SOILS INFORMATION AND ECOLOGICAL LAND USE PLANNING:
A CASE STUDY OF THE REGIONAL MUNICIPALITY OF OTTAWA-CARLETON

by

Alla Margaret Weeks Ault

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Department of Geography
Carleton University
Ottawa, Canada
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ABSTRACT

The research for this thesis focussed on improving the contribution of soil surveys as a tool to provide the soil data base needed in ecological land use planning.

The methodologies, merits and constraints of current ecological land use planning approaches are discussed. While a properly designed and executed soil survey appears to be an essential part of their methodology, the survey's usefulness in aiding interpretation of main ecological aspects of the area depends on the design of the survey itself. The recent urban-oriented soil survey for Gloucester and Nepean townships in the Regional Municipality of Ottawa-Carleton is discussed in the light of the merits of this type of survey for aiding ecological studies.

The soil data requirements of the three levels of jurisdiction (Regional, NCC and municipal) within the RMOC were reviewed by surveying land use planners by means of a questionnaire and personal interviews.

It was discovered that the Gloucester-Nepean type survey does indeed provide the necessary data items at the most appropriate scale of detail for the widest range of planning decisions in the RMOC. However, it was also determined that

the existing presentation of this high quality soils data does not fully realize its potential for communicating the capability of the soil to those in land use planning positions. To make land use suitability decisions confidently, the planner needs relevant, interpreted use capabilities of the soil. In addition, public accountability for land use recommendations demands that he also be provided with basic data and limitations to support these recommendations.

Factors other than the quality of the soil survey itself were discovered to impede the integration of soils information into the land use planning process. A series of recommendations relating to liaison, presentation format, interpretation basis, expediency and economy, creation of a Regional Environmental Information Centre, and a Land Use Planning Manual which the author feels would improve the utility of the information are presented.

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CHAPTER I

INTRODUCTION

I.1 Statement of the Problem

This dissertation is concerned with bringing the comprehensive urban land use planning practices abreast methodologically with the heightened environmental awareness of the 1970's. One response to this awareness has been the development of various ecological approaches to land use planning in an attempt to integrate the environmental component into the planning process. The degree of success of these approaches is very much dependent on the quality of the integrated studies undertaken on the environment. An integrated study, defined as one that considers the environment in a holistic perspective, requires a broad data base encompassing all the components in the study area. The soils component is only one of these, and yet, it is the source of data most demanded of the biophysical environment by planners; from this single source of data planners are provided with a wide range of information. This thesis is focusing on the contribution of soil surveys as tools for providing the soil data base required in ecological land

use planning. An investigation of the manner in which soil surveys can be made more pertinent to the process of planning land use choices will aid in optimizing its contribution. In this investigation a survey of the data needs as perceived by land use planners working in an urban/regional context will be undertaken.

I.2 Background to the Problem

Lang (1976) in his study of Urban Environmental Assessment in the USA and Canada stated that "we have failed miserably to give due regard to the physical and environmental framework within which land use development occurs". This failure can be explained in part by man's inadequate awareness and sensitivity to the complexities of nature's processes; his use of the land interrupts these processes and alters the state of the environmental system of which he is a part. There are numerous examples in the literature of the deleterious effects resulting from man's insensitive use of nature; Krueger (1977,p.3) cites a few:

Housing subdivisions have been located on organic soils with cracked foundations as a result; swamps have been set aside as parkland which, when drained, lost all of their vegetation; expensive houses have been built in mature woodlots that could not survive the disturbance; houses on septic tanks have been permitted on impermeable clay soils; crucial water catchment areas have been built upon thus reducing the city's ground water supply; populations have been permitted to grow far beyond a stream's capability to assimilate the sewage effluent; sand

and gravel deposits have been built upon (or the extractive industry completely prohibited) thus increasing costs of construction in the area; micro-climate differences have been completely ignored, resulting in increased air pollution hazards; and, urban development has been permitted on good agricultural land even when poor agricultural land was readily available.

Apart from directing attention to understanding the processes occurring in the environmental system, attention needs also to be directed towards increasing man's sensitivities to the range in use-capabilities occurring in nature. It is readily apparent that some areas are inherently more suitable for a specific land use than are others in that they are easier to utilize for that purpose. In addition, some land uses are less flexible in their requirements than other uses. This latter is the case with agricultural needs. "High quality agricultural lands are a finite limited resource. They originate ✓ through the interaction of an ideal climate and ideal soil ✓ properties" (Dumanski, 1976). Urban uses also place suitability requirements on the land; these requirements are often met by lands having capabilities for prime agricultural uses. This has led to concern being expressed for the loss of Canada's valuable food-producing land to urban growth; Nowland (1978) notes that over half of the class 1 agricultural lands and one third of the class 2 agricultural lands are within 80 km of Canada's twenty-three metropolitan centres. The experience of the soil scientists at Agriculture Canada has been that once

these high quality agricultural lands are committed to urbanization other options are lost forever (Dumanski, 1976).

Response to these concerns is taking place in two related areas:

- i) Soil scientists are inventorying Canada's agricultural land resources and investigating methods of optimizing the economic input/output ratio (Nowland & McKeague, 1977; Nowland (1978); Dumanski (1976)).
- ii) Ecological land use planning approaches have been developed to aid in understanding of the following: the intricacies of the environmental system; impacts on this system in response to specific demands; the capability of land to meet these demands.

It is to the latter response which this thesis is directed. Land use decisions should no longer be based solely on land availability and/or economic concerns; consideration of the land's alternative capabilities must enter the planning process. As Kellogg (1966, p. 1) observes:

The American people have nearly a hundred thousand kinds of soils, each with a unique combination of characteristics and potential for use. People in this country have no need to use soils for farming, commercial forestry, housing, recreation, or other purposes unless the soils are suited for that use or can be made so, economically.

Much of the urban development in Canada following the Second World War occurred in the absence of comprehensive planning.

"Land was recognized as a homogeneous commodity rather than a heterogenous resource" (Peterson, 1975, p.2) and shopping centres, housing development, etc. were constructed wherever desirable land was available with little consideration for any future impacts. Increasing sensitivity to nature's limits for unconditionally providing for these demands is leading to more environmental - oriented planning. Environmental planning implies an understanding of nature's processes, together with an appreciation of the difference between inherent capability of land and its use-suitability. The environmental planner is in no way a natural scientist, but, he must understand and utilize data generated by natural scientists. He must also be capable of integrating and bridging gaps between the various disciplines contributing this data. To be able to formulate sound environmentally-oriented land use plans he must be supplied with an appropriately broad data base.

I.3 Hypothesis and Objectives

Given the availability of high quality soils data, together with its high resolution of observation in urbanizing areas, the hypothesis for this dissertation is that while high quality soils information is essential to effective urban/regional land use planning, the existing presentation of this soils data does not fully realize the data's potential for communicating the capability of the physical base to those in land use planning positions and that, if the specific needs of

the planners were more fully investigated, a more useful data presentation format could be designed with the objective of aiding the planner with his difficult role.

The primary objectives of this paper are to investigate the needs of the planners regarding soil data, namely: the role of this earth science variable in land use planning; the planning concerns which dictate the specific data needs; and, the manner in which the jurisdictional area of concern has relevance for the scale of required data. The complexity of the environment, together with the pragmatic concerns of those in data inventory positions, dictate that a selection be made from the possible variables that could be inventoried: those which are perceived to be the best indicators of the environment's capability are selected. Investigations of the land use planning concerns which deal with the physical environment should lead, therefore, to a better understanding of the earth science contribution to land use decisions. It seems probable that greater understanding of the needs as perceived by the user might lead to a change in the design of the inventory programs and this adaptation might make the output more comprehensible to the urban land use planner.

1.4 Justification of the Study

When the official plan for the Regional Municipality of Ottawa-Carleton was being drafted, there was an inadequate source of relevant data to undertake an ecological land use

planning approach (May, 1973). Either there was no data of a particular sort available or the data was in a format irrelevant for land use planning decisions. Figure 1.1 illustrates the ecological land use planning process and Figure 1.2 makes clear the necessity for a broad factual data base for undertaking this process. The ecological planning process involves numerous decisions, which, if they are to be sound, must be based on factual information; and, as Harrison (1976,p.24) observes, "to promote the use of this information it must be available in a form readily comprehended by the planner."

Soil data is only one of the components at the base of the information pyramid (Figure 1.2) yet, because of the intensity of urban man's interaction with the soil, information on its capability is a necessity. Detwyler and Marcus (1972) describe this interaction with the soil in this manner:

Cities are nodes of maximum alteration by man of environment to suit his needs, and his working of the ground through urbanization is no exception. Urban man has changed the shape, distribution, and quality of soil in numerous ways. These include 1) consumption of great expanses of agricultural land by covering it with metropolitan structures; 2) the excavation of mineral materials (such as sand and gravel) from the earth to supply urban construction demands; 3) the erosion and sedimentation of soil; 4) the conscious remolding of the land by cutting and filling; 5) the filling of depressions with solid wastes; 6) the contamination of the ground, and water in it, by injecting liquid wastes; and 7) the desiccation of the soil both by making the surface impervious and by pumping of groundwater (Detwyler and Marcus, 1972, p. 136).

Figure 1.1: Ecological Land Use Planning Process, representative elements and relationships.

(Source: Wicken, 1978)

Figure 1.2 :Major information areas which support sound ecological planning. (Source: Harrison,1976)

High quality soil surveys are presently being undertaken in a number of urbanizing regions in Canada; therefore, the problem will soon be not so much the availability of this quality data, but rather its relevancy to the planning concerns of such areas and to the question of how this specialized information can optimally be integrated into the planning process.

I.5 Limitations to the Study

A distinction can be made between generalized, regional land use planning and the process of land use controls involving building permits and zoning. The scales of concern are quite different; data requirements for land use controls, by focussing on smaller parcels of land demand a resolution and scale greater than those for regional planning which focuses on a broader community level. Because the scale of the recent soil surveys for urbanizing areas (1:25,000) and that used for the general regional planning requirements are the same, this thesis is directing its attention to the needs of the land use planner undertaking generalized regional planning.

For the purposes of this paper the term urban/regional planning denotes planning for urbanizing problems within the context of a regional municipality jurisdiction. The planner's concerns, therefore, will encompass a geographic area wider than that of a single municipality. The determination of suitable areas for conservation and recreation, the identification of aggregate resource potential, and the locations of

growth nodes and major transportation links - these are only a few of the regional planner's concerns.

It is important to appreciate also, that physical determinants are but one set of parameters to be considered in determining land use. Spurr (1976) refers to the four filters determining the supply of development land as the physical filter, the timing filter, the legal/financial filter, and the ownership/social filter. He states that the physical filter is the initial factor determining the supply of expansion land. It is solely to the consideration of this initial filter - the physical - that this paper is directed.

I.6 Organization of Thesis

Ecological land use planning is one response to man's concern about providing the necessary integration of environmental capability into the land use planning process. Chapter II will be directed to the subject of ecological land use planning, its merits, approaches, and limitations. Chapter III will investigate the recent adaptations in soil survey procedures to provide the needed soil data base in urbanizing areas. This investigation will be undertaken by a study of the recent Gloucester-Nepean soil survey in the Regional Municipality of Ottawa-Carleton. Chapter IV will present the results of a survey of land use planners in the Region regarding their needs of this data. This survey was undertaken by

questionnaire and personal interview. Chapter V will summarize the thesis findings and provide recommendations to enhance the inclusion of soil information into the land use planning process.

CHAPTER II

THE ECOLOGICAL PERSPECTIVE IN LAND USE PLANNING

2.1 Introduction

As discussed in Chapter I, man's interactions with the environment can have deleterious repercussions, for himself as well as his environment. Arising from this awareness of man as being a part of nature's system, efforts towards re-directing society's actions, relative to this ecosystem have evolved. Land use planning is one of these areas where these efforts have been directed.

Ecological land use planning has been defined as "the process of developing a plan of action from mental formulations applying ecological principles" (Hills, et al., 1970, p. 18). This chapter will briefly present some characteristics of these ecological principles and derive from them criteria for evaluating the various approaches to ecological land use planning. A discussion of the merits, approaches, methodology and constraints hindering implementation of these ecological land use plans will comprise the main body of the chapter.

2.2 Ecology and Ecosystems

2.2.1 Ecology

Dorney recently discussed the philosophical dimensions of ecology, proposing that it be viewed simply as a reverence for life, a reverence for land and a reverence for diversity. He describes it in this manner:

The reverence for life is a concept Albert Schweitzer put forward; the reverence for land is the land ethic of Aldo Leopold rephrased, while the reverence for diversity is my contribution. It is this philosophical triad that underlies the ecological approach and distinguishes it from other more pragmatic approaches, such as economic determinism. Because Schweitzer included man and other forms of life in his concept and Leopold articulated the need to look at land use as an ethical concern, a man-oriented philosophy for ecology has developed (Dorney, 1977).

This inclusion of man's interaction with his environment is a concept which has moved away from the "pure" ecology concept held in the 1930's and 1940's. The concept at that time focussed solely on nonhuman forms of life and their biophysical environment.

In the 1960's, Ian McHarg, one of the earliest "ecological planners", developed a philosophy about man's relationship to nature. This philosophy - the harmony of both human and natural systems - was articulately presented and popularized in his book, Design with Nature (1969). McHarg found opposition to acceptance of this "interdisciplinary" approach because it

ran against strongly held ideas which preferred to preempt his broad concept of ecology with such specialist disciplines as biology (Holden, 1977). It is the characteristic of ecology as being "holistic" which attracted Cain (1968) to focus on this discipline when discussing the importance of ecological studies as a basis for land use planning. He explained his views in this way:

Separate scientific disciplines cannot yield an ultimate understanding of nature because they are essentially analytical and too compartmentalized. What is being appreciated gradually is that ecology is the science which is capable of (such) synthesis, because its attention is not directed at things, processes, and conditions as though they existed in isolation, but rather at the interrelations among them (Cain, 1968, p.33).

Dansereau (1971), in his definition of the scope of ecology, gives guidance as to how these interrelations, mentioned by Cain, must be understood:

The central purpose of ecology, however is Holistic. It is not enough to say that ecology studies living organisms (incl. man) in relation to their environment. Ecology is not ecology unless it devises means to apprehend the full complexity of a given space occupied by living organisms (including man); unless it can give an account of the dynamic whole; and unless it can situate the parts in their true relationship with each other and with the whole (Dansereau, 1971, p. 3).

There has been an evolution in thought about the discipline of ecology; the emphasis now is more on understanding the interrelationships between man and his environment, and the

dynamism in the environment with a holistic appreciation than solely on the traditional concerns. Prior to the environmental awakening of the early 1970's, ecologists indulged themselves with self-satisfying academic knowledge; they are now called upon to apply their fundamental knowledge to real problems dealing with environmental concerns. Curlin (1972,p.333) made the point that efforts toward basic research were no longer the most needed area of concern but rather that their professional challenge was now "to make ecological sciences relevant to the environmental problems facing the world." In large measure this can be accomplished by presenting the knowledge already possessed, in a usable and practical form. Man's recent perception of his need to be sensitive to both the nature and function of his environment has created these demands on the ecological profession. As May (1973) remarks, "ecological land use planning is a concept which has arisen to respond to a part of that need. It has arisen in response to the blatant absence of sensitivity to biophysical facts in land use systems." Land use systems are created by the interlinking of all the processes active on the landscape. "An understanding of these processes together will not only enable the planner to explain why landscapes look the way they do, but more important, to predict the consequences of alternative human actions" (Giliomee, 1977, p. 187).

This brings us to the concept of "ecosystems" as a tool of study to enable understanding of the land system.

2.2.2 Ecosystems

It can seem a massive undertaking to understand the components and processes in nature; delineating areas of study for the purpose of narrowing down the scope is a necessary prerequisite. Many undertaking such studies have found the ecosystem a useful tool to promote this understanding.

By being a unit of study, abstracted from the continuum of the landscape, an ecosystem is displaying its characteristic of separateness. This characteristic is illustrated by the following quote by Dansereau:

An ecosystem is a more or less closed environment where the resources of the site are cycled by a biomass of plant and animal populations associated in mutually-compatible processes (Dansereau, 1971, p. 4).

This property of being "mutually-compatible" is likewise stressed by Crowley's definition of an ecosystem:

... a biological community and its habitat visualized as a whole, a single entity. The community of living organisms and its inorganic or non-living environment are intimately integrated and function together as an ecological system
- an ecosystem (Crowley, 1971, p. 239).

The properties of being "intimately integrated" and "functioning together", illustrate that the behaviour of an ecosystem can not be determined by any one component in isolation. This has significance for man and his perception of his place in the ecosystem; neither man nor any other single element of the

ecosystem can determine its state. As May (1973,p.1) elaborated, "the ecosystem has developed over time through the intrinsic character of each element of the ecosystem, as well as through a changing and dynamic series of complex activities among these various elements." One of the many tasks of the ecological land use planner is to identify the nature and relative strengths of these interactions.

A recognition and measure of these relative strengths is not sufficient on its own. An appreciation of the "carrying capacity", or in other words, the ability of the ecosystem to absorb manipulation, is also essential. Stearns and Montag (1974) describe an ecosystem as being in a state of "dynamic equilibrium" governed by a self-regulatory mechanism. Previously it was the general view that ecosystems were in a state of "delicate balance". However, it has been learned recently that successful (in terms of survival) ecosystems are those which can absorb incremental changes to the system. This is described as "internal resilience of the system" (Stearns & Montag, 1974). "It is only when a series of incremental changes accumulate or a massive shock is imposed, that the resilience of the system is exceeded, thereby generating dramatic and unexpected signals of change" (Holling & Goldberg, 1971, p. 221). As these authors bring to our attention, it is this feature of resilience which presents so many challenges for planning. Inherent in the philosophy of planning and intervention in

systems, is the presumption that an incremental change will quickly generate signals revealing the quality of the intervention. If the signal indicates that the intervention produces higher costs than benefits, a new policy and incremental change can then be developed. However, the resiliency of ecosystems masks the feedback signals to the planner until such time as its inherent resilience is overcome. By this time it is generally too late to alter the interventions to those more favourably absorbed.

The nature of ecosystems to exhibit resiliency arises from four essential properties of ecological systems. Specifically these are:

- i. Ecosystems exhibit a systems property by encompassing many components with complex feedback interactions between them.
- ii. By responding to past events as well as present ones they show an historical quality.
- iii. By responding to events at more than one point in space they show a spatial interlocking property.
- iv. By the appearance of lags, thresholds, and limits they present distinctive non-linear properties.

(Holling & Goldberg, 1971,p.224)

Other authors (Wilson, 1976a,b; Dorney et al, 1969; Cooper and Vlasin, 1973) have chosen terms such as "stability", or "assimilative capacity" to express this same feature of resilience. Regardless of the terminology used, there is general agreement that the extent of this resilience is a function of the diversity level of the ecosystem; the greater

the systems diversity, the greater is its resilience. That this feature of resilience has implications for management and planning is brought to our attention by Wilson (1976) and Holling and Goldberg (1971) who note that systems which are low in diversity exhibit a low level of resilience, however they sustain a high level of productivity. Consequently, "decisions regarding the feasibility of keeping a very diverse system should be made according to the role that system should play in the urban fabric. The desired degree of diversity is related therefore, to appropriate management stability and health" (Wilson, 1976a, p. 213).

Odum (1977, p. 34) continues this theme of man's use or manipulation of the environment; "Most of our failures can be traced to shortsighted action that considered only the benefits to a part of the landscape rather than the whole, or to a lack of understanding of the entire chain of events that must follow any large scale manipulation of the landscape." In other words success depends on the degree to which the whole environment is considered in formulating a development strategy. The following pairs of contrasting words summarize the relevance of ecosystem development to landscape planning: production-protection; growth - stability; quantity - quality. Because both extremes cannot exist simultaneously in a landscape and because management strategies differ for each extreme, planning goals must be decided. Some examples of these management

strategies modified from Odum, are:

productive ... cropland
protective ... watershed, forest
compromised .. rivers, lakes
exploited ... urban-industrial
(Fuel powered vs. solar powered
for the other systems)

Similar concepts were applied to the Hazelton Ecological Planning Study (Berger, 1976) but these "management strategies" were referred to as "adaptive strategies" in which both the environmental and human subsystems were considered. The two concepts of ecology, firstly in the natural science sense of a balanced ecosystem and secondly in the adaptational approach to man which did not imply a continuing balance, were utilized in the study.

Subsequent to Dansereau's definition of ecosystem, quoted above on page 17, he states that any landscape whether wild, rural, suburban, or urban can be viewed as an ecosystem. For environmental management purposes it is useful to view the urban region as an ecological system that is a dynamic and open-ended component of the global ecosystem. "It spills over into and receives spillovers from other related ecosystems - a river basin or lake, an agricultural hinterland, or an atmospheric trough shared with other urban regions. It is linked solidly with other jurisdictions, urban, provincial, national and foreign. It is composed of natural and man-made elements ... and, indeed, within the urban ecosystem as elsewhere, it is the impact of the man-made upon the natural elements that gives

rise to problems of environmental management (MacNeil, 1971, p. 70). Dansereau's recommendation for alleviation of these failures in environmental management summed up by the following quotation, can profit the urban/regional land use planning process:

It hardly needs saying that most economic, sociological, technological, and other studies of pollution, urban development, industrial location, etc., are not carried on within an ecological compass of this kind. At best they are multi-disciplinary to the extent that the decidedly separate findings of engineers, architects, sociologists, and others are post-correlated. The need however is for pre-correlation, ie. investigations and planning by teams recruited in all of the relevant fields of natural and human sciences. Only such interdisciplinary groups can cope with either the research, or the planning, or indeed the implementation of environmental management (Dansereau, 1971, p. 5).

It is to this prerequisite for pre-correlation that ecological land use planning directs its efforts, methodologies and analysis techniques. By determining the assimilative capacities of local environments planners can incorporate the information to arrive at planning policies which will protect local environments.

2.3 Ecological Land Use Planning

We are living in a time when rapid and sometimes turbulent change can dominate our lives; synonymous with experiencing an exponential increase in technology we have been experiencing an exponential increase in knowledge about our environment. In

response to our awareness and acceptance of trends and changes in our lives, planning has become a necessity and ecology a science with quite a popular appeal (Coleman, 1975).

This section presents a brief summary of planning characteristics, and illustrates their relationships to ecological land use planning by presenting the merits of ecological inputs to planning. The conceptual bases and methodologies of various proponents of this planning approach will be discussed.

2.3.1 Planning: An Overview of its Characteristics

Apart from the more traditional societies where stability is easily maintained, the rapid pace of change in our lives has become universally accepted. Two effects on our lives arising from this threat of change are presented by Coleman (1975, p. 2): "First because change is now more visible, an uncertainty about the future is created; second, since we know that the future will be different from the present there is a desire to influence the direction of change." Planning is based on the confidence we have in man's ability to influence his destiny. The rationale of planning then, is the future, whether short-term, middle-range, or long-term. Yet, to realistically plan for each of these time periods, one must accept the limitations on the control one has for manipulating the directions of change. "The further in the future for which we are planning, the more unpredictable it is, but the more

likely we are able to alter its course. Conversely, in the short-term, there may be more predictability but there is much less possibility of altering its direction" (Coleman, 1975, p. 2). Regardless of the time period, the object of planning is to influence the future.

Commonly accepted definitions of the word "planning" abound in the literature and even when one ignores the specialist areas of planning (physical, economic, regional, etc.) there remain a number to consider. As an illustration, Dror (1963) quoted fourteen definitions before arriving at what he felt was appropriate for the purposes of administrative sciences:

Planning is the process of preparing a set of decisions for an action in the future, directed at achieving goals by optimal means (Dror, 1963, p. 50).

Planning is recognized as a methodology of rational thought and actions, a "set of procedures" rather than a specific "blueprint for the future" (Davidoff & Reiner, 1962; Dror, 1963; Lang, 1976a,b).

What are the main characteristics of planning as portrayed by this definition? Planning is normative thinking, explicitly concerned with decision-making and choice; each decision requires an exercise in judgement (or an introduction of values or goals) to evaluate the possible choices, and optimize the public interest (Coleman, 1975: Davidoff & Reiner, 1962). This characteristic leads to the considerations

of abstract values and goals as well as consideration of the physical environment.

Planning is forward-thinking, the decisions and choices deal with events and circumstances anticipated in the future. To make these decisions wisely necessitates an understanding of the factors to be affected.

Planning also strives to be comprehensive-thinking by attempting to understand the overall goals of the community, as well as the many factors and values. To achieve this aim a "rational" model of planning should be followed in which a planner:

- i) becomes aware of a problem;
- ii) posits a goal, value or objective;
- iii) lists all the possible ways of achieving his goals;
- iv) investigates all the important consequences that would follow from each of the alternative policies;
- v) chooses the policy most closely matching his goals (Lindblom, 1968, p. 13).

Rational comprehensive thinking leaves out nothing important.

It is this quality of comprehensive thinking that makes it virtually impossible for a planner, with a series of complex problems (each with a number of variables to consider) to achieve the ideal in application. A reality of life is the acceptance that firstly, all the consequences of actions cannot be surveyed and secondly, there is neither the time nor the assets to collect all the data required of rational choice

(Etzioni, 1967). It is this reality which presents the planner with the challenge of making wise compromises in the thoroughness of his investigations. The nature of these compromises involves simplification of the problem in a systematic manner thereby reducing the number of alternatives to be investigated. Many theories and strategies have been developed to aid this systematic approach. This subject is beyond the scope of this paper and will not be further considered here - the interested reader is referred to papers by: Lindblom (1973); Etzioni (1967); and Altshuler (1965).

In summary, the objectives of planning are clear - to influence the direction of change for the benefit of society. Unfortunately the methods to achieve this objective are imperfect because man is not completely rational, logical, and aware of all the consequences of his actions. Ecological land use planning is one approach which attempts to achieve these objectives. Let us now consider some of the characteristics of the ecosystem which contribute to the objective of the formulation of rational and comprehensive plans.

The discussion on ecosystems (section 2.2.2) presented man's place in nature as being that of one of the many organisms contributing to the dynamics of the system. Traditionally, planning has been related more to man's social, economic, and cultural needs than to his relationship with the environment. There existed what Marston Bates (1969, in Coleman, 1975, p.11) has

described as "the curious paradox of man as a part of nature, and man as apart from nature". In the past, the planner has only considered man as apart from nature and the ecologist has not studied man as a part of nature (Coleman, 1975). However, the interactions between man and environment are becoming of such critical magnitude, that man cannot continue to be studied in isolation. Some of the characteristics of ecosystems which contribute to the study of man in nature are summarized in the following quote:

In relation to the three characteristics of planning, ecology has something to offer. First, the ecosystem is an integrative, comprehensive concept. Thus it has the potential to provide the planner with a complete or comprehensive understanding of the natural environment. Second, the systems aspects of ecosystems allow the prediction of the implications of alternatives for the future (Coleman, 1975, p. 15).

Ecological land use planning has evolved and is evolving as a response to both the complexities of the environment and the complexities of the planning decisions. The merits of this approach and some of the methodologies evolved deserve elaboration.

2.3.2 The Merits of Ecological Land Use Planning

Urban/regional land use planning is complex. Land use decisions which focus on ecological concerns such as open space, locations and population densities for growth nodes, conservation

and recreation areas, and environmental standards in the past have been entirely in the hands of civil engineers, architects, landscape architects and planners. This section will illustrate the manner in which ecological concepts, when integrated into urban land use decisions can contribute to the desired "pre-correlation" propounded by Dansereau (1971).

Ecological land use planning, as defined by May (1973,p.65) is "the continuous process of allocation of land to a series of competing activities, each with different quantitative and qualitative characteristics, in a manner so as to optimize the use of land". Ecological land use planning is thus a tool to aid planners understand the complex environment. As Cain (1968,p.74) observed, "... the environment cannot be completely analysed, and diverse analytic data cannot at present be synthesized back into anything like the ecosystem as a whole". Any methodology thus developed should be addressed to two areas of concern: the first, which arises from this complexity in nature, is the identification of those variables considered important for the data inventory; the second, is the characteristics and goals of the planning process which enable normative, forward-thinking, and comprehensive decision making. Modern ecologists no longer hold to the traditional belief that all development is unacceptable, unnecessary, or immoral, rather, they have accepted that urban growth and landscape change are unavoidable. The ecological land use planner does have faith in his approach optimizing

man's benefit from the natural processes, yet minimizing environmental destruction.

How does an ecological approach to understanding the environment contribute inputs to planning? Coleman (1975) has outlined five important characteristics or dimensions: the systems; the spatial; the comprehensive; the quantitative; and the utility dimensions.

i) The Systems Dimension - The environment can be thought of as a general system, exhibiting many system characteristics. The ecological input provides a base-line state of the system and future change in the properties of the subsystems resulting from alternative human actions can thus be predicted from this state.

ii) The Spatial Dimension - The landscape is variable in terms of the distribution of its properties over space. The landscape can no longer be considered as "simply space to be disposed of to the highest bidder, or having static features to be preserved" (Dorney & Rich, 1976, p. 35). From the ecological land use planning perspective these landscape variations are considered to have a range of potentials to be analysed and utilized by the designer.

iii) The Comprehensive Dimension - The holistic quality of the ecosystem approach to environmental study contributes to the planner's prime goal of comprehensive planning.

iv) Quantitative Dimension - Qualitative data can aid prediction

of the direction of change in a system; however, the degree of this change can only be fully predicted with quantitative data indicating the base-line state of the system. Thus the ecological input contributes to the normative and forward-thinking characteristics of planning.

v) The Utility Dimension - Straight biophysical information is of limited use since the information must be relevant to the alternatives being considered and to the decision making process. The ecological approach clearly defines which information is relevant and the manner in which it is to be used. Interaction and coordination between ecologist and planner from the initial stages through to the final decision of the process will ensure its utility contribution.

These five ecological inputs, therefore, aid the planning process to achieve its goals. They also contribute to the optimization of the "man-land fit", unlike "flat earth", "contour" or "constraint" planning approaches. The latter approaches range from an imposition of man's design on the landscape (flat earth) to a consideration of physical features as constraints only, while the ecological approach views man and nature as being in dynamic equilibrium (Dorney & Rich, 1976). There are economic benefits of an ecological land use planning approach, as well. Cooper and Vlasin (1973) state that man has failed to take into account the external costs of environmental degradation when calculating economies of scale. Sites that are chosen on the basis of project compatibility with

existing physical characteristics of the land potentially can avoid some of these shortcomings; in some instances, as Dorney and Rich (1976) found, savings can accrue up to sixteen times the cost of the professional fees for this approach. Another example of savings comes from McHarg who claims that he saved a developer \$18 million by recommending that the water run off into an underlying aquifer rather than building a storm drain system (Holden, 1977).

In summary, the utilization of the ecological approach to land use planning has potential for optimizing the man-land relationship, minimizing hazards and deleterious effects of development, reducing costs and improving the utilization of resources. Some of the approaches designed to achieve these benefits will be presented in the next section.

2.3.3 Ecological Land Use Planning Approaches

The fundamental concept of ecological land use planning views the landscape as having various attributes which can be utilized for man's benefit. To identify and analyse the processes on the landscape, and to be in a position to predict the change resulting from alternate uses, man must follow a systematic environmental approach. Dorney and Rich (1976) state that the necessary components of such an approach should include administrative factors, ecosystem inventory, ecosystem synthesis, ecosystem monitoring, and environmental assessment. There are a

number of approaches designed to meet these requirements; four such approaches will be presented in this section.

2.3.3.1 Ecological land classification

Ecological land classification refers to an integrated holistic approach to classifying land areas according to their ecological unity. It is a process which attempts to identify those unique biological and physical characteristics which contribute to this unity. Ecological land classification, therefore, provides the baseline data needed for ecological land use planning.

Mabbut (1968) divides the various integrated inventory approaches into four types - genetic, landscape, parametric, and dynamic. Ecological land classification is a landscape approach which is:

based on the observation that within any given area there are only a few kinds of terrain, each being characterized by a particular combination of landforms, geologic deposits, soils, vegetation etc. These landscape patterns are quite recognizable on air photos as relatively homogeneous recurring patterns (Coleman, 1975, p. 20).

As Wiken (1978) discovered in his study of ecological land classification, there are many merits of the integrated approach to data collection and evaluation. Efficiency and effectiveness are greater than that achieved in interpretive surveys, or a comparable number of single disciplinary studies; in addition

duplication in transportation, fieldwork, support staff and material production are all avoided.

Many integrated approaches to land classification have been developed (for example, see Aitchison & Grant, 1968; and Christian & Stewart, 1968), yet there are few methods which utilize the ecosystem as the basic unit of study. Two approaches which utilize the ecosystem, those of Hills and Crowley, will be summarized here.

Hills' approach to ecological land classification has evolved over approximately twenty five years of research as a soil scientist. His approach emphasizes the supply and biological productivity aspects of the land; it bases its classification on those soil and climate features which are significant for supplying the matter and energy for this productivity (Hills, 1961). It considers as well, the constraints of geologic material (texture variations), topography (slope and aspect), drainage, stoniness and climate. The production of maps illustrating the suitability of the landscape for various uses is his ultimate objective.

The philosophy underlying the Hills system is the classification of land through an evaluation of its use capability, suitability and feasibility in socio-economic terms, but within the limitations imposed by considerations of the biophysical interrelationships influencing land use (Cattell, 1975, p. 32).

Hills directs his methodology at two levels of planning; i) the ecological planning level, namely that of forest, fish, wildlife and recreational land management; and ii) the geographical level, namely that of the rural community and regional planning (Hills, 1961).

This division arises from the fact that ecosystems may be conceived at the required level of integration and "tailored" to meet specific objectives. Hills restricts his concept of ecosystem units to homogeneous areas and his concept of land units to patterns of these homogeneous areas (Hills, 1976). His methodology subdivides and then classifies land areas according to the homogeneous area and thereby creates a "hierarchy of environmental units without reference to their spatial occurrence in the environment" (Coleman, 1975, p. 21). This hierarchy is as follows:

1. Site region: an area within which similar combinations of relief and parent material have similar climate and consequently a similar succession of plant communities. Such regions range in size from 280 km² to 110,000 km² in Ontario.

2. Land Type: A subdivision of a site region based on
 - a) Texture of parent material
 - b) Mineralogical composition of bedrock and parent material
 - c) Depth of parent material, and
 - d) Microclimatic features of the site region. Landtypes support distinctive patterns of plant communities in the various stages of vegetational succession.

3. Physiographic Site Type: A subdivision of landtypes based on:
 - a) moisture regime
 - b) local climate, and
 - c) significant variations in soil depth more specific than those which characterize land types.

4. Physiographic Site Phase: A subdivision of physiographic site types based on differences such as stoniness, steepness of slope, and type of peat, differences which are important in the production processes. (Hills et al., 1970, pp. 45-47).

The geographical mode (the pattern of land units) creates a hierarchy based on the spatial juxtaposition of units on the landscape. Figures 2.1 and 2.2 illustrate this process.

The landscape is now classified into physiographic site phases which can be evaluated for such uses as agriculture, forestry, wildlife, and recreation from the triple perspective of absolute capability, present suitability, and potential feasibility. Each perspective is evaluated independently, primarily on the basis of ecological indicators rather than economic. Economic evaluation resulting from significant differences in combinations of climate, landform, and soil on the actual production of crops enters his evaluation; economic evaluation arising from location in relation to population centres, transportation routes and present development does not (Hills, 1961). The weightings derived from this evaluation process offer a range of alternative possibilities which potentially add a valuable dimension to the planning process. Hills definitions for these capabilities are as follows:

1. Use Capability is defined as the potential of an area to produce goods and services of various kinds under specified types and intensities of economic technological controls.

2. Use Suitability is the capacity of the site in its present condition to respond to specific management practices ... for a specific kind and intensity of use.

FIGURE 2.1

HILLS PHYSIOGRAPHIC CLASSIFICATIONS

Source: Cattell, 1975

FIGURE 2.2
HILLS' PROCESS OF LAND CLASSIFICATION

1. Subdivision

1) Site Region	LARGER
• 1000 - 40,000 square miles	
2) Land Type	
• area not defined	
3) Physiographic Site Type	
• 5 - 100 A.	
4) Physiographic Site Phase	
• area not defined	
• units for site evaluation	SMALLER

2. Regrouping

1) Site Associations	SMALLER
• ecologically interrelated
Physiographic Site Phases	
• up to 10 A.	
2) Land Units	
• grouping of Site Associations
for broad management	LARGER
• 1 square mile +	

This is based on:

- a) the absolute levels of production for the same site or sites having the same physiography, and
- b) comparative levels of production for the same land use for different physiographic sites according to use capability and site condition.

3. Use Feasibility at the local ecological level is defined as the relative advantage of managing an area for a specific use or uses having regard to both its capability and its suitability for these uses under:

- a) existing socio-economic conditions, or
- b) forecasted socio-economic conditions.

(Hills et al, 1970, pp. 48-67).

Hills approach, by overemphasizing the physiographic characteristics of land in their spatial context, disregards the temporal relationships of ecosystems and their development, thus introducing a static quality into the planning process. Prediction of effects on the environmental base by the proposed land uses is inhibited by the omission of the interacting properties of the ecosystem components. With regard to this shortcoming Cattell (1975) is of the opinion that this method could reflect a more balanced system of land evaluation if the ecological analysis was extended to emphasize the dynamic interacting aspects of the ecosystem rather than emphasizing the productivity aspects of the land. The original design and subsequent development of this approach for rural areas causes it to be an inflexible method for settled areas; on the other hand, it is a useful and viable classification approach by providing and establishing a hierarchy upon which planning decisions may be made at any level.

In summary, Hills proposes that his land classification scheme forms the basis of ecologically sound land use planning, yet he provides no guidelines for undertaking the planning aspects of his scheme. Recommendations for minimum/maximum parcels of land based on ecological and economic concerns and land use priorities are concerns of planners. Hills acknowledges and, in theory, addresses his attention to these concerns (Hills, 1961, pp. 48,69) yet, in his methodology he gives no guidelines for their integration into a land use plan.

An ecological land classification system has also been devised by Crowley (1971) which, although similar to the method of Hills, has a simpler methodology. Crowley's framework is based on a hierarchical series of landscape units starting with the large geomorphological area and subdividing it into soil types. The drainage variable is introduced through the device of the soil catena. Description of the breakdowns in the hierarchy and the names of the units in the lower level of the Hierarchy are:

Stand - at this level the ecosystem is named by the soil and plant community which characterizes it. This level is constituted by the site (soil, surface material, and topography), biological community, and the microclimate. The stand is homogeneous throughout in terms of all its components - vegetation, animals, landform, surface material, soil and climate.

Site - this level groups the basic ecosystems that have similar climax vegetation and biological potential, although they may differ with regard to present vegetation. At this level the ecosystem is uniform for all the components except the plant community.

Catena - this level corresponds to the geomorphological unit having nearly uniform surface material throughout differing only as result of differences in drainage and/or topography. At this level of hierarchy the ecosystem is uniform only in terms of surface material and climate (Cassie et al., 1970, p. 25).

Ecosystems at each of the preceeding levels of hierarchy when delineated in the field or on a map, may constitute regions, if sufficiently compact in shape; these regions are named eco-regions. "An ecoregion is a fairly compact area of any size different from neighbouring areas, and characterized throughout by a single feature or a distinctive and recurrent combination of features" (Cassie et al., 1970, p. 27). Crowley's method proceeds to define higher levels of hierarchy; the method ultimately defines nine distinct levels.

This classification method is undertaken by a field research team comprised of a geomorphologist, a pedologist, and a plant ecologist. The geomorphological parcel or catena unit should be mapped first, with agreement on its limits and internal homogeneity arrived at by the geomorphologist and the pedologist. This parcel is divided into soil or site parcels on the basis of drainage and slope and then in turn subdivided by the ecologist on the basis of plant communities.

The classification procedure for a study of Wellington County (Cassie et al., 1970) created 34 site types, a number too large to be readily grasped by the human brain. Hence, for planning purposes, the site types were grouped into the

10 catena or geomorphological types. Once the reader of the map understands the concept of catena, the several site types within each catena can be easily learned. The concept of "catena" in this study is applied with more flexibility than that by a soil scientist. "The soil catena concept is expanded to that of site catena and the concept of European vegetation catena is incorporated to constitute the ecosystem catena" (Crowley, 1971).

Crowley's method, as was the situation with Hills, turns out not to be a planning method. Although each ecoregion is interpreted and described in terms of its resources, present use, use conflicts, and planning recommendations, no guidelines are given for their integration into the planning process. Socio-economic factors are not included; however, the method is sufficiently flexible to integrate these factors.

In summary, a survey to be appropriate for planning purposes must be capable of evaluating the following: current or expected land uses by identifying thresholds, limits, and lags of ecosystems; the range of management strategies available together with the environmental impact of proposals; the significance of new technologies; and the sequential land occupation (Wiken, 1978). These classification methods of Hills and Crowley do not meet these criteria. However, they are able to provide the broad descriptive data base from which ecological planning studies can be launched. The next section will present an approach

which has relied heavily on this type of land classification procedure.

2.3.3.2 Ecological Analysis/Interpretation

Ecological analysis is able to overcome the static presentation of the ecosystem (a shortcoming of the two previous approaches). This ability stems from its fundamental concept of ecology as being one which includes man as an element and an interactive factor in the ecosystem.

Robert Dorney, a professor at the School of Urban and Regional Planning, University of Waterloo, and President of Ecoplans, an environmental consulting firm in Waterloo, has been involved with new town selections in Southern Ontario for the past eleven years. His unique approach to ecological analysis has evolved from these experiences. Dorney (1969) characterized his concept of an "ecoplan" as one which follows five guiding principles. He outlines these principles as being:

- i) maximization of plant and animal diversity within the study area
- ii) identification of fragile environments which can withstand only limited development
- iii) identification of hazardous areas or areas which because of soils or geologic structure have developmental limitations
- iv) prediction of changes in vegetation through natural succession and water quality resulting from development and reflection of these anticipated changes in the urban design
- v) identification of what types of natural restoration of the landscape are feasible.

His methodology for achieving these principles is very flexible;

it varies according to the scale of the area under study, the budget constraints, and the perceived needs and level of sophistication of the client. With respect to this last point, Dorney remarks:

... we have found that highly sophisticated analyses of natural resource features can be self defeating unless equally sophisticated planning staff, knowledgeable in the sciences, can interpret the data base obtained (Dorney, 1973).

There exists a problem with articulating the masses of data which emanate from such intensive and technical studies as described in the previous section; Dorney overcomes this obstacle by encouraging an interactive approach in which the ecologist participates as a member of the design team. Dorney's team members find Crowley's land classification system relatively easy to utilize, flexible and adaptable to their specific study projects (Dorney, 1973). From the environmental data base, impact studies are undertaken to predict quantitatively the consequences of altering the present system.

Rather than outlining a methodology, as is the case with the two previous approaches, Dorney prefers to detail those items needing analysis for the organization of the study area.

Dorney's ecosystem approach examines the following items:

- a) conceptualize the new man-made values for the post-construction ecosystems rather than their present value;
- b) determine the renovation feasibility of the ecosystems deteriorated from past land-use practices;
- c) prevent, anticipate, or reduce deleterious effects of construction on unique soil, water, vegetative and animal resources;
- d) integrate aesthetics, microclimate, and educational opportunities on the site with the natural resources;

- e) assess potential damage to buildings and roads from settling, slipping, gas leakage, general geological formation, and high water tables;
- f) reduce construction, engineering and landscape maintenance costs through an understanding of the thresholds and the tolerances of the natural ecosystems;
- g) protect and enhance property values for home buyers and the short-term and long-term property tax base of the county or municipality;
- h) adjust the time, whenever possible, needed for field analysis to fit the clients' timetable, clearly communicating the analytical difficulties and error that may occur because of insufficient time seasonal environmental effects that cannot be measured;
- i) communicate these environmental opportunities and values to the client, appropriate decision-makers, the press, and the public in keeping with the confidentiality required of the project (Dorney, 1973,p. 185).

This analysis method appears to meet the needs of all five dimensions of ecological input into planning (section 2.3.2). Dorney does not base his plans of land use solely on biophysical analysis; rather, he discusses the possibilities and limitations of the various parts of the study area for man's activities. This consideration enables realistic utilization of his plans by the planning process. The acceptance of Dorney's approach is evidenced by his involvement in such new town selections in Ontario as, North Pickering, Townsend, Innisvale, and Erin Mills (Dorney, 1976a).

2.3.3.3 Overlay techniques

Sieve mapping, otherwise known as data overlays, was being utilized as an analysis technique as early as 1912 in North America (Steinitz et al., 1976), but only recently has gained prominence among land planners. In 1969 Ian McHarg popularized

the technique by publishing his book, Design with Nature, in which he presented his ecological planning philosophy. His land use planning approach will be presented here as an example of overlay techniques.

McHarg's concept of "physiographic determinism" has shaped his approach to land use planning. This concept proposes that a landscape has a certain morphology resulting from the interaction of the processes underlying it. This concept also embraces his idea that land inherently contains the optimum pattern of development; this suggests, then, that "development should respond to the operation of these natural processes" (McHarg, 1969). McHarg views these processes in nature as ones which can perform work for man. His methodology, then, is an attempt to identify and inventory the morphology of these natural processes so they can be evaluated with respect to man's demands of the land.

Land use planning for McHarg consists of two basic steps: the first involves the application of physiographic determinism to reveal the plan inherent in the land; the second involves the interpretation of the "intrinsic suitability" of his study area for each of the several land uses. To identify, inventory and understand the natural forces as they might be affected by planning alternatives McHarg believes an examination of six elements is necessary:

- i) ecosystem inventory
- ii) a description of natural process
- iii) identification of limiting factors
- iv) attribution of value
- v) identification of development constraints
- vi) criteria for performance on ecological determinism

McHarg's method is illustrated in Figure 2.3. The synthesis of the inventory data into suitability maps, and they, in turn, into composite maps involves the process of sieve mapping (or overlay techniques) utilizing shaded transparencies.

This methodology, although simple to follow, and producing maps with great clarity, does have its limitations. The principle shortcoming arises from McHarg's limited conception of ecology and ecosystem. He recognizes ecosystems as expressions of "fitness" between the organisms present, yet he views man and nature as dichotomized. Land is described only in terms of those discrete characteristics which perform work and constitute value for man, rather than from the broader aspects of other components in the ecosystem as a whole. By ignoring the interdependencies of the individual characteristics, as well as ignoring man's role within the ecosystem, McHarg's land use recommendation may not coincide with the best possible use of the land from an environmental perspective. It is more in line with the best possible use within the constraints imposed by man's intended use of the land (May, 1973; Cattell, 1975). Other shortcomings relate to the following points: i) the assignment of equal weightings to each of the factors considered;

FIGURE 2.3

MCHARG'S METHOD OF PROCEDURE

Source: Cattell, 1975.

ii) inaccuracies resulting from lateral boundary errors on each overlay, compounded by the sieve process. This can lead to useless or misleading composite maps (MacDougall, 1975); and
iii) an oversimplification of the environment to fit into the descriptive categories of "acceptable", "moderately acceptable" and "not acceptable".

These limitations of McHarg's approach weaken its ecological input to the planning process. As already mentioned, he recognizes the ecosystem as an expression of processes acting on the landscape, yet, because he treats the interrelatedness of the various components only intuitively, he introduces a subjectivity and a lack of reproduceability in his evaluation. In spite of these philosophical and technical drawbacks, many find this technique quite useful in the decision making process. This acceptance can be attributed to both its simple method of analysis (little sensitivity to the dynamics of the ecosystem is needed) and its clarity of presentation (as compared with the extensive descriptive detail in an ecological analysis study).

2.3.3.4 Computer mapping

The weaknesses in the overlay method of ecological analysis rise from the complexities inherent in the representation of substantial quantities of data within the rigid confinement of the manually-prepared visual medium. Weaknesses also arise from

the incapability of the human mind to conceive of and synthesize large ranges in values when undergoing the overlay technique. It is this incapability which necessitates a simplification in the analysis by the assignment of equal weights to each overlay. Computer mapping, together with information systems, has the capability to manipulate and analyze data with a rapidity and objectivity not realizeable with the overlay techniques.

In studies undertaken at the University of Waterloo, a few examples are: Dorney, 1969; Coleman & McNaughton, 1971; Cassie et al., 1971; and Coleman, 1975, the method of analysis involved the superimposition of a grid over the study area and the subsequent storage of the environmental data in the computer. The studies undertaken by Redekop (1974) and Peterson (1977) at the University of Washington, involved the storage of environmental data on a polygon base delimited by the soil mapping units. Both approaches allow for the many features of the spatial dimension to be analyzed on a much more reliable and quantitative basis than the simple overlay techniques (Coleman & McNaughton, 1971).

There are advantages to the computer analysis approach. The computer can spatially handle a variety of detail and can comprehensively integrate and analyze many variables. Its ability to do so quantitatively allows the planner a predictive input to planning not realized by the overlay technique of analysis. Generally speaking, though, this technique does not

adequately represent the systems dimension as it views the environment as static. Regardless, the computer's ability to rapidly manipulate and visually present the environmental impacts of land use plans contributes to its usefulness as a planning tool.

2.3.3.5 Summary

In summary, there are a variety of approaches to ecological land use planning, each approach having its own strengths and weaknesses. The choice of one method over another is based on the consideration of such factors as the purpose of the study, the scale, the size of the study area, and the personnel and funding available. Regardless of the cited shortcomings of these approaches, there have been many benefits arising from their use. The most significant of these is the heightened awareness by planners and the general public of man's place within nature.

These benefits aside, there are still directions needing further investigations for optimization of the ecological input to planning. For example, we have incomplete knowledge of both short-term and long-term effects of urbanization on the environment; this deficiency can be ameliorated by classifying and inventorying the properties of the environment on an ecosystem basis rather than the presently utilized single attribute study. Efforts need to be directed, as well, to the improvement of the utility dimension of these approaches. The data inventory

must be guided, therefore, by intuitive judgement of the ecosystem processes, and at the same time, be relevant to the alternatives being considered and the decision making process.

The next section will focus on this last point - that of the relevancy of ecological land use plans to the decision making process.

2.3.4 Implementation of Ecological Land Use Plans

In his book, Developing a Better Environment, Angus Hills states of a plan:

In spite of its many-dimensional aspect, the ultimate and only concrete plan is one which is implemented. Until it is approved, a plan, even though graphically expressed on paper and modulated by many authorities, remains only the conceptual expression of a mental formulation, that is, a scenario (Hills et al., 1970, p. 27).

An ecological land use plan is one which has utilized ecological principles in its development. Ideally, these same ecological perspectives should be maintained when making the best decisions and when implementing the plan (Hills, 1970). Planners must function within a framework which encourages and supports this ecological perspective throughout the entire planning process to its ultimate implementation.

What are some of the barriers which deter implementation of these plans? May (1973) in her study of policy content of ecological land use approaches makes the following points:

The problem in ecological land use planning is that those engaged in it do not appear to be aware, either of the kind of society in which they are involved, or of the kind of problem which they are attempting to alleviate, and are consequently unaware of the barriers which deter the societal realization of ecological land use planning goals, or of how to deal with these barriers (May, 1973, p. 81).

In this section those views gained by May (1973) from her study of an ecological approach to land use planning in the Regional Municipality of Ottawa-Carleton as well as those views arising from this present study will be presented.

For Ian McHarg, the role of ecological land use planning is to accomodate existing demands, goals, or trends, rather than to change or direct uses of the land. His approach lacks sensitivity to either, policy formulation as a supportive structure for the land use planner, or existence of levels of hierarchies in decision making. For example, he does not appreciate that a land use decision for agricultural use must consider, not just its physical capability for production, but also the agricultural characteristics and the policy content of the planning level, be it county, province or nation. Recommendations put forward by a planner in ignorance of these facts will be inconsistent with the overall goals.

Although Hills refers to the matter of acceptance and implementation of ecological land use plans (above quote), he does not discuss the problems associated with implementation of

his plans. He does acknowledge the necessity to consider economically viable recommendations (Hills, 1961, p. 69), yet, the methodology for incorporating this consideration is absent.

Robert Dorney's approach is sensitive to the practicalities of such constraints on the land use planner as time, budget, institutions and power. These conflicts contribute to an internal personality conflict for the planner because he is required to make technically optimal decisions which are at the same time politically and socially acceptable (Coleman & McNaughton, 1971). For Dorney, environmental planning is only one element in the total planning process.

Dorney observes that the major constraint to the realization of his goal for ecological land use planning lies, not in the techniques of the methodology, but rather, in the integration of the plan into the overall planning process. The formation of an Environmental Advisory Committee for the Regional Municipality of Kitchener Waterloo was an attempt to resolve the above-mentioned constraints; communication between ecological planners and decision makers through an interactive process increases the sensitivity of each discipline to these pragmatic constraints. Dorney advises this involvement continue throughout the full range of the planning process - primary, secondary and tertiary plans. As the scale of degree of detail becomes finer, the level of analysis, types of issues needing resolution similarly shift focus (Dorney, 1976). New concepts

can then be introduced at the proper time; this timely introduction increasing their chance for inclusion in the evaluation process. How then, can the framework within which ecological land use planning functions be adapted to enable implementation of land use recommendations, and at the same time, supply the policy backing necessary to ensure that the goals of the community are being met and not just those of the planners?

Huron County in Southern Ontario, undertook a study to recommend land uses for the county (MacLaren Ltd., 1976). Land use recommendations to be viable needed community acceptance; yet, to be functional it was essential to "establish an overall view point or perspective on the area's present and future dominant function" (MacLaren, 1976, p. 12). This identification would facilitate the establishment of land use priorities and development policies, thereby providing the necessary frame of reference for resolving land use conflicts within the traditional official plan process. This approach - Perspective Methodology - is a planning method, which appears to the author to resolve many of the constraints to implementation noted above.

Ecological land use planners require a policy framework within which to function. Without this framework there is no substantial backing for their recommendations and no support from community acceptance. Similarly there would be no protection of land uses from infringement by any future non-compatible uses. This policy framework can be formulated by

designating land use "perspectives".

The process of deciding on a particular perspective is similar to most planning processes, however, the factors considered in the Huron County planning process to arrive at each perspective, were unique and deserve mention. In the case of an agricultural perspective such criteria as land capability, existing land uses, economic viability of agriculture in the area, socio-economic character of the community, and impact of other uses were all considered. The importance of the existing land uses and socio-economic character of the community were recognized and revealed the value placed on the land by the community, as well as, important dependencies arising from related land uses. Illumination on this latter relationship would be obscured by a static map representation. These considerations emphasize the need for field work and interaction with the community. When studying the economic viability of an area, the range in intensity of land uses should be related to their economic outputs. A larger unit of farmland does not necessarily produce higher economic outputs. This point has merit when considering proposed non agricultural perspectives in areas which have the physical capability for agricultural uses, but which for any one of the other considerations cited above, are not viable for extensive farming. Once a perspective use has been designated, policy backing is provided the planner in the form of zoning bylaws; all subsequent proposed land uses must be compatible.

2.4 Concluding Remarks

In this chapter the framework for ecological land use planning has been presented and reviewed as a tool to enable optimum land use designations, and subsequently to reduce hazards, deleterious effects on our land resources, and development costs. We have seen that these environmental approaches, even when optimum in their ecological concepts, techniques, analysis, and presentation, are not able to fully achieve their objectives. Barriers are encountered in the implementation of these plans in that the policy guidelines to guide and support the planner with his land use recommendations are lacking. Moreover, there appear to be problems of relevancy in such areas as data collection, analysis and presentation, the level of planning, scale of study, jurisdictional area of concern, and the purpose for the study. To implement an "optimum use" land use plan these areas of concern will need to be investigated. One of the recommendations from Coleman's study (1975) was to direct efforts towards gaining an understanding of ecosystems and both the short-term and long-term effects of urbanization on our biophysical environment. Efforts which will enhance an understanding of our ecosystems by those dealing with land use concerns will contribute, then, to the realization of the optimum land use plan.

Most inventories for the purpose of land use studies, begin with an inventory of the soil resource. This is evaluated with respect to capability for such considerations as agriculture

vegetative growth, waterholding capacity, and water transmission capacity, to name a few. As a physical geographer, who recently has become interested in land use planning, I am concerned with the apparent lack of integration by some land use planners of the available scientific soil data base. This situation appears to have come about from either its "frustrating" presentation, "confusing" detail, "irrelevant" scale or simple ignorance of the existence of this data base. I am eager to see planners not only accept the value of this high quality data base but also utilize these data in their official, management and operational planning. Generally planners are not specialists in any one particular discipline, therefore they require as many tools as possible to enable them to efficiently act in their roles of coordinators, and synthesizers of knowledge from diverse fields. Can soil survey presentation be made more useful to their land use planning? This is the subject to which the remainder of the thesis will be addressed.

CHAPTER III

RECENT DEVELOPMENTS IN SOIL SURVEY DESIGN

3.1 Introduction

Urban man increasingly depends upon the soil. His interactions with the soil, moreover, are deeper and more complex than those of the farmer; they extend much beyond the root zones of crops. The soil's ability to meet these needs of cities is, however, limited and conditional. We are now beginning to see that soil problems are not all rural; the cities have them, too, and they are proliferating. Soil considerations should, one would expect, be of concern in urban planning, but, historically, little attention has been given to soil capabilities in deciding where and how to build. It is now clear, however, that a soil survey is an essential tool in urban planning, and that the planner must understand how soils respond to alternative uses.

Soil survey reports are a means of communicating soil capability to planners. Because these reports carry government endorsement, because they are often the sole source of scientific data on the subject, and because they have been of generally high quality, soil surveys have gained general acceptance by

the interested public. The agricultural orientation of these reports, however, has limited their value for urban planning. The need, therefore, is for soil studies to include the urban context. The urban orientation to the studies should not, however, be restricted to those portions of the total land area on which cities actually stand, or on which construction is anticipated since, as Friedman and Miller (1965) point out, urban influence on land use radiates into much wider "urban fields" surrounding the cities. Nowland (1976,p.49), for example remarks that "this more useful image of urbanism would have all of Southern Ontario falling into two or three urban fields". Within such "fields", both the frequency of demands for soil data, and the uses to which the data are put, demand specially designed surveys.

Figure 1.2 emphasizes that sound ecological land use planning is both dependent upon and facilitated by a broad base of information. To keep pace with the advancements occurring with these planning approaches, the quality of this data base must periodically be upgraded. Soil data is but one of the elements in this data base contributing to land use decisions.

The best way of using a soil depends on many economic, social, political and sometimes even religious considerations in addition to the soil characteristics and response. Soil maps, soil characteristics, soil classification, and technical groupings of soils, however, are important in selecting a type of land use and in classifying land (Steele, 1967, p. 1).

This chapter will describe the soil survey design and soil mapping procedures developed in Canada to meet the special needs of urban demands for soil data. The merits of the new mapping approaches in integrated ecosystem studies will also be discussed.

3.2 Use of Soil Surveys in Ecological Land Use Planning

As discussed in Chapter II, use of the ecosystem as the basic planning unit illuminates the land use planning process. As functional parts of nature ecosystems can be identified "on the ground". The ecological land use planner tries, to enhance his understanding of these systems because he believes that they are the logical planning units. He is interested, therefore, in any method of classifying and mapping land surfaces which aids such understanding.

Soil, as a three-dimensional body on the earth's surface is, as Vink (1975) says, "a piece of the landscape", describable at each site examined, by its surface and areal extent, its profile, and its internal characteristics. "In this sense, Vink says, "soil is a central, dominant part of the wider concept of 'land'" and as such is inherently mappable for the purpose of studying irregularities in its distribution. Large scale maps of soil data assist us to understand the relation between soil and landscape, and thus to gain insight both into the processes of soil formation and into the whole range of natural phenomena which, taken together, constitute the "landscape". An appreciation of the soil-landscape relationship is fundamental

to the understanding of both.

As "a piece of the landscape", the properties of a soil in a locality reflect the entire history of soil-environment interactions from its inception to the present. In the systems terminology used by Troughton (1977):

The soil combines three essential qualities; it is, at one and the same time, a critical interface between systems that bound and which contribute to it; and it is identified as a system in its own right with distinct internal characteristics resulting from responses to energy inputs; and third, it is a living dynamic complex (Troughton, 1977, p. 49).

It follows that "a soil of any kind in its particular environment has a predictable response to management, or to any kind of manipulation" (Steele, 1967, p. 1). A soil survey interpretation, therefore, should allow prediction of the performance of a given soil to uses of probable interest. It is not intended to give recommendations for the soil's use but, together with the data pertaining to economic, social or political conditions, intelligent and informed interpretation of the survey permits the planner to make balanced and comprehensive land use recommendations. Current interest in resource management and soil conservation is now producing a growing number of comprehensive biophysical surveys which treat soil in an environmental perspective.

Properly designed and executed soil surveys appear therefore

to be an essential part of the methodology of ecological land use planning. It is essential though, in any integrated study, to recognize not just the ecological factors present, but to appreciate their relative contributions to the state of the system, at the time of the survey. Vink (1975) warns that the soil, while always an ecological factor, will have a significance for the study influenced by the relative importance of such other variables as relief, site, extreme climate, exposure to strong winds, rain or sun etc. Those variables having particular significance for the state of the system Vink refers to as "key variables".

The usefulness of a soil survey in interpreting the main ecological aspects of the area studied, depends upon the design of the survey itself. It must be both practical in its purpose and scientific in its construction. The following section will describe the ways in which soil surveying is being adapted to meet the growing demands for urban oriented data.

3.3 The Soil Survey

3.3.1 General Introduction

Soil occurs as a continuum over the landscape. Its properties, however, vary from point to point as the result of the complex interplay of climate, biological factors, the topology of the area, its geological history and so forth. It is possible to delimit areas on a map for which "the lateral boundaries are

determined by geographic pattern of change in such characteristics according to objective boundary criteria" (Schelling, 1970, p. 120). The soil surveyor, in his desire to make his map intelligible to its user, is constantly tempted to oversimplify the complexity that is actually present. So great is this variability that "pure" soil units still remain elusive even at map scales as large as 1:10,000 (Nowland, 1976). Nevertheless, the pedologist must try, through the design of his survey and the way he maps its results, to reduce the complexity of nature to a form in which it can be digested and put to use by users having varying degrees of sophistication. The intensity of the survey must vary to meet the primary user's needs; in other words, the degree of detail recorded and displayed should be commensurate with the anticipated level of planning and management. As J.C. Woodward pointed out in the opening address to the Canadian Soil Survey Committee in 1970, public concern with environmental questions, and some appreciation by the public of the soil's importance as a resource, have drawn the pedologist - in his attempt to meet the challenges described above - into the forum of public discussion of these topics.

To reduce the complexity of nature to intelligibility, soil scientists create mental models of soils. When a soil survey is made, the data collection and mapping techniques used depend (explicitly or implicitly) upon the soil model adopted by the surveyor. Early models were mostly based on chemical or

geological concepts. In the former case, the soil was regarded as a storehouse of plant nutrients; in the latter, as granulometric material. The geologic model lent itself to mapping; the chemical model did not since it studied the soil only as a point in space.

The model generally employed by the present day soil scientists is the geographical concept which "attempts to set soils into useful spatial patterns, keyed to segments of landscape and climate" (Nowland, 1976, p. 50), thereby assisting interpretive and evaluative work. Through this process, the soil survey achieves its goal of transforming complexity into order.

A reasonably complete definition of soil survey would be that it is the systematic delineation of land areas in which the soils and their properties, and the topography, possess a certain homogeneity or a distinctive pattern varying within defined limits. To provide uniformity across Canada general standards and methodology for this process are defined at the biennial meetings of the Canadian Soil Survey Committee. Each pedologist must, beyond these standards, still define limits for features and concepts pertaining to his own area of work. This is true, particularly of those features and concepts that bear directly on the prescribed or best use of the soils in that area.

3.3.2 Soil Classification

Taxonomy (soil classification) is one of a number of tools used in soil survey. It organizes and synthesizes soil data into a form in which it can be remembered and communicated and which permits relationships among soils and between soils and environmental factors to be perceived. A fundamental dilemma of soil classification arises from the requirement that a classification system be based upon a thorough knowledge of the whole population of soils to be classified. Yet as any characterization and mapping of the soils of a nation is begun, the soils must first be classified to permit the necessary organization and communication of the information obtained from the field mapping exercise (McKeague, 1975). The Canadian System of Soils Classification (1978) describes the process thus (p. 14):

Soil classification systems are not truths that can be discovered but methods of organizing information and ideas in ways that seem logical and useful. Thus no classification system is true or false; some systems are more logical and useful for certain objectives than others. A classification system reflects the existing knowledge and concepts concerning the population of soils being classified. It therefore must be modified as knowledge grows and new concepts develop.

Objectives for a taxonomic system will affect its design. A soil classification system designed to meet the objective of taxonomists and geneticists (that being the pursuit of knowledge about soil genesis) would not be concerned about such

pragmatic issues as surveying techniques and map representation. On the other hand issues such as whether or not the system can function as the basis of a map legend or whether mapping units can be derived from it are practical concerns of most surveyors (DeBakker, 1970). The Canadian system of soil classification began as a field classification, i.e. the definitions corresponded to bodies of soil on the landscape, identical to map units. However, as knowledge increased the system evolved into a taxonomic or natural system. The conceptual entities called taxons - on which the classification rests - are generalizations drawn from the characteristics of many real soil bodies of similar type.

Thus has arisen the need for two classification systems: the first, a taxonomic system on which to base the orderly collection of information about specific soil types; the second, a mapping system to permit the ordering of this information and naming of areas delineated on soil survey maps. The need for two systems comes about because no single map unit is likely to have all the properties allowable within a taxon, while on the other hand, real bodies of soil are likely to have some characteristics falling outside the taxon, even when the map scale is very large.

The Canadian System of Soil Classification (1978 revision) is a hierarchical system in which taxa are concepts based upon generalization from properties of real bodies of soil. These

taxa are defined on the basis of observable and measurable soil properties which arise from processes of soil genesis and environmental factors. The classification system therefore is only partially based upon the soils origin or genesis, and is not based upon interpretations for use.

According to the Canadian System of Soil Classification (1978) there are five taxa or levels in the hierarchy with differentiation between taxa based on:

Order. Taxa are based on properties which reflect the nature of the soil environment and the effects of the dominant, soil-forming processes.

Great Group. Taxa are based on properties that reflect differences in the strengths of dominant processes.

Subgroup. Subgroups are differentiated on the basis of the kind and arrangement of horizons that indicate: conformity to the central concept of the great Group; intergrading toward soils of another order; or additional special features within the control section.

Family. Families within a subgroup are differentiated on the basis of parent material characteristics such as texture and mineralogy, and soil climatic factors and soil reaction.

Series. Series within a family are differentiated on the basis of detailed features such as similar kinds and arrangements of horizons whose colour, texture, structure, consistence, thickness, reaction, and composition fall within a narrow range. (Canadian System of Soil Classification, 1978, p. 16)

All soils can be classified at any level of this system. Classification at one level automatically conveys the information contained in all higher levels.

3.3.3 Mapping Units

Historically the soil series (a taxonomic class) has been

utilized as the mapping unit. This created the situation, stated above, in which the taxon also was a real body of soil in the landscape identical to its mapping unit. In time the series came to mean a landscape unit with a narrow range of soil properties, most of which had significance only for agricultural use. It was the agricultural orientation of the majority of soil surveys which contributed to the lingering use of the soil series as a mapping unit; agricultural lands are inherently relatively uniform with regard to topography, and as long as surface shape and horizontal structure are relatively uniform, significant variations in the soil body will be faithfully reflected by variations in profile characteristics.

Soil mapping techniques, however, failed to keep pace with the development of soil taxonomy for two related reasons:

- i) As the existing knowledge about the defined characteristics of the soil series expanded it became increasingly difficult to continue the delineation of homogeneous units on the landscape in accordance with its definition;
- ii) Surveying techniques which had been devised for relatively uniform agricultural lands, were no longer adequate for those surveys now being demanded in non-agricultural areas. One of the reasons for this inadequacy is attributable to the topographic variations of many non-agricultural lands. So long as surface shape and horizontal structure are relatively uniform, significant variations in the soil body will be faithfully reflected

by variations in morphology.

While at one time field reconnaissance was the prime element in soil mapping, the interpretation of aerial photographs is now of central importance in the integrated, multidisciplinary ecological (biophysical) studies of an area and are tending to replace the isolated soil surveys of the past. Landform data now acquires a significance it lacked in the older, agriculturally oriented studies as the effectiveness of the technique depends strongly upon the interpretation of landforms viewed in a stereophotographic image. Moreover, this multidisciplinary approach now requires a common terminology to permit communication within the team. The aerial photograph provides the common data, but in the common language of its interpretation geomorphology now plays a much more important role.

Recent changes in approach thus tend to emphasize the concept of soil as a component in the landscape. The majority of soil surveys in Canada now adopt a landform-parent material basis for the central concept of their mapping units. In response to the demands for a standardized approach to describing and mapping landforms in soil surveys the Canadian System of Soil classification (1978) includes the new landform classification system for Canada prepared over the last five or six years by D. Acton and his committee.

Clearly, the evolution of the mapping unit from a taxonomic concept (soil series) to a landform approach utilizing the more modern definition of the soil series is an advance in the direction of integrated, ecological interpretation of the landscape.

3.4 Case Study

3.4.1 Soil Survey Design

A recent development to aid integrated land use studies is illustrated in an urban area soil survey of Gloucester and Nepean Townships, in the Regional Municipality of Ottawa-Carleton, carried out by the Land Resource Research Institute of Agriculture Canada (formerly the Soil Research Institute, renamed April 1, 1978). Because of the presence of this institute's headquarters, the Region is convenient for testing new survey methods; successful advances in methodology can be applied to other locations with similar needs. The report for this survey (Marshall & Dumanski, in prep.) contains maps which appear to meet most requirements for an urban survey. The study comes too late for consideration in formulating the official plan for the Regional Municipality of Ottawa-Carleton; nevertheless, its maps have been used in evaluating the various alternative proposals for urban growth centres in the municipality (Nowland 1976). The survey, representing one kind of soil study in an ecological setting, has many affinities with the sort of ecological (biophysical) land classification work described earlier.

Figure 3.1 illustrates the elements employed by the surveyor to define scientifically the naturally occurring soil patterns that relate directly to the landscape, the scale of the survey and the probable interpretation that will be made from it. These patterns are distinguished on the basis of topography, drainage properties, and defined proportions of taxonomic soil components. Being controlled by features easily observed on the ground and on aerial photographs they are readily mappable. These soil patterns are called soil landscape units.

The "soil landscape unit", a subdivision of a landform, which in turn is a subdivision of a soil parent material, represents a homogeneous individual on the landscape. These individual map units are outlined by map delineations defined by a collection of symbols representing discrete soil/land elements.

Because each delineation is homogeneous with respect to its defined characteristics, each is a discrete, scientifically sound pedoecological area that can be reinterpreted at will for a multitude of uses by deciphering the information carried by the map delineation from the expanded legend (Dumanski et al, 1978, p. 4).

The soil landscape units are the smallest (4 ha.) natural uniform land areas with a stated range of physical characteristics which can be represented cartographically at the scale of this survey (1:25,000).

SOIL AND LAND ELEMENTS CONSIDERED
in the
MAPPING SYSTEM

CATEGORIES OF THE
MAPPING SYSTEM

FIGURE 3.1 Categories and elements of the soil mapping system employed in the survey. Note that the optional elements listed are supplementary to the basic elements, and are those that were considered to be particularly important in the area mapped. Other elements could have been used.

SOURCE: Dumanski et al., 1978.

To reduce confusion for the map user, and enhance comprehension of the soil-landform relationship, the soil landscape unit is represented on the map as a subdivision of a broader area denoting the parent material of the soil. These are called "soil associations"; they represent groupings of soils composed of similar material with similar climatic, physiographic and general landform properties. In defining an "association", more emphasis is placed upon the lithological nature of the material, than upon its origin. For that reason, the materials in an association can have more than one origin, yet would fall in the same textural class. This outcome is desirable from the point of view of land use studies, since texture is often of central importance in such work, while origin is not. Since the association is represented by colour coding on the map, the user can identify associations with similarities in landscape properties arising from affinities in the textures of the parent materials.

It should be noted that the soil association is strictly a mapping convenience used to group these collections of soils together to reflect pertinent aspects of the landscape. It is not a category in the Canadian System of Soil Classification. Thus to link the soil association with other soils in the Canadian classification system, the soil taxonomic description is applied at the series level of differentiation creating "soil components". Conversely, these soil components are subdivisions of the landscape units and in this way these taxons are also

placed in direct relation to the landform perspective of the mapping units.

Clearly there has been a response by soil scientists to make more efficient use of soil information for planning and management positions. This response by soil scientists has been felt in all the provinces and has therefore led to a national program, the Canadian Soil Information System (CanSIS). This system is a computerized soil information system established "to characterize and quantify soil and land units, as a basis for providing decision makers with a better appreciation of the actual environment and the relationships between man and the land" (Dumanski et al., 1975, p.181). The Gloucester-Nepean survey, just described, is part of this CanSIS system and acts as a test case for the operationalization of the system.

Pedologists have gradually become aware that soil information in the traditional form of the multi-coloured soil map is not very useful for many potential users; interpretive material in the form of derivative maps can provide a more comprehensive data base for land use evaluation, planning and management. Because of the massive volumes of data collected in the course of recent sophisticated soil surveys, the traditional manual data handling methods have proven slow and ineffective, their retention sometimes leading to the loss of primary data (Kloosterman, 1977). Computer-oriented data management overcomes certain of these deficiencies.

A soil information system belongs to the family of geographical information systems, which differ from other information systems in the requirement that data be referred geographically, thereby allowing analysis, retrieval and display of data on the basis of spatial criteria (Kloosterman, 1977, p. 19).

Over and above systematic data collection a soil information system provides a depository of soil data for future use - sometimes referred to as a "data bank" - as well as a soil data processing mechanism for manipulation of small, special purpose data sets for individual researchers. The design of a system capable of each of these functions demands expertise and knowledge in all three of these specialist areas. Only in the context of a completely integrated system can the data bank become a useful tool, permitting the retrieval of stored data and its processing into information for a particular use. To realize the goal of a fully integrated system, the following operational concepts for the CanSIS program have been established (P. 44-45, CSSC 1973):

- CanSIS is a collection of cooperative soil data banks, national and regional (provincial), that are linked together through agreement on organization, files and codes, with coordination provided by the central data bank.
- CanSIS is dedicated primarily to the collection of basic soil data. It will accept also data that affects and depicts soil use.
- CanSIS has an open-ended structure with the ability to accept new files at anytime in the future.
- most of the input will be compiled by provincially situated units.

- CanSIS is tailored to accommodate and respond to the needs for soil information in Canada.

Four basic input files were created for CanSIS at its inception. These were:

1) The soil data file containing "hard" or point data input. The need to collect this data on a national basis prompted the standardization of field collection and reporting techniques. The recent publication (1978) of the CanSIS field manual and field coding sheets has achieved this standardization;

2) The soil cartographic file. This file receives input in the form of map data. This data input is accomplished by either a grid or a polygon technique assisted by a digitizing or electronic scanning process (Kloosterman, 1977);

3) Administrative/Geographic file. This is envisaged as a national file that will be used as a reference base for data output (Dumanski et al., 1975); and

4) Performance/Management file. The underlying objective of the design of this file is to define concise relationships among soils, climate, productivity as reflected by yields, and response to management under various manipulations or treatment (Can. Soil Survey Com., 1973). To accommodate the growing needs of users and the increasing sophistication of soil data, an open-ended system of subfiles was developed. Since the inception of CanSIS in 1972, files such as "Soil Names", "Soil Description", and "Land Degradation" have been added.

The need for a national soil data bank was recognized by the Sub committee on Data Handling of the CSSC in 1970 (Protz, 1970) and work began in 1972 on the design of CanSIS. Full capacity of this system has yet to be realized. As observed by Kloosterman (1977), soil information systems are not as yet exploiting the full potential of computer assisted data handling. Current concepts of soil data handling retain the approaches developed when all data were handled manually; this conservatism contributes to the slow development of soil information systems. Efforts will continue to be directed toward expanding and optimizing the operational structure of the system. "Of equal importance is the need to predefine the users of the system, and their needs and expectations, as well as to develop a permanent relationship between users and specialists" (Kloosterman, 1977, p. 19). Users of the system belong to two categories: "active" - those actively engaged in soil science pursuits; and "passive" - those involved in such applied soil science fields as planning, management, and conservation. The needs of these two user groups clearly will differ, yet to design objectively an information system serving both categories of user, their respective needs and expectations should be investigated. The investigation of land use planners needs for soil information undertaken in this thesis and described in Chapter IV will contribute to an understanding of the needs of this group of passive users.

3.4.2 Planning Implications

This land related approach to soil survey for Gloucester and Nepean was designed to aid such non-specialist users of the soil survey map, as urban regional land use planners. The user's interpretative task is simplified by the grouping together of soil landscape units; those soils similar in lithology and parent materials are represented on the map by a broad area of a single colour. A general "feeling" for the landscape is acquired by referring to the legend on the face of the map for the concise descriptions of the soil associations, and then relating this information to the broad colour patterns of the associations. Rapid, cursory interpretations for land uses can be made in this manner.

The map symbols which represent each of the soil landscape units, by identifying all the important physical features of that area, convey information for more detailed planning. An extended legend (on a separate sheet) provides specific data, most of which is determined in the laboratory. Some examples of this data pertinent to land use decisions are soil drainage class, permeability rates, textural classification, linear shrinkage, compaction, shrink-swell characteristics, and so forth. To improve this survey's relevance to urban-related concerns, the depths of observations were increased from the more standard depth of 1 metre to 2 metres. Depth of sand over clay, depth to bedrock and water table all have either been obtained

by augering or inferred from exposures at road cuts, construction sites, or the well drilling history. This information is compiled and presented in the format of cross-sectional diagrams through selected transects.

Regardless of readily obtaining this "feeling" for the landscape, due to the complexity of the properties of the landscape units as well as their variations, the use interpretations of the landscape unit undertaken frequently by planners is difficult without the assistance of an interpretive scheme. The capability scheme for this survey (described by Dumanski et al., 1978) is similar to that of the Canada Land Inventory (1965) yet altered slightly to reflect the larger scale of survey. Unlike the CLI, the subclass limitation is divided into three degrees of severity, major, moderate and minor with one major equated to two moderate, to four minor, this subdivision creating what is termed land factor limitations. Despite this capability rating being specific to field crop agriculture, because these land factor limitations are basic land factors, ie. properties easily measured in the field such as wetness, stoniness, slope, bedrock etc., and because their respective degrees of severity are defined, the capability interpretation can be extrapolated and used by planners for non-agricultural uses. Such uses as housing sites, playgrounds, effluent disposal, septic tanks, highways and pipelines are affected only slightly by soil specific factors such as pocr structure, permeability, low fertility and

droughtiness. Thus initial capability evaluations for these uses can be undertaken by examining the areal extent of these basic land factor limitations.

Similarly ecological land use studies are aided greatly by the land related soil survey; in many cases ecosystem delineations can be based upon the mapped landform information. The "geomorphological parcel" or "catena" of Crowley's land classification method (section 2.3.3.1) is synonymous with the soil association concepts. This is a function of Crowley's definition of his "catena" as "a geomorphological unit having nearly uniform surface material throughout" (Cassie et al., 1970, p. 26). Crowley's further subdivision to "soil" or "site parcel", defined on the basis of drainage and slope criteria, is aided by the delineations of the soil landscape units. Field work for an ecological study can be reduced by preliminary study with a soil survey map that is presented on the basis of soil associations.

Hills, in his 1970 evaluation of the role of the soil series in the physiographic classification of land, found that, although the range of materials in his "site" classification was relatively narrow, it was still broader, theoretically, than the range used to establish the soil series. The mapping unit at that time would have been a fairly sophisticated definition of the soil series and would have defined homogeneity for mapping purposes within narrow limits. Hills' physiographic site types,

in theory, embraced more than one soil series; the number of series per site varied with the range of parent materials occurring in the region and with the refinement of the soil series (Hills et al., 1970). The major reason for more than one taxonomic soil series within each taxonomic physiographic site type arises from the differences in the geologic origin of the materials of the same texture and lithology. Soil series are usually specifically defined for each of till, lacustrine, deltaic and outwash materials; however, in many instances, the textures and soil moisture properties of these materials may be similar. This similarity led Hills to place within a single bounded area all of these materials when they occurred together in a form of similar texture and soil moisture. The awkwardness of delineating site types from soil series mapping units can be overcome by the use of a land-related survey technique like the recent Gloucester-Nepean one in which soil landscape units are used as the mapping unit. Soil survey maps, therefore, when based on the landform approach, can be a very useful tool in ecological land use planning.

3.5 Summary

This chapter has presented a response by the soil science profession to the evolving needs of the users - both passive and active - of their specialist information. These needs have arisen for two related reasons:

- 1) The increased focus on urban infringement of rural

areas and the subsequent desire to effectively direct expansion to optimize use of the land; and

2) The traditional agricultural orientation of soil survey maps has not been able to accommodate these urban planning needs.

The results of a survey of pedologists, undertaken to review their attitudes to these changing land use concerns and also to review the role they are, or should be, playing, were presented to the ninth Canadian Soil Survey Committee meeting held in 1973. The survey clearly indicated that, the soil scientists, felt both a commitment to be actively engaged in land use planning, and a need to direct efforts towards making soil surveys as useful as possible for planning purposes. Recommendations were presented to the Committee on topics of concern needing their attentions. The following are questions, representative of these concerns, which are pertinent to this study:

1) Are there any kinds of maps or soils information we should be putting out that would help in formulating attitudes and policies on land?

2) Are our standard maps and reports adequate or should we develop new ways of reporting soil surveys?

3) Should the Federal Soil Survey take a more active role in non-agricultural soils work? What kinds and to what extent?

Chapter IV will be addressed to an investigation of the needs of urban/regional land use planners - passive users of

soil science information in an attempt to answer these questions. The situation in the RMOC will be used as a case study and the needs for earth science information, and in particular, the need for and adequacy of soils information, as perceived by these planners will be studied.

CHAPTER IV

LAND USE PLANNING IN THE REGIONAL MUNICIPALITY OF OTTAWA-CARLETON - THE RELEVANCY OF SOILS INFORMATION

4.1 Introduction

The Regional Municipality of Ottawa-Carleton (RMOC) was established by provincial legislation on January 1, 1969. The regional municipality concept calls for matters of region-wide concern to be handled by the upper tier or regional level of government, thus giving standard, consistent direction to growth and development in the area. Expansion of the urban area within the RMOC is occurring rapidly, for example; farmland acreage in the RMOC decreased by 43,758 acres between 1966 and 1971 as a result of this expansion (Dumanski, 1976). Clearly, such a swiftly changing pattern of land use multiplies the information needs of planners and decision makers in the Region. This chapter considers the background earth science information available at the time the Official Plan was formulated, and in the light of the needs for soils information, in particular, attempts to assess the adequacy of the most recent soil survey methodology and format in meeting the needs of the planning at various levels within the RMOC. Its objective is to arrive at an understanding

of the wide scale of regional planning concerns, and to assess the degree to which presently available soils data meets the planners needs.

4.2 The Regional Municipality of Ottawa-Carleton: Land Use Planning History

After the formation of RMOC in 1969, five senior planners were given the task of creating a land use master plan for the Region. One of these planners, Lynne May, told "to do something on the resources of the Region", responded by attempting to undertake an ecological land use analysis. The results of her study (May, 1971a,b) were to be integrated into the land use plan for the Region. May's goal was "the achievement of plans of land use in which the activities of man were planned in such a way as to maintain or enhance a stable ecosystem and still achieve other societal goals to the same degree" (May, 1973, p. 109). Many problems were encountered in evaluating the physical environment in this manner; the data available did not permit understanding of the Region's ecosystems - let alone their evaluation as a part of ecological land use planning. Since these difficulties illustrate the pragmatic concerns of a land use planner undertaking an ecological analysis approach, the inadequacies of the information available to May deserve fuller consideration.

4.2.1 Biophysical Information Sources: 1969-1971

Information on the biophysical environment of the Region was available from consultant's reports and from such agencies as the Geological Survey of Canada, Agriculture Canada, the National Research Council and the Conservation Authorities concerned. The principal sources of information grouped according to subject area were:

1. Bedrock geology

Geology of the Ottawa-St. Lawrence Lowland,
Ontario and Quebec (Wilson, 1946)

This was a very thorough report presenting a detailed study of the bedrock geology of the Ottawa district, however it was not presented in a manner conducive to regional planning.

2. Surficial geology and geomorphology

Surficial Geology of the Ottawa Map Area,
Ontario and Quebec (Gadd, 1962)

The Physiography of Southern Ontario
(Chapman & Putman, 1966)

The utility of these reports to May's work was limited by their being more of a traditional, descriptive nature and by not interpreting their information in a manner which assisted planning for man's use of the land.

3. Slope stability and landslide hazard

Report on the Sensitive Clay Areas in the
Ottawa Area (McRostie et al., 1968)

This report presented a preliminary attempt to delineate areas within the Ottawa area that had potential slope

problems. It was not intended to identify any more than potential problem areas and addressed no other geotechnical limitations.

4. Soil

The Soil Survey Report for Carleton County
(Hills et al., 1944)

This report was undertaken for agricultural purposes with its survey of one half million acres undertaken in one season without the aid of aerial photography (Dumanski et al., 1978). Its small scale of one inch to four miles was inadequate to permit capability evaluations on a regional planning scale.

5. Groundwater Resources

As of 1969 these had not been inventoried and the Region commissioned a study (Sobranski, 1970) to evaluate this aspect. This study, however, did not "indicate the location of the aquifer recharge areas, and only evaluated the potential of aquifers to supply water to development projected along existing trend lines, and then only on a ordinal scale of nil-poor-fair-good. Such information is, of course, useless for any attempt at considering changes to existing trends" (May, 1973, p. 110).

6. Land Use Capability for recreation, forestry, and agriculture

Canada land inventory maps for these purposes were available but they did not address urban concerns.

7. Aggregate Resource Potential

No information was available, so estimates were used.

As can be seen there were major limitations in the information available and these limitations made May's goal of an ecological land use plan impossible to achieve. Not only did they preclude understanding the ecosystems of the Region, and thus assessment of the impact of proposed alterations of the environment but also they negated the normative, forward-thinking and comprehensive characteristics of good planning. May's experience underlines the need for relevant, quantitative spatially detailed, comprehensive data if ecology is to make a useful input to planning. In the RMOC case, as May remarks, the information available "did not provide any basis for assessing the biophysical implications of the juxtaposition of particular land uses or activities" (May, 1973, p. 109).

4.2.2 Biophysical Data Sources: The Present Situation

It is not surprising that the earth science data base available in 1971 was inadequate for environmental land use planning since general environmental awareness dates from about that time. It is of interest to review the response by local, provincial and federal agencies to the recognition of the need for increased and better information. Again, the case of the RMOC will be cited. It is worth noting that the existence of the many federal government agencies has resulted in the RMOC,

or parts of it, being used as a test area for various information systems and as such the state of data collection is more advanced, at least in some aspects, than is the general case. New surveys or sources of information which have become available since 1971 include:

1. Geologic and geomorphic information

The Urban Geology Automated Information System
(Geological Survey of Canada, OF-383, Scott 1970,
Belanger 1975, and Harrison 1975)

This system was conceived and designed "to evaluate, interpret and present both existing and new geological information in a form suitable for regional planning use "

(Harrison, 1975, p. 2). Its goal was to produce a package of information concerning the Region, with much of the information being presented in the form of updated, derived maps.

Surficial Geology of the Ottawa Area
(Richard, 1973)

This is an updated map covering the Ottawa map sheet 31G/5 except for the central city area.

2. Slope Stability and Landslide Hazard

Slope Stability Study of the Regional Municipality of Ottawa Carleton (Klugman & Chung, 1976)

This is a study undertaken jointly by the regional and provincial governments establishing guidelines for the planning and development of the Leda clay deposits by classifying all the slopes in the Region.

3. Soil

Soil Survey of Nepean and Gloucester Townships
(Marshall & Dumanski, in preparation)

This response to the inadequacies of the 1944 soil survey for urban oriented planning purposes has been discussed in detail in Chapter III.

4. Groundwater conditions

A Modern and Futuristic Approach to Hydrogeology and Rural Residential Development in Eastern Ontario
(Roed, 1976)

This study was undertaken to assess the terrain suitability for septic drain tile fields as a guide for directing country estate development in the township of March.

5. Land Suitability, Conservation and Recreation

Conservation Lands (the RMOC, 1978)

Rivers and Shores (the RMOC, 1978)

These studies were undertaken by the Region to fill in gaps in their information.

6. Aggregate Reserves Potential

An aggregate reserves study, by the Region is presently in progress.

The complexity of urban-related planning problems requires not only a broad data base from various disciplines (as illustrated in Figure 1.2) but also demands coordination between public agencies. These complexities have led to the development and general acceptance of the computer as a planning tool in

many municipalities, even small municipalities of 10,000 to 15,000 population have access to central processing units (Symons, 1973). As Peterson (1977, p. 3) remarks on this matter:

Since the appropriate configuration of computer hardware and programming skills are available (accessible even in small communities) it is possible to contemplate a systemic development for merging the conventional, pre-existing process of generalized land use planning into an interface situation with environmental data.

Recent developments in the RMOC are no exception to this trend; the National Capital Commission, Agriculture Canada, and the Geological Survey of Canada are but a few of the agencies maintaining geographical information systems in the Region. The situation still is far short of Peterson's concept of a municipal or regional environmental management system, yet the decision by the National Capital Commission to have the soil data base for their information system provided by Agriculture Canada's CanSIS system (which includes the soil survey of Gloucester-Nepean) is one step toward that ideal.

The remainder of this thesis will address the question of whether the soil survey carried out in Gloucester and Nepean townships by the Land Resource Research Institute with the intent of meeting the requirements of urban related problems is, in fact, adequate for that purpose. Are the various levels of planning (NCC, RMOC, the municipalities) adequately served? Is the level of detail required met by the survey? Are the mapping units consistent with or appropriate to their needs?

It is appropriate to assess whether the planners at the various levels in the RMOC feel that this new soil survey is meeting their needs or whether some elements are missing or require modification. To do this it is necessary to review the soil data requirements at the various levels and to poll or interview the planners themselves to obtain their reactions. The soil information needs of the planners at the RMOC, the NCC, and local municipalities will be reviewed in turn and the results of questionnaires and personal interviews at each of these levels will be summarized in the final section of this chapter.

4.3 Data Definition Process

4.3.1 Description

"Information systems, including geographical information systems, are not ends in themselves, but rather, they are tools of analysts and decision makers" (Marble et al., 1972d, p. 19-1). An information system although representing the ultimate in technical efficiency, is not considered a success unless it meets the needs of the users, in fact, satisfying the client objectives should be its primary objective. Therefore, before an information system is designed, every effort must be made to determine the specific objectives of the system's users. An Information System Design and Evaluation Model (Calkins, 1972, in Redekop, 1974) was developed as a vehicle for examining the use and economics of geographic information systems. This model

emphasizes what one should do and what products should be provided from the design process of an information system. In what follows, the initial part of this model has been adopted to provide a framework for an investigation of urban/regional planner's needs for soil data.

The model contains eighteen identifiable steps which are shown graphically in Figure 4.1. These steps are grouped into three major stages as follows:

Stage 1: The determination of the information system's objectives as a function of user objectives, data availability constraints, data acquisition costs, and supporting sub-system limitations.

Stage 2: The generation of alternative systems capable of meeting the objectives and an evaluation of each alternative in terms of technical components (hardware and software), operating environment, and the potential legal and political impacts.

Stage 3: The comparison of alternative systems with reference to benefits, cost and feasibility for an overall evaluation. (Marble et al., 1972a, p. 19-11)

An investigation of the needs of planners for soil data required undertaking only the first two steps of stage 1.

The first step of the Objectives stage provides for the identification of the clients by posing and answering such questions as: who are the clients and what do they do that requires information? (Marble et al., 1972b). A decision system

Figure 4.1: Information System Design and Evaluation Model

(Source: Calkins, 1973, in Redekop, 1974)

matrix, as in Figure 4.2, can aid in the identification of the proposed users of the system and in the description of their roles, actions, and information needs. Within the decision system user classes are specified as follows:

Primary users: those users whose aggregate needs form design objectives of the system.

Secondary users: those users whose needs are explicitly identified as being potentially satisfied by the system but do not form design objectives.

Tertiary users: those users who might be able to use the system but whose needs are not explicitly identified. ("all others" category)
(Marble et al., 1972a, p. 19-17)

Classifying users has the effect of setting definite boundaries both for system design purposes and for determining benefits. Subsequent to the identification of the users the objectives of these users must be determined. These user objectives can be of first, second or third order where the first order objectives relate to the direct accomplishments of a given program and thus, determine the information requirements. These objectives are identified, not by accepting the stated objectives of the organization, but rather, by examining the direct program or project level activities. In this way information requirements are directly related to the organization's actual role.

FIGURE 4.2

CLIENT CHARACTERISTICS		DECISION SYSTEM MATRIX			
		GOALS AND OBJECTIVES	ROLES	ACTIONS	INFORMATION NEEDS
CLIENTS	PRIMARY				
	SECONDARY				
	TERTIARY				

Source: Marble et al, 1971

The second step of the Information System Design and Evaluation Model determines the clients actual needs for specific data. "At this point the data required must be directly related to one or more of the objectives previously identified and must also be described in sufficient detail for the preparation of specifications" (Marble et al., 1972, p. 19-19). Figure 4.3, a Data Definition Table, is one vehicle for relating specific data items to the information requirements. As the model emphasizes, there may be alternative ways of meeting the informational requirements, however, the need should be satisfied with a minimum number of data items.

The above procedures offer a general data definition process of benefit in both the system's design stage and in its ongoing evaluation. The data definition process also can provide a base for the design and for evaluation of a single class of information, for example as in this study, the soils information class.

4.3.2 Data Definition Process for this Study

This thesis is concerned with evaluating the contribution of a soil survey of the Gloucester-Nepean type as a tool for providing the soil data base required in ecological land use planning in an urban/regional context. The primary user of the soils information class is thus defined as those land use planners whose decisions would be environmentally optimized by the integration of an ecological perspective into their

FIGURE 4.3
DATA DEFINITION TABLE

methodology, analysis, and implementation. To identify the planner's objectives and, hence, their soil information requirements a survey of land use planners at each of the three levels of jurisdiction in the Region was undertaken, both by questionnaire and personal interview. The objectives definition process, and data definition table were adopted solely as a structural tool both in the design of the questionnaire, and in the analysis of the results. This decision was made for the following reason: planners do not perceive their work as fitting into a structure comprised of "objectives", "information requirements" and "data items"; hence, data definition tables could not be circulated to planners for completion. Objectives perceived by planners would be revealed by such statements as: "to control all forms of environmental pollution" or "to protect good agricultural and forest lands". Objectives such as these give no indication of scale and refinement of information requirements and therefore would be of little value in the data definition process. The questionnaire (Appendix A) was designed to reveal the following information: the scope of the land use planning concerns of the organization retaining the planner's services; the level of management and planning position of the planner; the general subject areas of concern of the planner (resources management, conservation, urban development etc.); the range of planning projects and the specific problems or issues needing to be resolved; and lists of basic and non-basic data requirements. This focus on the

range of planning projects and the issues to be resolved, made possible a definition of required data items.

4.4 Survey of Land Use Planners

4.4.1 Survey Coverage

Questionnaires were mailed to twenty-five planners working on land-use projects within the boundaries of the Regional Municipality of Ottawa-Carleton (RMOC). The selection of planners was made on the basis of: i) referrals from planners with whom I had had previous contact, and ii) referrals from planning department directors. The intention was to survey planners in each of the three tiers of government in the Region since each tier participates in the decision-making for land use in the Region. Although the Regional government undertakes and directs the planning for the Region as a whole, both the Federal and Municipal governments have jurisdiction over certain land use decisions. The National Capital Commission undertakes the urban and rural planning for federally-owned land - specifically that of the Greenbelt - with the constraint that its land use decisions must be compatible with the planning directions for the Region as a whole.

Within RMOC there are ten municipalities, including the city of Ottawa. As the focus of this thesis is ecological land use planning within an urban/regional context only those municipalities with urbanizing centres were surveyed, namely: Ottawa; Gloucester township, with urban growth nodes at the South East

Urban Community, the South Urban Community and the East Urban Community (Orleans); Nepean township with urban growth nodes at the South Urban Community and the West Urban Community; March township with urban growth at the West Urban Community (Kanata); and Goulbourn with its urban growth at the West Urban Community, Richmond, Stittsville, and Munster.

The division of questionnaires among the three jurisdictional levels and the breakdown in the responses is presented below.

	Quest. mailed	Quest. only	Quest. & interview	Interview only	Total Response
RMOC	10	3	2	3	8
NCC	5	-	3	1	4
Municipalities	10	1	2	2	5

There was a 68% overall response to the survey (combining the personal interview technique with the returned questionnaires), these responses coming from planners in such positions as technician, project manager, intermediate planner, senior planner, and director of planning. Their planning concerns encompass both urban and rural contexts.

4.4.2 Problems Encountered During Survey

Initial unfamiliarity with the planning profession, its jargon, and the nature of its process hampered the initial progress

of the survey. The jargon problem was overcome by literature research combined with the assistance of those with expertise in the field (professors and a Regional Planner) who helped with the questionnaire design. The actual process of undertaking part of the survey by personal interview relieved the other constraints by allowing me to gain an awareness and a sensitivity to the planning process otherwise unobtainable.

Although the questionnaire was designed to encourage detailed descriptions of projects, soil information requirements, suitable scale of detail etc., few planners found time to give detailed responses. Consequently the questionnaire responses were not explicit enough to form adequate evaluations of data sources, nor to allow me to become sensitive to the planner's land use decision-making process and thereby understand his approach to land capability evaluation and land use conflict resolution.

The brevity of most of the questionnaire responses, therefore necessitated follow-up personal interviews. These interviews could not be as standard in their approach as were the mail out questionnaires for the following two reasons: first, each successive interview improved my interviewing skills; and second, no two successive interviews operated from the same knowledge base. These shortcomings, inherent in any personal interview technique, are not significant enough to detract from the benefits derived. It was only through the medium of the

interview that I came to fully appreciate such matters as the constraints of time and money, the numerous trade offs or short cuts necessarily undertaken, the difficulties obtaining data, the lack of communication between different planning levels and the political aspect of decision making. The interviews therefore gave me a "feeling" for the planning undertaken at each of the three levels of government in the RMOC in a way that no questionnaire would provide. These personal interviews (in some cases combined with a satisfactorily completed questionnaire) allowed an evaluation of data needs, as perceived by the land use planners.

4.4.3 Soil Data Needs for Land Use Planning in the Regional Municipality of Ottawa-Carleton

Each of the planning jurisdictions in the RMOC undergoes the same strategic, operational and management procedures; however, their jurisdictional level, by determining their major contribution to the land use decision making in the Region, thereby, also determines the scale and refinement of information needed to fulfill their role. The soil informational requirements for each planning level consequently may not be very different, however, it was discovered by this survey that the scale requirements for these data items do differ, not only between the different planning levels, but within as well, depending upon the type of planning being undertaken. The soils information needs will be presented, in turn, for each

of the three planning levels in the RMOC. This will be followed by a discussion of those elements common to each jurisdictional level.

4.4.3.1 The Regional Municipality of Ottawa-Carleton

The main preoccupation of the RMOC planners from 1969 to 1974 was formulating an official plan to become the legal basis for overall planning and development within the RMOC. Essentially, official planning is the process whereby population projections are made for the Region, evaluations of the Region's resources are undertaken and a plan delineating land uses and activities is drafted - a plan which optimizes resource use in the light of societal goals.

The RMOC "in house" preparatory studies were undertaken at a scale of 1:50,000 while the Official Plan was drafted at a scale of 1:100,000. The planners interviewed stated that for their official planning purposes they had no need for information at a scale greater than 1:50,000 as it was desirable to have all relevant data at a similar scale. Broad assessment of land capabilities occurs during the official planning process. Table 4.1 presents the soil informational requirements as perceived by the planners and revealed by the survey, along with those data items necessary to provide this information. These data items in some cases were communicated by the planner, but in most cases were assessed by the writer. As can be seen, the

TABLE 4.1

SOIL INFORMATION NEEDS: REGIONAL GOVERNMENT

OBJECTIVES	INFORMATION NEEDS	SOIL DATA ITEMS	COMMENTS
Official Planning (strategic & policy)			
- to evaluate the alternative proposals	land capabilities needed for all pro- posed land uses:		desirable scale; -"in house" studies 1:50,000 -draft of Official Plan 1:100,000
	i) Agricultural (Where are the prime agricultural lands?) - interpreted capability for this use.	soil texture soil depth soil structure fertility stoniness drainage class slope flooding	- planners rarely consult these basic data items, rather they rely on the ARDA classification scheme - occasionally, when conflicts in capability interpretations appear, these latter four items will be referred to - when writing reports or memos may make reference to texture
	ii) Aggregate Reserves (Where are the economi- cally viable reserves?)	-depth of deposit (in order to estimate volume) -quality of deposit (indicated by soil group in Unified or AASHO system)	- this information on aggregate reserves must be combined with agriculture and conservation information as these latter uses preclude future aggre- gate reserves.

iii) Road base	-soil drainage class -depth to bedrock -slope AASHO -soil group Unified	-planners do not want to have to determine suitability using all these basic data items; however they are interested in such items as frost susceptibility, drainage class and shrink swell properties of the subgrade
iv) Road fill	-shrink swell potential -susceptibility to frost action -stoniness -rockiness	

interpreted restrictions/
capability for these uses

v) Hazard Lands
Delineation
-sensitive clay locations
-organic soil locations
-extent of flood plain

-depth and areal extent
of Organic soils

-the presence of aggregate reserves and conservation lands are deleted

vi) Land Fill site:

-influence of wetness on operation of material
-ability of soil to retard movement of leachate from landfill
-aquifer and aquifer recharge areas for potential to pollute ground water

-depth to seasonal water table
-soil drainage classification
-flooding
-permeability
-slope
-soil texture
-depth to bedrock
-stoniness
-rockiness

-planners want the soil's capability for this land use interpreted for them
-they are interested in such basic data items as depth to bedrock, seasonal water table, flooding and slope

vii) Urban Development

a) Residential
b) Industrial

-interpreted restrictions for these uses.

soil drainage class
seasonal water table
flooding
slope

shrink swell potential
potential frost action
stoniness
rockiness
depth to bedrock

Planners initially select lands for this use after all other land uses have been delineated; ideally those lands which are well drained and of lower fertility for agriculture would be designated as suitable for urban development

viii) Groundwater Information

- location of aquifers
- capacity of aquifers
- aquifer recharge areas
- direction of groundwater flows
- this information gives the planner guidelines re: single family residences in country estate developments or industrial site locations

Development beyond serviced areas all demand septic tank servicing. Planners are desperate for interpretations of soil capability for these demands

ix) Recreation Forestry

-interpreted trafficability of the soil

Capability for these uses is not based solely on soil criteria, but rather aesthetics, and economic considerations

STRUCTURE PLANNING

Delineating suitable locations for:

This is a more detailed resource inventory than that for official planning. However, it is not as detailed as development planning which follows later; development proposals are presented to the municipalities

An ideal scale for soil information is 1:25,000.

OBJECTIVES	INFORMATION NEEDS	SOIL DATA ITEMS	COMMENTS
c) Subdivision Review (ie. development proposals)		<ul style="list-style-type: none"> -hydraulic conductivity -percolation rate -attenuation capacity 	<p>the proposed land use, the Region would like this information.</p>
		<p>The developer must provide detail investigation results to conform with provincial building and the "Plan of Subdivision" criteria.</p>	<p>A proposal by a developer for a new development is presented to the municipality concerned Department. Land use planners are not involved with this evaluation.</p>

Regional planner needs soil information which is interpreted as to capability for a wide range of uses. Those uses which are given preference initially are hazard lands, aggregate reserves, agricultural lands, and conservation. In this regard the Gloucester-Nepean survey presents capability interpretation for agricultural use, albeit at a scale larger than that which the Regional planners need for this type of planning. This source of information would thereby be reduced in scale to be compatible with other sources; in the reduction process much detailed information would be lost. For the other land uses of interest in official planning, the planners would need to undertake their own use interpretations utilizing the land factor limitations on the agricultural capability map. Intentions for the future are, however, to provide engineering interpretations on a soil association basis which will be of use in evaluating capabilities for home sites, road bases etc. (Nowland, J.L., pers. comm.).

Official (or strategic) planning is but one of many tasks of RMO planners. They are also occasionally involved in structure planning, undertaken to direct the structural development of a specific growth node. This has been engaged in and completed for both the East Urban Community (Orleans) and the West Urban Community (Kanata - Glen Cairn - Bridlewood) and will need to be undertaken for the proposed South Urban Community if its development is accepted by the Ontario Municipal Board. Structure planning consists of a detailed investigation of the physical resource base, the projected population and the

industrial base required for its support, followed by the formulation of a land use plan and policy statements delineating areas for such broad future uses as, the town centre, residential areas, hazard lands, industrial locations, school sites and regional shipping centres. Detailed soil information is clearly one of the informational requirements for this sort of intensive planning. The planner has simple and pragmatic concerns and is therefore looking for a source of information which indicates the physical constraints to use, by letting him know where he can put a use and what will happen when he does so. The soil data items required for such planning are adequately provided at the desired scale and refinement by a survey of the recent Gloucester-Nepean type. Unfortunately, the planners interviewed do not appreciate the relevancy of the landscape unit design on the soil map to aid their understanding of the landforms and their composition. They much prefer, because of time constraints and lack of expertise, to use capability interpretations as presented in the agricultural capability map. The basic land factors provided with this agricultural capability interpretation will aid interpretations for use capability for many of the other land uses in structure planning, however the planners interviewed indicated the need for the interpretations and the decision criteria on which the interpretations were based to be presented. As can be seen from Table 4.1 many of the planner's concerns in structure planning deal with determining the intensity of the use which can be sustained by the soil. In spite of the

detail provided by a survey such as the urban-oriented Gloucester-Nepean survey, because of the complexity of the sub-surface material throughout the RMOC, investigations of sites for broad uses which place higher demands on the strength properties of the soil, for example, the town centre, and industrial sites, still would require engineering reports. Other localities without this complexity might very well be adequately provided with information sufficient for all structure planning needs by such an urban-oriented survey as that for Gloucester-Nepean.

Soil information is also required for operational, management or policy planning although in most instances it is not the regional planner's responsibility to provide this information. The Official Plan for the RMOC is a legal document directing growth in the region, yet, at the same time, is intended to allow some flexibility. This flexibility creates the situation in which applications for severances of land or development proposals (residential or industrial) requesting allowances for non-conforming uses are considered. Surprisingly, an evaluation of the site's physical capability for the proposed use does not enter into the regional planner's considerations; rather, these applications are evaluated on their degree of compliance with the Official Plan, infringement of prime agricultural land being the first point questioned. Once policy planners are satisfied that the non-conforming use will detract little from the intentions of the Official Plan, the application is referred to such

planning departments as Operations, Land Division and Subdivision Review at the same time as to the twelve member Committee of Adjustments. It is the responsibility of the applicant to provide sufficient documentation to demonstrate that all necessary preliminary site investigations have been undertaken, according to the guidelines established by the diverse provincial regulatory agencies. It is these agencies acting through the Committee of Adjustments, which undertake the site evaluation for the proposed use and either grant or deny final approval. In the case where insufficient documentation to enable evaluation is provided, further investigations are demanded of the applicant.

The concerns of the operational, management or policy planner are primarily adherence to the Official Plan, with one of their major decision criteria being the loss of presently productive agricultural lands. The present criteria defining these lands are found in the ARDA sources at the scale of 1:100,000 with their 1:50,000 ozalids referred to only when conflicts in capabilities appear, however, more weight seems to be given by RMOC planners to the land's present use rather than its defined capability. The recent Gloucester-Nepean survey provides more detail than these planners generally require for their agricultural capability evaluations; for most purposes they would use a reduction of the 1:25,000 map accepting the loss in detail that occurs when doing so. Similarly, this type of urban oriented survey provides information such as Atterburg Limits, compaction data and shrink-swell estimates

which would not be utilized by operational planners.

In summary, now that the Official Plan of the RMOC has been formulated, apart from infrequent structure planning, the RMOC planners do not involve themselves with detailed use capability evaluations of sites. Rather, their main function is to influence the growth of the Region to conform to the guidelines of the Official Plan. Thus, the scale of most usefulness now for the majority of the Region's land use concerns would be that of the Official Plan, ie., 1:100,000. Because land evaluations for use capabilities were undertaken at the drafting stage of this plan at an "in house" scale of 1:50,000, the basic planning unit for these evaluations could be no smaller than 24 ha. (60 acres) (Vink, 1975, p. 95). Because operational, management and policy studies do not involve land evaluations for capabilities and because recommendations for land use are all made within the constraints of the Official Plan, land use capability studies for the RMOC, other than those undertaken for structural planning purposes are not made for parcel sizes less than 24 hectares. A survey of the Gloucester-Nepean type provides the necessary data items and the agricultural capability interpretations for most types of regional planning; however, actual information needs in the form of use capability is not readily available. The scale of detail available, although larger than needed for most of the RMOC's planning concerns, is suitable for most structure planning

concerns, however, planners are interested in more interpreted capabilities than are presently available.

4.4.3.2 The National Capital Commission

The NCC is unique inasmuch as it is a planning agency which owns all the land under its jurisdiction and thereby avoids many of the political complexities of the RMOC planning department. As yet, no master land use plan for the NCC Greenbelt has been formulated, both because the land use policies for the Greenbelt are changing and because there is no need to prepare a legal document to direct other government bodies.

Planning in the NCC can be considered under the headings of Land Use Development, Policy Planning, and Strategic Planning. Informational requirements for these NCC planning tasks are presented in Table 4.2. The table shows that, unlike the RMOC planner, the NCC planner is concerned mainly with site selections for specific purposes. Despite the absence of an official plan, and the land capability evaluations supporting it, the natural resources of the Greenbelt have been fully inventoried. Land use guidelines based on these inventories are employed by most NCC planners when making their recommendations. They do, however, need information on which to base their site selection. The preoccupation of NCC planners with site selection, initially led me to believe that a soil survey of the scale of the recent Gloucester-Nepean (1:25,000), with its minimum planning parcel of

TABLE 4.2

SOIL INFORMATION NEEDS: NATIONAL CAPITAL COMMISSION

OBJECTIVES	INFORMATION NEEDS	SOIL DATA ITEMS	COMMENTS
<u>LAND USE DEVELOPMENT</u>			
-proposals for sites for various uses -the planner determines the compatibility of the site with the specific needs of the client	<ul style="list-style-type: none"> i) Sanitary landfill site -influence of wetness on operation of material -ability of soil to retard movement of leachate from landfill -potential to pollute groundwater 	<ul style="list-style-type: none"> -depth to seasonal water table -soil drainage class -flooding -permeability -slope -soil texture -depth to bedrock -stoniness -rockiness 	<ul style="list-style-type: none"> -ideal scale for soil survey data would be 1:25,000 -all of these data items are needed for evaluating a site for this use, yet, planners expressed discomfort at using them. They feel comfortable using data on movement of leachate through soil, and potential to pollute groundwater though.
	<ul style="list-style-type: none"> ii) Snow Dump site -movement of the salt through the ground -information on the salt movement into streams and rivers 	<ul style="list-style-type: none"> -permeability -depth to bedrock -depth to seasonal water table 	<ul style="list-style-type: none"> Again, this information should be interpreted.
	<ul style="list-style-type: none"> iii) air port extension -information on subgrade stability 	<ul style="list-style-type: none"> -bearing capacity -depth of surficial deposits -engineering test data -shrink-swell potential -frost susceptibility -slope -drainage class 	<ul style="list-style-type: none"> Type of surficial deposits is of interest here. Strength interpretations could be used. However, considerations such as noise for present residential areas are more important.

OBJECTIVES	INFORMATION NEEDS	SOIL DATA ITEMS	COMMENTS
<p><u>POLICY PLANNING</u> (Management concerns ie. compatibility of land uses with pro- posed sites)</p>	<p>iv) Industrial Location (as in South Industrial Site) -restrictions to this use by site: -topography -strength -septic tank use</p>	<p>soil drainage class seasonal water table flooding slope shrink-swell potential potential frost action stoniness rockiness depth to bedrock</p>	<p>Again, planners are uneasy working with these items; they would like more infor- mation on the potential for groundwater pollution from these uses.</p>
<p><u>STRATEGIC PLANNING</u> (Research Branch)</p>	<p>i) Soil suitability for: a) ski trails b) nature trails c) picnic grounds d) car sales lots ii) minimum economically viable Farm size</p>		<p>For nearly all of these site specific uses there would be concern about the sensitivity of the terrain to support it - not just soil sensitivity but also vegetative and wildlife. Ideally interpretive capabilities of trafficability would help.</p>
	<p>i) Rapid transit concerns ii) Transportation networks iii) Housing Developments -Woodroffe -LeBreton Flats</p>		<p>These are long term planning projects and are done so with both Regional and Municipal representatives. They are concerned more with population trends and demands.</p>

no less than 4 hectares (10 acres) (Marshall, I., pers. comm.) would be deficient for their needs as even a detailed soil survey of this scale is not designed to give, nor can it provide, the refinement generally demanded by site selection studies. Further investigation of the NCC's projects led to the abandonment of that original assumption since the land uses being evaluated (land fill sites, industrial developments, airport extensions etc.) generally require a size of planning parcel adequately and reliably described by the available 1:25,000 soil survey. For more intensive land uses in their urban owned lands, the Gloucester-Nepean survey would be inadequate for evaluations of capabilities as geotechnical studies would normally be required, and the soil survey is not intended even if oriented to urban concerns, to present this information. The planning concerns of the NCC planners, by being more site specific than those of the RMOC planners, thereby demand a more detailed information base to assess site suitabilities. The specialized information provided by the urban oriented soil survey and the detail provided by its 1:25,000 scale make it suitable for many of these site evaluations.

4.4.3.3 The Municipalities

All the municipalities within the RMOC follow the same strategic, operational and management procedures as the RMOC government; they differ only in their scales of study. The official plans for these municipalities are on a scale larger

than that of the Region's (1:15,000 as opposed to 1:100,000) and demand a much more detailed information base than that provided by the Region's Official Plan. All the municipal official plans must conform to that of the Region, however, their larger scales encourage greater "ground truth" representation. The municipal plans thereby acknowledge in many instances the inclusion of non-conforming capabilities. This acknowledgement can take place only if the municipalities are provided with the needed data base for their studies, because any proposed deviations from the Region's land use plan must be well substantiated. The municipalities, thus, find themselves in a dilemma. On the one hand they have the opportunity to draft detailed land use plans and are, in fact, encouraged to do so; on the other hand, they are desperate for detailed data on which their proposals can be based and substantiated.

During the survey it became clear that obtaining soil data of sufficient refinement for their more detailed planning presented a hurdle to all the municipalities surveyed. Because funds are insufficient to initiate their own data inventories, the municipalities turn to the Region to provide for their needs. The result of this process is unsatisfactory because the Region's data is neither adequately refined for the municipalities scale of concern, nor does it provide detailed descriptions of the Region's decision criteria. In the cases of March and Goulbourn townships these constraints have led to the drafting of very general plans in which future land use proposals will be

covered by policy statements rather than detailed by boundary delineations. As with the Region, the municipalities are primarily concerned with the compliance of the proposed use with the Official Plan. This necessitates more highly refined data on agricultural capabilities than hitherto has been provided by the Region. The agricultural capability information provided by the new Gloucester-Nepean soil survey is adequate to supply the refinement desired for these decisions. Unfortunately, the two municipalities surveyed with the lowest financial resource base (Goulbourn and March) are not yet fortunate to have this data base provided by the Land Resource Research Institute.

Specific information needs for the municipalities are described in Figure 4.3. Other than the urban-related development in the growth nodes on serviced lots, all severences and development proposals must have septic tank servicing. As described in the section on the RMOC's needs, the final decision on the site suitability for septic tanks is made by the Ministry of Environment via the Committee of Adjustments. Despite the authority for these evaluations being with the province and because all future rural development is dependent on the soil's capability for septic tank use, information relating to drainage conditions and groundwater concerns is desired by municipal planners. Responding to this need March township invested in a study which mapped septic tile drainage capability (Roed, 1976) to provide its planners with a more complete

TABLE 4.3

SOIL INFORMATION NEEDS: MUNICIPALITIES

OBJECTIVES	INFORMATION NEEDS	SOIL DATA ITEMS	COMMENTS
<u>OFFICIAL PLANNING</u>			
-to evaluate their resources within the constraints of the Region's Official Plan	Land capabilities at a scale more detailed than needed by the RMOC	<ul style="list-style-type: none"> -soil texture -soil depth -soil structure -fertility -stoniness -drainage class -slope -flooding 	Ideal scales for this type of planning would be 1:15,000 but 1:25,000 would suffice.
	<ul style="list-style-type: none"> i) Agricultural Capability -the locations of prime agricultural lands 	<ul style="list-style-type: none"> -soil texture -soil depth -soil structure -fertility -stoniness -drainage class -slope -flooding 	<p>Planners in the municipalities would ideally like to have the Region's land use delineations detailed at a larger scale - but not possible - so necessary to undertake some of their own capability evaluations.</p> <p>-ARDA classification would be used here.</p>
	ii) Aggregate Reserves		<p>These reserves are delineated by the Region - but since their designations are precluded by present agricultural and conservation lands a more accurate representation of these uses may alter the Regions boundaries in the Official Plan of the municipalities. The municipality does not evaluate the potential of the aggregate reserve itself.</p>

OBJECTIVES	INFORMATION NEEDS	SOIL DATA ITEMS	COMMENTS
	iii) Road base iv) Road fill	soil drainage class depth to bedrock slope soil group (AASHO or Unified) shrink-swell potential susceptibility to frost action stoniness rockiness	This is a planning concern of the municipality because they must maintain all township roads.
	v) Hazard Land Delineation		Generally, the municipal planners accept the boundaries of the Region and cover any deviations by policy statements. They do not have the funds to undertake the same studies as the Region at a larger scale.
	vi) Landfill sites:		This is now under jurisdiction of the Region.
	vii) Urban Development a) Residential b) Industrial		Sites for these land uses are designated by the Region; investigations are undertaken by the Region in structure planning.
	viii) Country Estate Development (ie. suitability to septic tank usage)	-depth to water table -slope -permeability -hydraulic conductivity -percolation rate -attenuation capacity	The municipality would like to have interpreted information on soil capability for this use to direct development, although the Ministry of the Environment has the final word on approval.

OBJECTIVES	INFORMATION NEEDS	SOIL DATA ITEMS	COMMENTS
<u>OPERATIONAL PLANNING</u>			
a) Severence Applications (only farm related are allowed)			
b) Development Proposals - for non-conforming uses: industrial or residential			
	i) Agricultural Capability	see above	
	ii) Septic tank suitability	(see above, country estate development)	For approval the application is sent to the Committee of Adjustment at the Region - Ministry of the Environment has the final say. But this is information that the planners would like at their fingertips because it is so critical for all types of development in municipalities.
	iii) corosivity to piles and pipes - rated in relation to specific structural materials	-salinity -conductivity -total acidity -sulfates present	-even though it is the developers concern to adhere to construction guidelines, the municipality would like to have general areas outlined where there is this type of problem.

framework for directing future rural development. The urgency of the need for more groundwater information is emphasized by the fact that lack of information on aquifers and their recharge locations has led to arsenic pollution of the groundwater of an extensive area in Gloucester township. Groundwater information is not generally provided by a soil survey. The land factor limitation for wetness, provided by the Gloucester-Nepean survey and rated as major, moderate or minor, is interpreted only qualitatively for agricultural purposes and has limited value for the planners' needs relating to septic tanks.

In summary, for official planning purposes the municipalities have similar data needs to the RMOC but require it at a greater scale. Soil surveys of similar design to the recent Gloucester-Nepean survey are capable of meeting this need. The scale of data available from this survey at the same time meets municipal needs to assess agricultural capabilities for the purposes of evaluating severences and development proposals. The need remains however for interpretive information at the municipalities' scale of concern. This is not available from the Regional government and the municipalities lack sufficient funds to undertake their own studies. The Gloucester-Nepean survey in its present format does not provide the needed interpreted capabilities.

4.4.3.4 Summary of Survey Findings

A high quality soil survey of the Gloucester-Nepean type produces specialist information for more intensive uses of the land than previous agriculturally oriented surveys. The present study confirms that as its originators hoped, a soil survey of this type does indeed provide the necessary data items at the most suitable scale of detail for the widest range of planning decisions in the RMOC. Some of these planning decisions for which this scale is suitable are: the official, operational, and management planning for the municipalities; the structural planning at the RMOC; and the official, operational and management planning in non-urban areas for the NCC. The original hypothesis for this thesis, however, has been validated, for it was also discovered that the existing presentation of this high quality soils data does not fully realize its potential for communicating the capability of the soils and the potential uses of the soil data base to those in land use planning positions. The reasons for this shortcoming were clearly articulated during the personal interviews and appeared to be common to all jurisdictional levels within the RMOC regardless of the type of planning being undertaken and therefore deserve further consideration. --

The survey results consistently indicated that at all levels of government in the Region the initial basic data of the soil survey needs to be interpreted according to use capabilities.

Planners are, by the nature of their profession, short of time; also because they must bridge gaps between diverse disciplines they often lack the expertise to interpret the data with which they must deal. If this basic data is to contribute to the evaluative process it must be presented in a manner which aids its consideration. Land uses frequently being evaluated within the RMOC are agriculture, home sites, industry, country estates, septic tank suitability, major transportation routes, land fill sites, recreation, and forests. Deciding upon suitabilities of a parcel of land for one of these uses requires evaluations of many considerations other than just the soils' capability, thereby necessitating a presentation of the soils information in a manner which can readily be integrated with all the other considerations. This means a quantitative evaluation, if possible, of the soil's limitation to use. Major, moderate, or minor limitations of the basic land factors (eg. stoniness, wetness, topography etc.) contribute little to the planner's evaluation for use unless presented in terms of their respective restrictions to the specific uses being evaluated. Only then can the soil capability consideration be incorporated into a cost/benefit analysis in the same manner as the other considerations. This type of urban oriented survey of which the Gloucester-Nepean survey is an example, does not meet these needs now, nor does it appear that it will even when completed as interpretations for the above land uses are not presently available, and when they are undertaken it is intended to present them in the

qualitative format of low, moderate, high restriction (Nowland, J.L., pers. comm., April 1978).

Interpretations alone fall short of enabling the planner to knowledgeably and confidently deal with soil capabilities. When a soil survey presents interpretive information such as the agricultural capability interpretation of the Gloucester-Nepean survey, all the decision criteria for these capability ratings need to be detailed. In this way the planner learns to understand not only the limitations to use of each specific land factor, but will also learn to appreciate the cumulative effects of several limitations. Planners ultimately are accountable to the general public and to the representative politicians and to assume this accountability confidently also demands an understanding of the restrictions and limitations inherent in the data.

Information on the minimum size of field mapping unit is helpful for the planner, but far more important is for the planner to know what he can reliably do with the data presented to him. Details which should be provided the planner are: the minimum size of planning unit which can reliably be represented by the survey; the accuracy of the survey, ie. its percentage inclusions and the reliability of the boundary delineations; the scale of study at which the planner should initiate field investigations; and the fact that the soil map cannot be reliably "blown up" to be compatible with the scale of other data

sources. For the planner, being accountable also means being provided with disaggregated basic data to support their land use recommendations.

To briefly summarize the common elements of this survey of land use planners, the planner's public accountability for his land use recommendations means that he needs the original, basic data, as well as its limitations to support these recommendations; yet, on the other hand, he needs relevant interpretive use capabilities of the soil to knowledgeably make his use suitability decisions.

Clearly, there are factors other than the quality of the survey itself impeding integration of soils information into the land use planning process. The next chapter will present a few of these factors which became apparent during this study, as well as some recommendations which may in some marginal way, improve this situation.

CHAPTER V

RECOMMENDATIONS

5.1 Preamble

Soil data is one of the most demanded types of biophysical information in that it can give indications of environmental limitations for plants, animals and man. This thesis was undertaken with an awareness of the frustration some land use planners express regarding the usefulness of the soil information normally available and with some limited insight into the design of the recent Gloucester-Nepean soil survey (the map has recently been printed but the report is as yet unavailable). Discussions with the personnel at the Land Resource Research Institute responsible for this survey revealed that they were attempting to respond to the demand for urban-oriented soils information. Despite the high quality of the survey, the design adaptations and agricultural interpretations intended to enhance its relevancy to urban-oriented land use planning it seemed fruitful to undertake an investigation of the planner's needs as perceived by the planner and by myself after discussions with planners, to determine if the survey design could be made even more relevant to their requirements.

During the course of the survey it became apparent that the ecological awareness of the land use planners in the Region was greater than initially expected. This awareness was manifested among the planners at all three levels of government by sensitivities to such considerations as: desire to maintain the integrity of aquifers by preventing disturbance to the groundwater system by alterations in either its catchment or its output; reluctance to continue allowing development in country woodlots both because of the potential disturbance to the groundwater system and because of the low tolerance of mature trees to absorb changes in the ecosystem from development invasion; awareness that land uses cannot be designated simply on the basis of land capability but must consider as well the compatibility with or impact on the adjacent uses of land; and desire to rate terrain suitability in the natural state. The planners' awareness of the need to appreciate the state of the systems in nature has grown in response to the opportunity their work affords them to observe the deleterious effects on the Region of development undertaken in ignorance.

At the time of the preparation of the RMOC's Official Plan some of these ecological considerations were being addressed by innovative planners. Consequently, the Region's Official Plan attempted to be environmentally sensitive. The land use recommendations generated by the planners at that time were based on ecological concerns (May, 1971b); however, when final decisions were made political and economic factors in many cases

appear to have been decisive. With the Official Plan drafted it is the case that for operational and policy planning the major criterion for land use decisions is conformance to this legal document. Therefore the degree to which present and future land use decisions in the Region can be influenced by ecological inputs is constrained by the degree to which these inputs are reflected in the Official Plan which is constrained, in turn, by the quality and relevance of data available at that time. Recommendations regarding the role of the Official Plan and natural environment concerns will not be dealt with here, as it is beyond the scope of this thesis. The interested reader is referred to Lang and Armour (1976).

Clearly, there have been efforts in the last few years directed towards the provision of a more relevant and comprehensive biophysical data base for planning purposes (Section 4.2.2). Additionally, for part of the RMOC, the soil component of this biophysical base has been inventoried and presented in a manner thought by the Land Resource Research Institute to be more relevant for the planners' use. Yet, how does one measure the effectiveness of these improvements in soil information? To undertake this evaluation an investigation of the usability of a soil survey of the Gloucester-Nepean type was undertaken for one user group, that being the land use planner. The usability of the output information (soil survey report and map) would be a performance measure of the entire soil survey process from inception to final presentation, and would be constrained

by the least developed element in the process. Those elements evaluated for this type of soil survey included the inventory design and procedure, field mapping units, data items collected, and final presentation format.

This investigation of usability began with the data definition process presented in Chapter IV and discovered that, regardless of the relevancy of the soil survey design and scale, and regardless of the necessary data items being provided, the usability of this information does not meet its potential for this user group. Thus, it appears, to improve the performance measure of the soil information provided, one must extensively investigate not only the soil survey process and the user's decision system, as was undertaken in this thesis, but also the mode of interfacing the two. Since the use of information does not begin until the output has been successfully transferred to the user, any factor impeding this delivery would be undermining its usability. One such factor appears to be the conflict existing between the nature of a research institute and that of the planning process. Traditionally research institutes have directed little attention to the application of their specialist data directing more efforts to the advancement of their science. However, soil scientists have found themselves drawn into the forum of land use planning by responding to the various demands by non-specialists for their information. An adequate sensitivity to the reality of the land use planning situation is not visible

or it presumably would be reflected in greater attempts to improve the applicability of their information to planner's needs.

Some recommendations which I feel would alleviate these impediments to optimizing the inclusion of soil survey information in the land use planning process follow.

5.2 Recommendations

5.2.1 Increased Liaison

Integration of soil capability studies into the Region's planning has been hampered by the unfamiliarity of some of the planners with the data sources available to them. No doubt this is a function of the number of planners attracted from outside the RMOC to fill recently created planning positions at all levels of jurisdiction. Surprisingly, regardless of the Land Resource Research Institute's (LRRI) input at the recent Ontario Municipal Board hearings, some of the planners polled or interviewed were unaware of such government organizations as the LRRI which can knowledgeably provide soil information and advice for planning purposes, and the Geological Survey of Canada which as well as bedrock information, can provide surficial geology data for these same purposes. The LRRI's capability is well known at the NCC (the Greenbelt is entirely within the new Gloucester-Nepean survey boundaries), in Gloucester and Nepean townships, and RMOC senior planners but

elsewhere there exists a definite lack of acquaintance

-----Recommendation 1-----

An increased liaison between planners and the "experts" at such places as the LRRI and G.S.C. could assist the municipalities in obtaining new data or interpreting existing data.

5.2.2 Soil Survey Format

Delivery of information from a soil survey is generally in the format of the traditional multi-coloured map accompanied by descriptive tables of soil properties and characteristics; this format does not encourage integration of this information into the decision process. Rather than criticizing planners for not utilizing soil information to its potential, soil scientists must first fully accept the nature of the planning profession and direct efforts toward those contributions most valued by the planner.

-----Recommendation 2-----

By accepting that traditionally planning decisions were made without regard for biophysical information the soil scientist must meet the challenge of presenting his information in such a format that the planner himself views as being relevant. He must use his expertise to present interpreted use restrictions for those land use concerns communicated by the planner as being important.

5.2.3 Interpretation Basis

The agricultural capability system of the Gloucester-Nepean survey differentiated major, moderate and minor land factor limitations to provide for extrapolations of this capability rating for non-agricultural uses. However the rating of these land factor limitations on the basis of field crop agriculture reflects the attempts by the soil scientist to adapt traditional measures rather than to derive possibly more appropriate new ones. Topographic restrictions or stoniness restrictions limiting the use of machinery, or droughtiness restrictions limiting crop growth do not aid the land use planner in an urban/regional context to evaluate land use capabilities (see Appendix B for complete breakdown of restrictions). An urban-oriented survey has no need to define limitations by agricultural use criteria; any land not presently in agricultural production within the RMOC, will be designated for other uses regardless of its agricultural potential when allowance for non-conforming use is requested (Section 4.4.3.1).

-----Recommendation 3-----

The agricultural basis of interpretation of limitations is inadequate for an urban-oriented soil survey. New criteria and/or interpretation procedures are needed. Land factor limitations rated on the basis of restrictions to urban uses would improve the relevancy of the soil survey. Quantifying these restrictions would contribute more substantive accountability to the planner's land use recommendations.

5.2.4 Expediency and Economy

The soil scientist must accept that expedience is the nature of the land use planning process. Relevant, interpreted soil data, not available until official planning is completed, loses its potential input to land use planning in the Region. I agree with the statement by Nowland (1976) (see page 58) that all soil surveys undertaken in the Windsor-Quebec City axis should be urban-oriented; however, by observing the lengthy production period required for a survey such as that for Gloucester-Nepean, it appears to be impractical, from the user's standpoint, to strive for this ideal on the current township by township basis. An urban-oriented survey must be timely and is costly since it demands extra sampling time at each soil pit to obtain the extra samples required for geotechnical and engineering analyses.

-----Recommendation 4-----

The field approach of the survey needs to be changed not to give uniform level and direction of coverage throughout the whole area, but to provide for urban-oriented concerns in some areas, agricultural concerns in others, and both types in certain areas. After undertaking a general, smaller scale survey for the entire area, specialist surveys can be designed for specific locations, the observations, intensity of observations, and interpretations reflecting the probable use or allowed use if an Official Plan is already adopted. The level of information required for preliminary official plan purposes is not as great as for more detailed urban considerations, such as growth nodes, very little urban-oriented information is needed for an area destined to remain agricultural, and rural development concerns

have only a few information requirements at a detailed scale.

5.2.5 Regional Environmental Information Centre

Research proves its usefulness when it is utilized to benefit the community which financially supports it. Much more effort needs to be directed to increasing public awareness (planners included) of the high quality government endorsed information sources available.

-----Recommendation 5-----

The creation of a Regional Environmental Information Centre, informed regularly of ongoing programs of pertinent research institutes in the Region would be one means of accomplishing increased public awareness and the first step toward successful interfacing of information sources with users.

5.2.6 Land Use Planning Manual

The next necessary step to ensure high usability of the information provided and integration into the planning process is adequate translation. A planner not trained in soil science should be enabled to gain a sensitivity to the soils limitations for unconditionally providing for man's use.

-----Recommendation 6-----

A land use planning manual could be devised in which the actual planning problems at various scales of concern are described, detailing the relevance of the soil survey to each situation. Such elementary topics as soil definitions, inherent limitations

of mapping discontinuous features, scale limitations, size of mapping units and their degree of variability, size of reliable planning unit etc. should be included. To educate the planner on use restrictions each basic land factor would need to be discussed in the light of its restrictions to all anticipated uses.

We must not lose perspective in the planning process. Soil information would be only one kind of information taken into account when decisions are made, and as May (1976) observed, there are many forces other than information which determine the outcome of any planning process. But accurate, relevant, easily available information can be a powerful tool in any planning process. The ultimate conclusion of this thesis is that soil surveys are already valuable tools in the land use planning process but, that their usefulness can and should be improved.

A P P E N D I X A

QUESTIONNAIRE

DATA REQUIREMENTS

1. In your present planning position have you had need of soil survey reports?

often _____
 sometimes _____
 Not at all _____

b) If so, was it readily available?

c) Did you succeed in finding the information in the soil survey report which your were seeking?

d) Was it in a utilitarian and understandable format?

e) Do you have any recommendations re: soil survey presentations for your purposes?

2. In your present planning position have you even had need of the following basic, raw data? (ie. non-interpreted data)

	often	sometimes	Not at all
rockiness	_____	_____	_____
stoniness	_____	_____	_____
depth to water table	_____	_____	_____
surface drainage patterns	_____	_____	_____
soil texture	_____	_____	_____
soil bulk density	_____	_____	_____
shrink swell character	_____	_____	_____
bedrock structure	_____	_____	_____
depth to bedrock	_____	_____	_____
organic soils	_____	_____	_____
slope	_____	_____	_____
soil acidity (pH)	_____	_____	_____
engineering properties	_____	_____	_____
other	_____	_____	_____

a) Was this data readily obtainable?

b) Was it in a utilitarian and understandable format?

c) Would you have any recommendation for improvements in the presentation of this data in order to aid your understanding or its usefulness?

3. In your present planning position have you even had need of any of the following interpreted data?

	often	sometimes	not at all
suitability for specific crop	_____	_____	_____
suitability for recreation	_____	_____	_____
suitability for home sites	_____	_____	_____
septic tank suitability	_____	_____	_____
suitability for forest	_____	_____	_____
soil susceptibility to drought	_____	_____	_____
water quality	_____	_____	_____
aggregate resource potential	_____	_____	_____
potential frost action	_____	_____	_____
soil susceptibility to erosion	_____	_____	_____
soil suitability for land fill	_____	_____	_____
soil suitability for road base	_____	_____	_____
other	_____	_____	_____

a) Was this data readily obtainable?

b) Was it in a utilitarian and understandable format?

c) Would you have any recommendations for improvements in the presentation of this data to you to aid your understanding and its usefulness?

4. Do you find a qualitative or quantitative presentation more readily incorporated into your decision making process?

qualitative _____ (example: slight slope)

quantitative _____ (example: slope 0-8%)

SCALE

5. It is recognized that the requirements for information on the physical environment ranges over a considerable wide scale depending on the nature and the location of the project undertaken. Different levels of detail of earth science data would be needed for projects or development planning taking place in the CBD as compared with the level of detail required for estate planning in the rural fringe, for example. The level of detail required is a function of both the location and the function of the planning project.

a) Could you please expand on the range of the planning projects you are involved with and illustrate how the different functions and/or locations demand different scales of data.

b) If you only require one level of detail in the presentation of earth science data could you please describe the functions you are planning for and the ideal scale of data presentation?

SCOPE

6. Planning operates at all three levels of management: Strategic planning (official planning, objective setting, revisions etc.); Management control (effective, efficient utilization of resources); and Operational control (focuses on tasks, execution).

a) Which level of management involvement do you mainly deal with?

Strategic planning _____
 Management control _____
 Operational control _____

6. b) Do you also deal with others? If so, which ones?

Strategic planning _____
Management control _____
Operational control _____

c) Which types of general areas of concerns do you deal with?
(example: official planning, resources management, conservation planning,
housing development control, redevelopment planning, severences, etc.)

d) Which of these areas of concern would have the physical environment
as one of its considerations and would then utilize earth science data
(stoniness, soil stability, crop suitability, etc.) during the decision
making?

PLANNING PROBLEMS

7. a) What do you identify as the specific problems or issues that need
to be resolved when dealing with these areas of concern, eg. site
selection? (Please confine your answer to earth science concerns.)

7. b) What earth science variables then do you need to have collected and presented to you, the planner, to utilize in resolving these planning problems?
- c) When you are faced with planning decisions such as these do you need to seek the advice of specialists re: what the needed data would be? If so, then to whom, or where do you turn for this assistance?
- d) When planning issues arise there are many concerns other than physical to be considered. The stage of planning has a great affect on the weight ascribed to the physical variables when incorporated together with all the other concerns. Can you illustrate this by using some examples, please?

SCOPE

8. The scale of the planning will determine both the kind of policies formulated and the kind of contribution earth scientists and earth science data should make to the decision making process.

- a) Which levels of planning are you involved with?

National _____
Provincial _____
Regional _____
Municipal _____
Other _____
(Specify) _____

- b) How large is the area over which you make your decisions?

8. c) Which planning level position do you hold? (eg. technical, policy formation, policy decision-making)

FOCUS

9. Statements of objectives broadly identify the kind of environment which is expected that proposals of a plan will achieve.

What are the statements of objectives for your planning unit, which will affect the physical environment?

10. Have you been provided with adequate data to be enabled to have the needed foresight to avoid environmental problems as a consequence of your planning decisions? Is there scope for improvement in this area of concern?

11. Do you have any other recommendations which you could offer on this topic which I have overlooked?

A P P E N D I X B

LAND FACTOR RESTRICTIONS
(from Dumanski et al., 1978)

WETNESS

- W' - Major - excessive wetness generally due to ponding, seepage or impermeable subsoil. May cause suffocation and winter kill of plants.
- W - Moderate - wetness or poor to very imperfect drainage on flat to gently sloping land. Often on clay land or over impervious subsoil.
- w - Minor - periodic wetness or imperfect drainage on sloping land. Mainly on lower slopes of till ridges.

SOIL STRUCTURE

- D' - Major* - massiveness, poor structure and/or firm consistence, causing poor aeration and slow moisture distribution. Tillage is difficult and requires special management, and trafficability is poor when wet.
- D - Moderate - massiveness, poor structure and/or firm consistence, causing poor aeration and root penetration through subsoil.
- d - Minor - poor structure, causing minor air and water movement problems.

* This category does not exist in the area.

DROUGHTINESS

- M' - Major - a condition generally found in well to excessively drained sands and gravels which require irrigation for normal crop growth under average weather conditions. Such soils may undergo wind erosion when non-irrigated and unprotected.
- M - Moderate - generally found in well to excessively drained loamy sands, coarse sandy loams, and fine sandy loams or loams overlying sands or gravels. Without irrigation, crop yields may be acceptable during average to wet years, but not in dry years.
- m - Minor - well drained fine sandy loams or loams which, with proper soil moisture conservation practices, give acceptable yields under average climatic conditions.

STONINESS

- P' - Major - soils sufficiently stony to make use of machinery difficult. (3 to 15% on surface)
- P - Moderate - stones cause a minor nuisance to operation of machinery (0.1 to 3% on surface)
- p - Minor - soils with low surface stones (0.1% on surface),

NATURAL FERTILITY

- F' - Major - very low nutrient status and base exchange capacity due to low organic matter and/or clay content. Possible severe nutrient imbalance due to acidity or alkalinity (pH <4.5 or >7.6).

- F - Moderate - low nutrient status due to low organic matter and/or clay content or moderate nutrient imbalance due to adverse acidity or alkalinity (pH 4.5 - 5.5 or 7.4 - 7.6)
- f - Minor - minor nutrient imbalance due to low organic matter content and/or unsuitable reaction (pH). Affects only a few crops and may need moderate lime.

INUNDATION* RELATIVE TO BIOLOGIC GROWTH

- I' - Major - frequent land flooding of extended duration (>5 days)
- I - Moderate - occasional overflow of short duration (<5 days) causing high water tables of extended duration (>5 days)
- i - Minor - occasional, brief inundation (1 day) with very high water table. Affects only deep rooted plants.

BEDROCK

- R' - Major - solid rock at less than 0.5 metres, with outcrops covering >10% of surface.
- R - Moderate - solid rock between 0.5 and 1.0 m with outcrops covering <10%, or shattered rock (shale, schist) between 0.3 and 1.0 m, with outcrops covering 20% of surface.
- r - Minor - solid rock between 1 and 2 m or shattered rock between 0.5 and 1.0 m.

* This does not consider spring flooding of the Jock, Rideau and Ottawa Rivers.

TOPOGRAPHY

- T' - Major - short slopes (<100 m) steeper than 9%, which affect the use of machinery and which require protection against water erosion.
- T - Moderate - short slopes (<100 m) less than 9%, which interfere slightly with the use of machinery and which require some protection against water erosion.
- t - Minor - slopes of 3 to 6% which do not interfere with machinery but may result in slight water erosion and/or non-uniformity in moisture distribution and plant growth.

VARIATIONS IN DRAINAGE

- V' - Major - alternation of two or more soil drainage classes within 50 metres, due to surface undulations 1 m or more in height.
- V - Moderate - alternation of drainage of one soil drainage class over a distance greater than 50 m, on undulations of less than 1 m in height.
- v - Minor - any minor variation in drainage over a distance of less than 100 m which results in non-uniformity biological growth.

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