100 (0) 100-500 (2) >500 (20)	Outside range (15) Outside feeder(7)	0 - 5 (16) 5 -10 (3) > 10 (1) N.R. (2)	Solid (18) Semi-solid(3)	<100 (1) 100-500 (15) >500 (6)	<1000 (2) 1000-5000 (3) >5000 (17)
Medium (167)	40.1	<100 (68) 100-500 (68) >500 (10) N.R. (21)	<100 (6) 100-500 (33) >500 (128) N.R. (0)	Outside range (144) Outside feeder(15) Covered (5) N.R. (3)	0 - 5 (123) 5 -10 (35) > 10 (3) N.R. (6)	Solid (161) Semi-solid(4) N.R. (2)	<100 (5) 100-500 (89) >500 (68) N.R. (5)	<1000 (3) 1000-5000 (19) >5000 (0) N.R. (145)
Small (31)	21.4			Outside range (7) N.R. (24)	0 - 5 (4) 5 -10 (3) N.R. (24)	Solid (7) N.R. (24)		
Beef - Large (2)	185.0	<100 (2)	>500 (2)	Outside feeder(2)	0 - 5 (2)	Solid (2)	<100 (1) >500 (1)	>5000 (2)
Medium (27)	70.3	<100 (9) 100-500 (11) >500 (4) N.R. (3)	<100 (0) 100-500 (5) >500 (22)	No cover (1) Outside range (18) Outside feeder(4) Covered (4)	0 - 5 (20) 5 -10 (5) N.R. (1)	Solid (24) Semi-solid(3)	<100 (0) 100-500 (13) >500 (12) N.R. (2)	<1000 (0) 1000-5000 (3) >5000 (0) N.R. (24)
Small (83)	33.3			No cover (1) Outside range (17) Outside feeder(1) Covered (4) N.R. (60)	0 - 5 (10) 5 -10 (11) > 10 (2)	Solid (21) Semi-solid(2)		
Feed-lot Cattle - Large (84)	320.4	<100 (22) 100-500 (34) >500 (28)	<100 (2) 100-500 (17) >500 (65)	Outside range (9) Outside feeder(71) Covered (4)	0 - 5 (61) 5 -10 (15) > 10 (2) N.R. (6)	Solid (24) Semi-solid(60)	<100 (8) 100-500 (42) >500 (34)	<1000 (1) 1000-5000 (1) >5000 (82)
Medium (5)	115.0	<100 (1) 100-500 (4)	<100 (0) 100-500 (1) >500 (4)	No cover (1) Outside feeder(4)	0 - 5 (4) 5 -10 (1)	Solid (3) Semi-solid(2)	<100 (1) 100-500 (2) >500 (2)	<1000 (0) 1000-5000 (0) N.R. (5)
Small (NIL)								
Hogs - Large (53)	541.1	<100 (19) 100-500 (26) >500 (8)	<100 (1) 100-500 (7) >500 (45)	Outside range (1) Outside feeder(2) Covered (49) N.R. (1)	0 - 5 (38) 5 -10 (13) > 10 (2)	Solid (5) Semi-solid(42) Liquid (6)	<100 (6) 100-500 (25) >500 (22)	<1000 (0) 1000-5000 (2) >5000 (51)
- Medium (33)	202.1	<100 (11) 100-500 (13) >500 (7) N.R. (1)	<100 (0) 100-500 (5) >500 (27) N.R. (0)	Outside range (0) Covered (22) N.R. (1)	0 - 5 (5) 5 -10 (17) N.R. (1)	Solid (11) Semi-Solid(20) Liquid (1) N.R. (1)	<100 (3) 100-500 (15) >500 (12) N.R. (2)	<1000 (2) 1000-5000 (1) >5000 (0) N.R. (29)
Small (14)	60.7			Outside feeder(3) Covered (7) N.R. (4)	0 - 5 (7) 5 -10 (4) N.R. (3)	Solid (6) Semi-solid(5) N.R. (3)		
Poultry - Large (9)	> 30,000	<100 (4) 100-500 (2) >500 (3)	<100 (0) 100-500 (1) >500 (8)	Outside range (1) Covered (8)	0 - 5 (5) 5 -10 (4)	Solid (3) Semi-solid(6)	<100 (1) 100-500 (4) >500 (4)	<1000 (0) 1000-5000 (2) >5000 (7)
Medium (10)	~25,000	<100 (3) 100-500 (5) >500 (1) N.R. (1)	<100 (0) 100-500 (1) >500 (9)	Outside feeder(1) Covered (9)	0 - 5 (6) 5 -10 (4)	Solid (6) Semi-solid(4)	<100 (0) 100-500 (9) >500 (1)	<1000 (0) 1000-5000 (3) >5000 (0) N.R. (7)
Small (14)	~10,000			Covered (2) N.R. (12)	0 - 5 (2)	Solid (1) Semi-solid(2)		

* See Appendix IV-2, See notes below Table IV-1.

** Average denotes average recorded unit of particular characteristic for all operations of given type and sizes, except where only one is present, then actual recorded material is provided.

All numbers is brackets ( ) refer actual number of operations for which characteristic was recorded.

N.R. = Not Recorded.

TABLE IV-4 CHARACTERISTICS* OF LIVESTOCK OPERATIONS WATERSHED GA-4 (Selective inventory survey only)

Livestock Operation and Size Class		Average** Size of Operation No. Animals	Distance from Run-off Channel feet	Distance Stream of Lake feet	Confinement	Average** Slope Vicinity of Buildings %	Manure Storage Type	Proximity of Road feet	Proximity of Urban Area feet
Dairy -	Large (NIL)								
	Medium (13)	37.7	<100 (2) 100-500 (7) >500 (3) N.R. (1)	<100 (0) 100-500 (1) >500 (12)	Outside range (13)	0 - 5 (4) 5 -10 (6) > 10 (2) N.R. (1)	Solid (13)	<100 (2) 100-500 (6) >500 (5)	<1000 (0) 1000-5000 (1) >5000 (0) N.R. (12)
	Small (9)	21.7			Outside range (9)	5 -10 (6) > 10 (2) N.R. (1)	Solid (9)		
Beef -	Large (NIL)								
	Medium (6)	65.8	<100 (3) 100-500 (2) >500 (1)	<100 (0) 100-500 (0) >500 (6)	Outside range (6)	0 - 5 (1)	Solid (6)	<100 (0) 100-500 (4) >500 (2)	<1000 (1) 1000-5000 (1) N.R. (4)
	Small (13)	44.6			Outside range (13)	0 - 5 (2) 5 -10 (6) > 10 (4) N.R. (1)	Solid (13)		
Feed-lot Cattle -	Large (16)	305.8	<100 (6) 100-500 (5) >500 (5)	<100 (0) 100-500 (2) >500 (14)	Outside feeder(16)	0 - 5 (13) 5 -10 (2) N.R. (1)	Solid (2) Semi-solid(13) N.R. (1)	<100 (1) 100-500 (7) >500 (8)	<1000 (0) 1000-5000 (2) >5000 (14)
	Medium (1)	100.0	100-500 (1)	>500 (1)	Outside feeder(1)	> 10 (1)	Solid (1)	>500 (1)	N.R. (1)
	Small (NIL)								
Hogs -	Large (13)	662.7	<100 (4) 100-500 (7) >500 (2)	<100 (0) 100-500 (4) >500 (9)	Covered (13)	0 - 5 (7) 5 -10 (6)	Solid (2) Semi-solid(4) Liquid (5) N.R. (1)	<100 (2) 100-500 (10) >500 (1)	<1000 (1) 1000-5000 (2) >5000 (10)
	Medium (3)	244.4	100-500 (2) N.R. (1)	100-500 (0) >500 (3)	Covered (3)	0 - 5 (2) 5 -10 (1)	Solid (1) Semi-solid(2)	100-500 (2) N.R. (1)	>5000 (1) N.R. (2)
	Small (NIL)								
Poultry-	Large (1)	>30,000.0	>500 (1)	>500 (1)	Outside feeder(1)	0 - 5 (1)	Semi-solid(1)	100-500 (1)	>5000 (1)
	Medium (NIL)								
	Small (9)	8,700.0			Covered (1)	5 -10	Solid (1)		

* See Appendix IV-2, See notes below Table IV-1.

** Average denotes average recorded unit of particular characteristic for all operations of given type and size, except where only one is present, the actual recorded material is provided.

All numbers in brackets ( ) refer actual number of operations for which characteristic was recorded.

N.R. = Not recorded

ANALYSIS OF THE PROJECT:

Referring to the list of objectives of the project on page 61 it can be generally concluded that these objectives were achieved. However, the objectives included a greater degree of analysis and interpretation of the data collected than was possible within the time and funds allotted. It may therefore be concluded that the potential usefulness of the data generated has by no means been exhausted.

The application of the methodology used in this project was somewhat unique. Questionaire techniques are most often used for surveys or inventories of this type. It is therefore of interest to compare the results and resource demands of this approach with that which would probably have been necessary had a questionaire technique been used. Approximately $10,000 was spent on aerial photographs. To obtain the information for an equivalent number of large farms by enumeration, at least 100,000 questionaires would have to be mailed out at a cost of approximately $20,000. This assumes a return rate of 20%, which is common for such surveys, and allows for the fact that only about 20% of the farms in the area can be considered 'large' in the context of this project. However, it is impossible to estimate how many of the questionaires returned would be from farm operations which would be of interest to this inventory either because of size or because of location. Extensive follow-up checks would therefore be necessary to ensure that the largest and most significant operations had not been omitted. Consultation with local agricultural representatives would be required to estimate the value and significance of the returns; and it is worthwhile to note here that, at the planning stage of this project, Ontario Ministry of Agriculture and Food Extension Service Representatives indicated that there would probably be an unwillingness to participate in such consultations should they be requested.

Although data storage and retrieval costs would be similar if either enumeration or airphoto techniques were used, the technical manpower requirements would be different. The project used approximately 1.3 man years of technical manpower, plus training, supervision and consultation. The total time taken to complete the selection, interpretation and recording processes averaged approximately 30 minutes per farm recorded over the whole project. However, it must be emphasized that in the later phase of the project when only large farms (or smaller sized farms close to streams or urban areas) were being recorded, at least five times as many farms were looked at, and an evaluation made of their relation to the criteria for inclusion in the inventory. Thus the average time per farm looked at is closer to 5 minutes, which compares favourably with the time needed to read and evaluate returns from a questionaire. Moreover, time is not wasted on farm operations which are clearly of no interest to an inventory of this type.

The estimated number of animals in a set of buildings is based on the estimated capacity of these buildings. Except for situations where the farm is clearly unused, the data recorded represents the probable maximum capacity, and not the actual number of animals present. The number of animals of a given type housed in a given area will vary from farm to farm depending on the operator, and will vary at different times of the year.

An advantage of the airphoto technique can also be cited as the ability to re-check and re-interpret any specific farm or region at any time. This permits the amendment of recorded data in the light of information or expertise which may become available at a later time. Interfarm comparisons may also be made with greater objectivity and confidence as similar criteria can be applied to each farm. Data such as distances from streams or roads can be compared with greater confidence if collected from airphotos than if only estimates made by different farm operators can be used. Considerable individual bias is therefore removed.

A disadvantage of the approach used in this study, however, is the need for competent airphoto interpreters who are familiar with Canadian agricultural practices, and with the region being surveyed. Such interpreters are not always readily available. Another disadvantage is that the results are dependent upon the date of the photography. If the area is covered by photography taken at intervals several years apart, inter-area comparisons are impossible.

A further problem is that of interpretation differences between airphoto interpreters. Generally, large modern livestock facilities present few difficulties. However, old or converted buildings must be considered in the light of other factors (such as feed storage, vehicle tracks etc.). In these cases, interpretation becomes critical for accurate determinations.

Some of the information requested on the interpretation forms, which are filled out by the interpreters, is liable to vary. Estimating the manure handling and storage facilities requires a thorough knowledge of farm practice. Liquid manure, if used, is usually clearly evident. However, the differences between solid (with bedding) and semi-solid (free stall) manure is dependant primarily on building type for interpretation. Ultimate disposal of manure is impossible to determine from photographs taken at only one date in the year. Measured distances to streams, roads, etc., usually present no difficulties, unless it is in determining what is a runoff channel (intermittant flow) and what is a stream (year round flow).

The data presented on the maps and in the appendix are a good estimate of large livestock operations taken as a whole. If, however, individual farm sites are selected for further study, no detail should be taken from this report without further clarification of the operation characteristics from either ground checks or from very recent aerial photography.

REFERENCES

Agriculture Canada Publications:

Number 1451, 1971, Confinement Swine Housing

Number 1442, (Section 4), 1973, Swine Production, Building and Equipment

Number 1509, 1973, Broiler Raising in Canada

Number 1404, 1969, Ventilation of Livestock Buildings

Number 1358, 1968, Corn for Livestock and Poultry

Number 1503, 1973, Engineering for Intensive Housing of Livestock

Number 1390, 1969, Farm and Ranch Equipment for Beef Cattle

Agriculture Canada, Canada Farm Building Plan Service - revised catalogues:

Beef Cattle Housing and Equipment, 1970, catalogue of plans, 40 p.

Dairy Cattle Housing and Equipment, 1968, catalogue of plans, 52 p.

Agricultural & Rural Development Act Administration (ARDA), 1967-1969, Canada Land Inventory, Soil Capability for Agriculture: 1:250,000 maps and related texts for Southern Ontario map sheets, Lands Directorate, Environment Canada.

Bird, N.A., (no date), Modern Poultry Buildings, Department of Agriculture and Food, Ontario.

Canada Department of Agriculture; Ontario Department of Agriculture & Food, Ontario, (various years), Soil Survey reports and accompanying maps of counties in Southern Ontario.

Canada Animal Waste Management Guide Committee (Canada Committee on Agricultural Engineering), 1972, Canada Animal Waste Management Guide.

Chapman, L.J. and D.F. Putnam, 1966, The Physiography of Southern Ontario, University of Toronto Press, Toronto, 386 p.

Clarke, J.H., 1972, Problem Areas of Odour Pollution in the Livestock Industry, 9 p., University of Guelph, unpublished.

Department of Agriculture and Food, Ontario, (no date), Beef Husbandry in Ontario, Publication 509, 86 p.

McClellan, J.B., L. Jersak, C.L.A. Hutton, 1968, A Guide to the Classification of Land Use for the Canada Land Inventory, 18 p., Lands Directorate, Environment Canada.

Ryerson, R.A., 1973, An Interpretation Training Package for the Remote Enumeration of Livestock in Southern Ontario, Applications Division, Canada Centre for Remote Sensing, Ottawa, unpublished.

Ryerson, R.A., 1974, An Investigation of Agricultural Data Collection from Aerial Photography: The Prediction of Land Use Change. (Unpublished, Ph.D. Thesis pending, Faculty of Environmental Studies, University of Waterloo, Waterloo, Ontario).

Ryerson, R.A. and H.A. Wood, 1971, "Air Photo Analysis of Beef and Dairy Farming", Photogrammetric Engineering, Feb. 1971, 157-169 p.

Statistics Canada:

User Summary Tapes, Agriculture, 1971 Census.

United States Department of Agriculture, Miscellaneous Publications:

Number 1129, Issued March 1969, 3-storey Broiler House

Number 1120, Issued February 1969, Poultry House-floor Management

Number 1218, Issued December 1971, Finishing Floor for 400 Pigs

Number 1179, Issued October 1970, Farrowing House for Sows

Number 1112, Issued January 1969, Farrowing and Growing Building for Hogs

Number 1159, Issued January 1969, Farrowing House - tilt-up concrete construction

Numbers 1117, 1134, 1137

APPENDICES

APPENDIX I.

AGRICULTURAL AREA NO. 1

Kent and Essex Cash-crop Clays

1. Area — Most of Essex County; Lambton County except the Northeast section; South and West Kent County

2. Climate — Climate 1 (West)

3. Size — Area about 1,560 miles^2 (4,040 km^2)

4. Soils — Soils of Group V - high potential for contribution of pollutants to surface and ground water. Clays of the St.Clair Clay Plains. High capability restricted slightly by wetness (Class 2_W).

5. Crops — Corn, Soybeans - high density

   Small grains, Vegetables - moderate density

   Tobacco, Fruits, Hay - low density

6. Livestock — Hogs - moderate to high density

   Others - low density

7. Other Regions Represented: A small area in Southwest Middlesex County; scattered areas along the shoreline of Huron County.

REPRESENTATIVE SUB-WATERSHED NO. 1

1. Location — Big Creek tributary of the Thames River, at bridge Concession 9, West of Strangfield Intersection
   U.T.M. Zone 17 - 374,750 M. East
   - 4,672,100 M. North

2. Area — 20.7 miles^2 (53.7 km^2)

3. Existing Gauging: None

4. River Basin — Thames River - Lands Directorate System 2GH-9
   - M.O.E. System - 1

AGRICULTURAL AREA NO. 2

Norfolk Sands

1. Area — Norfolk County; Southwest Brant County; Northeast Oxford County

2. Climate — Climate 1

3. Size — Area about 920 $miles^2$ (2,382 km^2)

4. Soils — Soils of Group III - high potential for contamination of ground water. Sands of the Norfolk Sand Plain. Capability moderate to low for most crops (2_S, 3_S, 4_S), some wetness limitations (5_W).

5. Crops — Tobacco - high density

   Corn, Fruits - very variable in density

   Small grains - moderate density

   Soybeans, vegetables, hay - low density

6. Livestock — All livestock - low density

7. Other Regions Represented: Small areas of tobacco grown on sands scattered through the southern part of the province.

REPRESENTATIVE SUB-WATERSHED NO. 2

1. Location — North Branch, North Creek tributary of Big Creek.
   At Highway 3.
   U.T.M. Zone 17 - 539,400 M. East
   - 4,744,500 M. North

2. Area — 9.8 $miles^2$ (25.3 km^2)

3. Existing Gauging: None

4. River Basin — Big Creek - Lands Directorate System 2GC-4
   - M.O.E. System - 6

ACRICULTURAL AREA NO. 3

Middlesex Intensive Mixed-farming Clays

1. Area — Northeast Lambton County; Northwest Middlesex County; South Huron County; West Perth County; North Elgin County; South Oxford County

2. Climate — Climate 1 (West)

3. Size — Area about 1,633 miles^2 (4,230 km^2)

4. Soils — Soils of Group I - high potential for contamination of surface water. Soils mainly clays and loams. Capability is high with some slope restrictions (1, 3_T).

5. Crops — Corn - high density

   Small grains, soybeans - moderate density

   Tobacco, fruits, vegetables, hay - low density

6. Livestock — Total Cattle, hogs - high density

   Others - low to moderate density

7. Other Regions Represented: Scattered areas in Essex, Kent and Southern Middlesex Counties.

REPRESENTATIVE SUB-WATERSHED NO. 3

1. Location — Little Ausable River at Second Bridge downstream of Elimville
   U.T.M. Zone 17 - 466,000 M. East
   - 4,795,400 M. North

2. Area — 23.8 miles^2 (61.8 km^2)

3. Existing Cauging: Existing summer gauging station at Lucan - about 8 miles downstream

4. River Basin — Ausable River - Lands Directorate System 2FF-5
   - M.O.E. System - 31

AGRICULTURAL AREA NO. 4

Wellington Dairy Farming Clays

1. Area — Central Wellington County; Northwest Waterloo County; East Perth County; North Oxford County

2. Climate — Climate 2

3. Size — Area about 611 $miles^2$ (1,532 km^2)

4. Soils — Soil Group I - high potential for contamination of surface water. Mainly clays and loams of the Stratford and Dundalk Till Plains. High capability restricted somewhat by slope (Class 1, 3_T)

5. Crops — Small grains - high density

   Hay - moderate density

   Soybeans, corn, vegetables, fruits - low density

   Tobacco - none

6. Livestock — Dairy, hogs - high density

   Others - low to moderate density

7. Other Regions Represented: Scattered areas in South Wellington County.

REPRESENTATIVE SUB-WATERSHED NO. 4

1. Location — Canagagigue Creek - above Flordale at Wellington-Waterloo County line
   U.T.M. Zone 17 - 532,000 M. East
   - 4,834,700 M. North

2. Area — 7.3 $miles^2$ (18.9 km^2)

3. Existing Gauging: Existing Federal gauging Station at the same location. Good records.

4. River Basin — Grand River - Lands Directorate System 2GA-1
   - M.O.E. System - 10G

AGRICULTURAL AREA NO. 5

Oxford-Waterloo Dairy Farming Loams

1. Area — Central Waterloo and Central Oxford Counties
2. Climate — Climate 1
3. Size — Area greater than 990 miles^2 (2,564 km^2)
4. Soils — Area of Soil Group IV, Soil Group II and Group IV/II Complex. Loams of the Waterloo Hills/Oxford Till Plain regions. Low to moderate potential for pollutant transfer to either surface or ground water. Mostly high capability (Class 1)
5. Crops — Corn - high density

   Small grains, hay - moderate density

   Soybeans, vegetables, fruit trees - low density
6. Livestock — Dairy, hogs - high density

   Others - low to moderate density
7. Other Regions Represented: Small regions in Middlesex, Elgin and Oxford Counties.

REPRESENTATIVE SUB-WATERSHED NO. 5

1. Location — Unnamed tributary of the Middle Thames River, at First Bridge, upstream from the Middle Thames, approximately 3 miles West of Embro

   U.T.M. Zone 17 - 503,000 M. East
   - 4,775,000 M. North
2. Area — 12.0 miles^2 (31.1 km^2)
3. Existing Gauging: None
4. River Basin — Thames - Lands Directorate System - 2GD-3
   - M.O.E. System - 27E

AGRICULTURAL AREA NO. 6

Huron Mixed Farming

1. Area — North Huron County; South Bruce County

2. Climate — Climate 2

3. Size — Area about 786 $miles^2$ (2,036 km^2)

4. Soils — Soils of Group III/IV Complex. Mainly soils with high potential for transfer of pollutants to ground water (sandy, organic and swampy regions) surrounded by soils of low potential for pollutant transfer to surface or ground water. Soils mainly sands and loams of Horseshoe Moraines (West) physiographic regions.

   Capability ranges from high to extremely low because of wetness, steepness or stoniness (1, 2_W, 4_S, 6_{TS})

5. Crops — Small grains, hay - moderate density

   Corn, fruit, vegetables - low density

6. Livestock — All livestock - low to moderate density

7. Other Regions Represented: In conjunction with Sub-Watershed No. 4, a large area of the upland region including soils of Groups I, II, III and IV

REPRESENTATIVE SUB-WATERSHED NO. 6

1. Location — Teeswater River East of Village of Teeswater, at N/S Highway 2 miles East of Highway 4

2. Area — 2o.2 $miles^2$ (52.4 km^2)

3. Existing Gauging: None. Water Quality Station (M.O.E.) planned for downstream of Teeswater

4. River Basin — Saugeen - Lands Directorate System 2FC-6
   - M.O.E. System - 36A

AGRICULTURAL AREA NO. 7

Lake Ontario Shores

1. Area — Most of Northumberland; Most of Durham; South Peterborough; South Ontario Counties

2. Climate — Climate 1 (East)

3. Size — Greater than 2,000 $miles^2$ (5,180 km^2)

4. Soils — Soils of Groups I and III, with a smaller area of Group IV, includes soils with a high potential for contribution to surface water, soils with a high potential for pollution of ground water and a small area of soils with low potential for surface and ground.

   Mainly sands, sandy loams, with some shallow soils. Capability ranges from high to low, with soil and slope limitations.

5. Crops — Small grains, hay - moderate to high density

   Tobacco - moderate density

   Corn - low density

6. Livestock — All livestock - moderate density

7. Other Regions Represented: None

REPRESENTATIVE SUB-WATERSHED NO. 7

1. Location — Ganaraska River, at bridge over Northwest branch, North of Osaca
   U.T.M. Zone 17 - 705,200 M. East
   - 4,876,800 M. North

2. Area — 15.8 $miles^2$ (40.8 km^2)

3. Existing Gauging: Existing Federal recording gauge, continuous operation. (Water Survey of Canada).

4. River Basin — Ganaraska Creek - Lands Directorate System 2HD-6
   - M.O.E. System - 24

AGRICULTURAL AREA NO. 8

Perth Poorly Drained Clays

1. Area — Central Perth County

2. Climate — Climate 2

3. Size — Area about 108 $miles^2$ (280 km^2)

4. Soils — Soils of Group V - high potential for contamination of surface and ground water. Poorly drained clays of the Stratford Till Plain. Capability is reduced by poor drainage (Class 2)

5. Crops — Small grains - high density

   Hay - moderate density

   Corn, vegetables, soybeans, fruits - low density

   Tobacco - none

6. Livestock — Dairy, hogs - moderate to high density

   Others - low to moderate density

7. Other Regions Represented: In conjunction with Sub-Watershed No. 3, will represent Area 17.

REPRESENTATIVE SUB-WATERSHED NO. 8

1. Location — Boyle Drain at first road East of Highway 23, South Branch, 2-3 miles Northeast of Monkton
   U.T.M. Zone 17 - 497,100 M. East
   - 4,828,400 M. North

2. Area — 14.9 $miles^2$ (38.5 km^2)

3. Existing Gauging: Boyle Drain has Federal gauging downstream at Atwood (about 5 miles downstream)

4. River Basin — Maitland River (Middle Maitland) - Lands Directorate System 2FE-3
   - M.O.E. System - 34C

AGRICULTURAL AREA NO. 9

Escarpment Sands

1. Area — North Brant County; Southeast Waterloo; South and East Wellington; Northwest Halton; Northwest Peel; Southeast Dufferin; Central Simcoe

2. Climate — Climate 1 (East)

3. Size — Area about 1,292 miles^2 (3,346 km^2)

4. Soils — Soils of Group III - high potential for contribution of pollutants to ground water. Soils are mainly sands and permeable loams of the Horseshoe Moraines physiographic region. Capability is medium to low, mainly due to steepness or stoniness (Class 2_S, 4_S, 5_{TP})

5. Crops — Corn, small grains - moderate to high density

   Vegetables, hay - low to moderate density

   Soybeans, fruits, tobacco - low density

6. Livestock — Beef - moderate to high density

   Hogs - variable

   Others - low to moderate density

7. Other Regions Represented: None.

REPRESENTATIVE SUB-WATERSHED NO. 9

1. Location — West Humber River upstream of Cedar Mills - at first road West of Ballycroy about 7 miles upstream of Cedar Mills.
   U.T.M. Zone 17 - 589,100 M. East
   - 4,869,000 M. North

2. Area — 21.9 miles^2 (56.7 km^2)

3. Existing Gauging: Existing Federal gauging station at Cedar Mills

4. River Basin — Humber River - Lands Directorate System 2HC-4
   - M.O.E. System - 20

ACRICULTURAL AREA NO. 10

Haldimand Clays

1. Area — Most of Haldimand County; South Lincoln County; Northwest Welland County; South Wentworth County; East Brant County

2. Climate — Climate 1 (East), South of Niagara Escarpment

3. Size — Area about 1,171 $miles^2$ (3,033 km^2)

4. Soils — Soils are of Group I - high runoff pollution potential. Clays of the Haldimand Clay Plain. Capability high to moderate with limitations including wetness (Class 1, 2_S)

5. Crops — Corn - moderate to high density

   Small grains, hay - moderate density

   Soybeans, fruit trees - low density

   Vegetables, small fruits (grapes) - variable from low to high density

   Tobacco - none

6. Livestock — Hogs, poultry - high density

   Others - moderate to low density

7. Other Regions Represented: Small area in Norfolk near Lake Erie shores.

REPRESENTATIVE SUB-WATERSHED NO. 10

1. Location — North Creek branch of Twenty Mile Greek, at first bridge upstream from Twenty Mile Creek. (About 2 miles Southeast of Smithville).
   U.T.M. Zone 17 - 620,100 M. East
   - 4,770,000 M. North

2. Area — Area is 14.0 $miles^2$ (36.2 km^2)

3. Existing Gauging: None

4. River Basin — Twenty Mile Creek - Lands Directorate System 2HA-2
   - M.O.E. System - 14

AGRICULTURAL AREA NO. 11

Peel Clays

1. Area — East Halton; East Peel; Central York; South Simcoe
2. Climate — Climate 1 (East), East of Niagara Escarpment
3. Size — Area about 820 $miles^2$ (2,120 km^2)
4. Soils — Soils are of Group I - high potential for runoff pollution. Clays of the Peel Plain and South Slopes physiographic regions. Capability is high, except where restricted by slope or wetness (Class 1, 3_{TW})
5. Crops — Hay, small grains, corn - moderate density

   Soybeans, fruits and vegetables - low density

   Tobacco - none
6. Livestock — Total cattle, dairy - moderate to high density

   Hogs, poultry, beef - low density
7. Other Regions Represented: None.

REPRESENTATIVE SUB-WATERSHED NO. 11

1. Location — West Humber River above Wildfield
   U.T.M. Zone 17 - 602,500 M. East
   - 5,752,600 M. North
2. Area — 11.6 $miles^2$ (29.2 km^2)
3. Existing Gauging: Existing Federal gauging at Wildfield
4. River Basin — Humber River - Lands Directorate System 2HC-3
   - M.O.E. System - 20

AGRICULTURAL AREA NO. 12

Shield Fringe

1. Area — Central Hastings; South Lennox & Addington; South Frontenac Counties

2. Climate — Climate 1 (East)

3. Size — Area about 928 miles^2 (2,404 km^2)

4. Soils — Soil Groups III and IV - soils with a high potential for contamination of ground water together with those with a low potential for pollution of either surface or ground water. Loams of the upper Napanee Plain at the fringe of the Canadian Shield. Some soils are shallow over bedrock. Capability varies from high to low depending on stoniness or shallowness (Class 1 to Class 6)

5. Crops — Hay - high density

   Corn, small grains - moderate density

   Fruits, vegetables - low to moderate density

   Soybeans - very low density

   Tobacco - none

6. Livestock — Dairy - moderate to high density

   Total Cattle - moderate density

   Beef, hogs, poultry - low density

7. Other Regions Represented: Scattered shallow loams along the fringe of the Shield and in Prince Edward County.

REPRESENTATIVE SUB-WATERSHED NO. 12

1. Location — Wilton Creek upstream of the East-West Highway through Harrowsmith
   U.T.M. Zone 18 - 366,200 M. East
   - 4,917,800 M. North

2. Area — 7.4 miles^2 (19.1 km^2)

3. Existing Gauging: Existing M.O.E. gauge at bridge one-half mile West of Harrowsmith

4. River Basin — Wilton Creek - Lands Directorate System 2HM-4
   - M.O.E. System - 56

AGRICULTURAL AREA NO. 13

Kent and Essex Sands

1. Area — South Essex County; Central and East Kent; Southwest Elgin County

2. Climate — Climate 1

3. Size — Area about 816 miles^2 (2,113 km^2)

4. Soils — Soils are Groups III and IV - sands and sands over clay, with high potential for ground water pollutant transfer, or low potential to either surface or ground water. Capability is restricted somewhat by the soil texture (Class 2_S, 3_S)

5. Crops — Corn, soybeans, vegetables, fruits - high density

   Tobacco - moderate density

   Small grains, hay - low density

6. Livestock — Hogs, beef - moderate density

   All others - low density

7. Other Regions Represented: Scattered sands and sands overlying clays, throughout Southern Ontario

REPRESENTATIVE SUB-WATERSHED NO. 13

1. Location — Hillman Creek, Northeast branch at first bridge upstream from the tidal section.
   U.T.M. Zone 17 - 375,600 M. East
   - 4,657,100 M. North

2. Area — 8.9 miles^2 (22.9 km^2)

3. Existing Gauging: None

4. River Basin — Hillman Creek - Lands Directorate System 2GH-9
   - M.O.E. System - 1

AGRICULTURAL AREA NO. 14

Bruce Clays

1. Area — Central and West Bruce County; North Grey County
2. Climate — Climate 1 (North)
3. Size — Area about 877 miles^2 (2,271 km^2)
4. Soils — Soil Groups I and I/V Mixture. High potential to transfer pollutants to surface water, and Group I/V Mixture also to ground water - clays and loams. Capability high except where reduced by wetness or steepness (Class 1, 2_W, 3_W, 3_T).
5. Crops — Hay - moderate density

   Corn, small grains, soybeans, fruits and vegetables - low density

   Tobacco - none
6. Livestock — Beef - moderate density

   Other livestock - low density
7. Other Regions Represented: Scattered soil complexes in Northern Bruce and Grey Counties.

REPRESENTATIVE SUB-WATERSHED NO. 14

1. Location — Little Mill Creek tributary of the Mill Creek branch of the Saugeen River, at bridge on 3rd Concession line, East of North Bruce
2. Area — 10.0 miles^2 (25.8 km^2)
3. Existing Gauging: None
4. River Basin — Saugeen River - Lands Directorate System 2FC-4

   - M.O.E. System - 36A

AGRICULTURAL AREA NO. 15

Elgin Mixed Farming

1. Area — East Elgin County

2. Climate — Climate 1

3. Size — Area about 257 $miles^2$ (666 km^2)

4. Soils — Mixed area of soil Groups I, III, IV and V. Potential for pollution of both surface and ground water. Capability variable (Class 1 to Class 4_S).

5. Crops — Corn - moderate to high density

   Small grains - moderate density

   Vegetables, fruits, hay - low density

   Soybeans, tobacco - low to moderate density

6. Livestock — Hogs, poultry - low to moderate

   Beef, dairy - low density

7. Other Regions Represented: Scattered areas throughout Southern Ontario.

REPRESENTATIVE SUB-WATERSHED NO. 15

1. Location — Little Jerry Creek tributary of the Big Otter Creek, at Highway 3, North of Bayham Village
   U.T.M. Zone 17 - 512,000 M. East
   - 4,736,000 M. North

2. Area — 15.5 $miles^2$ (40.1 km^2)

3. Existing Gauging: Existing M.O.E. periodic discharge station at site. Two other similar stations within the watershed

4. River Basin — Big Otter Creek - Lands Directorate System 2GC-4
   - M.O.E. System - 5

AGRICULTURAL AREA NO. 16

Niagara Fruit Belt

1. Area — Niagara Fruit Belt

2. Climate — Climate 1

3. Size — About 112 miles^2 (290 km^2)

4. Soils — Soils of Groups III and V, sands and clays. Soils with high potential for transfer of pollutants to ground water and to both ground and surface waters. Capability Class 2 and 3, with some wetness restrictions.

5. Crops — Fruits, vegetables - high density

   All others - low density or non-existant

6. Livestock — Hogs, poultry - high density

   Other livestock - low density

7. Other Regions Represented: Fruit tree growing area on sandy soil near Collingwood, Thornbury and Meaford - North Grey County.

REPRESENTATIVE SUB-WATERSHED NO. 16

1. Location — Unnamed Creek, West of Vineland, draining into Lake Ontario
   U.T.M. Zone 17 - 6,229,900 M. East
   - 4,782,400 M. North

2. Area — 1.2 miles^2 (3.1 km^2)

3. Existing Gauging: None

4. River Basin — West Lincoln Lakefront - Lands Directorate System 2HA-1
   - M.O.E. System - 14

ACRICULTURAL AREA NO. 17

Perth Mixed Clays

1. Area — Central Perth County

2. Climate — Climates 1 and 2

3. Size — About 332 miles^2 (860 km^2)

4. Soils — Soils of Croups I and V, Mixed -- high potential to contribute pollutants to surface water or to both surface and ground waters. Mainly clays of Stratford Till Plain. Capability is high except where reduced by wetness (Class 1, 2_W)

5. Crops — Small grains - high density

   Corn, hay - moderate density

   Fruit, vegetables - low density

   Tobacco, soybeans - none

6. Livestock — Hogs - moderate to high density

   All others - moderate density

7. Other Regions Represented: None

REPRESENTATIVE SUB-WATERSHED NO. 17

None.

The mixture of Croup I and V soils occurring in this area can be represented by a combination of those studies being carried out on Group I soils in Area No.3, and on Croup V soils in Area No.8. The climatic conditions and agricultural land uses in these areas are sufficiently similar to allow such representation.

AGRICULTURAL AREA NO. 18

Clay Plains of Lake Ontario Shores

1. Area — Parts of Prince Edward, South Hastings, South Lennox & Addington Counties

2. Climate — Climate 1 (East)

3. Size — About 336 miles^2 (870 km^2)

4. Soils — Soils of Group V, clays of the Napanee Clay Plain. High potential for transfer of pollutants to both surface and ground waters. Capability low due to wetness (Class 3_W)

5. Crops — Hay, pasture - high density

   Corn, small grains - low density

   Tobacco, soybeans - none

6. Livestock — Predominantly dairy

7. Other Regions Represented: None

REPRESENTATIVE SUB-WATERSHED NO. 18

None.

The small area of low intensity agriculture represented by this region was assigned a low priority, and did not warrant selection of a representative watershed.

AGRICULTURAL AREA NO. 19

Saugeen Uplands

1. Area — Southeast Grey County; Northwest Dufferin County; Northeast Wellington County

2. Climate — Climate 2

3. Size — Area about 335 $miles^2$ (868 km^2)

4. Soils — Soils of Groups II, III and IV - complexed with muck and swampy areas. Mainly mixed loams and sands with either a low or moderate potential for pollutant transfer, or high potential for transfer to ground water. Located on the Dundalk Till Plain. Capability high or limited by wetness (Class 1, 2_W)

5. Crops — Hay, small grains - moderate density

   Corn, vegetables - low density

   Soybeans, tobacco, fruits - none

6. Livestock — All livestock - low density

7. Other Regions Represented: Similar soils in North Perth County.

REPRESENTATIVE SUB-WATERSHED NO. 19

None.

The low intensity agriculture carried on in this region did not warrant its inclusion as an agricultural study site. Area 6 of this study is representative of low intensity agriculture, and is similar to this area in many ways.

AGRICULTURAL AREA NO. 20

Bruce Peninsula

1. Area — Bruce Peninsula

2. Climate — Climate 1

3. Size — Greater than 500 miles^2 (1,295 km^2)

4. Soils — Shallow loams overlying bedrock, soil Group III and high potential for pollutant transfer to ground water. Capability mixed, including many unusable areas. (Class 2_W, 3_W, 7_R^P)

5. Crops — All crops - low density

6. Livestock — All livestock - low density

7. Other Regions Represented: None

REPRESENTATIVE SUB-WATERSHED NO. 20

This area will not be included in the agricultural study due to its extremely low intensity agriculture.

ACRICULTURAL AREA NO. 21

Holland Marsh

1. Area — Holland - Bradford Marsh (Southeast Simcoe County, Northwest York County)

2. Climate — Climate 1

3. Size — Small

4. Soils — Artificially drained organic soils (muck), high capability. Soils of Croup I - high potential for contribution of pollutants to surface water.

5. Crops — High vegetable density

6. Livestock — None

7. Other Regions Represented: Other artificially drained muck soils where vegetables are grown - Eriean, Leamington Peninsula, etc.

REPRESENTATIVE SUB-WATERSHED NO. 21

None

APPENDIX IV.

APPENDIX IV - 1

All photographs commercially available from:

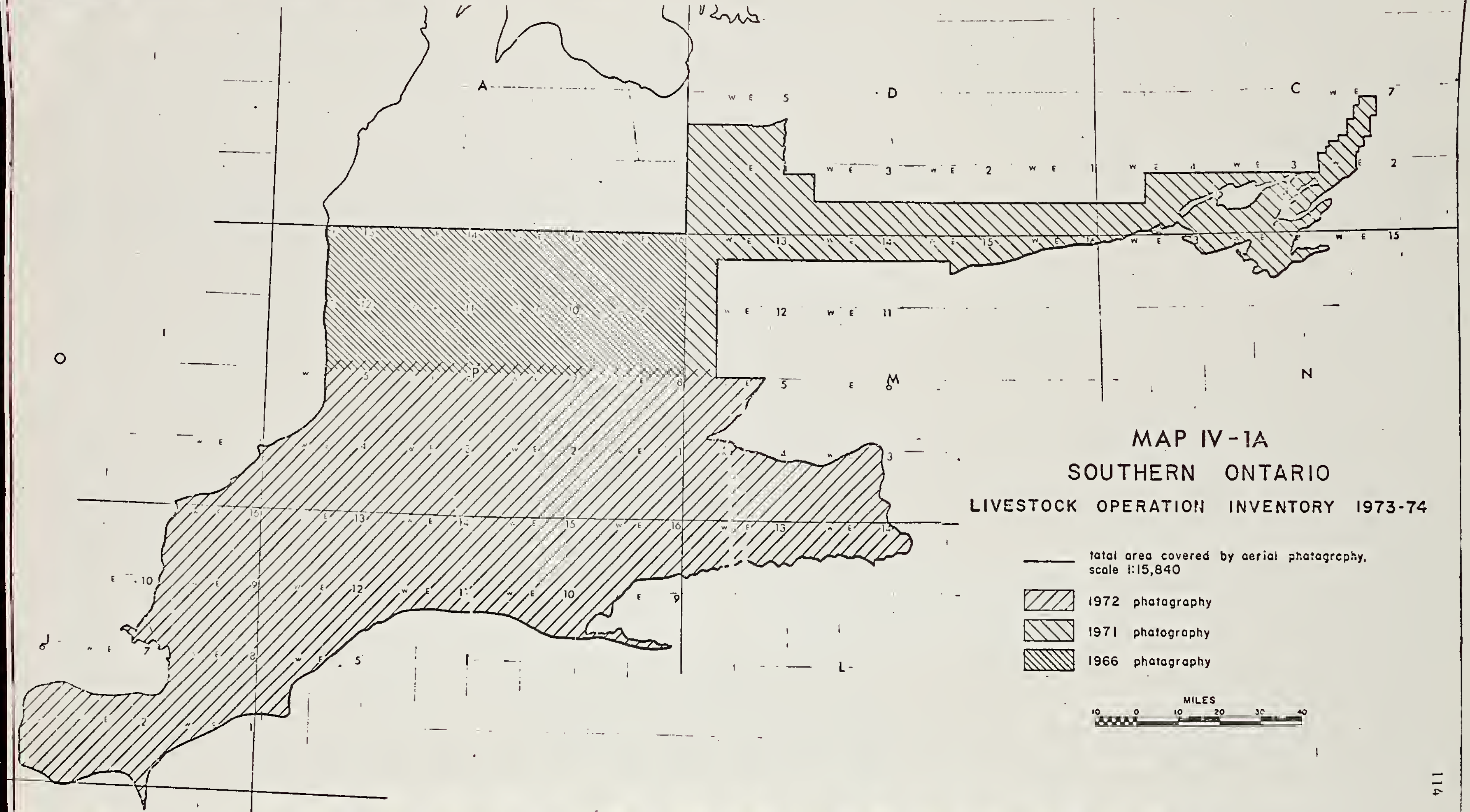
Aerial Photography
Ministry of Natural Resources
Government of Ontario
Whitby Block,
Toronto

All photographs available for viewing on location:

1966 material Photograph Library
Ministry of Natural Resources
Government of Ontario
Whitby Block,
Toronto

1971 and 1972 material
Room 3002, Neatby Building,
Agriculture Canada,
Research Branch,
Government of Canada,
Ottawa

NOTE: Map IV-1 and Map IV-1A


MAP IV-1A
SOUTHERN ONTARIO
LIVESTOCK OPERATION INVENTORY 1973-74
total area covered by aerial photography, scale 1:15,840
1972 photography
1971 photography
1966 photography
MILES
10 0 10 20 30 40

APPENDIX IV - 2

1) Project Information Sheet

ENGINEERING RESEARCH SERVICE & SOIL RESEARCH INSTITUTE - C.D.A.

LIVESTOCK OPERATIONS INVENTORY, 1973 - 1974

1. [ ] 2. Photo # [ ]
3. Map sheet number .... [ ]
4. Enumeration district .... [ ]
5. Enumeration area .... [ ]
6. U.T.M. zone .... [ ]
7. Easting (metres) .... [ ]
8. Northing (metres) .... [ ]
9. Watershed # (Lands Directorate System) .... [ ]
10. Livestock type .... [ ]
   [01] Dairy,'□';[02] Beef(mixed ages),'■';[03] Steers,'▣';
   [04] Pigs,'⬡'; [05] Poultry,'▽'; [06] Sheep,'⊙';
   [07] Dairy and/or beef,'○'; [08] Beef and/or pigs,'●';
   [09] Mixed (undifferenciated),'⊙'; [10] Horses,' ';
   [11] Other animals,'▼'; [12] ?(to be investigated),'▽';
11. Size of operation - numbers of livestock[1] .... [ ]
12. Size class .... [ ]

	[1]	[2]	[3]
Dairy	0-25	25-75	>75
Beef or steers	0-50	50-150	>150
Pigs	0-100	100-300	>300
Poultry[2]	small	medium	large
Sheep	0-150	150-450	>450
Horses	0-25	25-75	>75

13. Confinement .... [ ]
   [1] Covered only; [2] Covered with outside feeders;
   [3] Covered with outside range; [4] No cover
14. Manure handling and storage .... [ ]
   [1] Solid with bedding; [2] semi-solid; [3] liquid; [4] ?;
15. Slope of ground in vicinity of buildings .... [ ]
   [1] Flat (0-5%); [2] Sloping (5-10%); [3] Steep (> 10%)
16. Distance to most probable runoff receiving channel, gulley or drain (feet) .... [ ]
17. Distance to most probable runoff receiving lake, river or stream (feet) .... [ ]
18. Distance to nearest public road or highway (ft)..... [ ]
19. Distance to nearest urban development (4 houses +), if less than 1 mile .... [ ]

Comments:

Footnotes: 1. For mixed operations, use number calculated for 1st. animal type
2. By judgement - calculation of numbers usually impossible

0121-9.0

APPENDIX IV - 3

Measurement* Tables prepared for the purpose of livestock enumeration in Southern Ontario

1. Table 1A - Conventional Dairy Barns

   Table 1B - Loose Dairy Operation

2. Table 2 - Steers

3. Table 3 - Hogs

4. Table 4 - Poultry (Chickens)

*Measurement Units on all tables refer to .005 general purpose scale on the Bausch & Lomb measuring magnifier reticular with measurements taken using 1:15,840 scale photography.

DAIRY CATTLE

TABLE 1A

Measuring Units* & Number of Cattle - Conventional Dairy Barns

	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Dairy - 1 row <5.75	7	8	9	11	12	13	15	16	17	18	20	21	22	24	25	26	28	29	30	32	33
Dairy - 2 rows 5.75 to 8.5	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
Dairy - 3 rows > 8.5	15	18	21	24	27	30	33	36	39	42	45	48	51	53	56	59	62	65	68	71	74

TABLE 1B

Measuring Units* & Number of Cattle re Dairy, Loose (Stall & No Stall)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1																									
2																									
3			7	9	12	14	16	18	21	24	26	29	31	33	36	38	41	43	45	47	50	52	54	56	59
4			9	13	16	19	23	26	29	31	34	38	41	44	48	51	54	57	60	63	67	70	73	76	79
5			12	16	20	24	28	32	36	40	44	48	51	55	59	63	67	71	75	79	83	87	91	95	99
6			14	19	24	28	33	38	43	48	52	57	62	67	71	76	81	86	90	95	100	105	109	114	119
7			17	22	28	33	39	44	50	55	61	67	72	78	83	89	94	100	105	111	116	122	128	133	139
8			19	25	32	38	44	51	57	63	70	76	82	89	95	101	108	114	120	127	133	139	146	152	158
9			21	29	36	43	50	57	64	71	78	86	93	100	107	114	121	128	135	143	150	157	164	171	178
10			24	32	40	48	55	63	71	79	87	95	103	111	119	127	135	143	150	158	166	174	182	190	198
11			26	35	43	52	61	70	78	87	96	105	113	122	131	139	148	157	165	174	183	192	200	209	218
12			29	38	48	57	67	76	86	95	105	114	124	133	143	152	162	171	181	190	200	209	219	228	238

e.g. length
16 units
width
7 units ---- 89 cattle

TABLE 2

STEERS

Measuring Units*

Steers (25 sq. ft. per) feet	Scale																									
165.0	25																									1,089
158.4	24																								1,004	1,045
151.8	23																							922	962	1,002
145.2	22																						843	882	920	958
138.6	21																					768	805	842	878	915
132.0	20																				697	732	767	802	836	871
125.4	19																			629	662	695	728	761	795	828
118.8	18																		565	596	627	659	690	721	753	784
112.2	17																	504	533	563	592	622	652	681	711	741
105.6	16																446	474	502	530	558	585	613	641	669	697
99.0	15															392	418	444	470	497	523	549	575	601	627	653
92.4	14														342	366	390	415	439	463	488	512	537	561	585	610
85.9	13													294	317	340	362	385	408	430	453	476	498	521	544	566
79.2	12												251	272	293	314	335	355	376	397	418	439	460	481	502	523
72.6	11											211	230	249	268	287	307	326	345	364	383	402	422	441	460	479
66.0	10										174	192	209	227	244	261	279	296	314	331	348	366	383	401	418	436
59.4	9									141	157	172	188	203	220	235	251	267	282	298	314	329	345	361	376	392
52.8	8								112	125	139	153	167	181	195	209	223	237	251	265	279	293	307	321	335	348
46.2	7							85	98	110	122	134	146	159	171	183	195	207	219	232	244	256	268	281	293	305
39.6	6						63	73	84	94	105	115	125	136	146	157	167	178	188	199	209	220	230	240	251	261
33.0	5					44	52	61	70	78	87	96	105	113	122	131	139	148	157	166	174	183	192	200	209	218
26.4	4				28	35	42	49	56	63	70	77	84	91	98	105	112	118	125	132	139	146	153	160	167	174
19.8	3			16	21	26	31	37	42	47	52	57	63	69	73	78	84	89	94	99	105	110	115	120	125	131
13.2	2		7	10	14	17	21	24	28	31	35	38	42	45	49	52	56	59	63	66	70	73	77	80	84	87
6.6	1	2	3	5	7	9	10	12	14	16	17	19	21	23	24	26	28	30	31	33	35	37	38	40	42	44
	Scale	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

TABLE 3

HOGS

Measuring Units* and Number of Hogs - Legend 75 square feet sows/piglets
15 square feet integrated
8 square feet feeders

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1 3 5	1 6 11	2 9 16	2 12 21	3 14 27	3 17 22	4 20 38	4 23 43	5 26 49	6 29 54	6 32 59	6 34 65	7 37 70	8 40 76	8 43 81	9 46 99
2		2 11 21	3 17 32	4 23 43	5 29 54	6 34 65	8 40 76	9 46 87	10 52 98	11 58 108	12 63 119	13 69 130	15 75 141	16 81 152	17 87 163	18 92 174
3			5 26 49	6 34 65	8 43 82	10 52 98	12 60 114	13 69 130	15 78 147	17 87 163	19 95 179	20 104 196	22 113 212	24 121 228	26 130 245	27 139 261
4				9 46 87	11 58 108	13 69 130	16 81 152	18 92 174	20 104 196	23 116 217	25 127 239	27 139 261	30 151 283	32 162 304	34 174 326	37 185 348
5					14 72 136	17 87 163	20 101 190	23 116 217	26 130 245	28 145 272	31 159 299	34 174 326	37 188 353	40 203 381	43 217 408	46 232 435
6						20 104 196	24 121 228	27 139 261	31 156 294	34 174 326	38 191 359	41 209 392	45 226 424	48 243 457	52 261 490	55 278 522
7							28 142 266	32 162 304	36 182 343	40 203 381	44 223 419	48 243 457	52 264 495	56 284 533	60 304 571	65 325 609
8								37 185 348	41 209 392	46 232 435	51 255 469	55 278 522	60 302 566	65 325 609	69 348 653	74 371 696
9									47 235 441	52 261 490	57 287 539	62 313 588	67 339 637	73 365 686	78 392 735	83 418 784
10										58 290 544	63 319 598	69 348 653	75 377 707	81 406 762	87 435 816	92 464 871
11											70 351 658	76 383 718	83 415 778	89 447 838	95 479 898	102 511 958
12												83 418 784	90 453 849	97 487 914	104 522 980	111 557 1,045
13													98 490 920	105 528 990	113 556 1,061	120 604 1,132
14														113 569 1,067	121 609 1,143	130 650 1,219
15															130 653 1,225	139 696 1,306
16																148 743 1,393

	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	9 49 92	10 52 98	11 55 103	11 58 108	12 60 114	12 63 119	13 66 125	13 69 130	14 72 136	15 75 141	15 78 147	16 81 152	16 84 157	17 87 163	18 90 168
2	19 98 185	20 114 196	22 110 206	23 116 217	24 121 228	25 127 239	26 133 250	27 139 261	29 145 272	30 151 283	31 156 294	32 162 304	33 168 315	34 174 326	36 180 337
3	29 148 277	31 156 294	33 165 310	34 174 326	36 182 343	38 191 359	40 200 375	41 209 392	43 217 408	45 226 424	47 235 441	48 243 457	50 252 473	52 261 490	54 270 506
4	39 197 370	41 209 392	44 220 413	46 232 435	48 243 457	51 255 479	53 267 500	55 278 522	58 290 544	60 302 566	62 313 588	65 325 609	67 336 631	69 348 653	72 360 675
5	49 246 462	56 261 490	55 275 517	58 290 544	60 304 571	63 319 598	66 333 626	69 348 653	72 363 680	75 377 707	78 392 735	81 406 762	84 421 789	87 435 816	90 450 843
6	59 296 555	62 313 588	66 331 620	69 348 653	73 365 686	76 383 718	80 400 751	83 418 784	87 435 816	90 453 849	94 470 882	97 487 914	101 505 947	104 522 980	108 540 1,012
7	69 345 647	73 365 686	77 386 724	81 406 762	85 426 800	89 447 838	93 467 876	97 487 914	101 508 952	105 528 990	109 548 1,029	113 569 1,067	117 589 1,105	121 609 1,143	126 630 1,181
8	78 394 740	83 418 784	88 441 827	92 464 871	97 487 914	102 511 958	106 534 1,001	111 557 1,045	116 580 1,089	120 604 1,132	125 628 1,178	130 650 1,219	134 673 1,263	139 696 1,306	144 720 1,350
9	88 444 833	94 470 882	99 496 931	104 522 980	109 548 1,029	114 574 1,078	120 601 1,127	125 627 1,176	130 653 1,225	135 679 1,274	141 705 1,323	146 731 1,372	151 757 1,421	156 784 1,470	162 810 1,519
10	98 493 925	104 522 980	110 551 1,034	116 580 1,089	121 609 1,143	127 638 1,197	113 667 1,252	139 696 1,306	145 726 1,361	151 755 1,415	156 784 1,470	162 813 1,524	168 842 1,579	174 871 1,633	180 900 1,687
11	108 543 1,018	114 574 1,078	121 606 1,138	127 638 1,197	134 670 1,257	140 702 1,317	146 734 1,377	153 766 1,437	159 798 1,497	166 830 1,557	172 862 1,617	178 894 1,677	185 926 1,736	191 958 1,796	198 990 1,856
12	118 592 1,110	125 627 1,176	132 662 1,241	139 696 1,306	146 731 1,372	153 766 1,436	160 801 1,502	166 830 ,1556	174 871 1,633	181 906 1,678	188 940 1,764	195 975 1,829	202 1,010 1,894	209 1,045 1,960	216 1,080 2,025
13	128 641 1,203	135 679 1,274	143 717 1,344	151 755 1,415	158 792 1,486	166 830 1,557	173 868 1,628	181 906 1,698	188 943 1,769	196 981 1,840	203 1,019 1,911	211 1,057 1,981	218 1,094 2.052	226 1,132 2,123	234 1,170 2,194
14	138 691 1,295	146 731 1,372	154 772 1,448	162 813 1,524	170 853 1,600	178 894 1,677	187 935 1,753	195 975 1,829	203 1,016 1,905	211 1,057 1,981	219 1,097 2,058	227 1,138 2,134	235 1,179 2,210	243 1,219 2,286	252 1,260 2,363
15	148 740 1,388	156 784 1,470	165 827 1,551	174 871 1,633	182 914 1,715	191 958 1,796	200 1,001 1,878	209 1,045 1,960	217 1,089 2,041	226 1,132 2,123	235 1,176 2,205	243 1,219 2,286	252 1,263 2,368	261 1,306 2,450	270 1,350 2,531
16	157 789 1,481	167 836 1,568	176 828 1,655	185 929 1,742	195 975 1,829	204 1,022 1,916	213 1,068 2,003	223 1,115 2,090	232 1,161 2,178	241 1,208 2,265	250 1,254 2,352	260 1,300 2,439	269 1,347 2,526	278 1,393 2,613	288 1,440 2,700

TABLE 4

POULTRY

(Chickens conventional poultry barns)

Poultry 0.6 broiler

0.8 layers

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
2		3 2	4 3	6 4	7 5	8 6	10 8	12 9	13 10	14 11	16 12	17 13	19 14	20 15	22 16	23 17	25 18	26 20	27 21	29 22	30 23	32 24	33 25	35 26	36 27	38 28	39 29	41 30	42 32	44 33	45 34
3			7 5	8 7	11 8	13 10	15 11	17 13	20 15	22 16	24 18	26 20	28 21	30 23	33 25	35 26	37 28	39 29	41 31	44 33	46 34	48 36	50 38	52 39	54 41	57 42	59 44	61 46	63 47	65 49	68 51
4				12 9	15 11	17 13	20 15	23 17	26 20	29 22	32 24	35 26	38 28	41 30	44 33	47 35	49 37	52 39	55 41	58 44	61 46	64 48	67 50	70 52	73 55	76 57	78 59	81 61	84 63	87 65	90 68
5					18 14	22 16	25 19	29 22	33 25	36 27	40 30	44 33	47 35	51 38	54 41	58 44	62 46	65 49	69 52	73 54	76 57	80 60	83 63	87 65	91 68	94 71	98 74	102 76	105 79	109 82	113 89
6						26 20	30 23	35 26	39 29	44 33	48 36	52 39	57 42	61 46	65 49	70 52	74 56	78 59	83 62	87 65	91 69	96 72	100 75	105 78	109 82	113 85	118 88	122 91	126 95	131 98	135 101
7							36 27	41 30	46 34	51 38	56 42	61 45	66 50	71 53	76 57	81 61	86 65	91.5 69	97 72	102 76	107 80	112 84	117 88	122 91	127 95	132 99	137 103	142 107	147 111	152 114	158 118
8								47 35	52 39	58 44	64 48	70 52	76 57	81 61	87 65	93 70	99 74	105 78	110 83	116 87	122 91	128 96	134 100	139 105	145 109	151 113	157 118	163 122	168 126	174 131	180 135
9									59 44	65 49	72 54	78 59	85 64	91 69	98 74	105 78	111 83	118 88	124 93	131 98	137 103	144 109	150 113	157 118	163 123	170 127	176 132	183 137	189 142	196 147	203 152
10										73 55	80 60	87 65	94 71	102 76	109 82	116 87	123 93	131 98	138 103	145 109	152 114	160 120	167 125	174 131	182 136	189 142	196 147	203 152	211 158	219 163	225 169
11											88 66	96 72	104 78	112 84	120 90	128 96	136 102	144 108	152 114	160 120	167 126	176 132	184 138	192 144	200 150	208 156	216 162	224 168	232 174	240 180	248 187
12												105 78	113 85	122 91	131 98	139 105	148 111	157 118	166 124	174 131	183 137	192 144	200 150	208 156	218 163	227 170	235 176	244 183	253 189	261 196	270 203

APPENDIX IV - 4*

1. General remarks and explanatory material pertinent to a two-day ground check, December 10-11, 1973.

2. Livestock operations ground checked, February 20-21, 1974

3. Telephone calls regarding identification of agricultural units.

* This material written by Mr L. E. Philpotts, Economics Branch, Agriculture Canada, Ottawa

1. General Remarks pertinent to a Two-Day Ground Check Carried out by the Aerial Photo Interpreters, in Southwestern Ontario, December 10-11, 1973.*

A two-day trip was made to carry out ground checks mainly to varify work performed in Ottawa by the four aerial photo interpreters, and also to view typical farms'.**

All of the farms involved were found in the general vicinities of Guelph, Woodstock, Preston and Burfood. Two cars were used. On the first day all personnel visited selected livestock operations while on the second day two parties travelled in previously outlined areas relevant to the interpretations previously done in Ottawa. Six farms in the vicinity of Guelph and 40 farms in the remaining areas were visited and on most of these the interpreters were able to interview the farmers and to view the farmsteads in a general manner. The period of time allotted to the survey restricted the amount of time available for each farm. In addition to the visited farms, about 120 farms were viewed from the automobiles, travelling at a slowpace along the public roads or on farm lanes. Reasonable identification of active livestock operations in this Unit could be made and noted on either photographs or 1:50,000 scaled topographic maps.

Among the enlightenments of the interpreters during the survey the most profound one was, perhaps, that which indicated that the original basis for the calculation of space previously allotted for the individual livestock was more than sufficient. One progressive producer, for instance, operating a dairy (loose stall) enterprise stated emphatically

* Summary provided by Mr L. E. Philpotts

** Farms visited selected by Mr Martin Wrubleski, Ontario Ministry of Agriculture and Food, University of Guelph, Guelph, Ontario.

that he was housing more animals than originally intended for the size of the building (as he said, "While one cow ate, a friend relaxed in the stall away from the manure and the maddening crowd"). The same type of situation relevant to increased numbers within an individual barn was apparent for many steer and mixed beef farms and for anumber of farms where hogs were being produced. Many of the conventional barns formerly used for dairy purposes were involved with hog production or mixed beef or steer production or for combinations of these. Some of the new ancillary structures associated with the conventional barns such as hog feeders and new types of silo were installed as late as six months prior to the ground check. It was possible, however, to identify most of the feeders especially those relative to hog production, and newer types of silo from the photography taken in 1972 (Table A5 indicates that the total number of cattle for beef purposes, and for hogs of an age of 6 months and over increased from 1971 to 1972 in three areas of interest in Ontario. It shows also that the total number of hogs decreased from 1972 to 1973 while on the other hand the total number of cattle for both milk and beef purposes increased). It was also found that a number of barns used for dairy purposes contained milk house facilities inside the barns unlike the typical milk houses usually attached to or near the main barns. The dairy farms where the milk house facilities were within the barns were generally associated with milk for manufacture purposes.

As mentioned above the aerial photography used for the interpretations was taken in the summer of 1972 while the ground checks were made about 1.5 years later, and as might be expected, changes were found according to farm type and farm practice. Based on the photography of 1972, the two ground checks revealed that the interpretations were reasonably accurate. This early ground check clarified numerous points and served as a basis upon which to built a firm interpretation system.

TABLE 1 - Total Livestock in Southern, Western and Central Ontario for Years 1971, 1972 and 1973

Year and area in Ontario	Livestock								
	Bulls	Cows and Heifers, Milk Purposes	Cows and Heifers, Beef Purposes	Steers	Calves	Pigs: 6 months & over	Pigs: Total	Sheep and Lambs	Horses
	- number (000's) -								
1971 -									
Southern	7	210	143	162	129	162	870	41	19
Western	12	303	318	342	256	191	1,136	80	25
Central	7	147	133	72	116	42	218	42	17
Sub-Total	26	660	594	576	501	395	2,224	163	61
1972 -									
Southern	6	203	151	167	130	166	826	42	19
Western	13	291	329	358	261	197	1,042	76	26
Central	7	143	139	74	117	39	187	42	16
Sub-Total	26	637	617	599	508	402	2,055	160	61
1973 -									
Southern	6	201	156	195	125	152	769	43	(a)
Western	13	295	347	371	263	194	1,014	78	(a)
Central	7	146	144	80	120	39	179	41	(a)
Sub-Total	26	642	647	646	508	385	1,962	162	(a)

(a) No count taken in 1973

Source: Agricultural Statistics for Ontario, Ontario Ministry of Agriculture and Food.

Guelph Area Farms Selected by Mr. Martin Wrubleski (Visited Dec. 10, 1973)

1 - Hogs, sows and weeners fed out

Building, 36 ft X 228 ft = 8,208 sq. ft.

1,000 hogs

8,208 sq. ft./1,000 hogs = 8 sq. ft./hog

The owner, who is also a veterinarian, stated that he is preparing for about 12 sq. ft./hog. He said further that 15 sq. ft. seemed to be a reasonable unit area as calculated by the visiting party for the present barn.

2 - Dairy

Building (stall or stanchion) 72 ft. X 48 ft. = 4,176 sq. ft.

3 rows X 12 cows = 36 cows

24 calves were penned adjacent to one side of the barn

(how does one calculate for the 24 calves?)

Building (for replacement animals)

22 ft. X 48 ft. = 1,056 sq. ft.

15 heifers or replacement cattle

1,056 sq. ft./15 animals = 70 sq. ft./animal

3 - Dairy

Building (loose housing)

66 ft. X 150 ft. = 1,900 sq. ft.

400 steers

1,900 sq. ft./400 steers = 25 sq. ft./steer

6 - Beef (mixed) and hogs

Building, 71 ft. X 64 ft. = 4,545 sq. ft.

61 cattle

4,545 sq. ft./61 cattle = 75 sq. ft./animal

Building, 30 ft. X 60 ft. = 1,800 sq. ft.

18 sows and 126 weeners (an average of 7/litter was noted)

1,800 sq. ft./144 hogs = 12 sq. ft./hog

Description of Three Farms Indicating the Typical Housing Space Per Animal or Bird in the Woodstock - Preston - Burford Area

#15 - Steers

Building (loose housing) - 17,538 sq. ft.

800 steers (maximum as indicated by producer)

17,538 sq. ft./800 steers = 22 sq. ft./steer

#25 - Hogs, feeders

Building, 7,070 sq. ft.

800 feeders (maximum as indicated by producer)

7,070 sq. ft./800 hogs = 8.8 sq. ft./hog

#35 - Poultry, broilers

Buildings - 49,200 sq. ft.

81,500 birds

49,200 sq. ft./81,500 birds = 0.6 sq. ft./bird

2. Farms Ground Checked in the Thamesville - Rodney - Strathburn Area, and Sarnia Area, February 20-21, 1974 1/

The interpreters indicated that ground checks were needed for certain farms situated in the general environments indicated above in order to maintain confidence of interpretation. Many of the farms were interpreted as being typical while other farms raised conjectural aspects as to type and condition. Some of the farms of the latter category were, for instance, associated with buildings about which the interpreters were undecided as to the identity of poultry or as to the identity of buildings housing either poultry or hogs (it was found in the earlier ground check survey that poultry barns had been altered for the use of hog production). The ground check data did not include the size of buildings because this type of information was more readily available from measurements made on the photography by the interpreters. It simply remained for the interpreters to calculate the space per individual livestock and to adjust for other interpretive implications.

As the aerial photography was taken a year or so previous to the ground check, the interpreters, were not able, of course, to identify most recent changes of farm practice on some of the farms. The interpretation, made relative to the date of photography and having the inherency of gained experience as the study progressed, were found to be well within the reasonable level of accuracy according to the type of farm and to other phenomena (population, manure, land use and activity patterns).

1/ Feasibly carried out in combination with other agricultural work. Summary provided by Mr L. E. Philpotts, Economics Branch.

Identity of farm	February 1974 Field Check	Original Interpretation
a	160,000 turkeys, fed 75% corn and concentrates - manure, semi solid mixed with wood shavings	150,000 poultry assumed to be turkeys
b	1,000 hogs, feeders - new barns since aerial photography was taken in 1972	450 hogs integrated total
c	500 hogs (100 sows and 400 fed out)	480 hogs integrated
b	100 steers, fed corn silage 1,000 poultry, layers	mixed unit, number questioned
c	150 steers	160 steers
f	30,000 pullets 280 hogs (30 sows and 250 fed out) Had 100 steers in 1972, but, none in 1973	mixed operation number questioned
g	780 hogs (80 sows and 700 fed out)	800 hogs integrated
h	600 hogs, feeders, fed 75% corn and concentrates 100 steers, fed corn silage	600 feeder hogs medium sized steer operation
i	200 hogs, feeders, fed 60% corn and concentrate 85 steers, fed 75% hammered corn	280 hogs
j	145 steer and heifer calves, feeders 2,000 poultry, layers Had 15,000 layers in 1972	15,000 poultry layers 100 confined feeding operation - small (veal)
k	Poultry, layers Building may contains from 24,000 to 30,000 birds	35,000 poultry
1	20,000 poultry, layers, fed 100% corn Liquid manure spread from mobile tank - volunteered the information that the odor of the spread manure lasts only one day	22,000 poultry (layers)

Identity of farm	February 1974 Field Check	Original Interpretation
m	200 steers	180 steers
n	834 hogs (48 sows and 200 weeners in "H" type farrowing barn with 36 sows in centre section, and 550 fed out in other typical barns).	1,250 hogs integrated total
o	700 steers and heifer calves, feeders New owner of farm since 1972. Hogs in 1972 but the number of hogs was not known by new operator.	450 hogs integrated
p	2,080 hogs (80 sows and 2,000 fed out) Disorderly farmstead. The farmer had been involved with or had tried various practices and livestock types.	2,000 hogs taken as integrated total 170 steers
q	Auction Market established for the sale of cattle and hogs. Solid manure spread in fields adjacent to buildings.	Auction market 400 steer/beef/hog total hold
r	100 cows, dairy, fed corn silage. Spotty pattern of cornfield in 1972 was due to touch of frost and too much Atrazine sprayed at the same period of time. The farmer stated that the yield for this field was well below the normal one.	80 milkers
s	30,000 turkeys, fed mostly corn and some concentrates. Manure, solid mixed with wood shavings.	28,000 poultry (assume turkeys)

3. Telephone Calls to Agricultural Representatives:

The county agricultural representatives are able, generally, to give immediate identification concerning unusual types of farms or other agricultural establishmentsproviding such enterprises have geographic locations which can be readily described in telephone conversation.

Eight telephone calls were made to various agricultural representatives and about 20 farms or other agricultural enterprises were generally quickly identified according to type by the representatives. The identificiation concerned farms or establishments which caused some interpretation problems because of the comparatively large size, extremely well kept condition in relation to others in the same region or because of unusual agricultural activity relevant to establishments which were difficult to directly identify from aerial photography. In several cases the buildings were not typical for the area and were located near or in urban areas. The farms or establishments identified by telephone conversations consisted generally of those pertinent to; fur farms; poultry farms; hog farms; livestock breeding organizations; agricultural businesses, such as a seed growers enterprise which had poultry cages adjacent to the main building; a mushroom industry which had regular shaped and positioned humus piles near the main building; stables, paddocks and exercise areas; and, other types of farm where the buildings were differently shaped and situated in comparison to the typical ones within the particular region.

Appendix IV-5

Sample of printout for airphoto livestock inventory of southern Ontario, 1973-74.

(Complete printout under separate cover)

NOTE: Abbreviations - Housing - OUT FEED - covered with outside feeders in yard
- OUT RNGE - covered with open range or fields
- COVERED - covered with inside feeders

- Manure - SOL. - manure with bedding mixed in to form material handled as a solid
- S/S - semi-solid material with little bedding such as from freestall barns
- LIQU - liquid or slurry material in a form suitable for pumping

* *
* ALL DATA ARE "INTERPRETED" FROM PHOTOGRAPHY OF DATE SHOWN. CHANGES MAY HAVE OCCURED SINCE PHOTOS TAKEN. *
* INACCURACIES MAY EXIST DUE TO INTERPRETATION AND/OR BUILDINGS WHICH MAY BE USED FOR > 1 TYPE OF L/STOCK *
* *

WATERSHED NUMBER (LANDS DIRECTORATE SYSTEM): 2GA--4

PRINCIPAL OR MOST PROBABLE LIVESTOCK TYPE	CAPACITY (NUMBER)	DISTANCE (FEET) TO NEAREST: MOST PROBABLE RUNOFF CHANNEL (0=NOT DETERMINED)	STREAM OR LAKE	PUBLIC ROAD	URBAN DEV.	CONFINEMENT HOUSING TYPE	MANURE HANDLING	SLOPE OF AREA	CENSUS ENUMERATION DISTRICT	CENSUS AREA	LOCATION U.T.M. UTM ZONE	METRES EAST	METRES NORTH	TOPO. MAP SHEET	AIRPHOTO DATE	AIRPHOTO LINE	AIRPHOTO NO.	SERIAL NUMBER
LIVESTOCK OPERATION SIZE CLASS: LARGE																		
STEERS	314	5	> 5000	410	> 5000	OUT FEED	S/S	5-10%	579	155	17			40P16	66	4332	84082	
STEERS	295	40	> 5000	40	> 5000	OUT FEED	S/S	0-5 %	576	203	17			40P 8	72	4317	7192	
STEERS	209	40	> 5000	780	> 5000	OUT FEED	S/S	0-5 %	578	252	17			40P 9	66	4325	77170	
STEERS	250	80	> 5000	430	> 5000	OUT FEED	S/S	0-5 %	578	19	17			40P 8	72	4318	5081	
STEERS	431	80	> 5000	520	> 5000	OUT RNGE	S/S	0-5 %	578	263	17			40P 9	66	4328	79077	
STEERS	251	80	> 5000	740	> 5000	OUT FEED	S/S	0-5 %	578	316	17			40P 9	66	4330	88052	
STEERS	190	300	1800	325	2400	OUT FEED	SOL.	0-5 %	578	19	17			40P 8	72	4319	4081	
STEERS	192	350	> 5000	375	3700	OUT FEED	SOL.	5-10%	576	203	17			40P 8	72	4317	7193	
STEERS	210	450	1500	425	> 5000	OUT FEED	S/S	0-5 %	576	206	17			40P 8	72	4320	4190	
STEERS	397	683	> 5000	750	> 5000	OUT FEED	S/S	0-5 %	578	261	17			40P 9	71	0	17005	
STEERS	675	828	828	958	> 5000	OUT FEED	S/S	0-5 %	578	261	17			40P 9	71	0	17004	
STEERS	399	200	200	616	> 5000	OUT FEED	S/S	----%	578	261	17			40P 9	71	0	17005	
STEERS	321	> 5000	> 5000	475	> 5000	OUT FEED	S/S	0-5 %	578	252	17			40P 7	71	0	17007	
STEERS	203	330	330	825	> 5000	OUT FEED	----	0-5 %	578	253	17			40P 9	66	4326	78070	
STEERS	271	> 5000	> 5000	200	> 5000	OUT FEED	S/S	0-5 %	578	257	17			40P 9	66	4325	77174	
STEERS	286	> 5000	> 5000	1070	> 5000	OUT FEED	S/S	0-5 %	578	261	17			40P 9	66	4327	78171	
PIGS	375	10	200	75	> 5000	COVERED	LIQU	5-10%	576	206	17			40P 8	72	4321	6051	
PIGS	925	40	> 5000	120	> 5000	COVERED	LIQU	0-5 %	578	16	17			40P 8	72	4320	4197	
PIGS	1207	40	330	60	> 5000	COVERED	S/S	0-5 %	576	203	17			40P 8	72	4318	5075	
PIGS	350	50	300	200	900	COVERED	LIQU	5-10%	578	19	17			40P 8	72	4319	4081	
PIGS	450	100	> 5000	275	> 5000	COVERED	S/S	5-10%	576	203	17			40P 8	72	4318	5073	
PIGS	300	160	160	330	> 5000	COVERED	SOL.	0-5 %	576	202	17			40P 8	72	4320	4191	
PIGS	713	230	> 5000	285	> 5000	COVERED	S/S	5-10%	578	17	17			40P 8	72	4319	4084	
PIGS	450	250	2000	250	4200	COVERED	SOL.	0-5 %	578	19	17			40P 8	72	4319	4081	
PIGS	500	1300	3000	600	3600	COVERED	?	5-10%	576	201	17			40P 8	72	4318	5080	
PIGS	976	425	1300	330	5200	COVERED	SOL.	0-5 %	578	16	17			40P 8	72	4320	4194	
PIGS	1461	> 5000	> 5000	165	> 5000	COVERED	LIQU	0-5 %	578	262	17			40P 7	66	4327	78174	
PIGS	546	> 5000	> 5000	450	> 5000	COVERED	LIQU	0-5 %	579	153	17			40P16	66	4333	84180	
POULTRY		5	> 5000	610	> 5000	OUT FEED	S/S	0-5 %	579	155	17			40P16	65	4332	84081	
BEEF PIG	425	180	> 5000	200	> 5000	OUT FEED	S/S	5-10%	578	16	17			40P 8	72	4320	4194	
LIVESTOCK OPERATION SIZE CLASS: MEDIUM																		
DAIRY	26	0	0	525	0	OUT RNGE	SOL.	5-10%	578	19	17			40P 8	72	4319	4081	
DAIRY	36	25	2800	575	3300	OUT RNGE	SOL.	5-10%	578	19	17			40P 8	72	4319	4081	

DAIRY	45	75	300	75	0	OUT RNGE	SOL.	0-5 %	576	202	17	40P 8 72 4319	4077
DAIRY	30	100	550	150	0	OUT RNGE	SOL.	5-10%	576	202	17	40P 8 72 4318	5076
DAIRY	35	100	0	600	0	OUT RNGE	SOL.	5-10%	576	201	17	40P 8 72 4318	5079
DAIRY	40	100	0	450	0	OUT RNGE	SOL.	> 10%	576	207	17	40P 8 72 4320	4188
DAIRY	40	100	0	75	0	OUT RNGE	SOL.	0-5 %	576	207	17	40P 8 72 4321	6050
DAIRY	55	300	1200	2600	0	OUT RNGE	SOL.	5-10%	576	206	17	40P 8 72 4320	4189
DAIRY	30	350	0	400	0	OUT RNGE	SOL.	5-10%	576	206	17	40P 8 72 4320	4188
DAIRY	34	450	1100	400	0	OUT RNGE	SOL.	> 10%	576	206	17	40P 8 72 4320	4190
DAIRY	42	700	800	125	0	OUT RNGE	SOL.	----%	576	206	17	40P 8 72 4320	4191
DAIRY	43	800	4800	350	0	OUT RNGE	SOL.	0-5 %	578	256	17	40P 8 72 4320	4192
DAIRY	34	1600	1700	750	0	OUT RNGE	SOL.	0-5 %	576	206	17	40P 8 72 4320	4186
BEEF MIX	75	10	900	450	0	OUT RNGE	SOL.	5-10%	578	19	17	40P 8 72 4319	4081
BEEF MIX	75	50	0	600	900	OUT FEED	SOL.	5-10%	576	201	17	40P 8 72 4318	5077
BEEF MIX	95	75	0	250	0	OUT RNGE	SOL.	5-10%	576	202	17	40P 8 72 4319	4076
BEEF MIX	60	200	0	600	5000	OUT FEED	SOL.	5-10%	578	19	17	40P 8 72 4318	5080
BEEF MIX	60	400	0	275	0	OUT FEED	SOL.	5-10%	576	206	17	40P 8 72 4321	6050
STEERS	100	250	0	925	0	OUT FEED	SOL.	> 10%	576	202	17	40P 8 72 4319	4078
PIGS	217	0	0	700	0	COVERED	S/S	0-5 %	578	262	17	40P 9 66 4328	79083
PIGS	226	200	1000	330	5000	COVERED	SOL.	0-5 %	578	16	17	40P 8 72 4320	4194
PIGS	290	300	0	500	0	COVERED	S/S	5-10%	576	203	17	40P 8 72 4318	5075
DRY/BEEF	30	1200	3200	400	0	OUT RNGE	SOL.	0-5 %	578	16	17	40P 8 72 4320	4195
OTHERS		200	4700	450	0	COVERED	SOL.	5-10%	578	16	17	40P 8 72 4320	4196

LIVESTOCK OPERATION SIZE CLASS: SMALL

DAIRY	20	10	100	75	0	OUT RNGE	SOL.	5-10%	576	202	17	40P 8 72 4319	4077
DAIRY	20	50	2500	75	1800	OUT RNGE	SOL.	5-10%	576	201	17	40P 8 72 4319	4078
DAIRY	22	50	375	275	4200	OUT RNGE	SOL.	> 10%	578	19	17	40P 8 72 4319	4080
DAIRY	24	75	450	250	0	OUT RNGE	SOL.	5-10%	576	202	17	40P 8 72 4319	4077
DAIRY	24	100	0	75	0	OUT RNGE	SOL.	5-10%	576	203	17	40P 8 72 4318	5075
DAIRY	24	150	0	250	0	OUT RNGE	SOL.	5-10%	576	203	17	40P 8 72 4318	5073
DAIRY	20	700	4000	1100	0	OUT RNGE	SOL.	5-10%	578	17	17	40P 8 72 4320	4191
DAIRY	20	700	4700	300	2800	OUT RNGE	SOL.	> 10%	578	19	17	40P 8 72 4318	5080
DAIRY	22	2000	2200	60	0	OUT RNGE	SOL.	----%	576	206	17	40P 8 72 4320	4191
BEEF MIX	30	0	0	0	0	--------	----	----%	502	64	17	40P 1 72 4310	24099
BEEF MIX	35	0	0	300	0	OUT RNGE	SOL.	5-10%	578	19	17	40P 8 72 4319	4081
BEEF MIX	45	75	375	200	0	OUT RNGE	SOL.	> 10%	576	206	17	40P 8 72 4320	4189
BEEF MIX	48	75	1050	3100	0	OUT RNGE	SOL.	> 10%	576	206	17	40P 8 72 4320	4189
BEEF MIX	35	75	900	2500	0	OUT RNGE	SOL.	5-10%	576	206	17	40P 8 72 4320	4189
BEEF MIX	40	100	0	1050	0	OUT RNGE	SOL.	> 10%	576	206	17	40P 8 72 4320	4190
BEEF MIX	48	150	0	275	0	OUT FEED	SOL.	0-5 %	576	206	17	40P 8 72 4319	4076
BEEF MIX	35	150	2300	275	0	OUT FEED	SOL.	5-10%	576	201	17	40P 8 72 4319	4080
BEEF MIX	50	300	0	600	0	OUT RNGE	SOL.	5-10%	578	19	17	40P 8 72 4318	5080
BEEF MIX	40	450	0	775	0	OUT RNGE	SOL.	5-10%	576	207	17	40P 8 72 4320	4188
BEEF MIX	50	500	2400	175	4000	OUT RNGE	SOL.	5-10%	578	19	17	40P 8 72 4318	5080
BEEF MIX	40	550	1600	425	0	OUT FEED	SOL.	> 10%	576	206	17	40P 8 72 4320	4190
BEEF MIX	30	2000	3000	1100	0	OUT RNGE	SOL.	0-5 %	576	206	17	40P 8 72 4320	4192
POULTRY	8700	10	300	600	600	COVERED	SOL.	5-10%	578	19	17	40P 8 72 4319	4081