CHAPTER I

LAND BANKING: PLANNING DEVICE VERSUS SOCIAL POLICY

The Misuse of Land Banking

More land will be developed for urban use in Canada over the next twenty-five years than has been developed from the time of the first European settlements (McNeill, 1971, 85). This growth is both a challenge to and an opportunity for urban public policy. If the challenge is met, this growth can improve our cities, for growth creates form (Boulding, 1953, 326). However, judging from past experience the prospects are not good. Many prominent authorities such as Carver, Certler, Jackson and Rashleigh to name only a few, have cited many missed opportunities of the past. Undoubtedly, the most fundamental of these missed opportunities has been landbanking: the advance acquisition and assembly of land in anticipation of future urban requirements.

This theme calls for a reassessment of how we allow our cities to grow. The past performance of both the private and public sectors is

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SHAPING URBAN FUTURES:
AN EXAMINATION OF LAND BANKING,
URBAN GROWTH AND URBAN FORM

BY

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Submitted in Fullfillment of the
Requirement of Geography 45:599

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1980

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"SHAPING URBAN FUTURES: AN
EXAMINATION OF LAND BANKING,
URBAN GROWTH AND URBAN FORM"

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ABSTRACT

This study calls for a reassessment of how we allow our cities to grow. Using Edmonton as a case study the past performance of both the private and public sectors is examined. Choosing directions for urban growth necessitates the creation of a land related planning data base. The Edmonton Regional Growth Studies Data Base is described and analyzed. A new method of assessing a region's land resources is presented. From this base of land related information two simulations were undertaken. The first models how Edmonton will develop given the existence of the Mill Woods Project. The second models Edmonton's growth had this public land banking venture not been undertaken. The two simulations are compared and contrasted.

RÉSUMÉ ANALYTIQUE

L'auteur de cette étude souligne la nécessité de réévaluer nos politiques d'expansion urbaine. Prenant comme exemple la ville d'Edmonton, il examine les actions entreprises jusqu'ici par les secteurs privé et public. Pour être en mesure de diriger la croissance urbaine, il faut disposer d'une base de données sur l'aménagement foncier. L'étude renferme une description et une analyse de la Base de données sur la prospective de l'expansion régionale d'Edmonton. On y présente une nouvelle méthode pour évaluer les ressources foncières d'une région. A partir de cette base de données sur l'aménagement foncier, l'auteur effectue deux simulations sur modèles. La première montre comment se développera la ville, grâce au Mill Woods Project (constitution d'une réserve publique de terrains), la deuxième indiquant ce qu'il serait advenu sans cette initiative. L'auteur compare et confronte les deux modèles.

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The initial idea for this study was conceived just over four years ago. Since then, through both full and part-time study, many people have assisted, instructed, advised and supported me in my efforts. I owe them more thanks than I can express.

Mr. Gordon Tweddell, Senior Planner, Edmonton Regional Growth Studies Group, Edmonton Regional Planning Commission, provided the data and documentation which made this study possible. Three individuals took time away from their heavy responsibilities in other organizations to guide my reading and tutor me in their area of expertise. Dr. N.H. Lithwick, then Chairman of the Department of Economics, instructed me in land economics. Mr. D. Abbott, Associate Professor, Department of Law, tutored me in land law. Mr. Peter Spurr, Director of Research, Land Assembly and New Communities Division, CMHC, guided my reading and tutored me in the urban land development process. Two personal friends, Mr. Michael Whitehead, Software Manager, Commodore Business Machines UK Ltd., and Dr. K.C. Lam, Research Associate, Science Council of Canada, assisted me by writing the computer programs for the simulations and the factor analysis. Mr. Herschel Belkin, Analyst, Computer Centre, Carleton University, instructed me in the use of the SYMAP mapping program. Ms. Christine Du Bois typed the manuscript quickly and proficiently. I would also like to acknowledge the efforts of Mr. Duncan Anderson, Associate Professor of Geography, my initial advisor, for coordinating my tutorials and directing my early studies. I especially thank Dr. D. Michael Ray, Professor of Geography, my thesis adviser, for his very sound advice, helpful criticisms and his constant encouragement. While my work has benefited from the input of each and everyone mentioned, the faults and weaknesses that remain are of my own construction.

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TABLE OF CONTENTS

ABSTRACT.....	<u>Page</u> ii
RÉSUMÉ ANALYTIQUE.....	iii
ACKNOWLEDGEMENTS.....	iv
TABLE OF CONTENTS.....	v
LIST OF TABLES.....	viii
LIST OF ILLUSTRATIONS.....	xviii
Chapter	
I LAND BANKING: PLANNING DEVICE VERSUS SOCIAL POLICY.....	1
The Misuse of Land Banking.....	1
An Overview of Land Banking.....	7
The Mill Woods Experience.....	13
II MILL WOODS: A CASE STUDY.....	14
Mill Woods is Created.....	14
Flying in the Face of History.....	19
Land and Housing in Edmonton.....	28
The History of Mill Woods.....	33
Summary.....	40
III THE ATTRIBUTES OF LAND.....	42
Introduction.....	42
Description of Data Base.....	43
AE-Accessibility to Employment.....	46
AR-Accessibility to Retail Services.....	49
AS-Accessibility to Social Services.....	51
PA-Air Pollution.....	55
PN-Noise Pollution.....	55
AY-Agricultural Yield.....	59
CS-Cost of Services.....	61
ES-Wildlife Habitat.....	63
LQ-Landscape Quality.....	65
RC-Recreational Capability.....	67
The Political Development Potential Index (PoldPI).....	67
IV THE FACTORIAL DEVELOPMENT POTENTIAL INDEX.....	72
The Factor Analysis.....	73
The Factorial Development Potential Index (FadPI).....	86
FadPI Versus PoldPI.....	86
Summary.....	90

V	SIMULATING GROWTH.....	91
	Population Projections.....	92
	Introduction to Simulations.....	95
	Simulation Strategy.....	96
	Analysis and Comparison of Simulations.....	100
	Summary.....	110
VI	CONCLUSIONS.....	111
APPENDIX		
	COMPUTER PROGRAMS.....	114
	BIBLIOGRAPHY.....	120

LIST OF TABLES

Table	Page
2.1 Population of the City of Edmonton Selected Years.....	24
2.2 Land and Housing Prices.....	31
2.3 Summary of Single Family Lot Development; 1973-1979.....	38
2.4 Summary of Multiple Family Dwelling Unit Development; 1973-1979.....	39
3.1 Index to Land Attributes.....	47
4.1 Correlation Coefficient Matrix.....	74
4.2 Varimax Rotated Factor Matrix.....	76
5.1 Population Projections for Selected Areas in Edmonton Regional Planning Area, 1971-1991.....	93
5.2 Population Projections for Outline Plan Areas, 1971-1991.	94

LIST OF ILLUSTRATIONS

Figure	Page
2.1 Mill Woods and Edmonton, 1969.....	16
2.2 Annexation of Mill Woods.....	17
2.3 Internal Structure of Mill Woods.....	20
2.4 Metropolitan Edmonton: Regional Setting.....	22
2.5 Edmonton Regional Planning Commission: Planning Region..	27
2.6 National Trends in Land and Housing Prices.....	29
2.7 Metropolitan Edmonton Trends in Land and Housing Prices.	30
2.8 Population Growth, 1971-1975.....	34
2.9 Shares of Development in the Outline Plan Areas, 1971-1975.....	36
2.10 Projected Growth in the Outline Plan Areas, 1975-1986...	37
2.11 Mill Woods: Development to December 31, 1978.....	41
3.1 Edmonton Metropolitan Area.....	44
3.2 Index to E.R.G.S. Data Base.....	45
3.3 AE-Accessibility to Employment.....	50
3.4 AR-Accessibility to Retail Services.....	52
3.5 AS-Accessibility to Social Services.....	54
3.6 PA-Air Pollution.....	56
3.7 PN-Noise Pollution.....	58
3.8 AY-Agricultural Yield.....	60
3.9 CS-Cost of Servicing.....	62
3.10 ES-Wildlife Habitat.....	64
3.11 LQ-Landscape Quality.....	66
3.12 RC-Recreation Capability.....	68
3.13 PolDPI - Political Development Potential Index.....	71

4.1	Factor I - Accessibility.....	78
4.2	Edmonton: Regional Roadways.....	79
4.3	Factor II - Topography.....	81
4.4	Edmonton: Regional Soils.....	82
4.5	Edmonton: Regional Topography.....	83
4.6	Factor III - Environmental Quality.....	84
4.7	Edmonton: Regional Fish and Wildlife Areas.....	85
4.8	FacDPI - Factorial Development Potential Index.....	87
5.1	Index to Modified E.R.G.S. Data Base.....	97
5.2	SIM1-76.....	101
5.3	SIM2-76.....	102
5.4	SIM1-81.....	103
5.5	SIM2-81.....	104
5.6	SIM1-86.....	105
5.7	SIM2-86.....	106
5.8	SIM1-91.....	107
5.9	SIM2-91.....	108

CHAPTER I

LAND BANKING: PLANNING DEVICE VERSUS SOCIAL POLICY

The Misuse of Land Banking

More land will be developed for urban use in Canada over the next twenty-five years than has been developed from the time of the first European settlements (McNeill, 1971, 85). This growth is both a challenge to and an opportunity for urban public policy. If the challenge is met, this growth can improve our cities, for growth creates form (Boulding, 1953, 326). However, judging from past experience the prospects are not good. Many prominent authorities such as Carver, Gertler, Jackson and Rashleigh to name only a few, have cited many missed opportunities of the past. Undoubtedly, the most fundamental of these missed opportunities has been landbanking: the advance acquisition and assembly of land in anticipation of future urban requirements.

{ This thesis calls for a reassessment of how we allow our cities to grow. The past performance of both the private and public sectors is

examined. Choosing directions for future growth necessitates the development of a land related planning database. Such a database is described and analyzed. A new method of evaluating a region's land resources is developed. From this base of land related information, simulations of future urban growth are made in order to observe the spatial effects of Edmonton's Mill Woods Public Land Banking Program.

Canada has misused land banking as an instrument of public policy in our cities. Although dozens of reasons for land banking can be found, the literature generally points to three basic policy goals: regulating land prices, capturing capital gains, and improving both site and regional planning (Flechner, Hamilton, Pearson, Ravis, Spurr, Watson). Obviously these are conflicting goals (Kam, 1971). Price reduction is incompatible with profit taking and both may often conflict with planning improvements which might result in increased costs. Within the context of public policy, we can reduce these three goals to a dichotomy of fundamental objectives: social policy versus planning control. To date, Canadians have become involved with land banking for the wrong reasons, trying to achieve social policy rather than gaining planning control.

As our cities grow the optimal use to which any piece of land may be put changes constantly. Economists since the early writings of Ricardo have explained the market pressures that push all economic activity towards optimal use of land and location. Similarly, geographers from the time of von Thunen have explained the impact that this drive for economic ordering

has on our landscape.. In general it can be said that demand for higher use of land is a direct result of growth. Anyone holding land through such upward shifts in land use may realize a capital gain upon its sale, even without improving the property. The amount of profit realized from such a sale is referred to as an unearned increment as the vendor captures an increase in value not generated through his efforts but rather because of the city's communal growth (Ellickson, 1967). It is the unearned increment which is the object of social policy when land banking is undertaken for either the price or profit motive.

Under the price regulative motive, social policy is affected by directing the unearned increment, either in whole or part, to some needy segment of society in the form of lower land prices. While the total value of the unearned increment across an entire city is large, its value per lot of land represents only a small fraction of the final cost of housing. This housing subsidy can take two forms: lower rent prices for special purpose publically owned housing, e.g., old age, geared to income and low rent accommodations, or a straight subsidization of private home ownership. The former is a generally acceptable use but the latter is at best questionable and at worst a terrible misuse of public funds. Because the subsidy is only a small portion of the total housing cost its benefits can only be effectively used by that small fraction of lower middle income earners who can already almost afford private home ownership. Surely there are many more pressing social problems which lack proper funding than the subsidization of private home ownership among lower middle income citizens.

4

However, even if we assume this to be a desirable objective the reality of implementing such a policy into an effective program has many problems. The first is simply identifying the target population. The best measure found to date uses income as an indication of need. However, many people who do not need the subsidy fall into this category, for example: young upwardly mobile people whose incomes while presently low will skyrocket shortly and older retired people on modest pensions but who have accumulated sizeable invested wealth. It seems clear that the target population is a quite narrow portion of society and is quite difficult to define. Under these conditions the subsidy is often likely to be misdirected.

A second serious problem involves keeping the subsidy on target; that is, to ensure that the social transfer payment is used for housing. Experience has shown it difficult to prevent the resale of the housing unit and thereby the capitalization of the social transfer payment. Once the subsidy has been capitalized it may well be put to unintended uses. Regulating the resale amounts to removing the most basic element in the bundle of rights which are the fee simple. Such a regulation conflicts with the policy of subsidizing ownership and points to the fallacy of the entire objective.

Finally, the price regulation motive has also been suggested as a mechanism for breaking up any oligopolistic arrangements which might exist in a city's land market. It is suggested that the public sector act as an

independent agent in the urban land market, one who is not influenced by the possible rewards of an oligopoly. It is reasoned that if the public sector occupies a sufficiently large portion of the market, and undersells the oligopoly, that the other actors will suffer sufficient losses that their arrangements would disintegrate and a return to open competition is encouraged. However, there is as yet no proof to substantiate the existence of any effective oligopolies in any Canadian land market although the conditions necessary for such a development are improving daily as Canada's future urban land supply is concentrated in fewer and fewer hands. Further, it should be noted that massive amounts of publically financed capital would have to be sunk into such a program in order to gain an effective position in the market. If the unearned increment is then transferred to home owners, it would be the public at large who would absorb the substantial lost opportunity costs on the sunken capital investment required to run this program.

Social policy may also be affected by land banking which is motivated by profit taking. The public sector can either tax away a portion of the unearned increment or capture it entirely through a public land banking operation. In the Canadian context it is generally conceded that while public corporations may generate profit but their primary function should be to provide or insure services. Profit taking can therefore not be the primary motive for public land banking, although it is clearly the only motive for private land banking.

The third and final motive for land banking is planning control, at both the site and regional scales. In the case of private land banking control is effected through zoning mechanisms. These zoning measures regulate allowed uses for specific parcels of land. In every case the goal is to prevent undesirable uses from occurring. In this sense, the process is a one way negatively oriented mechanism which pushes unacceptable uses away. Whether or not this process has been successful is a matter open to debate. What is clear is that the process is entirely market driven. The city has the power to prevent uses but none to force a particular type of development when and where it wishes. Whether it be for legitimate reasons or for purposes motivated by an oligopolistic arrangement, it is presently as a result of decisions taken at the whim of the private sector, that urban land is allocated to meet demand and thereby shape future growth.

Public land banking could be used as a complementary planning tool to existing zoning mechanisms. Planners could pull growth in desired directions with public land banking, as well as push it away from undesirable locations with zoning. Many other benefits could ensue from the planning motive. At present, site planning in a land bank involves a time consuming, complex and costly process of subdivision control. Under a system of public land banking much of the present duplication of effort and the administrative interface between sectors could be eliminated. Private firms have to pass on their losses from bad land investment decisions to their future customers, thus increasing consumer costs. The public sector

has more information at its disposal, especially concerning the provision of social infrastructure. Therefore, its investment decisions are less risky and significant savings can be passed on to the consumer. Centralized planning is thus seen as a more attractive, more efficient energy alternative than others.

In summary, land banking has been abused in the past Canadian experience. Land banking should not have social policy as its prime objective but rather it should be used first and above all else as a planning device. Price should be set slightly below market value. The capital gains should be reinvested in the bank with a portion of the profits equal to the normal market rate of return on the capital investment being directed to other programs of social welfare.

An Overview of Land Banking

While the greatest part of this thesis deals with the Mill Woods public land bank it is by no means the only type of land bank nor the only Canadian example. What follows is a very brief overview of the types of land banks and several international and Canadian examples.

In his study of 'Public Landbanking in Red Deer', Kenneth Watson developed the following tentative categorization of the different concepts which have at one time or another been referred to as 'landbanks' (Watson, 1974, 10).

Special Purpose Landbanks

Public Land Trusts

Agricultural Landbank

Project Assemblies

Urban Renewal Assemblies

"Industrial Landbank" (not considered by Watson)

2) Passive Agents of Urban Land Conversion

Greenbelts

Recreational Open Space

The "Reserve Landbank"

Public Utilities Landbank

3) Active Agents of Urban Land Conversion

New Towns

Planned Unit Landbank (Public or Private)

*Public land trusts involve open space acquisition and banking for public purpose. It can be said that national wilderness parks are a type of public trust land bank. Privately funded public land trusts such as San Francisco's "The Trust for the Public Land" are few in number and small in scale.

Many examples of agricultural land banking exist throughout the world; many with quite different objectives. The Saskatchewan Landbank Commission attempts to preserve the family farming unit, and increases

farming productivity. It provides a purchase and leaseback arrangement to farmers. Farmers are able to capitalize their land assets and buy machinery with the proceeds to modernize their operations. The bank also buys land from retiring farmers and leases it to new young farmers who would otherwise not be able to afford a farming operation. In Israel a state landbanking fund has been established for agricultural settlement. The fund leases land for forty-nine years to farmers at a cost of four per cent per year of the land's value.

Project assemblies are associated with urban renewal programs but refer specifically to the clustering of low income and welfare families into a single expansive assembly of land.

Urban renewal assemblies, such as Ottawa's Le Breton Flats Project, are also associated with urban renewal programs but they involve a much wider variety of future uses than project assemblies.

Also falling within this category, but not dealt with by Kenneth Watson are industrial land banks. This type of operation is intended to acquire, assemble, plan, develop and lease or sell land for desired future industrial uses. The most notable example of this type of land banking operation is the Philadelphia Industrial Development Corporation (PIDC). It was founded in 1957, its board of directors represented business, labour and government. Activities of the PIDC in industrial and commercial

development include land development, financing, assistance to industrial developers and promotion of development. Between 1967 and 1971, the PIK was responsible for over 64 transactions, involving more than 3 million square feet of plant space and resulting in space for over 1,000 jobs, of which almost 40 per cent were new. The PIK offers broad financing assistance for development of both privately owned as well as PIK owned land. Flechner, 1974, p. 11.

The second major type of land banks are those that act as passive agents of urban land conversion. Greenbelts are meant to prevent the continuous sprawl of urban land uses over the countryside or between existing urban areas. Ottawa's greenbelt is a prime example of the former type, while the Randstat area of Holland is perhaps the best example of the latter type.

Lands with high recreational or aesthetic value can be protected from inappropriate uses by a recreational open space land bank. National, provincial and municipal parks are all examples of such land banking activities.

The "reserve land bank" concept has a compact urban form as its prime purpose. The program calls for the purchase and withholding of a broad band of land around a city. The band must be of such a size that leapfrog development is not practical. These actions are supposed to force the most efficient use of existing land resources and result in a

compact urban form. When the inner city's resources are exhausted, the city sells the inner area of the land, replacing it with purchases of new land at the outer edge. Although this strategy received much attention in the literature and was suggested by the Urban Land Research Analysts Corporation in several of their reports commissioned by the United States Department of Housing and Urban Development, it has no known prototypes.

Public utility land banks involve the banking of land for utilities and essential public services such as schools, hospitals, roads, churches, police and fire stations, sewage treatment plants, etc. This process has been practised by many North American municipal planning authorities. The United States' Housing and Urban Development Act of 1965 provided funding to municipalities for such purposes. In a survey entitled Advance Land Acquisition by Local Governments, conducted by the National League of Cities and the National Association of Counties, it was discovered that of 306 cities surveyed and 144 returns, that 73 cities made occasional purchases. California is the most active state with a \$30,000,000 fund annually for land purchases in advance of highway development.

Watson's third and final category of landbanks are those that act as active agents of urban land conversion. The type of 'New Towns' that Ebenezer Howard described in his book entitled Garden Cities, represents perhaps the general public's strongest impression of landbanking. This process involves the creation of an entirely self-sufficient city,

pre-planned and located away from the direct influence of any existing urban centres. The best known examples are the British New Towns and Vallingby and Frasta near Stockholm and Tapiola near Helsinki.

The public planned unit land bank is a public intervention in the process of conversion of land to urban use. It involves the acquisition and assembly of land to enable the planning of large contiguous areas as integrated units (Watson, 1974, 27). Some of the more notable Canadian examples include Mill Woods, Edmonton; Mt. Pearl, St. Johns; Saltfleet, Hamilton; Carlsbad Springs, Ottawa; and the cities of Saskatoon and Red Deer. The Canadian federal government through the Central Mortgage and Housing Corporation (CMHC) has made funds available to the provinces and municipalities through the National Housing Act (NHA) since 1949. Most public land banking operations since that time have taken advantage of this source of funding. Currently assistance is provided under Sections 40, 42 and 45 of the NHA Act.

"Under Section 40, CMHC enters into a project partnership with a province or its agency, paying up to 75% of capital costs and sharing profits or losses. Similar terms apply in the 'new communities' legislation of Section 45(1). Under Section 42 CMHC may provide a loan, secured by a first mortgage or debentures, for up to 90% of the capital cost of acquiring and developing a land project. The interest rate cannot exceed the going rate in Federal banks by more than .5% and the maximum term is twenty-five years." (Spurr, 1976, 259).

The Mill Woods Experience

Mill Woods is a public land bank of the planned unit land bank type, located within the city of Edmonton. It is now owned by the city of Edmonton and was financed through a federal-provincial agreement under Section 42 of the NHA. The decision to secretly purchase and bank nearly 5,000 acres of land caught the public by surprise. This courageous public sector decision is all the bolder given the past failure and collapse of the Edmonton land market. Amidst a falling birth rate and rampant inflation their decision seems to have been vindicated by ever continuing growth fueled by western oils.

Chapter II details the experience of Canada's fastest growing urban centre with public land banking. Chapter III then begins the task of identifying the attributes of land as a resource. There are two fundamental attributes: locational and physical. In the theories of land rent, von Thunen deals with the first, Ricardo with the second. As cities grow, there are economic returns to both. To date the public concern has been with who captures these returns, rather than with the benefits of using land banking as a planning device. But to achieve these planning benefits, we need to examine carefully the attributes of land, to develop a composite index of development potential and equally important, to understand the philosophies which have guided land banking in the past.

CHAPTER II

MILL WOODS: A CASE STUDY

Mill Woods is Created

In the summer of 1969 a law firm began to purchase large tracts of land in the rural municipality of Strathcona, adjacent to the southeast border of Edmonton's city limits. By year's end, 4,864.25 acres had been acquired from thirty eight private land owners at a cost of \$11,109,221 (Flood and Spurr, 1976, 1). It was later announced that the law firm had been secretly acting on behalf of the newly formed Alberta Housing Corporation (AHC) and the City of Edmonton. In the early months of 1970 the city put an end to widespread speculation concerning these clandestine land activities with the release of a report entitled The Mill Woods Development Concept. The report called for the creation of a new town on the site which was to house some 120,000 persons in 29,000 residential units before the end of the century. These land acquisitions were subsequently financed under three land assembly loans between the municipal, provincial (AHC) and the federal government (Central Mortgage and Housing Corporation, CMHC) under Section 42 of the National Housing Act (NHA).

The Mill Woods Assembly is Canada's largest public landbank, occupying approximately nine square miles of land located about seven miles distant from Edmonton's central business district (see figure 2.1). Its boundaries are formed by the extension of 91st and 34th streets to the east and west and 51st and 15th avenues to the north and south respectively.

The Mill Woods Project is not entirely publicly owned. In fact, some thirty-two per cent, or 2,075 acres, of the 6,500 total acreage remains in private hands. Most of the private ownership is present in the southwest, northeast and central locations. Private ownership at the time of assembly took the form of 1) large parcels of one or more entire quarter sections; 2) small parcels either within one of the small existing subdivisions or a farm house site which was previously subdivided; or 3) utility easements, e.g., power, pipelines, etc. At the time of assembly the land was relatively unencumbered containing only twenty-six residential dwellings (City of Edmonton, Mill Woods Development Concept, 1970). Most of the Mill Woods Assembly along with some adjacent lands were annexed into the City of Edmonton in 1971 (see figure 2.2).

The Mill Woods area is largely prime agricultural land. Soft woods, such as aspen, poplar and white spruce line the banks of Mill Creek, the area's most distinctive physiographic feature in an otherwise flat plain, and the source of its name (see figure 4.5). Soils range from loam to clay loam with black rich topsoils of between four and twenty inches in depth (see figure 4.4).

Figure II 1 Mill Woods & Edmonton 1969

Figure 11 2 Annexation of Mill Woods

- 1964 ANNEXATION
- 1971 ANNEXATION
- CITY BOUNDARY - 1976

The Mill Woods Development Concept report clearly states its primary goals as being price, and intra system planning.

"...the concept reflects two fundamental goals to reduce the price of housing generally through land marketing and servicing program, and to upgrade the quality of residential environments respecting the social, physical and economic needs of the residents. (City of Edmonton, Mill Woods Development Concept, 1970)

Several other objectives are noteworthy and while they are clearly subordinate in nature no priorities are given to these often conflicting program objectives:

1. To guarantee the availability of serviced lots for general housing purposes.
2. To guarantee sites for specific needs, such as schools, public housing, hospitals, parks, etc. at minimum costs.
3. To guarantee the most economic form of growth for the City.
4. To control land value escalation so that fewer residents will be forced to rely on some form of subsidized housing.
5. To implement at lower right-of-way costs, major transportation facilities.
6. To reinvest the proceeds of lots sales in a very specific land acquisition program (a public landbank) which will bear a direct relationship to the municipal public works program.
7. To progressively service land in an orderly fashion in order to provide public and private housing of good quality at a minimum cost.

The Mill Woods Development is to be composed of nine communities, the largest of which will contain 11,000 people. Each community is to be built in separate stages. These communities in turn are composed of three or four neighbourhoods containing a maximum of 3,000 people on approximately two hundred gross acres of land. Each neighbourhood is planned to be a functional unit which while unique in character can grow within the overall super system of the Mill Woods Project (see figure 2.3).

Mill Woods is planned to be a self sustaining unit. Plans call for the formation of 10,000 jobs within the project's borders. This would account for approximately twenty-six per cent of the estimated 40,000 person workforce. To physically and psychologically reinforce this sense of community Mill Woods would be separated from Edmonton proper by a buffer of functional barriers, i.e. an outer ring road, freeways, utility corridors and industrial land uses. Site planning and development was to be undertaken by the city which purchases land from the AHC as it is required for each new development phase. CMHC's loan is then repaid with the proceeds of the lot sales.

Flying History In the Face

Mill Woods is by no means the first case of Edmonton's city fathers deciding to intervene in the private marketplace. However, the city's purchase of the Mill Woods Assembly is all the more audacious given Edmonton's past experiences with public sector involvement in urban development. The City of Edmonton began life in 1795 as a Hudson Bay

Figure 11-3 Internal Structure of Mill Woods

Source: City of Edmonton Planning Department

company fur trading post on the north shore of the North Saskatchewan River (see figure 2.4). In 1874 it became an outpost for the North West Mounted Police. The Canadian Pacific Railway reached the neighbouring town of Strathcona in 1891 and the very next year Edmonton became an incorporated city. The new city's first massive boom came shortly afterwards in 1898 in the form of the Klondike gold rush. Three years later another major railway, the Canadian Northern Railway, reached Edmonton and stimulated further growth. By 1905 Alberta had become a province in the Canadian Confederation and Edmonton, with a population of only four thousand, became its capital city.

Even by these very early times the city of Edmonton had already established quite a reputation as a municipality eager to encourage urban development.

"As the 20th century began, Edmonton's municipal government was vigorously promoting private development. Between 1885 and 1915 it attracted four railroads to the city, purchased, subdivided and sold at cost at least 350 acres of land for industrial use; purchased and enlarged the hydro, telephone, water, and transit companies to improve service; conducted a concentrated campaign to promote immigration by people and industry; provided tax deferrals, cheap land and services to new industry; extended its jurisdiction to cover 41 square miles of which only 5.5 square miles were developed and ran municipal services out into adjacent municipalities to foster their growth." (Spurr, 1976a, 14)

Figure 11.4 Metropolitan Edmonton Regional Setting

By 1911, the purses of Edmontonians were overflowing with wheat dollars, the result of several consecutive bumper crops and extremely strong wheat markets. Signs of growth and prosperity were everywhere as population counts grew fifteen fold over the space of a single decade. The mood could conservatively be described as wildly optimistic.

As a result of the favourable financial climate, optimistic spirits, and an aggressive public sector involvement in all forms of urban development, a land boom was triggered. Land prices skyrocketed and the market ran wild until it finally crashed in 1918. Only after this crash could the speculatively inflated level of the market be truly seen. "...building permits plummeted from over \$10,000,000 to under \$500,000 and tax arrears began to accumulate as speculators cut their losses." The boom was so strong and so exaggerated that at its peak in 1913-1914 the city's net assessment was \$200,000,000, a level which would not be reached again until 1954, despite continued growth and inflation. The final result of this boom then bust was that some 70,000 lots of land, or 43% of the city's buildable area, were defaulted through tax arrears to the city between 1918 and 1920 (Spurr, 1976a, 143).

For Edmonton, the land market failure was only the beginning as the next two decades took the city into its first and only real recession. World War I and the Great Depression were bad throughout the western world. But Edmonton suffered a disproportionately heavy loss of population: one in three citizens left the city (see table 2.1).

TABLE 11

Population of the City of Edmonton - Selected Years

<u>Year</u>	<u>Population</u>	<u>Year</u>	<u>Population</u>
1905*	4,000	1956**	126,402
1911**	24,000	1962*	152,131
1915*	32,000	1967*	176,015
1917*	50,000	1968**	171,265
1927*	63,000	1969*	181,230
1937*	77,500	1970*	422,418
1947*	97,000	1973*	442,380
1951**	159,631	1986*	550,000

Sources:

* Bernard, et al., 1974, 10

**Acres Consulting Services, Land Use Forum, Technical Report #4, 1974.

Towards the middle of the "dirty thirties" came a renewed sense of hope in Canada. Edmonton was at its centre, as Canada's gateway city to the far north and west. The year 1935 proved to be the turning point as building permits started to increase annually once again. By 1937 the population had once again risen and just surpassed the previous high attained in 1914 and stood at 77,500. In the decade from 1937 to 1947 growth was moderate but steady at two per cent per year. During the Second

World War Edmonton solidified its gateway function while serving as a base of operation for the construction for the Alaska Highway and the Canol Pipeline linking Norman Wells with Whitehorse in the Yukon. During these years much of the new growth was housed on land which had been publicly owned. By 1945, fully fifty-six per cent of the city's buildable land had passed through public ownership and forty-six per cent of the city's defaulted land stocks had been sold to private interests once again (Spurr, 1976a, 146).

After World War II oil was found at the neighbouring town of Leduc with subsequent discoveries at Redwater and Woodbend in 1948, and Edmonton grew dramatically. Population soared as dramatically for the black gold of the fifties as it had once before for the yellow gold of the Klondike years. In the decade between 1941 and 1951, and again in the next decade between 1951 and 1961, Edmonton's housing stock doubled. Once again much of this new development occurred on publicly banked lands. The sixties and seventies have been years of continued growth characterized by attempts to build a solid and diversified industrial sector financed by petro-dollars. During these latter years a declining proportion of new housing was built on publicly owned lands as the city allowed its land stocks to dwindle. By 1966 Edmonton was effectively out of the land ownership business after half a century of strong direct involvement in that marketplace.

New planning practices were coming into play just as the city's role in the land market was declining. In 1957 the Alberta Planning Act forced Edmonton to adhere to regional development plans as devised by the Edmonton Regional Planning Commissions (see figure 2.5). This Act increased the quality and quantity of services required to constitute a legally serviced lot. Further, plans for staged growth introduced new and significant delays in the planning approval process. The approval process had been lax and haphazard and growth in Edmonton had sprawled over some 2,200 acres per year. Under these conditions of low density development the outlying municipalities often grew at rates exceeding twenty-five per cent of the previous year's population (Alberta Land Use Forum, 1974). Between 1957 and 1966 the municipal boundaries were frequently extended as municipal planners and servicing authorities tried to catch up with the rapid rate of sprawl. While somewhat successful from a planning point of view, these actions resulted in increased servicing costs, reduced supply and cut consumer choice. By 1968 the consumption of land had fallen to 810 acres per year or one third that of a decade before and prices rose as dramatically.

During this same period of time there was a distinct trend towards the concentration of potentially developable land. Large scale developers started to increase their hold on the market and questions regarding an oligopolistic withholding of supply arose. Of the required 8,790 acres of land for urban use between 1971 and 1980, some 8,500 or 96.7 per cent of it was controlled by the six leading developers in the region. (H. McCrea, 1977, 24).

Figure 11 5 Edmonton Regional Planning Commission Planning Region

In fact, while both the planning process and the concentration of land ownership have acted to put pressure on supply neither factor can adequately explain the source of inflation. In the winters of 1968 and 1970 enough lots were carried over in NHA accepted subdivisions alone, to meet over ninety per cent of the following year's starts and yet average lot prices rose 13.9 per cent and 13.2 per cent in the respective following years (Spurr, 1976b, 10). Even in Edmonton where growth and new construction has been so dramatic by far the bulk of all housing transactions are associated with the existing stock. Clearly the causes of rising housing costs must be examined in the context of the entire market and not within the confines of new supply in response to demand. Whatever the source of land and housing price increases it is the resultant levels of inflation and the political response which they elicit which is of interest.

Land and Housing in Edmonton

Figure 2.6 illustrates what most Canadians already sense: that housing costs are rising faster than the average consumer's ability to pay. The margin may, however, surprise some readers. This same figure also shows that nationally there has existed a fairly stable relationship between serviced land values and total housing costs. This trend was broken by a short lived decline in 1973 which has been followed by continued and ever accelerating increases in land values. This national trend has been much more pronounced in the Edmonton market. Figure 2.7 depicts the rate of increase of housing costs, serviced land costs and the consumer price index from 1961 to 1979. While the consumer price index has doubled, housing costs have risen four fold and land values have risen over eight fold.

Figure 2.6
National Trends in Land and Housing Prices

Source: See Table 2.2 on page 31.

- Notes: 1. Indexed average land costs for single-detached dwellings NEA financed, 1961=100.
2. Canadian Home Ownership Cost Index, 1961=100
3. Consumer Price Index, 1961=100

Figure 2.7

Metropolitan Edmonton Trends in Land and Housing Prices

Source: See Table 2.2 on page 31.

- Notes: 1. Indexed average serviced lot price in Metropolitan Edmonton.
 2. Indexed average new family dwelling sales price in Metropolitan Edmonton.
 3. Consumer Price Index for Canada.

TABLE 2.2

Land and Housing Prices

Year	Indexed Average Serviced Lot Price* 1961=100 (constant dollars)	Indexed Average New Family Dwelling Sale Price** 1961=100 (constant dollars)	Consumer Price Index 1961=100	Canadian Home Ownership Cost Index*** 1961=100	Indexed Canadian Average Land Costs**** 1961=100
1961	100.0 (3,558)	100.0 (15,051)	100.0	100.0	100.0
1962	97.9 (3,514)	101.5 (15,278)	101.2	102.8	107.1
1963	100.8 (3,615)	103.7 (15,605)	103.0	105.9	119.6
1964	107.9 (3,873)	103.5 (15,585)	104.8	110.3	118.5
1965	113.3 (4,065)	107.6 (16,189)	107.4	115.0	119.0
1966	118.2 (4,240)	115.9 (17,445)	111.4	120.0	133.9
1967	121.8 (4,369)	127.5 (19,188)	115.4	126.8	137.6
1968	132.2 (4,742)	142.0 (21,371)	120.1	136.1	143.9
1969	147.7 (5,299)	146.7 (22,075)	125.5	148.3	161.6
1970	164.0 (5,886)	159.8 (24,056)	129.2	161.1	161.0
1971	185.3 (6,649)	161.9 (24,374)	133.4	174.2	176.4
1972	194.2 (6,967)	176.2 (26,526)	139.8	188.2	187.8
1973	224.5 (8,054)	198.0 (29,803)	150.4	207.0	179.7
1974	273.7 (9,821)	222.8 (33,531)	166.8	227.0	187.1
1975	368.2 (13,211)	310.5 (46,730)	184.8	250.2	278.5
1976	533.5 (19,142)	375.0 (56,447)	198.7	284.7	354.7
1977	703.8 (25,252)	420.3 (63,262)	214.6	315.7	394.9
1978	816.7 (29,304)	441.2 (66,409)	233.8	341.6	421.5
1979	—	464.6 (69,923)	255.2	362.9	521.5

Source: Personal communication with Ms. Judy Bartakovich, Statistical Services, CMHC

Notes: *Average serviced lot price, fully paid local improvements included, for new single-detached dwellings financed under NHA, in Metropolitan Edmonton.

**Average new family dwellings sales price, for freehold tenure, financed under NHA in Metropolitan Edmonton.

***Based on a national average of the following indices: property taxes, mortgage interest, owner repairs, new house sales price and dwelling insurance.

****National average land costs for single-detached dwelling, financed under NHA.

Based on our present perspective, the gap between the Edmonton land market and the consumer price index, in the late sixties, was just beginning its exponential growth. However, neither Edmonton's planning officials nor its politicians had the benefits of this hindsight. In their minds, and especially in the minds of their constituents, something had to be done to narrow the gap between housing prices and the consumer's ability to pay. The city's hands were tied. The municipal coffers had been depleted by the rampant demands for social infrastructure which accompanied the population increases. Under these conditions, the city, as a major buyer of urban land, was also feeling the pinch of higher land prices.

"The new transportation facilities required to serve the declared growth directions (essentially to the West, South-west and North-east) were placing a great financial strain on the City. Land costs for rights-of-way to serve these areas had become a problem of major proportions." (City of Edmonton, Hill Woods Development Concept, 1970)

The city fathers had their backs against the wall and were searching for room to maneuver. It was reasoned that if the city itself could control the entire development of a large area that the city could phase growth adequately so as to maintain a reasonable cash flow, minimize their debt position and eliminate the practice of purchasing rights-of-way and land for public works projects at incredibly inflated prices.

Therefore, while the national picture was not very bright, Edmonton's inflation rate for housing was even worse and land prices were running wild. The municipal government was being pressured to do something. A 'Planned Unit Development' type of public landbank, funded by the more senior levels of government, seemed like a good solution to the problem.

"In the mid sixties the supply of serviced land for suburban housing was declining and the cost of land was increasing dramatically. The city had no way of guaranteeing the maintenance of an adequate supply. Land in the declared expansion areas was under private ownership and servicing depended upon private sector decisions. The decision to establish a new direction of growth was essential if land for housing was to be available at an uninflated value." (City of Edmonton, Mill Woods Development Concept, 1970)

The History of Mill Woods

Being publically owned, Mill Woods is certainly the "black sheep of the family". There are five other major residential landbanks: North East, West Jasper Place, Castle Downs, Riverbend Terwillegar and Kaskitayo but each of these is privately owned. In addition, there are three industrial landbanks: Northwest, Southeast and Southern which surround the city (see Figure 2.8). These other private landbanks are owned by large-scale developers and have accounted for the majority of lot registrations since the inception of the outline plan areas in 1967. Mill

Figure 11.8 Population Growth 1971-1975

Prepared by The City of Edmonton Planning Department
Research and Long Range Planning Branch
September 1975

Woods competes directly with these areas for all of its resources and market. Figure 2.9 shows the relative shares of development in the various outline plan areas from 1971 to 1975. Figure 2.10 shows the projected distribution of growth in the outline plan areas from 1975 to 1986. According to these figures Mill Woods had captured just over 20 per cent of new growth from 1971 to 1975 and is projected to increase its share to a full 25 per cent of the market in the period between 1975 and 1986.

The reality of Mill Woods is in some ways quite different from what the original plans called for a decade ago. Table 2.3 presents a historical overview of single family lot development as compared with the city's total for all outline plan areas. In total, 36.5 per cent of the Outline Plan Areas' registered lots have been generated by the Mill Woods site. Similarly, 36.4 per cent of all newly serviced lots in the outline plan areas have come from the public landbank. Finally, this table illustrates that over its eight year recorded history, Mill Woods has accounted for 29.9 per cent of the outline plan areas' lots for which building permits have been issued.

Table 2.4 illustrates the same type of information but for multiple family dwelling units measured in potentially developable units (PDU). Mill Woods has accounted for 25.2 per cent of registered PDUs, 23.5 per cent of those serviced and 16.2 per cent of those for which building

Figure 11.9 Shares of Development in the Outline Plan Areas 1971-1975

Figure 1110 Projected Growth in the Outline Plan Areas 1975-1986

Prepared by The City of Edmonton Planning Department
Research and Long Range Planning Branch
September 1975

TABLE 2.3

Summary of Single Family Lot Development, 1973-1979

	New Registered Lots		New Serviced Lots		New Building Permits	
	City*	Mill Woods	City*	Mill Woods	City*	Mill Woods
1973 1/1-31/3	--	--	548	692	613	30
1/4-30/6	131		131	0	506	174
1/7-30/9	1343	1054	1264	1096	573	296
1/10-31/12	392	0	385	0	662	418
Total	1866	1054	2738	1288	2354	918
Percentage share		56.5		65.3		39.0
1974 1/1-31/3	233		233	0	481	389
1/4-30/6	630		259	58	497	174
1/7-30/9	2266	844	1014	0	299	92
1/10-31/12	314	49	768	443	152	19
Total	3210	893	2274	501	1429	674
Percentage share		27.8		22.0		47.2
1975 1/1-31/3	553	518	836	0	406	220
1/4-30/6	430	0	1419	1046	870	244
1/7-30/9	681	123	527	0	1136	398
1/10-31/12	750	48	910	123	1112	403
Total	1308	689	3692	1169	3524	1165
Percentage share		52.7		31.7		33.1
1976 1/1-31/3	666	11	557	0	811	132
1/4-30/6	381	381	335	0	854	58
1/7-30/9	1476	990	893	381	479	152
1/10-31/12	433	54	1451	1021	575	250
Total	2956	1414	3236	1402	2719	592
Percentage share		47.8		43.3		21.8
1977 1/1-31/3	428	5	731	5	359	175
1/4-30/6	1038	743	363	42	866	204
1/7-30/9	2901	1396	1250	556	649	235
1/10-31/12	755	463	2782	2014	1065	440
Total	5122	2607	5126	2617	2939	1054
Percentage share		50.9		51.1		35.9
1978 1/1-31/3	630	0	643	0	940	283
1/4-30/6	1237	0	424	0	1189	522
1/7-30/9	--	--	--	--	--	--
1/10-31/12	3558	2723	2755	1969	1706	749
Total	5425	2723	3822	1969	3835	1565
Percentage share		50.2		51.5		40.8
Total 1973-79	19887	9380	22888	9446	16800	5968
Percentage share		47.2		41.3		35.5
Total 1967-79	27861	10182	25918	9428	20840	6246
Percentage share		36.5		36.4		29.9

*For Outline Plan Areas

TABLE 2.4
Summary of Multiple Family Dwelling Unit Development, 1975-79

	New Registered PDUs		New Serviced PDUs		New Building Permits PDUs	
	City*	Mill Woods	City*	Mill Woods	City*	Mill Woods
1975 1/1	1148	365	1601	0	194	75
1/4	147	-151	1323	620	684	308
1/7	184	0	723	0	1561	134
1/10	704	-136	623	0	710	121
Total	2183	78	4270	620	3149	638
% share		3.6		14.5		20.3
1976 1/1	151	-35	1528	0	1368	181
1/4	391	235	133	0	1002	393
1/7	759	618	2850	400	1602	98
1/10	229	0	1000	529	1172	6
Total	1530	836	5511	929	5144	670
% share		54.6		16.9		13.2
1977 1/1	173	28	1126	0	1133	436
1/4	1658	1208	730	27	1046	186
1/7	4659	1195	1568	478	2369	331
1/10	2512	719	3062	1544	2249	178
Total	9002	3150	6486	2049	6797	1131
% share		35.0		31.6		16.6
1978 1/1	1939	-4	1320	0	1306	139
1/4	1939	489	785	32	1117	391
1/7	—	—	—	—	—	—
1/10	4916	2707	4392	2075	2449	576
Total	8794	3192	6497	2107	4872	1106
% share		36.3		32.4		22.7
Grand Total	41165	10378	36089	8497	26648	4322
% share		25.2		23.5		16.2

*For all Outline Plan Areas

permits were issued. In both single and multiple dwellings there is a definite trend towards accelerating development in Mill Woods well in excess of the planned 25 per cent share of the market. At present Mill Woods is home for an estimated 28,872 people (1979 Civic Census, estimated). Figure 2.11 illustrates the present extent of development.

Summary

Edmonton has seen both good and bad times. As Canada's fastest growing urban center, both today and at several times in the past, it follows that Edmonton has exhibited many of the problems associated with such rapid development. What is perhaps unique, and important to note, is the wide range of growth management philosophies which the city has experienced. From a free enterprise, open market system to direct public ownership and many stages between.

In addition, to its most suitable history Edmonton houses Canada's largest 'Planned Unit Development' type of public landbank. This landbank has a ten-year documented record and promises at least as long of an active life expectancy. The Mill Woods Land Assembly Project is a rare example of cooperation between federal, provincial and municipal authorities on matters of urban policy. Mill Woods also established an entirely new direction for urban growth in Edmonton. But, decidedly the single most important reason for choosing Edmonton as the case study was the availability of the Edmonton Regional Growth Studies planning database. This database is described and analyzed in the following chapter.

Figure 11.11. Mill Woods Development to December 31 1978

CHAPTER III

THE ATTRIBUTES OF LAND

Introduction

In the twenty years between 1971 and 1991 Edmonton will have to provide new shelter for a third of a million new citizens. It is conservatively estimated that an average annual supply of between 1140 and 1620 gross acres of land will be required to meet these pressures (City of Edmonton, Technical Paper #3, 1975, 120). This chapter examines the attributes of Edmonton's available land resources as detailed in the Edmonton Regional Growth Studies land use planning data base (ERGS file). Each of the ten variables contained in the data base is described and mapped. The 'Development Potential Indices' (DPI), a subjective modelling technique developed by the ERGS group is described. The DPI-technique is then used to model the May 1978 city council decision which defined in general terms how they wished the city to grow to the year 2000. A map detailing the implications of this decision upon the region's land resource is presented.

Description of Data Base

In 1975 the Edmonton Regional Planning Commission (ERPC) undertook the creation of a land use planning databank, called the Edmonton Regional Growth Studies (ERGS) file. The ERGS file was created from original research, field surveys and in part borrowed data from the Province of Alberta's Land Use Planning Data Bank (LANDUP). The ERGS file describes ten land related attributes for each of the 2509 sections of land which comprise only the Metropolitan Edmonton Planning Region* (see Figures 3.1 and 3.2). The LANDUP data base is in turn largely based upon the federal government's Canada Land Inventory data bank.

The ERGS file extracts the following attributes from the LANDUP system: AB-Agricultural Yield; RC-Recreational Capability; WUC-Ungulate Capability and WC-Waterfowl Capability. These four attributes have been converted from a quarter section basis to a full section basis and have been manipulated so as to yield slightly different attributes, i.e. AY-Agricultural Yield, RC-Recreational Capability, LQ-Landscape Quality and ES-Wildlife Habitat. The remaining six attributes were defined through a public participation survey and refined by the Edmonton Regional Planning staff. They are: AE-Access to Employment, AR-Access to Retail Services, AS-Access to Social Services, CS-Cost of Servicing, PA-Air Pollution, and PN-Noise Pollution.

*The data base does not include sections which are covered by more than 50% water or urbanized land uses. Therefore, the city of Edmonton and all existing urban municipalities are not assigned attribute values and appear as white blanks in all SYMAPS.

Figure III.1: Edmonton: Metropolitan Area

Figure III 2. Index To E.R.G.S. Data Base

Scale: One cell is equal to one
section or one square mile

Source: Shawn P. Brennan

In general, there are two types of variables; those which are locational, i.e., AE, AR, AS, PA, PN and those which measure some physical quality of the land, i.e., AY, CS, ES, LQ and RC. Table 3.1 depicts this basic division and serves as a reference page for all of the variables, defining for each its: mnemonic, short name, description, map number and its minimum/maximum, mean and standard deviation values. What follows is a brief description of each attribute and the manner in which they were calculated for the ERGS file (Edmonton Regional Planning Commission, Technical Report #5, 1976).

AE - Accessibility to Employment

This attribute has been calculated by the application of two gravity models; a and b, as follows:

$$a) \quad J_i = \sum_{j=1}^n \frac{P_j}{d_{ij}}$$

where J = Job Competition Index

P = Population

d_{ij} = Travel time from i to j, by automobile, over least cost route

n = 2509

$d_{ii} \neq 0, i = 1, \dots, n$

The "Job Competition Index" treats each of the 2509 cells as both a population centre and an employment centre. It credits each population

TABLE 3.1
Index to Land Attributes

Thematic Short Name	Description	Map Number	Minimum Value	Mean Value	Maximum Value	Standard Deviation
Location Related Activities						
1) AS Accessibility to Employment	Does gravity model to define accessibility of a section to employment opportunities (1971)	3.3	38,400	58,373	144,700	17,348
2) AR Accessibility to Retail Services	Does gravity model to define accessibility of a section to retail services (1971)	3.4	22,368	34,201	99,997	11,542
3) AS Accessibility to Social Services	Subjectively weighted evaluation of accessibility of a section to a wide variety of social services	3.5	580	809	2,630	273
4) PA Air Pollution	Defines proportion of a section which is affected by any significant source of air pollution	3.6	0	30	260	47
5) PN Noise Pollution	Defines proportion of a section which is affected by road, rail or airport noise pollution	3.7	0	19	300	37
Land Related Attributes						
6) AT Agricultural Yield	Adapted from Canada Land Inventory - measures potential wheat production	3.8	0	13,035	21,120	3,064
7) CS Cost of Servicing	Measures the relative costs of constructing social infrastructure	3.9	96	139	410	52
8) BS Wildlife Habitat	Adapted from Canada Land Inventory - measures the habitat quality of a section for waterfowl and ungulate populations	3.10	20,000	65,577	109,730	15,772
9) LQ Landscape Quality	Adapted from Canada Land Inventory - measure is based on vegetation, land forms, topographic patterns and viewing	3.11	0	4,223	23,077	5,405
10) RC Recreational Capability	Adapted from Canada Land Inventory - measures potential quantity of use of 25 recreational land features	3.12	20,750	55,767	60,000	5,123

cell with a value representing its accessibility to all other employment cells based upon travel time. The "Job Competition Index" may be seen as an indication of the competition for jobs in a particular community based upon the population of all communities in the regional system and their relative accessibility to employment centers.

Next, a measure of the magnitude of jobs available, "Job Attraction", in each employment centre was developed as follows:

$$A_i = N_i / J_i$$

where A_i = "Job Attraction"

N_i = Number of jobs

J_i = "Job Competition Index"

The final AE-Accessibility to Employment attribute value for each township in the region was found by dividing the "Job Attraction" value for each job location by the travel time squared from each township to job location as shown below in formula b:

$$b) \quad AE_i = \sum_{j=1}^n \frac{A_j}{d_{ij}^2}$$

where AE = Accessibility to Employment Index

A_i = "Job Attraction Index"

d_{ij} = travel time from i to j

$n = 2509$

$d_{ii} \neq 0, i = 1, \dots, n$

Figure 3.3 illustrates the nature of the AE variable when mapped with five equal interval classes of data values. The map depicts the attractiveness of locations in close proximity to existing urban settlements and to a lesser extent, rural locations which are well serviced by the region's roadway network (see figure 4.2 for map of regional road network).

AR-Accessibility to Retail Services

This attribute also makes conceptual use of a gravity model of sorts in that mass of interaction and distance are the key determinants. Total volume of retail sales in 1971, for communities with sales in excess of \$5,000,000 is used as an indication of the quality and variety of available retail services. The attribute's values are determined by summing the quotients resulting from dividing each community's total retail sales by the travel time from the centre of the township in question to each community as follows:

$$AR_i = \sum_{j=1}^n \frac{R_j}{d_{ij}}$$

where AR = Accessibility to Retail Services

R_j = Total volume of Retail Sales

d_{ij} = Travel time from i to j

$n = 2509$

$d_{ij} = 0, 1, \dots, n$

Figure III 3. AE-Accessibility To Employment

Figure 3.4 presents the mapped AR values. Again, the influence of the existing road network and settlement pattern is obvious. There is a strong visual correlation between the AE and AR variables, although the latter is more concentrated in specific areas around the city limits. This reflects the more punctiform nature of retail services as compared with a measure of areas offering any form of employment.

AS-Access to Social Services

An inventory of significant social services was undertaken and the magnitude of each service was then normalized by a relevant population figure. Each municipality's total number of hospital beds, physicians, dentists and ambulances was normalized by that municipality's total population. The number of nursing home beds and senior citizen lodge beds was normalized by the number of persons over 65 years of age in that municipality. Likewise, the number of approved day care spaces was normalized by the municipal population aged four years or less.

The resultant figures were then converted to a scale of zero through ten. The scaled figures were weighted by a subjective relevance factor. This weighting was an attempt to model the locational attraction of each social service upon the regional population. Hospital beds, and physicians were weighted at a full 10 points; ambulances at 8; dentists at 6; and nursing homes, senior citizen lodges and day care spaces all received a weighting of 4. Municipalities housing specialized health delivery units e.g. Alcohol and Drug Abuse Clinics, Rehabilitation Centres, Handicapped Service facilities, etc. were assigned an arbitrary bonus of

Figure III.4: AR - Accessibility To Retail Services

five units for each such facility. The scaled, weighted and bonus values were summed for each municipality.

The resulting municipal scores were interpreted as a reflection of the mass of social services offered to the community and travel time was used as a proxy for ease of access. The following equation yields the AS attribute:

$$AS_i = \sum_{j=1}^n \frac{HSS_j}{d_{ij}}$$

where AS_i = Accessibility to Social Services

HSS_j = Health and Social Services Index

d_{ij} = Travel time from i to j

$n = 2509$

$d_{ii} = 0, i = 1, \dots, n$

Figure 3.5 shows the mapped AS values. Once again the influence of roads and existing population centres is obvious. This variable is also closely correlated with the AE and AR variables.

Figure III 5. AS - Accessibility To Social Services

PA-Air Pollution

The measurement of this attribute is based upon its aeral extent and not its intensity. The Edmonton Regional Growth Studies Group identified all known sources of air pollution and established the probable distance over which each pollutant would be an irritant to urban development. For instance, they established a setback of 1000 feet from sewage lagoons and one mile from a sour oil field. Sections which fell wholly or partially within the boundaries of such setbacks were deemed to be polluted. The figure attached to each affected section was simply calculated as the percentage of aeral extent of affected area. Values can, and do, exceed 100% if several sources of air pollution affect a single section.

Figure 3.6 describes a pattern which reflects the peculiarities of the locations of sewage lagoons and industrial sites such as sour oil fields.

PN-Noise Pollution

This attribute considered only the following primary sources of noise pollution: primary highways, railroads, and airports. The PN values are determined in the same manner as the PA values. The percentage of affected areas of a section are summed as follows:

$$PNI = H + R + A$$

where Pni = Noise Pollution Index

H1 = % of a section affected by highway noise pollution

R1 = % of a section affected by railroad noise pollution

A1 = % of a section affected by aircraft noise pollution

Figure III 6. PA - Air Pollution

Highway Noise Pollution was defined as the 56 decibel outdoor daytime residential standard, based upon "L10" levels (that the level is not exceeded more than 10% of the time). The Ontario Ministry of the Environment technique for predicting noise levels was employed. It considers vehicle speed, vehicle volume and the percentage of truck traffic.

Land within one mile of a heavily traversed railroad line (ten or more trains per night), or land within one half mile of any operational line (one or more trains per night) were said to be within an affected range of noise pollution.

Standards identified by the Federal Ministry of Transport in their Noise Exposure Forecast Maps and by Central Mortgage and Housing Corporation in their report entitled: New Housing and Airport Noise: A Supplement to the Site Planning Handbook were used as the yardsticks by which areas affected by aircraft noise pollution were defined.

Figure 3.7 could almost be mistaken as simply a map of the regional roadway and railway network, (see figure 4.2) however, it is a map of the FN data. Apart from paralleling the road and rail patterns it also shows high values for the airport around cell 1262 and around noisy business enterprises such as cells 730 and 1032.

Figure III 7 PN - Noise Pollution

AY-Agricultural Yield

This attribute is an adaptation of the Canada Land Inventory's (CLI) information on agricultural capability. The CLI classifies each quarter section of land into one of seven capability classes. The AY attribute normalizes this data into a relative level of potential wheat production measured in bushels per section, per year. When more than one half of a quarter section was covered by water or urbanized land uses, the entire quarter section was given no value. In bringing the respective four quarters together to form a value for a single full section the following procedure was employed to achieve equivalence in cases where one or more of the quarter sections had no CLI value given. The values for each quarter section were summed and then bonused by multiplying the reciprocal of that fraction of the section which was included in the CLI survey.

The resultant raw figures were normalized by the total range of values for the region and converted to a scale of 1 through 100. The range was from 1 bushel to 22,000 bushels, therefore a production value of 18,000 bushels was treated as follows:

$$\frac{18,000}{22,000} = 80.8 = \text{AY attribute value}$$

The AY variable is mapped in Figure 3.8. The resulting pattern is complex but it clearly shows that Edmonton enjoys a very good and widespread agricultural land base.

Figure 111 8. AY - Agricultural Yield

CS-Cost of Servicing

Servicing cost ratios were determined by estimating the separate costs of standard infrastructure construction for the various types of terrain found in the Edmonton region. Only waterlines, sewers and roads were costed and as such considerations were given to trenching, de-watering and compaction of earth. Intensive use was made of soil surveys, hydro-geological reports, surficial geology reports, national topographical maps, aerial photographs and actual field surveys.

The separate cost ratios for each service were then weighted by the average percentage cost share figures for total servicing in the region and then summed as follows:

$$RCR = W \times 0.19 + S \times 0.19 + SS \times 0.21 + R \times 0.41$$

where RCR = Relative Cost Ratio

W = Water Cost Unit

S = Sanitary Sewer Cost Unit

SS = Storm Sewer Cost Unit

R = Roadway Cost Unit

The resulting values were grouped into seven classes and values were assigned to each section of land in the region. These values ranged from 1.0 to 4.1 and represented the CS-Cost of Servicing attribute. Figure 1.9 illustrates the resultant values. In this case the darker cells are less desirable for the purposes of urban development because of a higher cost for providing social infrastructure. There is a very high level of

Figure III 9. CS - Cost Of Servicing

correlation between this mapping and figure 4.5 which presents a generalized topography for the study area. All of the poor classes of Land identified in the CS variable are found to be in the class of "Gently Rolling to Rolling". Although a gently rolling to rolling relief is not normally considered to be a serious handicap to most types of construction, the CS measure is relative in nature and keys upon the relative increase in the costs of providing services in this topographic region. The CS measure discriminates most notably against the entire Cooking Lake Moraine area to the southeast of Edmonton and against the moraine features surrounding the Glory Hills area to the west of the city.

ES-Wildlife Habitats

This attribute was determined by defining the types of habitats which are essential to either waterfowl or ungulate populations. The raw data are taken from the CLI's quarter section values for UC-Ungulate Capability and WC-Waterfowl Capability. The procedure described in the section on AY-Agricultural Yield is employed here if necessary to achieve equivalence in the transformation from quarter sections to full sections. The Canada Land Inventory (CLI) values ranged from "1", i.e., representing lands with no limitations to wildlife to "7" which represent lands with severe limitations. The ES variable adds the two CLI variables and results in a possible range of data value from 2 to 14. Figure 3.10 illustrates the resulting pattern, which is quite complex in detail but generally discriminates against well populated or travelled areas.

Figure III 10. ES - Wildlife Habitat

LQ-Landscape Quality

This attribute is determined by the presence and extent of one or more of four landscape qualities, i.e. 1) E-vegetation; 2) L-Landforms; 3) Q- Topographic Patterns, and 4) V-Viewing. The measurement of this attribute is taken from the CLI information on "Recreational Capability" and is calculated as follows:

$LQ = S \times P$ where S = the number of classes of E, L, Q, V

P = the % of each section covered by each class or combinations of classes in each capability rating of 1 through 7.

Once again, as described in section 4, AY-Agricultural Yield, a bonusing procedure is used if necessary to achieve equivalence in the transformation from quarter sections to full sections. The resulting range of potential values is from 0 through 30,000. Figure 3.11 shows the mapped results of this measure. In a rough sense it seems to favour many of the areas that the CS variable discriminated against. Values are higher for rolling lands and higher again if there is a river or lake nearby (e.g., cell 867 and cell 2251 near Pigeon Lake).

Figure III 11 LQ - Landscape Quality

RC-Recreational Capability

The data used in the determination of this attribute is from the "Land Capability for Outdoor Recreation" file of the CLI. The CLI identifies twenty-five recreational land features and bases its measurement of these features according to potential quantity of use. Seven classes of land were defined, class "1" being very high in potential and class "7" being very low. The procedure described in the section on AY-Agricultural Yield is employed here if necessary to achieve equivalence in the transformation from quarter sections to full sections. Only the location specific recreation capability class values were considered in the calculation. The RC value is calculated by summing the products of each class and the percentage of the section convened by that class. Figure 3.12 maps the results. It appears that the RC variable is negatively correlated to both the LQ and CS variables. It seems that this measure credits areas of higher relief only if they are easily accessible.

The Political Development Potential Index (PolDPI)

The ERCS file has as its end product a ten point description of each section of land within the study area. The Development Potential Index (DPI) Technique is a modelling technique developed by the Edmonton Regional Growth Studies Group (ERCSG) which allows for the reduction of these ten factors into a single figure. The DPI technique describes "the urbanization patterns which result when weighted priorities with respect to a number of land related objectives are applied to the region land

Figure III 12. RC - Recreational Capability

resource" (Edmonton Regional Planning Commission, Technical Report #5, 5). This subjective procedure is used to generate alternative spatial growth strategies for regional planning purposes. The technique may also be used to indicate the optimum directions for growth given a specific growth management strategy.

To arrive at a final DPI value for each section not all of the ten attributes are treated in the same manner. High values for the AR, AS, AE, ES, RC and LQ attributes suggest a potential advantage for urban development. Conversely high values for the AY, PW, PA and CS attributes would suggest a low potential for such activities. The DPI technique distinguishes between these two cases through the application of the following formulas:

case #1. The higher the attribute value the higher the DPI value:

$$C = \frac{1 - 99(X-S)}{R} \text{ where } C = \text{coded cell number}$$

R = range of values
X = section value
S = minimum value

case #2. The higher the attribute value the lower the DPI value.

$$C = \frac{100 - 99(X-S)}{R} \text{ where } C = \text{coded cell number}$$

R = range of values,
X = section value
S = minimum value

The scaled attributes for each section are then multiplied by the determined subjective weighting factor and summed to create the individual DPI values for each section of land.

The Edmonton Regional Growth Studies group generated many possible growth scenarios and generated DPI maps to represent the effects of these growth management strategies to politicians and the public. After a very lengthy and successful public participation campaign the politicians finally decided in May of 1978 which scenario would be adopted as the basis of their regional plan. Not all of the ten variables contained in the ERGS file were necessary in order to achieve the desired modelling of this growth strategy. Only the AE, AS, CS, PA and PW attributes - each weighted equally - were required. The AR attribute was found to be redundant to the AE and to a lesser extent to the AS attribute. Consideration of the AR attribute would have resulted in an over weighting of the existing urban areas' locational attraction force. The AY, ES, RC and LQ attributes were not employed in this model, reflecting perhaps the politician's lack of concern for environmental factors and indirect potential costs. Figure 3.13 depicts the resultant political Development Potential Indices (PoldPI). Appendix #1, Program 1, contains the computer program used to generate these values.

Figure III.13. PolDPI - Political Development Potential Index

CHAPTER IV

THE FACTORIAL DEVELOPMENT POTENTIAL INDEX

The "Development Potential Index Technique" described in Chapter III has an undeniable aggregate utility. But such an index does not clarify the interrelationships among the variables. On the other hand, separate indices fail to identify any broad dimensions of a region's land resources. Furthermore, the "Development Potential Index Technique" is based on a subjectively defined weighted algorithm applied to the data base. In this sense it does not provide an invariant measure of development potential. This chapter presents a mathematically objective development potential index based on a multivariate analysis of separate indicators. The analysis shows that any such index must weigh three components: accessibility, topography, and environmental quality. These three principal components, which are weighted linear combinations of the test variables in the ERCS file, are described and mapped. The linear combinations are computed by factor analysis.

The Factor Analysis

Factor analysis is a multivariate statistical technique often used for condensing large numbers of variables into more manageable summary dimensions.

"The single most distinctive characteristic of factor analysis is its data-reduction capability. Given an array of correlation coefficients for a set of variables, factor-analytic techniques enable us to see whether some underlying pattern of relationships exists such that the data may be 'rearranged' or 'reduced' to a smaller set of factors or components that may be taken as source variables accounting for the observed interrelations in the data." (SPSS, Jae-onkim, Factor Analysis Chapter)

Table 3.1, apart from being a general reference guide to the ten variables, also contains the variable's mean value, and standard deviation. The correlation coefficients of the ten variables are given in Table 4.1. The most notable result is the extremely strong correlation between each of the three variables which measure facets of accessibility, i.e., AE, AS, AR, all of which are correlated at .851 or above (see figures 3.1, 3.2 and 3.3). The LQ - Landscape Quality - variable is negatively correlated to these three accessibility variables. This seems reasonable as one would expect landscape quality to decline as accessibility increases. Similarly, AY - Agricultural Yield is negatively correlated to CS - Cost of Servicing. Again, this is an expected result as one can imagine servicing costs decline as potential agricultural yield increases.

TABLE 4.1

Correlation Coefficients

Variables	AE	AR	AS	PA	PN	AY	CS	ES	LQ	RC
AE	—	903	851	173	338	221	-039	037	-371	219
AR	903	—	875	131	334	156	010	-028	-333	141
AS	851	875	—	103	323	138	010	-052	-329	121
PA	173	131	103	—	-011	060	-044	316	086	183
PN	338	334	323	-011	—	138	-099	020	-165	090
AY	221	156	138	060	138	—	-521	092	-331	438
CS	-039	010	010	-044	-099	-521	—	-215	093	-414
ES	037	-028	-052	316	-020	092	-215	—	000	494
LQ	-371	-333	-329	086	-165	-331	093	000	—	-357
RC	219	141	121	183	090	438	-414	494	-357	—

Note: The lead decimal points have been omitted - see Table 3.1 for explanation of variables.

The factor analysis exercise resulted in the reduction of the ten variables into three summary dimensions after the varimax rotation; accessibility, topography, environmental quality. Table 4.2 presents the variables with their loadings, or the correlation of the variables with the broader dimensions.

The first factor measures accessibility to central Edmonton. The variables which load most heavily onto it are: AE, AR and AS, all of those three have loadings greater than 0.9 on the first dimension. As expected the LQ - Landscape Quality and ES - Wildlife Habitat variables are negatively correlated to the accessibility dimension. A quick glance at figures 3.3, 3.4, 3.5, 3.8 and 3.9 will provide visual confirmation of these empirical findings. Apparently home-buyers must expect to make a trade-off between accessibility and environmental quality in addition to the rent gradient-transportation gradient.

The second factor is a topography dimension. The AY and RC variables (see figures 3.6 and 3.10) load most heavily on this component. While individual loadings and the eigenvalue are, as expected, lower than for the first dimension, they are equally convincing, ranging from 0.6 to 0.77. Once again two of the ten variables, general descriptors LQ-Landscape Quality and ES-Cost of Servicing (see figures 3.7 and 3.9) are negatively correlated to this dimension with values of -0.61 and -0.36 respectively. This inverse relationship is not unexpected, the same attributes that increase agricultural yield, such as well-drained level

TABLE 4.2

Varimax - Rotated Factor Matrix

Variables	Factor I	Factor II	Factor III
	Accessibility	Topography	Environmental
			Quality
AE Employment	<u>936</u>	088	147
AR Retail	<u>954</u>	002	084
AS Social	<u>908</u>	002	046
PA Air	091	-003	<u>398</u>
BN Noise	<u>349</u>	127	-028
AY Agriculture	158	<u>778</u>	-023
CS Servicing	033	<u>-614</u>	-119
ES Wildlife	-101	181	<u>833</u>
LQ Landscape	<u>-362</u>	<u>-356</u>	035
RC Recreation	116	<u>610</u>	<u>461</u>

Note: Last decimal points have been omitted.

Based on SPSS PA2 Principal with iterations.

Refer to Table 3.1 for outline of data variables.

land, decrease construction costs. The factor analysis points out the dilemma of preserving Canada's scarce agricultural land resources in the face of rapid urban growth.

The third dimension measures environmental quality. It loads most heavily on the ES-Wildlife Habitat, RC-Recreational Capability and to a lesser extent, on the PA-Air Pollution variables (see figures 3.8, 3.10 and 3.11) with loadings of 0.83, 0.46 and 0.40 respectively. There is a slight negative correlation of -0.12 between this environmental dimension and the CS-Cost of Servicing variable (see figure 3.7). The sorts of areas with a high environmental quality are characterized by interesting breaks in topography, rivers or lakes, variety in soils and vegetation. These attributes tend to make construction more expensive.

The factor scores reveal the geography of land supply. The broad patterns of accessibility, topography and environmental quality are shown by mapping the highest and lowest twenty per cent of the land cells on each index. Figure 4.1 shows such a mapping of the accessibility dimension's factor scores. There is a very good fit between the accessibility dimension and metropolitan Edmonton's roadways, as shown in figure 4.2. To the north, Highway 37 and roadway 635 group areas of accessibility. Highway 15 provides good accessibility far into the northeast towards Fort Saskatchewan. However, just to the south, around cell 766, there are poorer accessibility values reflecting a lack of access to the nearby highways. The southern boundary of high factor scores extends southward to

Figure IV 1. Factor I - Accessibility

Figure IV.2: Edmonton: Regional Roadways

Leduc closely following Highway 2. On the west the same is true for highway 16 as high values reach out as far as Stony Plain.

Figure 4.3 maps the second factor: topography. The second dimension's poorer areas are most strongly correlated to the presence of luvisolic soils (see Figure 4.4). Both of the major poor areas, i.e., in the west around cell 2475, and in the east around cell 385, can be explained by the presence of stony glacial deposits, the Glory Hills Area and the Cooking Lake area respectively (see figure 4.5). These deposits make farming very difficult and would reduce agricultural yields, a variable which loads heavily on this dimension. The best soil, with respect to the factor loading, seems to be chernozemic. Correspondingly, the best topography is one ranging from flat to gently rolling.

The third dimension's Environmental Quality is mapped in Figure 4.6. The third dimension favours those lands along the North Saskatchewan River banks. There is a general agreement in pattern between the second and third dimensions, both are influenced by RC-Recreational Capability and to a lesser extent ES-Wildlife Habitats. An unexpected result is the absence of any positive effect by the region's lakes on this dimension. In fact, most areas containing lakes are considered poor according to this dimension (see figure 4.7). This may be due to the nature of the data base itself, i.e., the exclusion of bodies of water if they covers more than fifty per cent of a quarter section and its incorporation with three other quarter sections to form a whole section value.

Figure IV 3. Factor II - Topography

Figure IV.4: Edmonton: Regional Soils

Figure IV.5: Edmonton: Regional Topography

Figure IV 6. Factor III - Environmental Quality

Figure IV. 7: Edmonton; Regional Fish & Wildlife Areas

22
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The Factorial Development Potential Index

The dimensions of the factor analysis are statistically independent. A given cell of land is not more likely to score high, or low, on any factor because of a given performance on any other factor. All scores are needed to describe fully any property, each adding a full measure of information to the others. Because of this quality, the dimensions are therefore additive. Figure 4.8 illustrates this study's most important finding: the values that result from the summation of the three dimensions into the Factorial Development Potential Index (FacDPI). This map scales the Edmonton area on its attractiveness for urban development.

The FacDPI measure favours cells which are in close proximity to central Edmonton, particularly those along both Highways 2 and 16. It also favours flat, well-draining lands around the existing rural municipalities. To a lesser degree the measure gives higher than average values to cells around the region's river banks, particularly the banks of the North Saskatchewan River. In general, it gives poorer values to lands with higher reliefs as is the case with the Cooking Lake Moraine area to the east and southwest of Edmonton.

FacDPI Versus PolDPI

A comparison of FacDPI (Figure 4.8) and PolDPI (Figure 3.13) yields several interesting observations. The mapping of both indices reflects above all the positive effects of proximity to the Edmonton

Figure IV.8: FacDPI - Factorial Development Potential Index

central business district on the region's land resources. This same relationship is exhibited to a lesser degree with the sections of land surrounding the existing rural towns.

In the area between Edmonton's city limits and most of the satellite towns (i.e., 0 to 7 miles), the PolDPI index favours sections to the east near Sherwood Park, to the northwest around St. Albert, and to a lesser extent along the entire western boundary of the city limits. On the other hand, the FacDPI index strongly favours sections due west along Highway 16, to the south between the North Saskatchewan River and Highway 2, and to a lesser extent to the east between the city and Sherwood Park.

In the next area, the middle region about 7 to 12 miles from the city limits, the PolDPI again favours the eastern side of the region with a great many sections in the first, second, third and even a few in the fourth class of data values. By comparison the FacDPI map shows no values above the lowest class level to the entire middle and far eastern side of the region. The FacDPI index does credit the southwest area south of Devon with second class data values while no similar values are recorded on the PolDPI map. However, the PolDPI index shows much higher values to the south than does its counterpart. A general agreement seems to exist to the west along Highway 16 and to the northeast along Highways 21 and 15 surrounding Fort Saskatchewan. The FacDPI map spreads class one, two and three values fairly evenly throughout the middle north whereas the PolDPI map patterns similar values only very tightly bordering the major roadways, e.g., highway 2 to Morinville.

In the last area, those sections further than approximately twelve miles from the city limits, the PolDPI index favours the east while its counterpart ignores it completely. Again the PolDPI index favours the southern area over the FacDPI index. By contrast the FacDPI map shows many values in classes one, two, and three extending solidly into the far southwest. The PolDPI map shows only a minor level of agreement having two small clusters containing class one and two values in this region. Very close agreement is noted between the two maps to the far west around Stony Plain. Finally, the PolDPI measure favours the northwest while the FacDPI favours those sections due north of the city of Edmonton.

By its very construction, the PolDPI measure is most affected by proximity to urban services and flat well drained soils. The FacDPI measure is also greatly attracted towards these two variables with even more influence being exerted by proximity. However, this latter measure is also weighted in favour of environmentally attractive sections and against undesirable sections, PolDPI has no such input variables and therefore cannot make such distinctions.

Summary

A factor analysis of the separate variables yielded three summary dimensions: accessibility, topography and environmental quality. These three principal factors were summed to give a Factorial Development Potential Index. Such a measure is an objective method of describing a region's land resources. Upon comparison it seems clear that most of the differences between the PoldPI measure and the FacDPI measure can be explained by the former index's exclusion of most of the land related set of variables. These are the key variables in the construction of the topography and environmental quality dimensions of the FacDPI measure.

Although quite different patterns are represented by each measure there is no doubt that an abundance of choice is present as Edmonton charts its future growth. As will be shown in greater detail in the next chapter, Edmonton could grow at its current explosive rate to the year 2055, being then a city of more than two million people and still only occupy ten per cent of its regional land supply. Although throughout this exercise there has been a breakdown of the region's land resources into many different classes, it should be noted that all classes, but the lowest, are quite easily capable of supporting urban land uses. Clearly, the supply of potentially developable land is great and growth could logically occur in many directions.

CHAPTER V

STIMULATING GROWTH

Should Edmonton continue to grow at the rate it established in the sixties and seventies then a new-born Edmontonian could live to see the city's population triple, reaching over two million persons and its urbanized area increase by about one hundred and fifty square miles.* In the year 2050 Edmonton could rival the size of present day metropolitan Toronto or Montreal. Although such a phenomenal growth rate will probably not be sustained for so long into the future, it is clear that the location and sequence of growth will be crucial to the city's future well being.

*Based on 8,000 persons/square mile and continued growth rate of 16,666 persons/year for 75 years. Rates are from City of Edmonton, Technical Paper 3, 1975, 120 (the calculations are my own approximations).

This chapter examines the demand for urban land and the spatial implications of its allocation. Population projections are presented and the resultant demands for residential land uses in various areas of the region are estimated. Based upon these estimates, two simulations are undertaken in order to represent two possible growth management scenarios. The results are analyzed and then compared.

Population Projections.

Table 5.1 contains past population data and future projections as estimated by the City of Edmonton's Research and Long Range Planning Branch. The projected figures are based upon the City's medium cohort survival projections undertaken in 1976. This table presents data on expected population growth for the entire metropolitan planning region, the City, the fringe (i.e. the region minus the city) and the Mill Woods Assembly. Table 5.2 shows population data and fill up dates* for the six outline plan areas within the present city limits. These figures are

*There is a serious discrepancy between planning agencies with regard to the development densities of the six Outline Plan Areas. The data supplied by different agencies at different points in time varies greatly. This may reflect the politics involved with current debates regarding the annexation of large tracts of land into the city. However, whatever the cause for these inconsistencies and since this study attempts only a comparative examination of growth patterns, not actual figures, the data supplied by the City has not been altered, but is recognized to be suspect.

TABLE 5.1

Population Projections for Selected Areas in Edmonton Regional
Planning Area, 1971-1991

Year	Region	Annual Regional Increase	City	Annual City Increase	Fringe	Annual Fringe Increase	Mill Woods	Annual Mill Woods Increase
1971	523,478	--	436,264	--	87,214	--	--	--
1972	539,006	15,528	441,530	5,266	97,476	10,262	567	567
1973	549,132	10,126	442,365	835	106,767	9,291	1,715	1,148
1974	563,277	14,145	445,691	3,326	117,586	10,819	3,943	2,228
1975	578,048	14,771	451,635	5,944	126,413	8,827	7,117	3,174
1976	597,965	19,917	461,559	9,924	136,406	9,993	11,967	4,850
1977	615,000	17,035	471,474	9,915	143,526	7,120	15,675	3,708
1978	630,000	15,000	480,500	9,026	149,500	5,974	17,931	2,256
1979	645,000	15,000	489,900	9,400	155,100	5,600	20,281	2,350
1980	661,000	16,000	499,600	9,700	161,400	6,300	22,706	2,425
1981	675,100	14,100	509,600	10,000	165,500	4,100	25,206	2,500
1982	690,100	15,000	519,800	10,200	170,300	4,800	27,756	2,550
1983	705,200	15,100	530,300	10,500	174,900	4,600	30,381	2,625
1984	720,200	15,000	540,900	10,600	179,300	4,400	33,031	2,650
1985	735,300	15,100	551,400	10,500	183,900	4,600	35,656	2,625
1986	750,300	15,000	561,900	10,500	188,400	4,500	37,541	2,885
1987	765,300	15,000	572,400	10,500	192,900	4,500	41,191	3,650
1988	780,400	15,100	583,000	10,600	197,400	4,500	45,894	4,703
1989	794,600	14,200	592,900	9,900	201,700	4,300	50,844	4,950
1990	808,700	14,100	602,800	9,900	205,900	4,200	55,794	4,950
1991	822,900	14,200	612,800	10,000	210,100	4,200	62,540	6,746
Total	822,900	299,422	612,800	176,536	210,100		62,540	62,540

Source: Personal communication with Ms. Sarah Trogen, Senior Planner, Research and Long Range Planning Branch, Planning Department, City of Edmonton.

TABLE 5.2

Population Projections for Outline Plan Areas, 1971-1991

Year % Share	Mill Woods 25%	North East 25%	West Jasper 15%	Castle Downs 15%	Riverbend 10%	Kaskitayo 10%	Total Outline Plan Area 100%
1971-72	567	1,684	2,407	476	3,093	--	8,227
73	1,715	1,908	4,025	1,159	4,248	--	13,055
74	3,943	2,168	4,453	2,034	4,580	--	17,178
75	7,117	2,238	6,150	2,927	5,288	1,049	24,769
76	11,967	5,315	7,213	4,688	5,782	2,130	37,095
77	15,675	9,805	11,018	7,845	5,739	4,891	54,973
78	17,931	12,061	12,372	9,199	6,642	5,794	63,999
79	20,281	14,411	13,782	10,609	7,582	6,734	73,399
80	22,706	16,836	15,237	12,064	8,552	7,704	83,099
81	25,206	19,336	16,737	13,564	9,552	8,704	93,099
82	27,756	21,886	18,267	15,094	10,572	9,724	103,299
83	30,381	24,511	19,842	16,669	11,622	10,774	113,799
84	33,031	27,161	21,432	18,259	12,682	11,834	124,399
85	35,656	29,786	23,007	19,834	13,732	12,884	134,899
86	37,541	32,671	24,798	20,385	14,926	14,078	144,399
87	41,191	34,270	27,023	--	16,439	15,591	154,899
88	45,894	--	29,845	--	18,320	16,785	165,499
89	50,844	--	32,815	--	20,300	--	175,399
90	55,794	--	35,785	--	22,280	--	185,299
91	62,540	--	37,845	--	22,900	--	194,725
Filled up according to city*	62,540	34,270	37,845	20,385	22,900	16,785	194,725
Filled up according to CMHC & Region	110,000	40,000	66,450	76,800	50,000	38,000	381,250

*Based on 900 acres development/year, therefore filled up by 1991.

Source: Based on table 5.1, page 93 and the author's own calculations assuming the defined percentage share for each Outline Plan area and given the "filled up figures" as supplied in personal communication by Ms. Sarah Trogen, Senior Planner, Research and Long Range Planning Branch, Planning Department, City of Edmonton.

based on the planned percentage share of serviced lots to be generated by each outline area given different density parameters as defined by the City.

Introduction to Simulations

A wide range of distributions of future Edmontonians is possible; however, the possible is not always the acceptable. In this case density and spatial distribution are the two parameters which control the margins of acceptable solutions. The situation may be represented by a line scaled from one to ten. The start near the value one represents distribution solutions approaching maximum entropy, where the entire population would be spread evenly over the fringe area. On the end near the value ten, is a condition of maximum negentropy or maximum clustering. Neither extreme is acceptable, the former for environmental and servicing reasons and the latter for social and psychological reasons. The set of possible solutions lies somewhere between. SIM1 models the public decision to proceed with the Mill Woods Land Assembly which can be viewed as opting for a decision approaching a value of ten on the scale. SIM2 models the scenario where the Mill Woods concept was not undertaken, a choice which approaches a value of one on the decision scale.

With the "Political Development Potential Index" (PDIPI) values at hand, we have a measure of the attractiveness of each square mile of potentially developable land in the planning region which models the

political decision of how the city should grow. Based upon the assumption that the lands most suited to urban uses, those with the highest PolDPI values, will develop first, and most completely, it is then possible to simulate the two decisions for urban development around the city of Edmonton.

Simulation Strategy

In SIM1, the 2509 cell values contained in the ERGS file are considered (see figure 3.2), this does not include Mill Woods which is within the city limits of Edmonton. In SIM2, thirteen additional square miles of land are added to the existing ERGS file bringing the total number of cells to 2522 (see figure 5.1). These thirteen new cells represent the Mill Woods Project and some additional lands that were annexed into the city in the same action. These thirteen new sections were assigned DPI values based upon extrapolation from known raw attribute values for neighbouring cells, actual visual survey by myself in the summer of 1978, and by examination of national topographic maps.

Computer program 2 performs SIM1 and program 3 associates the results with the appropriate cell reference numbers. Similarly programs 4 and 5 perform the simulation for SIM2 and directs the results to the corresponding cells (see Appendix A for all computer programs).

Figure V.1: Index To Modified E.R.G.S. Data Base

Scale: One cell is equal to one section or
one square mile

Source: Shawn P. Brennan

In an attempt to model the region's decision to protect prime agricultural land and to realistically take account of areas which are so poorly suited for urban development that no real potential exists, within a twenty-year framework, a cut-off value was defined. The PoldPI median value of 299 was used as a cut-off point. In order to mechanically simplify the computation and mapping of the simulation, seven classes of PoldPI values were subjectively defined as follows: 1) over 400, 2) 380-400, 3) 360-380, 4) 340-360, 5) 320-340, 6) 300-320, and 7) below 300. There were 1,177 active cells, distributed among the six active classes as follows: 1) 12, 2) 29, 3) 48, 4) 172, 5) 364, 6) 552. Program Number 2 in Appendix A builds a numberline with six segments each of which represents one of the six classes of PoldPI data values. Each successive segment is much longer than the former reflecting the increasing attractiveness of each successive PoldPI data class. The segment length is defined by the formula: $B(1) = T(1)$

$$B(i) = B(i-1) + T(i) \times M^i \quad \text{for } i = 2, \dots, 6$$

where: $M = 5$

$$T(1) = 552, T(2) = 364, T(3) = 172, T(4) = 48, T(5) = 29,$$

$$T(6) = 12.$$

A random number is generated to represent each new citizen being added to the Edmonton region. Program Number 2 then searches along the number line to find which segment contains the random number. A second random number is generated within the range of the class in question, and is the basis upon which the former value is assigned to a cell in its appropriate class. The process is repeated for each citizen for each of the 20 years.

Program Number 3 runs systematically through the output file created by Program Number 1 determining which class each cell's PolDPI value falls within. It then associates the first available sequential value from the appropriate class, as defined in the output file of Program Number 2, with that given cell.

SIM2 uses the output file of Program Number 1 with thirteen new given PolDPI entries which represents the Mill Woods Assembly. Programs Number 4 and 5 perform the same functions for SIM2 as Programs Number 2 and 3 did for SIM1.

It was beyond the scope of this study to examine the matrix of cells after each year for both simulations and then come to some reassessment of PolDPI values based upon that year's distribution (i.e. bonus cells with higher densities in an attempt to model the added attractiveness of clustering). And yet, this is a factor not to be ignored since the time horizon of the simulation is twenty years. The result was a decision to "tighten" the periodicity (the number of random numbers which the computer will turn out before it starts to repeat its cycle) of the random number generator between each successive year in the simulation. In this way cells which were chosen in the first state have an increased chance of being chosen again in a subsequent year of the simulation. This was seen as an effective way to build a feedback mechanism or a dynamic nature into the simulation.

The results of the simulation are mapped in figures 5.2 through 5.9. The six data value classes used in the mapping were defined by the following strategy:

	1976	1981	1986	1991
SIM1	0--X1	0--X2	0--X3	0--X4
SIM2	0--Y1	0--Y2	0--Y3	0--Y4

$$Y_i > X_i, \quad i=1, 2, 3, 4$$

Define $Z_i = X_i$; $Z_i = \min(X_i, Y_i)$

Symbol 1 = 0

$$\text{Symbol 2} = \frac{1 \rightarrow X_1}{2}$$

$$\text{Symbol 3} = \frac{X_1 + 1 \rightarrow X_2}{2}$$

$$\text{Symbol 4} = \frac{X_2 + 1 \rightarrow X_3}{2}$$

$$\text{Symbol 5} = \frac{X_3 + 1 \rightarrow X_4}{2}$$

$$\text{Symbol 6} = \frac{X_4 + 1 \rightarrow \infty}{2}$$

Analysis and Comparison of Simulations

In all maps one can easily note the different shape of the City of Edmonton which results when Mill Woods is either included, (SIM1) or excluded (SIM2) from the city proper. In the first state, the year 1976, there are only 673 cells in SIM1-76 with any population at all, as compared to SIM2-76 which has 694 populated sections. Further, some 13 cells in SIM2-76 have populations reaching into the fourth class of data values, whereas there are no such cells in SIM1-76.

Figure V.2: SIM1-76

Figure V.3: SIM2-76

Figure V.4:SIM1-81

Figure V.5: SIM2-81

Figure V.7: SIM2-86

Figure V.8: SIM1-91

Figure V.9:SIM2-91

By the second mapped state, the year 1981, SIM2-81 has already fully fourteen square miles of land which can be considered wholly urbanized. SIM1-81 has only twelve such cells which have reached the highest data value class. In this state SIM1-81 has twenty-nine fewer cells which have received any population at all.

By 1986 an additional twenty square miles of land in SIM2-86 have broken out of the first class and into the second, no such development is present in SIM1-86. The upper boundaries appear constant, because of the range of the data class values, however, the actual figures indicate that SIM2 values are constantly increasing more rapidly towards a saturation density.

In the last year of the simulation, 1991, SIM2-91 has forty-seven more populated sections than SIM1-91. The first class of data values contains most of these additional cells with thirty-three more observations than SIM1-91. Twelve more are present in the second class. Finally, two additional sections are in the highest class. Again the raw data show that all SIM2 data values are higher than their SIM1 counterparts at any given state.

In general, the pattern of development between the simulations is quite similar especially for the highest and lowest data value classes. The major difference requires some diligence to detect and are noted only amongst the middle class values. In SIM1 Mill Woods is wholly urbanized by 1991, in SIM2-91 only two of the twelve sections (i.e. cells 2512 and 2515)

are considered wholly urbanized. Only three of the twelve cells are in class two (i.e. cells 2,513, 2,521 and 2,522). The seven remaining sections are all in class one data values. The people who were in effect redistributed from this region by the SIM2 scenario seem to have been attracted to the area between the city and St. Albert (i.e. cells 1038, 1039 and 1367) and between the city and Sherwood Park (i.e. cells 697, 719, 721 and 727). The raw data support this observation as values for the SIM2 cells mentioned above are even significantly higher within that data class range.

Summary

In summary, the results of the simulations would suggest that only some small proportion of the people who will actually be housed in the Mill Woods Project would have otherwise been attracted to the area. In general terms, most of the other people would have infilled in the areas between the city limits and the towns of St. Albert and Sherwood Park.

CHAPTER VI

CONCLUSIONS

To date Canada's experience with land banking has been tainted by policies which attempt to achieve cross purposes. Three motives for land banking have been identified: public sector control of land prices, the capture of capital gains by either sector, and greater site and regional planning control by public authorities. History points to the mistakes and missed opportunities of the past. This study suggests that land should be publically banked to meet our cities' future needs. Public land banking was shown to be a very cumbersome instrument of social policy and it is recommended that the prime policy motivation for public land banking must be the achievement of greater planning control. This use requires a better understanding of what constitutes optimum urban growth and form. Optimal growth, in turn, should be based on the development potential of the urban region's land base. This study is a first attempt to simulate the impact of public land banking on one urban region's growth using a computed development potential index.

This study has recognized two fundamentally independent attributes of land for urban development: location and physical quality. Location will become increasingly important to Canadians as oil prices move rapidly towards international price levels and transportation costs skyrocket. Further, there is no reason to doubt that either this or the next generation of Canadians will drop their expectations of what constitutes an environmentally pleasing settlement pattern. The Edmonton case study illustrates that even if Canada's fastest growing metropolis, less than ten per cent of its metropolitan regional land supply will be required to the year 2050. As a direct result of these conditions the trade-offs between locational and physical land attributes will become more important in the future. It seems quite likely that both the community in general and individual consumers of residential land will become more discriminating. Public officials must recognize the inevitability of this movement and prepare, in advance, a suitable response to this forthcoming challenge.

This study formulates a factorial index of potential urban development which blended together five locational and five physical attributes of land, taken from the Edmonton Regional Growth Studies (ERGS) Planning Data Base. As always, the mere selection and use of any variable is in itself a subjective process. Notwithstanding this fact, the analysis presented in this study suggests that any accurate measure of potential urban development must weigh at least three broad dimensions: accessibility, topography and environmental quality. The Edmonton case

study points to the inherent danger of building a development potential index based on subjective criteria. The index developed by ERGS gave little attention to the topographic factor and almost no consideration to the broad dimension of environmental quality. Factor analytic techniques are not the only mode of analysis which may be employed in this area of inquiry. However, this study has shown that some form of mathematically objective analysis is a crucial first step in the evaluation of a region's land resources and the subsequent determination of likely future directions for growth.

Simulating population growth and dispersion on the basis of such development potential indices offers a concrete visual mechanism for portraying possible future growth patterns. Such a simulation was implemented for the Metropolitan Edmonton Sub-Region both with and without the employment of the Mill Woods public land bank. The results suggest that public land banking may be used as an effective planning device in shaping Canada's future metropolitan growth.

APPENDIX A

COMPUTER PROGRAMS

PROGRAM 1

```

0000100 SHAUN4: PROC OPTIONS (MAIN) ;
0000200 DCL ERGSIN FILE RECORD INPUT ;
0000300 DCL PRT PRINT FILE ;
0000400 DCL SECW FIXED BIN (15,0) INIT (0) ;
0000500 DCL 01 ERGSREC ,
0000600 02 MERIDIAN CHAR (1) ,
0000700 02 RANGE CHAR (2) ,
0000800 02 TOWNSHIP CHAR (3) ,
0000900 02 SECTION CHAR (2) ,
0001000 02 MARKER CHAR (1) ,
0001100 02 ER CHAR (2) ,
0001200 02 SUBREGION CHAR (1) ,
0001300 02 B1 CHAR (5) ,
0001400 02 ELEC DIS CHAR (3) ,
0001500 02 B2 CHAR (1) ,
0001600 02 ENUM AREA CHAR (3) ,
0001700 02 B3 CHAR (120) ;
0001800
0001900 DCL IDENT CHAR (8) DEFINED ERGSREC ;
0002000 DCL TYPE CHAR (2) DEFINED ERGSREC POS (14) ;
0002100 DCL AEN PIC '(6)9' DEFINED ERGSREC POS (17) ;
0002200 DCL ASM PIC '(4)9' DEFINED ERGSREC POS (17) ;
0002300 DCL CSN PIC '(3)9' DEFINED ERGSREC POS (17) ;
0002400 DCL PAN PIC '(3)9' DEFINED ERGSREC POS (17) ;
0002500 DCL PMW PIC '(3)9' DEFINED ERGSREC POS (17) ;
0002600 DCL DPI FIXED DECIMAL (10,3) ;
0002700 ON ENDFILE (ERGSIN) GOTO ENDIT ;
0002800 READR: READ FILE (ERGSIN) INTO (ERGSREC) ;
0002900 IF ER = 'ER' THEN DPI = 0 ;
0003000 IF TYPE = 'AE' THEN
0003100 DPI = DPI + (AEN - 38500) / 1061 ;
0003200 IF TYPE = 'AS' THEN
0003300 DPI = DPI + (ASM - 580) / 20.5 ;
0003400 IF TYPE = 'CS' THEN
0003500 DPI = DPI + 100 - 99 + (CSN - 96) / 314 ;
0003600 IF TYPE = 'PA' THEN
0003700 DPI = DPI + 100 - 99 + PAN / .26 ;
0003800 IF TYPE = 'PW' THEN DO ;
0003900 SECW = SECW + 1 ;
0004000 DPI = DPI + 100 - 99 + PMW / .3 ;
0004100 PUT FILE(PRT) SKIP EDIT (SECW,IDENT,ROUND(DPI,0))
0004200 (F(4),X(1),A(8),X(1),F(4)) ;
0004300 END ;
0004400 GOTO READR ;
0004500 ENDIT: END SHAUN4 ;

```

PROGRAM 2

```

10 SET LL=132
20 LET A=1
30 LET R=.64972109
40 FILE #1;"PEOPL",2
50 LET X2=1177
60 DIM P(X2)
70 LET M=5
80 DIM T(6)
90 DIM B(6): DIM B2(6)
100 DATA 352,364,172,48,29,12
110 FOR I=1 TO 6
120 READ T(I)
130 NEXT I
140 LET B(I)=T(I)
150 LET B2(I)=0
160 FOR J=2 TO 6
170 LET B(J)=B(I-1)+T(I)*M*I
180 NEXT I
190 FOR I=2 TO 6
200 LET B2(I)=B2(I-1)+T(I-1)
210 NEXT I
220 DIM Z(20)
230 FOR I=1 TO 20
240 READ Z(I)
250 NEXT I
260 DATA 10262,9291,10819,8827,9993,7120,5974,5600
270 DATA 6300,4100,4800,4600,4400,4600,4500,4500
280 DATA 4300,4300,4200,4200
290 FOR I=1 TO 20
300 FOR J=1 TO Z(I)
310 LET X=B(6)+BND(0)
320 FOR K=1 TO 6
330 IF X<B(K) THEN LET S=K: LET K=6: GOTO 340
340 NEXT K
350 LET E=B2(S)+1+BND(I*J)+T(S)
360 LET P(E)=P(E)+1

```

```

370 NEXT J
380 LET G=0
390 LET Y=1970+I
400 PRINT "RESULTS AFTER ";Y
410 FOR J=1 TO X2
420 LET G=G+P(J)
430 PRINT P(J);
440 PRINT M1;P(J)
450 NEXT J
460 PRINT "TOTAL DISTRIBUTED: ",G
470 NEXT I
480 CLOSE #1
490 END

```

PROGRAM 3

```

10 LET N=2509
20 DIM T(2509): DIM X(2509)
30 SET LL=130
40 FILE #1:"DPIFL",1
50 FOR I=1 TO N
60 READ #1;A,B,C
70 LET A=INT((C-280)/20)
80 IF A<0 THEN LET A=0
90 IF A>6 THEN LET A=6
100 LET T(I)=A
110 NEXT I
120 CLOSE #1
130 FILE #2:"PEOPL",1
140 FILE #3:"SIM1/2",2
150 DATA 552,364,172,48,29,12
160 FOR K=1 TO 4
170   FOR I=1 TO 6
180     READ A
190     LET S=1
200     FOR J=1 TO A
210       READ #2;B
220       IF T(S)=I THEN 240
230       LET S=S+1: GOTO 220
240       LET X(S)=B
250       LET S=S+1
260     NEXT J
270   NEXT I
280   FOR I=1 TO N
290     PRINT #1,I;";";25I,X(I);
300     PRINT #3;X(I)
310   NEXT I
320 PRINT
330 RESTORE
340 NEXT K
350 CLOSE #2,#3
360 END

```

PROGRAM 4

```

10 SET LL=132
20 LET A=1
30 LET R=.64972109
40 FILE #1;"PEOPL",2
50 LET X2=1190
60 DIM P(X2)
70 LET M=5
80 DIM T(6)
90 DIM B(6): DIM B2(6)
100 DATA 552,364,173,56,31,14
110 FOR I=1 TO 6
120 READ T(I)
130 NEXT I
140 LET B(1)=T(1)
150 LET B2(1)=0
160 FOR I=2 TO 6
170 LET B(I)=B(I-1)+T(I)*M-I
180 NEXT I
190 FOR I=2 TO 6
200 LET B2(I)=B2(I-1)+I*(I-1)
210 NEXT I
220 DIM Z(20)
230 FOR I=1 TO 20
240 READ Z(I)
250 NEXT I
260 DATA 10829,10439,13047,12001,14843,10828,8230,7950,8725,6600
270 DATA 7350,7225,7050,7225,7385,8150,9203,9250,9150,12140
280 FOR I=1 TO 20
290 FOR J=1 TO Z(I)
300 LET X=B(4)*RND(0)
310 FOR K=1 TO 6
320 IF X<B(K) THEN LET S=K: LET K=6: GOTO 330
330 NEXT K
340 LET E=B2(S)+1+RND((I+J)*T(S))
350 LET P(E)=P(E)+1
360 NEXT J
370 LET O=0
380 LET Y=1970+I
390 PRINT "RESULTS AFTER ";Y
400 FOR J=1 TO X2
410 LET G=G+P(J)
420 PRINT P(J);

```

440 NEXT J
450 PRINT "TOTAL DISTRIBUTED: ",G
460 NEXT I
470 CLOSE #1
480 END

PROGRAM 5

```

10 LET N=2522
20 DIM T(N): DIM X(N)
30 SET LL=130
40 FILE #1:"DP1FL",1
50 FOR I=1 TO N-13
60 READ #1:A,B,C
70 LET A=INT((C-280)/20)
80 IF A<0 THEN LET A=0
90 IF A>6 THEN LET A=6
100 LET T(I)=A
110 NEXT I
120 CLOSE #1
130 DATA 4,4,6,5,4,6,4,4,4,3,4,5,4
140 FOR I=N-12 TO N
150 READ T(I)
160 NEXT I
170 FILE #2:"PEOPL",1
180 FILE #3:"SIM1/2",2
190 DATA 552,364,173,56,31,14
200 SET OP=1
210 FOR K=1 TO 4
220 FOR I=1 TO 6
230 READ A
240 LET S=I
250 FOR J=1 TO A
260 READ #2:B
270 IF T(S)=I THEN 290
280 LET S=S+1: GOTO 270
290 LET X(S)=B
300 LET S=S+1
310 NEXT J
320 NEXT I
330 FOR I=1 TO N
340 PRINT X51;I;";";X41;X(I);
350 PRINT #3;X(I)
360 NEXT I
370 PRINT
380 RESTORE 190
390 NEXT K
400 CLOSE #2,#3
410 SET OP=0
420 END

```

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