THE OPTION DEMAND MODEL: A PLANNING TECHNIQUE FOR RESOLVING THE CONFLICT BETWEEN RURAL RESIDENTIAL DEVELOPMENT AND AGRICULTURAL LAND

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by

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A thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

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To My Husband
Perry E. Graham

ABSTRACT

The 1970's and early 1980's have witnessed the development of rural nonfarm residences in the country side surrounding cities. One major problem associated with this development was the loss of agricultural land. The documents and programs the federal and provincial governments put forward to deal with this problem have had limited success. The significance of this loss of agricultural land to rural residential development is unknown as the opportunity costs from developing agricultural land have not been measured. Lack of this information makes it difficult for planners and politicians to reject or redirect development to alternate sites. In this thesis the Option Demand Model is used to quantify the opportunity costs of agricultural land versus rural residential development therefore allowing better land use decisions to be made.

The model was applied to two sites similar except for soil quality in the Rural Municipality of Rockwood in the Province of Manitoba. A stream of discounted net benefits over a 20 year period was calculated for both the preservation and development options of both sites. Assuming rural residential development has a right to exist the net benefits indicated which of the sites should be developed or preserved.

The results from the Rockwood Case study indicated a trade off existed between the high cost of energy and productive agricultural land. They also indicate when the site with the shortest commuting distance

has the lower agricultural soil quality that site should be developed and the other site preserved. When the site closest to the employment center has the higher agricultural soil quality factors such as the difference in soil quality between sites, the distance between them, and their parcel sizes will affect the decision concerning which of the sites should be preserved or developed.

From these results it was concluded the decision of where to allow development to occur or not occur varied according to the circumstances of the case under study. Although the results of the Option Demand Model can not be used alone to make land use decisions, it has provided essential information bringing the goal of better land use decisions closer.

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Chapter I

INTRODUCTION

1.1 PROBLEM AND OBJECTIVE

The 1970's and early 1980's have witnessed the migration of some urban residents to the country. This residential development occurs in or near towns and villages located within commuting distances of the cities. These middle class rural residents move to gain the benefits of a rural lifestyle while also enjoying access to urban employment and other amenities. Rural municipalities are quick to welcome these residences because of their spending impact on local communities and the additional tax base they provide. In some cases it is felt these benefits outweigh the social, economic, and environmental problems associated with rural residential development. This opinion is questioned when the taxes of all the municipality's residents are increased to cover the increased servicing costs resulting from rural residential development. Other associated problems are tresspass, disturbance of livestock, vandalism, contamination of water supply, and loss of agricultural land. Both the rural residential lot and adjacent land are taken out of agricultural production because of the haphazard manner in which the development occurs. The appreciating land values, additional revenue in the small communities, nor the additional tax base may not compensate for these conflicts and losses. As more rural residences are approved and built the problems intensify.

These problems did not go unnoticed by the federal and provincial governments. Their concern especially about the loss of prime agricultural land was reflected in the Ontario Foodland Guidelines, the British Columbia Land Reserves, the Manitoba Provincial Land Use Policies and various federal programs. The success of these documents and programs has been limited and valuable agricultural land continues to yield to other developments. The significance of this occurance is unknown as the opportunity costs from developing agricultural land have not been measured. Lack of this information makes it difficult for planners and politicians to reject or redirect development to alternate sites. This thesis will help resolve this problem by using the 'Option Demand Model' to quantify the opportunity cost of agricultural land versus rural residential development.

The 'Option Demand Model' takes into consideration both the preservation and development option. In this case the preservation of agricultural land makes up one option and the development of rural residences composes the other. Two sites, similar except for soil quality, in the Rural Municipality of Rockwood are examined. A stream of discounted net benefits over a twenty year period are calculated for both the preservation and development options for both sites. Assuming rural residential development has a right to occur, net benefits indicate a decision on development versus preservation. More significantly, it indicates given a specific situation which classes of agricultural land should be developed.

The results from the application of this model can assist planners and politicians in appraising the impact of land use decisions and show-ing there are alternative choices. Land use decisions can not solely be made based on the results of an economic model. Other considerations social, environmental, and political in nature must be taken into consideration especially when rural residential development and agricultural land are the land uses under consideration. The measurement of preservation values presented here may not provide all the necessary information however, it does supply information badly needed by planners and politicians not previously available.

1.2 OUTLINE OF THESIS

The thesis is divided into six chapters. Chapter I discusses the problem, objective and layout of the thesis. Chapter II explores the various methods of land use allocation and the conflicting land uses of rural residential development and agriculture. These land uses will be discussed indepth to indicate the several issues that must be taken into consideration when land use decisions are being made. This discussion will indicate why successful land use allocation approaches are rare. With this understanding the various means of allocating land will be discussed.

Based on the information presented in Chapter II, Chapter III discusses the land use conflict between rural residential development and agriculture and the problems in resolving it. The option demand model is presented as a method of aiding decision making and resolving land use conflicts. In order to explain the model previous applications are discussed as well as the adaptations made for its use here.

Chapter IV is the Case Study. In this chapter the site criteria, site selection process, and the sites themselves are examined. These study sites are then used to locate the benefit and cost components of the model for both the rural residential and agriculture sections.

Chapter V presents the results including sensitivity testing of the variables and experimentation with various values such as commuting distance, parcel size, and agricultural soil quality.

Chapter VI presents the summary comments and conclusions.

Chapter II

CURRENT SITUATION AND PROBLEMS

2.1 INTRODUCTION

The objective of this thesis is to provide planners and politicians with a technique for evaluating information. In order to demonstrate why a technique is needed this chapter will explore various methods of land use allocation and the conflicting land uses of rural residential development and agriculture. The land uses will be discussed in depth to indicate the several issues that must be taken into consideration and why successful land use allocation approaches are rare. With this understanding and background information the land use allocation section explores the roles and failures of the market, the Federal government, and various provincial governments in making good land use decisions. Other planning methods used mainly in the United States will also be explored.

2.2 RURAL RESIDENTIAL DEVELOPMENT

Exurban or rural residential development is commonly known as non-farm residences. The majority of rural residents commute into urban centers or industrial areas for their major source of employment income. Rural Residences take the shape of mobile homes, converted farm houses or newly constructed houses. Lot sizes range from half an acre to forty acres in size, (Regional Planning Section 1980).

2.3 PAST TRENDS AND LOCATION

Rural residential development has occurred continually throughout the twentieth century and was most noticable in the late 1920's, early 1930's, late 1960's and 1970's. The demand for development is associated with the economic viability of an area and increased personal disposable incomes. Although the demand for rural residential development has slowed around Winnipeg, it continues unabated in Alberta and Saskatchewan.

Rural Residences locate within commuting distance of industry and urban centers. The residents have the advantage of being close to work and basic services while enjoying the "rural lifestyle." The disadvantage is this development usually locates on a resource such as agricultural land or gravel deposits. It also causes many other social, physical and economic problems. Before these problems are discussed the nature of the rural residential demand will be explored.

2.4 THE RESIDENTS AND THE NATURE OF DEMAND

Surveys concerning rural residential development have indicated common traits exist. Rural residents are upper middle income four person families with a wide educational background who commute to work. The majority of families previously lived in an urban centre and approximately half of the adults have rural backgrounds. Reasons residents moved to the country were better environment for children, more privacy, more space, ability to keep animals, lower living costs and the investment potential. The residents surveyed generally were satisfied however, found they had overestimated the level of services available and underestimated the time spent commuting. Despite these revelations their original reasons for moving to the country keep the rural residents from returning to the city. The result has been a haphazard subdivision of land around several urban centres in Canada.

2.5 SOCIAL, ECONOMIC AND ENVIRONMENTAL PROBLEMS

2.5.1 Social Concerns

Some social, economic and environmental problems are a direct result of unplanned and minimally planned rural residential developments. With the influx of rural residents into a municipality problems concerning crowding and reduced levels of services, increased taxes, and land use conflicts result. The rural residents are often resented by the life long residents because the latter's group's schools, arenas and other facilities have become crowded and their school and property taxes have increased. Differences in values between these two types of residents also cause conflicts expecially when the exurbanites have been elected to the municipal council. Once in power the exurbanites may choose to provide additional services to their residences through increasing their taxes and those of the other residents of the municipality.

Land use conflicts are another result of rural residential development. Rural residents may complain about the adjacent farmers practices of crop spraying, stubble burning, cattle drives and raising cattle or hogs. Farmers find they must deal with increasing vandalism, trespassing, and livestock disturbance. In some cases agricultural practices have been terminated This increases the social tension between both resident groups.

Two other social problems are security problems and family break up. Security problems are a result of day time thefts from rural residences. The response of the exurbanites was to purchase dogs. This raised the dog population and incidence of dog related disturbances in the municipality. These disturbances and the fact dog catchers have had to be hired have and continues to cause a stressful situation between several of the municipality's occupants.

The problem of family break up has not been thoroughly researched however is hypothesized as being a result of the social isolation and distance from basic amenities. Family break up is one of the major reasons for the turn over in ownership of rural residences. This whole area of social problems needs more investigation. This section has indicated rural residential development has created its own socially related problems.

2.5.2 Economic Concerns

Economic concerns exist in the provision of services and utilities and in the opportunity cost of rural residential development. The services usually provided are snow and garbage removal, fire and police protection, school busing, new or enlarged schools, road upgrading and maintenance, social welfare services and in some cases water and sewage services. The municipality is required to absorb the costs of these services through land and building taxes. Since rural residents own less land than farmers they pay less in taxes for equal services. In some municipalities taxes have been increased to help cover the costs of servicing new rural residential developments. The farmers can not understand why their taxes must increase to service the rural residents while ironically this latter group does not understand why they do not receive all the services their urban neighbours do. Various cost-benefit analyses have been done concerning this tax and servicing cost issue. Diemer (1974) in the County of Parkland, Alberta, compared the tax yields of different townships with various levels of rural residential development. His results indicate the township with the most subdivision had the greatest deficit and the township with a minimum amount of subdivision produced a small, but net surplus. These results were confirmed in the Rural Residential Growth Background Study conducted in Alberta, (Regional Planning Section 1980). Generally municipalities can economically supply services to a certain level of rural residential development however, each municipality has its own point where more of this development will impose a burden on existing taxpayers.

These studies also indicated the provincial taxpayers also support rural residential development. The costs of supplying telephone, and hydro services to rural residences is subsidized by the province's urban residents. The costs of natural gas services is only partially subsidized as the rural resident has to pay some of the line laying and installation costs.

Another economic concern is the opportunity costs of rural residential development. The estimated costs of the loss of agricultural output, recreational potential, historical sites, wildlife areas, mineral and gravel deposits and resource extraction due to the construction of rural residences are significant. Added costs will be incurred in locating and acquiring similar resources. Agricultural land is one resource lost when rural residential development occurs. Rural residences often locate on the perifery of a section of land on lots of various depths and widths. The lack of lot definition makes it difficult for the owners of the property located in the middle of the section to define their property boundaries. Due to the high costs of land surveys these boundaries remain physically undefined. As a result the land is more difficult to farm and often lies idle. When rural residential development occurs on the perifery of a section it not only takes the residential lot out of production, but often takes the adjacent land also.

Rural residences are also built on lots within approved subdivision. Agricultural land is lost when the whole subdivision is developed however, the adjacent land usually remains in production. In several cases only a few residences have been built even though several of the lots have been sold. The result is large tracks of agricultural land lying idle with a few residences located in what appears to be a haphazard fashion. This land may remain undeveloped for several years as lot owners find they can not afford to build or sell. Those parties who bought lots for investment purposes may not sell as their earning expectations have not been met. This is because in some areas the supply of lots has outstripped the demand while in others the tight supply keeps speculators holding on for higher profits. The unfortunate part is this land remains underutilized. Farmers often do not negotiate with each individual lot owner in order to farm the individual parcels. They also do not want to deal with any conflicts with the existing rural residents arising as a result of viable farm practices such as crop spraying or stubble burning.

Not only do those vacant parcels remain underutilized, but a large portion of the individual lots that rural residences are located on are also underutilized. Surveys indicate fifty percent or more of each individual lot are not utilized, (Regional Planning Section 1980). Rural residents indicate one reason for having large lots is privacy however, they locate their houses side by side with the bulk of the lots located behind the houses. Another reason rural residents want large lots is for investment purposes. For these reasons agricultural land is taken out of production and underutilized from all perspectives.

From an economic perspective there are several problems that must be overcome before allowing rural residential development to occur. The assessment procedure must be revised so that these residents will pay for a larger portion of the basic services they receive. The size and location of lots must also be planned so valuable resources are not permanently lost. Lastly, the number and location of lots brought on stream for development on a specific site must be controlled. This would allow the site residual to remain in agricultural use for a longer period.

2.5.3 Environmental Concerns

Disruption of surface drainage, contamination or depletion of water supplies, and destruction of the rural landscape and character are only some of the environmental concerns. The disruption of surface drainage can result when unplanned overdevelopment of an area occurs. Previously safe lands can become flood prone or subject to ponding while other parcels can lose their water supply.

With increasing rural residential development comes the risk of contamination or depletion of the water supply. Overdevelopment can place demands on limited groundwater supplies while the concentration of septic fields will cause wastes to percolate into the water supply instead of evaporating. It is essential studies are conducted prior to development to ascertain if an adequate water supply exists and if septic fields can be used and at what density. Since every area is different each situation must be individually evaluated on its own.

Destruction of the rural landscape and character are other environmental concerns. The majority of rural residences are not built to complement the landscape or to take advantage of existing natural features. In several cases houses are built on the edge of the road, side by side, similar to an urban subdivision. Although the site may be treed or have a rolling terraine the majority of residents will not use these features to create a more environmentally sensitive setting. Rural residences also dominate scenic areas like Manitoba's Red River between Winnipeg and Lockport. City dwellers are forced to go elsewhere for a scenic river drive. If development is allowed to continue in highly scenic areas such as the Red River, provisions for the public must be made. From this discussion it is apparent rural residential development must be planned in order not to cause irreversible environmental damage.

In summation when the physical, social and economic concerns and problems are considered cumulatively, the reasons for allowing rural residential development to occur must be questioned. The demand for its existence however, cannot be ignored especially when it continues to surface in new areas of industrial development and economic viability.

Although this thesis will only deal with one of these concerns, this discussion has shown the complexity of the issues planners must face when dealing with rural residential development. Planners in conjunction with other professionals have indicated the conflicts and problems associated with rural residential development can be minimized through the implementation of policies and planning. Canada's agricultural land situation and the current planning methods used to deal with land use conflicts and the loss of agricultural land will be discussed in the following sections.

2.6 CANADIAN FOOD SITUATION

Studies of the Canadian Agricultural land situation have indicated it to be a complex and confusing one. This section will examine the agricultural land situation, land reserves, land quality issues and consequences.

Only ten percent of Canada is arable and only half a percent is Class I agricultural land (Winslow 1979). Class I is a rating from the Canada Land Inventory referring to land which has no limitations on agricultural productivity. Increasing amounts of this limited resource continues to be lost to other land uses. One of the largest losses of agricultural land is to urban uses. Nearly one half of Canada's agricultural land is located within fifty miles of the twenty-two largest cities (Manning 1979). According to the estimates of two hundred acres per one thousand population increase, 1.3 million acres will be lost in Ontario alone by the year 2000 (D. Glerman 1973). This figure only includes urban growth not the multitude of other uses that take agricultural land out of production.

New reserves of agricultural land are being brought into production however, do not match the rate that land is being lost. These reserve lands are also lower in productivity. For example land reserves largely located in the Peace River Region of Alberta and British Columbia were brought into production between 1961 and 1976. This land counter balanced the number of acres lost on the Prairies and in British Columbia, but did not compensate for the land lost in Ontario, Quebec, and the Maritimes nor the quantity or types of crops lost. The reserve lands, located in the northern areas of Canada are subject to climate restrictions and are lower in productivity. This means once land in the Fraser Valley, Okanagon Valley and Niagara Fruit Belt are lost they and their specialty crops cannot be replaced. Replacement of agricultural land may soon become difficult in Canada. The exact amount left in reserve is unknown however, it is diminishing and requires more inputs in order to be brought into production, e.g., irrigation costs. Generally all of Canada's agricultural land is beginning to require more inputs. As a result of improper farm practices increasing amounts of land are being affected by salinization, erosion, water logging and the loss of topsoil. Increased usage of fertilizers has helped mask the decaying quality of the soil, but the soaring price of this input has resulted in the questioning of their continued use. If fertilizer applications are not increased and some soil management practices not improved crop production will not continue to grow.

In summary, Canada is a large food producing country. The quality and quantity of the agricultural land is diminishing as a result of poor farm practices and nonfarm development. Preservation of all agricultural land is not the action called for. Land uses other than agriculture are needed and have the right to exist. Ideally the solution would be to direct development to more appropriate locations and minimize the amount and quality of land taken out of production. These things may be achieved through planning. The objective of this thesis was to help planners make better land use decisions. Having examined the Canadian agricultural land situation this thesis will now examine the current methods used to deal with the loss of agricultural land.

2.7 LAND USE ALLOCATION

2.7.1 Introduction

The way land use decisions are made varies from area to area. This section will examine the market, the Federal government and three provincial government roles in making land use decisions. Other planning tools used mostly in the United States will also be explored.

2.7.2 The Market

There are many ways to control the loss of agricultural land to other uses. Some groups vehemnently oppose government intervention and feel the market place will arbitrate among competing land uses. The land market however, can fail to efficiently allocate land resources as a result of monoloply or monopsony, collective goods and externalities. Since in this case there is no monopoly or monopsony on agricultural land for rural residential development the market will not fail for this reason. The market will fail because of the other reasons.

Some of the benefits of agricultural land can be considered as collective goods. Collective goods have two fundamental characteristics: the impossibility of excluding consumers who do not pay for the good in question and consumption by one consumer occurs without reducing the quantity of the good available for other consumers (Mishan 1969). When agricultural land is developed the option, also known in this case as the collective goods resulting from using the land for agriculture, are lost and may be difficult or impossible to replace. A demand exists for this option as the public wish to insure the supply of food is secure for them and future generations needs. The demand exists even though there is no current intention to develop an area and the option may never be exercised. The public may just demand the option to exist. The demand for private rights are handled in the market however, no market has developed dealing with the demand for preservation options. The reason for this is there are several problems in organizing a payment system for public options or collective goods. As mentioned earlier the characteristic of a collective good or keeping an option open is the impossibility of excluding consumers who do not pay for the good or option. As a result of this the size of the demand for the option is unknown. Due to the nature of collective goods or in this case keeping the preservation option open the market fails to aribtrate among competing land uses.

The market may also fail as a result of unnegotiation and uncompensated external effects as a result of land allocation among uses. For example when a developer sells a parcel of agricultural land for rural residential development and adjacent land owners, usually farmers, receive no compensation. The farmers taxes may increase as a result of equalized assessment or increased servicing costs for the new residents. The value of the farmer's land does not increase as it would if this situation occurred on the urban fringe therefore he is not compensated for any problems he may incur as a result of his new neighbours. For example rural residents will complain about farm activities such as fee lot operations, crop spraying, and stubble burning. They may even succeed legally in closing farming operations down. Besides coping with this farmers may also have to deal with increased vandalism, trespassing and livestock disturbances. In this case the adjacent land owners are not compensated for the externalities they must deal with when rural residential development occurs. For this reason and from the perspective of collective goods the market fails to arbitrate among competing land uses. As a result the government must become involved so more factors can be taken into consideration and land uses allocated more fairly.

2.7.3 Role of the Federal Government

The role of the Canadian federal government in land use policy and planning has varied in the past. Canada Mortgage and Housing Corporation (CMHC) and the Ministry of State for Urban Affairs (MSUA) were the two main participants. The disappearance of the MSUA and the reduction of CMHC'c mandate are hypothesized as being a result of federal government lack of direction and uncertainty (Hightower 1981, p. 57). The Lands Directorate of Environment Canada has now become the leading federal agency with respect to land planning. This agency provided the

Canada Land Inventory data used by federal, provincial and private agencies. From this agency's involvement was seen the need for a national policy.

The Federal government being responsible for federal lands located in the provinces and territories realized it was having an effect on adjacent land in these areas. In March of 1981 the Federal Policy on Land Use was announced. In order not to create misunderstandings the document indicated the provincial areas of jurisdiction were recognized and their planning efforts would be supported.

The document is made up of a series of policy positions and land use guidelines. The guidelines will consider the impact of policies and programs on:

1. urban land,
2. land with high agricultural capability,
3. land with high forestry capability,
4. the use and development of lands with potential for production of non-renewable resources,
5. land required for transportation and communication,
6. watersheds, aquifers, recharge and storage areas,
7. historical, cultural and recreational lands,
8. fragile and critical habitats,
9. hazard land, and
10. other regional and provincial planning and policy documents. (Government of Canada 1981).

The guidelines are to be followed by federal departments and agencies. To coordinate these groups an Inter-departmental Committee on Land was set up under the direction of the Minister of the Environment. A coordinating body is needed since each province and federal department presently plans in isolation. Harry Lash feels the inter departmental committee will fail as a result of "our political system which places great importance on department and ministerial perogatives of independence," (Lash 1981, p. 66). He also indicates the document enables the federal government to ignore the policies and guidelines if necessary. It is with great scepticism that the future success of the federal policy on land use is viewed and it is felt the successful allocation of land uses will be limited.

2.7.4 Role of Provincial Governments

Provincial governments are the agencies most involved in land use planning and regulation. The following section will discuss the planning approaches of various provincial governments and their results.

In 1976 the Food Land Guidelines, a reaction to the massive losses in agricultural land, were released in Ontario. The three major sections of the guidelines involved are:

1. the identification of agricultural resource lands,
2. the estimating of future land needs through the evaluation of existing land uses,
3. designating agricultural areas and related policies. (Rodd 1979, p. 57).

Since the Ontario government did not impose a freeze on agricultural land, local governments were not forced to prepare development plans. Those that did were required to justify the amount of agricultural land designated for urban use and provide an urban-rural buffer area. In areas not preparing development plans the provincial government enforced minimum land use policies. These development plans and land use policies were overruled in numerous cases by local government decision-makers, and through municipal board hearings. As a result, the guidelines have not done much to protect agricultural land. When hundreds of local decisions are being made solely by local governments, it is impossible to effectively and comprehensively protect agricultural land. In conclusion the Ontario government has fallen short of successfully planning land uses and stopping the massive losses of agricultural land.

The British Columbia Agricultural Land Reserves have also experienced limited success. In December 1972, the B.C. government issued Order in Council 4483, freezing the development of all farmland in British Columbia. In 1973 the ad hoc land freeze was replaced by the Land Commission Act, renamed in 1977 to the Agricultural Land Commission Act. The main purpose of the Commission is to act as an agricultural land zoning authority. The Commission's objectives were to:

1. preserve agricultural land,
2. encourage the establishment, maintenance and preservation of farms and encourage uses of land in an agricultural land reserve compatible with agricultural purposes, and
3. advise and assist municipalities and regional districts in the preparation and production of the land reserve plans required for the purpose of this Act, (Ince 1977, p. 175).

The B.C. Department of Agriculture drew up Agricultural Land Reserve maps to guide development until the municipalities established regional district land reserves. The land reserve plans upon amendment by the Agricultural Land Commission went to public hearing and were accepted by Cabinet. Upon approval, the rights of application and appeal under the Land Commission Act came into effect. The Commission received thousands of applications from developers, land speculators and older farmers considering retirement. If the Commission rejected the application, the applicant could appeal to the Minister of Environment and Land Use Committee of Cabinet. Between 1973 and 1977 one-third of the appeals were successful. The provincial government then changed hands resulting in changes to the appeal process. The number of successful appeals increased and land use decisions previously made by the Commission were reversed in the political arena. Members of the Commission, appalled by the decisions being made, resigned. The actions of the provincial government did not change. The existence of the Agricultural Land Reserves is being questioned. What started out to be a rather successful approach to land use planning and the protection of agricultural land has gone sour. The British Columbia government as the Ontario government has fallen short of dealing with the agricultural land loss issue.

In November 1980 the Manitoba Government under the jurisdiction of the Planning Act formally adopted the Provincial Land Use Policies. The goals of the policies are:

1. the rational allocation of lands based on:
   a) land capabilities,
   b) the existing pattern of use,
   c) the maintenance of a reasonably high standard of environmental quality,

2. minimization of land and resource conflicts while providing for ample residential development,
3. the protection of provincial resources e.g., agricultural land, limestone, etc.
4. the minimization of servicing costs paid by municipal and provincial governments; the protection of provincial investment in existing facilities and the reduction of provincial land acquisition costs,
5. allowing the assessment of land to reflect its use especially when it can be ensured the land will remain in its particular use e.g., agriculture, and
6. the maintenance of health and safety in and around highways, flood lands and other dangerous areas.

In attainment of these goals 13 Provincial Land Use Policies were set up. The policies guide general planning in the province and provided a framework for the drafting of Basic Planning Statements and Development Plans. These documents are only written after a Planning District has been set up. Once these documents are approved by the provincial government applications for subdivision are dealt with under their guidance. Until that time, the policies are used to review subdivision applications.

Presently all subdivisions applications rejected for approval have a good chance of being approved by the Minister of Municipal Affairs. There appears to be no difference in the number of applications rejected before or after the adoption of the Provincial Land Use Policies. Rejection decisions are being overturned largely as a result of political decisions. On the positive side, the formation of districts has allowed land to be identified for its best use. Unfortunately under this structure the land could be rezoned at anytime to any use by the not so unbiased nor unpolitical district members. Another problem with setting up districts is it is unknown what the effect of several individual plans will be. For example, it is unknown how many acres of agricultural land are preserved through development plans and how many have been taken out of production. The land use planning process in Manitoba generally appears to be making more headway in a shorter period of time than the other provinces discussed however, it also falls short.

2.7.5 Other Planning Tools

Preferential Assessment, Deferred Taxation and Restrictive Agreements are all relatively new land use planning tools primarily used in the United States. Preferential Assessment is taxation with a reduced rate for agricultural land without any rollback or penalty taxes if the land is converted to another use, e.g., urban uses. Deferred Taxation is preferential assessment however when the zoning of agricultural land is changed, back taxes at the rate of the new land use must be paid. There is usually an interest rate attached to the deferred taxes.

These two approaches help keep agricultural land in production by keeping the farmers′ taxes at agricultural land levels and not those calculated by market value. Deferred taxation is a superior method to preferential assessment as it acts as a deterrent to the land speculator.

There are several loopholes and problems with these approaches. Most of the programs enacted are voluntary and farmers and speculators on the urban fringe are not signing up. These programs are only working well in areas past the commuting distance of urban centers. Where deferred taxation does occur on the urban fringe and speculators choose to get involved, they often sell the land for prices that more than cover the back taxes. There are also administrative problems with the programs. On the positive side the newer programs like Wisconsin's are not having as many problems because additional land use controls and methods are being used and the state is becoming more directly involved.

The use of restrictive agreements is an example of an additional land use method. Used in conjunction with preferential assessment restrictions on the use of land can be legally enforced. Through signing contracts owners legally bind themselves from developing their land until the end of the period agreed upon in the contract. If the program is voluntary it will only work well in areas past the commuting distance of urban centres. Governments must become more involved not only in enforcing these tools, but in deciding which lands should be developed or preserved.

Another land use tool is the concept of transferrable development rights. The term "development right" describes the "rights" the landowner has to change or intensify the use of the land by development in some way, e.g., placing buildings on it. The basic concept of Transferrable Development Rights (T.D.R.) is the development right is severable from the land, it can be sold or controlled apart from the surface rights of the land, the same as mineral rights. This concept does not allow the landowner to develop land as chosen however, establishes a system for the "qualification and transfer of development rights in a designated area under an administratively created market." Some of the states having set up such administrations are Maryland, Wisconsin, New York, California. Development Rights are issued in a specific area. They can be issued according to the number of dwellings eliminated by keeping an area in agriculture or by issuing a combination of rights separately defined as residential, commercial, and industrial. The developer who wishes to build on the permitted areas must purchase development rights from those areas where development has been restricted and where a surplus of development rights exist. The owner of the T.D.R. who sells this commodity to a developer is compensated for the restriction he faces by not being able to develop the preserved property. The final result is that resources such as agricultural land are protected from development.

In theory the concept is ideal however, in those states where it exists both success and problems have been experienced. It is S.I. Schwartz and D.E. Hansen's opinion a T.D.R. system will not completely remove the incentives or abuses that exist under zoning. Development of land designated for preservation will occur anyway. The lack of strong land use controls backed by relevant information and the weak administration by governments will hold the success of the T.D.R. concept back. Again the problems of weak governments and lack of sound information are brought up as major roadblocks in the rational planning of Canadian resources.

In summation, of the various methods of making land use decisions the market place fails and planning falls short. Lack of information in key areas makes it difficult for politicians and planners to make decisions solidly based on fact. When this occurs the planning process breaks down and land use decisions are made based on political pressure. If more constructive organized information can be provided to show land development options exist perhaps better land use decisions will be made.

2.8 SUMMARY

This chapter has examined various aspects of rural residential development, the Canadian agricultural land situation and the various methods of land use allocation. Through examining both rural residential development and the agricultural land situation it was found there are numerous complex issues to be dealt with when land use decisions are made. When the various methods of land use planning were explored, it was found they fell short especially when dealing with agricultural land. This failure was a direct result of decisions being made in the political arena. Due to the lack of vital pieces of information politicians and planners were not as prepared to deal with political pressure. There is no one solution to this problem however, the Option Demand Model can assist in filling this void. By weighing the opportunity costs lost through developing various pieces of land solutions can be found where both development can occur and agricultural land will be preserved. With this technique and information perhaps better land use decisions can be made. The Option Demand model will be discussed in the next chapter.

Chapter III

OPTION DEMAND MODEL

3.1 PERCEPTION OF THE PROBLEM

The demand for land subdivision for rural residential development is still occurring. Land owners believe it is their right to subdivided and/or develop their land for any use. They view it as a means of increasing their wealth or assisting a family member by giving them the land to build a house on. The provincial government however, is responsible for examining the application for land subdivision from a wider perspective. The effect development may have on adjacent land owners, and on the rest of the province must be examined from environmental, agricultural, social, and economic perspectives. The decision the province makes concerning land subdivision and development must be backed with substantiated information.

The previous chapter discussed some of the problems of land use decision making, resolving land use conflicts, and of allocating land to its best use. It was found that since planners and provincial politicians had limited information on which to base their decisions, situations have resulted which may and have had negative impacts on the public's future. Politicians are subject to public pressure. If adequate information is unavailable to combat this pressure inadequate desicions are made. Part of the solution to better land use decisions is to improve the information available and to educate the public, the planners, and the politicians.

Neither of these proposals are easy to achieve. Educating the public and the decision makers takes years. Making more information available to people is only part of the solution. Improving the system for organizing and evaluating information is in actuality more beneficial. Planners, politicians and the public need a way to evaluate the consequences of their decisions. No one method can provide this assistance however there are methods that can help.

The use of computer models are a means of organizing information and evaluating it. These models are beginning to be used in public and private planning offices. The majority of studies using computer models have used cost benefit types. The results have been limited in scope and often misleading. What is needed is more sophisticated types of models specified to the situation at hand. Use of a model will not completely resolve the problems encountered in decision making. It is only a technique used to clarify issues permitting better decisions to be made.

This thesis proposes to use the Option Demand Model to help resolve land use conflicts. This application of the model is a new one. The following sections will describe its operation, previous applications and proposed application. This model will help positively determine, given certain standard situations, where development such as rural residences should occur.

3.2 THE OPTION DEMAND MODEL

The conversion of agricultural land to rural residential development is an irreversible action. In an analysis of the consequences of such an irreversible decision conventional cost-benefit analysis falls short. The Option Demand Model is structured to take into consideration and value the preservation option. It assumes that once the development decision is made it is irreversible and artificial restoration can not be accomplished even at a high cost. Evaluating the preservation alternative prior to development has posed a difficult problem in the past. Often the preservation option was ignored or understated in the decision making process due to difficulties evaluating it in monetary terms.

The evaluation of agricultural land is very important in the land use decision making process especially when the demand for food is growing over time. Since the productive capability of agricultural land varies the value of preserving higher classes of land is greater than preserving lower classes. Assuming that development will occur the model is used to determine what the value of the preservation alternative would have to be in order to preserve one parcel of agricultural land versus another. The model assumes the planner's or politician's objective is to maximize the present value of returns from the proposed use while taking into account the value of the opportunities forgone. The planner or politician will not necessarily approve a development unless the alternatives have been evaluated and the development, from preservation and development perspectives, can not occur more economically on an alternate parcel.

In order to do this the model takes into consideration the net present value of the preservation and development alternatives as they occur over a period of time. This contrasts with the standard cost-benefit analysis which only takes into consideration the initial investment and discounts the future heavily. This type of analysis may result in misleading comparisons of present values and present costs. In the Option Demand Model the natural environment or agricultural land is evaluated for its present use such as recreation or food production. In doing this the increasing demand for its use and the maximum capacity of its use are estimated using various scenarios. These figures are discounted at various rates to give a range of estimates representing the present value of preservation. This figure is then compared with the net benefits of the development option. The results indicate at which level of recreation or food production (preservation option) the development option will be overturned and directed to another area. The validity of these results are restricted by the assumptions made when the model is specified. These assumptions could prove to be incorrect in the future however, if they are based on the best information available at the time nothing can be done about this possibility of error. If the assumptions made concerning the variables of the model are accepted as being reasonable by planners and politicians, the economic information now exists to make better decisions.

3.3 PREVIOUS APPLICATIONS

The Option Demand Model was first developed by J. Krutilla, A. Fisher, J. Cicchetti and V. Smith. Since that time people such as R. Bailey and J.A. Gray have been applying this model to development issues such as the Churchill River Diversion in Northern Manitoba. Krutilla originally applied the model to the Hell's Canyon of the Snake River in Idaho. This application will be discussed here.

The Hells Canyon reach of the Snake River came under consideration for hydro electric power development in the 1940's. During the 1950's licences for development of three sites were issued. Applications for licences to develop the remaining lower 58 miles was made and challenged in court. One major concern of the court was the Federal Power Commission had not adequately considered whether non-development of the canyon might be in the public interest. The reason for this concern can be seen when it is realized the Hells Canyon is one of the deepest and last great canyons in the United States, (Krutilla 1975). If the canyon was developed the consequences would be irreversible from perspectives such as recreation, spawning grounds and fishing.

Krutilla's strategy was to determine how large the benefits from preservation had to be in order to equal or exceed the benefits from development. He found it was not enough to simply account for the initials year's development and preservation benefit as both could change through time. For example, in terms of the development of a hydro-electric facility the annual benefits could change as the regional power system developed and as technological advances in alternate sources of power evolved. Using a study period of several years Krutilla obtained a single discounted present value sum of the total stream of benefits from the development project. He did the same for the preservation option. Krutilla took into consideration the capacity the preservation option could support for recreation while still preserving the quality of the experience. A simple simulation model calculated the growth in demand over time as a function of the increase in the population's income and their changing tastes. The growth in demand and in the price the population was willing to pay indicated what the annual benefits of the preservation option would be. It should be noted that once the capacity of the area was reached the benefits would be measured only as a function of willingness to pay. From this stream of incomes a single discounted present value sum of benefits would be obtained for the preservation alternative.

Some of the values used to calculate the net benefit sums for both the development option and preservation option were changed to test the sensitivity of the net benefit numbers. Having done this the net benefit sums for development and preservation were compared to see what level of preservation benefits would be needed to overturn the development option. The results indicated the estimated value of preservation benefits was by far greater than those estimated for development. The difference was in the range of $900,000 which was in large excess of the amount needed to establish a case based on economic grounds for preserving Hells Canyon in its present state.

When only some of the quantifiable benefits from preservation were used to calculate the net benefits, (e.g., fishing) it was found they still exceeded the development net benefits. A conventional cost benefit analysis may have tipped the scales in the other direction. Krutilla's Option Demand Model allows many other relevant factors to be taken into consideration producing results revealing the inadequacy of older methods of analysis. It is with the help of this model that better land use decisions can be made.

3.4 APPLICATION OF THE OPTION DEMAND MODEL

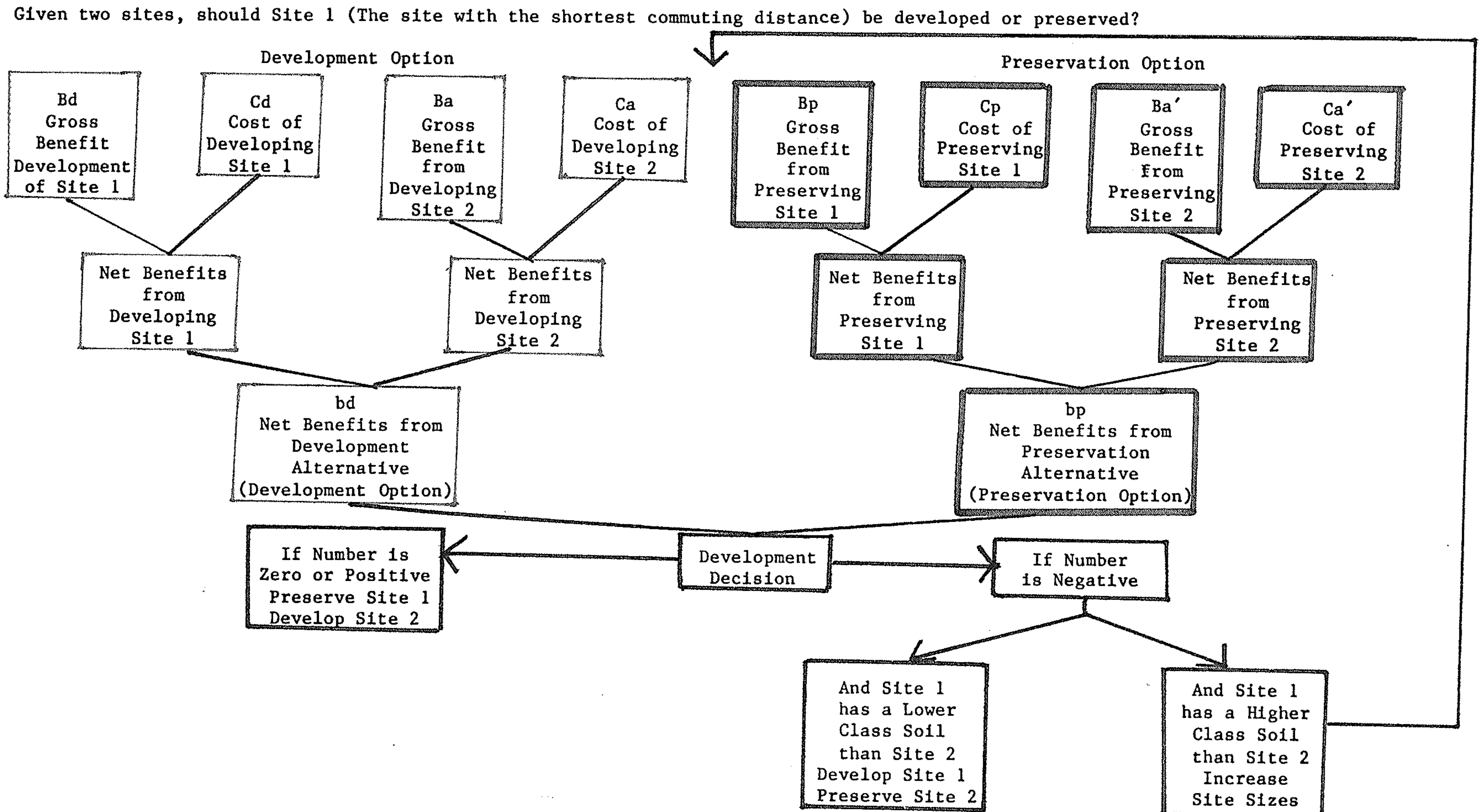
The Option Demand Model is structured to take into consideration and value the preservation option as well as the development option of land. Since agricultural land varies in quality the preservation option will vary for different classes and parcels of land. The development option may also vary from parcel to parcel. In the previously discussed example, the approach was to examine one site and find what the value of the preservation alternative would have to be in order to over turn development. In this thesis the Option Demand Model will be used as a development location model. This is because rural residential development and agricultural land both have a right to exist. The model by evaluating various sites for their preservation and development options will indicate which sites should be developed and which ones preserved. In this way both land uses are allowed to occur and the value of the opportunity costs foregone are minimized.

Illustration 1 will be used to explain how the Option Demand Model operates. Of the two sites to be analyzed, one will be called Site 1 and the other Site 2. The first step is to calculate a stream of net benefits for both the preservation and development options for both sites, (See Illustration 1). These net benefits are then discounted into present values. Next the net benefits from developing both sites are subtracted as are the net benefits from preserving them. The resulting figures representing the development option and preservation option are added. This figure indicates the development decision, (See Illustration 1). If the figure is zero or a positive number Site 1 is preserved and Site 2 is developed. This is because the preservation option is larger or equal to the development option. When the figure is negative and Site 1 has a lower agricultural soil productivity than Site 2 then Site 1 is developed and Site 2 preserved. The reason for this is the preservation option was not as large as the development option. If Site 1 has a higher agricultural soil productivity than Site 2 and the Development Decision figure is negative then the lot sizes are increased and the program run again (See Illustration 1). Through this process a lot size will be found which will change the development decision to a positive number or zero. Then this occurs Site 1 should be preserved and Site 2 developed.

The following chapter will discuss the model and the variables used for the Case Study.

Illustration 1

Option Demand Model



Chapter IV

CASE STUDY

4.1 THE RURAL MUNICIPALITY OF ROCKWOOD

After examining several municipalities, the Rural Municipality of Rockwood was found to be the only one encompassing study sites which met the selection criteria. Before this criteria and the sites are examined this municipality and its characteristics will be discussed in more depth.

The Rural Municipality of Rockwood is located northwest of the City of Winnipeg (See Illustration 2). Like several of the other municipalities surrounding Winnipeg, the RM of Rockwood experienced an increase in rural residential development in the 1970's. This development reached its peak in 1976 and has slowly tapered off since that time, (See Illustration 3). Although there is not a large amount of development occurring at this time rural residences are still being built and lots are being sold. It is anticipated with the construction of the Alcan Aluminum Smelter approximately fourteen and a half kilometers (nine miles) north of Stonewall, more rural residences will be constructed. The smelter is proposed to employ approximately 700 people after its construction. People from the area will be hired however, a large number of the employees are expected to come from elsewhere. This latter group is expected to move into the municipality and perhaps into rural residences.

Illustration 2

Rural Municipality of Rockwood - Site Location

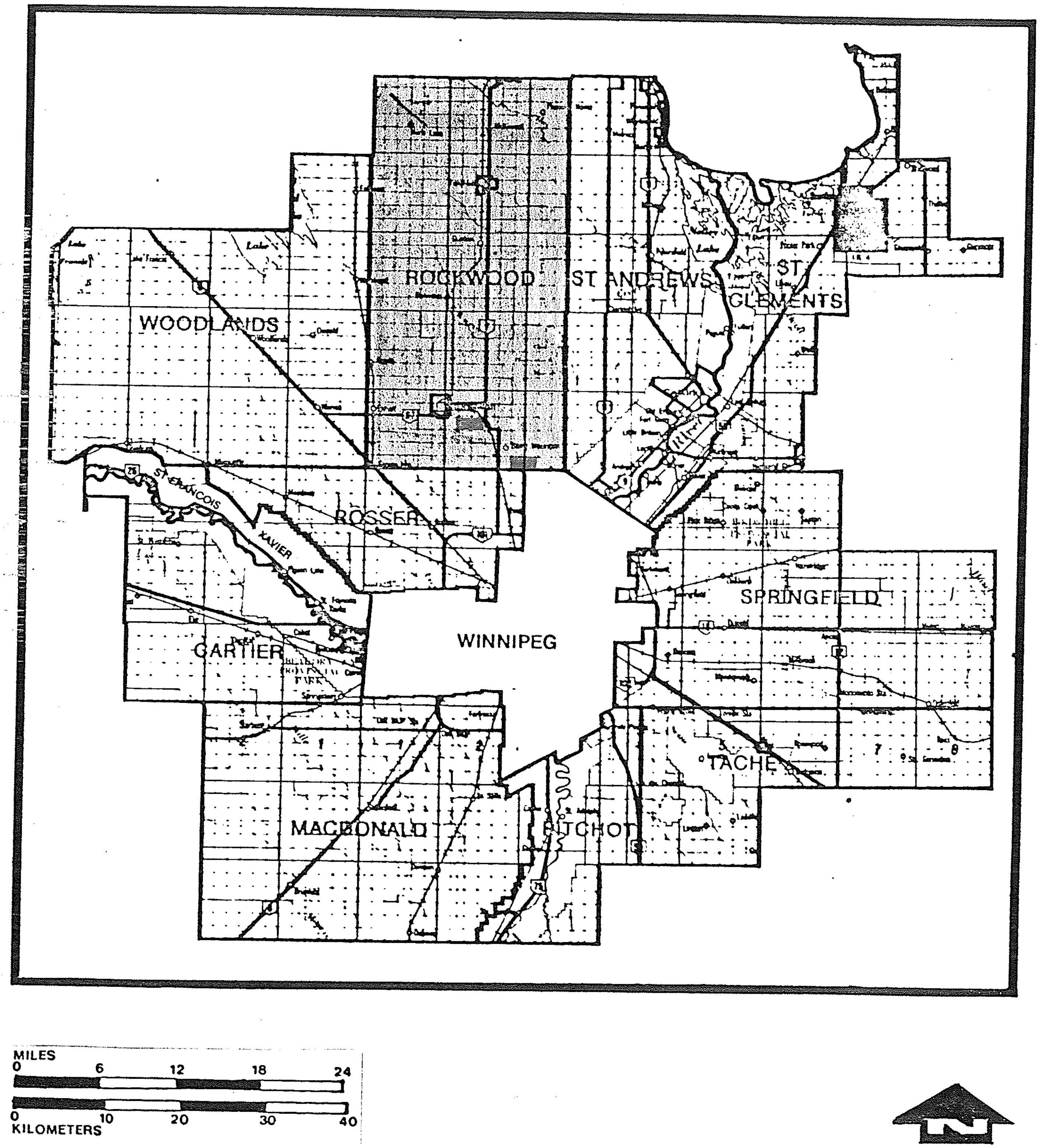
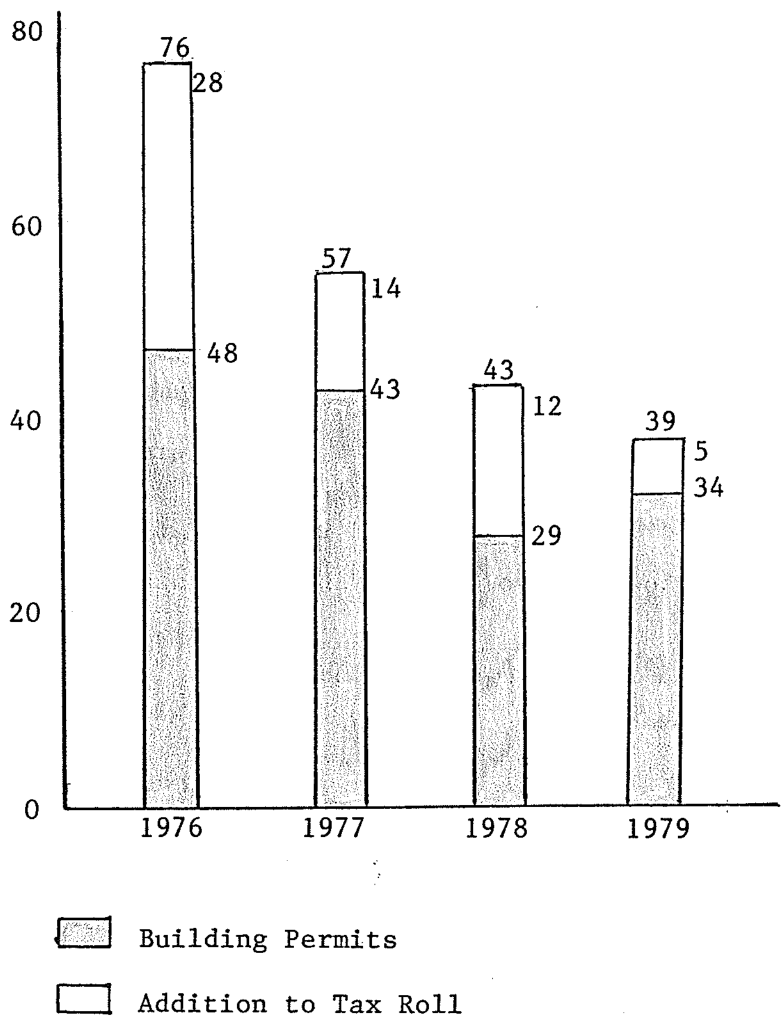


Illustration 3

Rural Residential Demand 1976 - 1979



Source: Municipal Planning Branch 1980.

The municipality is not only attractive for rural residential development, but also for various forms of agriculture. In the Rural Municipality of Rockwood the Crop Insurance Crop Production Index for soils indicates a range from highest to lowest of D through J, (see Illustration 4 and Table 1). The best use for the I and J rated lands are cattle grazing and forage crops. Portions of these lands in the municipality are owned and protected by the Crown. This area is known as Oak Hammock Marsh, (see Illustration 4). The remaining portions of the I and J lands are solely used for agriculture as it will not economically support structural development. Due to the various levels of peat in these areas, roads, buildings, and septic fields, are extremely difficult and expensive to construct. As a result if buildings are to be constructed in this municipality they will most likely be placed on more productive agricultural land.

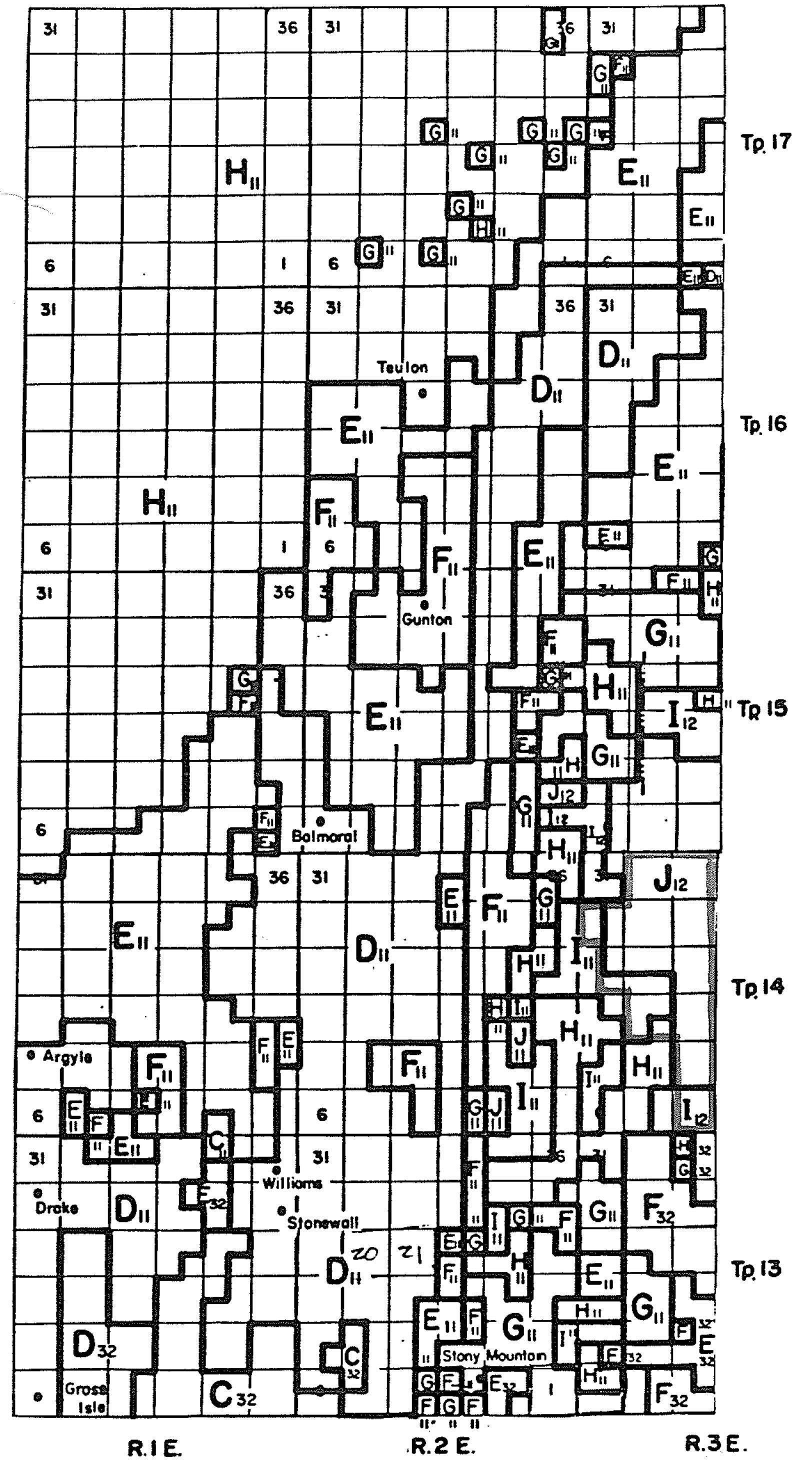
Table 1

Crop Insurance Index - R.M. of Rockwood, 1980

	Red Spring Wheat
Soil Zone	Bushel/Acre
A	30.3
B	28.8
C	26.8
D	26.8
E	26.8
F	24.4
G	21.3
H	21.3
I	18.3
J	8.3

Illustration 4

Crop Insurance Index - R.M. of Rockwood - 1980



4.2 STUDY SITE CRITERIA

Before any extensive research could be done concerning the model and its components the study sites had to be located. The reason for this was the component measurements were largely site specific. In choosing sites the following specifications had to be met:

1. The sites had to be located in the same rural municipality. They would be subject to the same local government conditions, such as tax assessment structure and planning bylaws. By choosing sites located in different municipalities the bylaws governing rural residential development could result in major differences such as lot size requirements.
2. Rural Residential Development had to exist on both sites.
3. The sites had to have approximately ten or more rural residences located on comparable sized lots encompassed in each section.
4. Amenities such as access to shopping and schools, had to be available to both sites,
5. Under the Canada Land Inventory's Agricultural Productivity Index one site had to be rated low and the other site rated high.
6. The areas chosen had to have similar access conveniences. For example, a site having a paved road access would not be compared to one with a a dirt or gravel road access.

In locating the sites the following procedure was followed. First land use maps, air photos, Canada Land Inventory Maps, and Crop Insurance Index Maps were all examined for several municipalities. Once sites were identified they were eliminated for one or several of the following reasons:

1. The sites were located too close to communities to be considered separated from them.
2. The required number of residences were not located on the sites.
3. The required sites could not be found in the same municipality.
4. The sites were located on gravel deposits. Using these sites would have resulted in losing one valuable resource opposed to another.

After examining several municipalities, the Rural Municipality of Rockwood was the only one containing two study sites which met all the specifications.

4.3 THE STUDY SITES

For the purpose of easy identification, the study sites will be referred by the name of the community they are located closest to. The Stony Mountain site is two sections in size and located approximately 1 to 2 miles south east of Stony Mountain, (see Illustration 5). It encompassed Section 1 of township 13 of Range 2 East and Section 6 of township 13 of Range 3E, (see Illustration 6). There are ten rural residences located on section 1 and thirteen located on Section 6. The lot sizes vary from half of an acre to forty acres. Access to these residences is by gravel road. The residences are according to the Canada Land Inventory located on Class 4 land and according to the Crop Insurance Index situated on G and H classified land, (see Illustration 7).

The Stonewall site is located 1 to 2 miles south east of Stonewall. It is also composed of two sections, Sections 20 and 21 of township 13 of Range 2 East, (See Illustration 5). Section 20 has nineteen rural

Illustration 5

Location of Study Sites

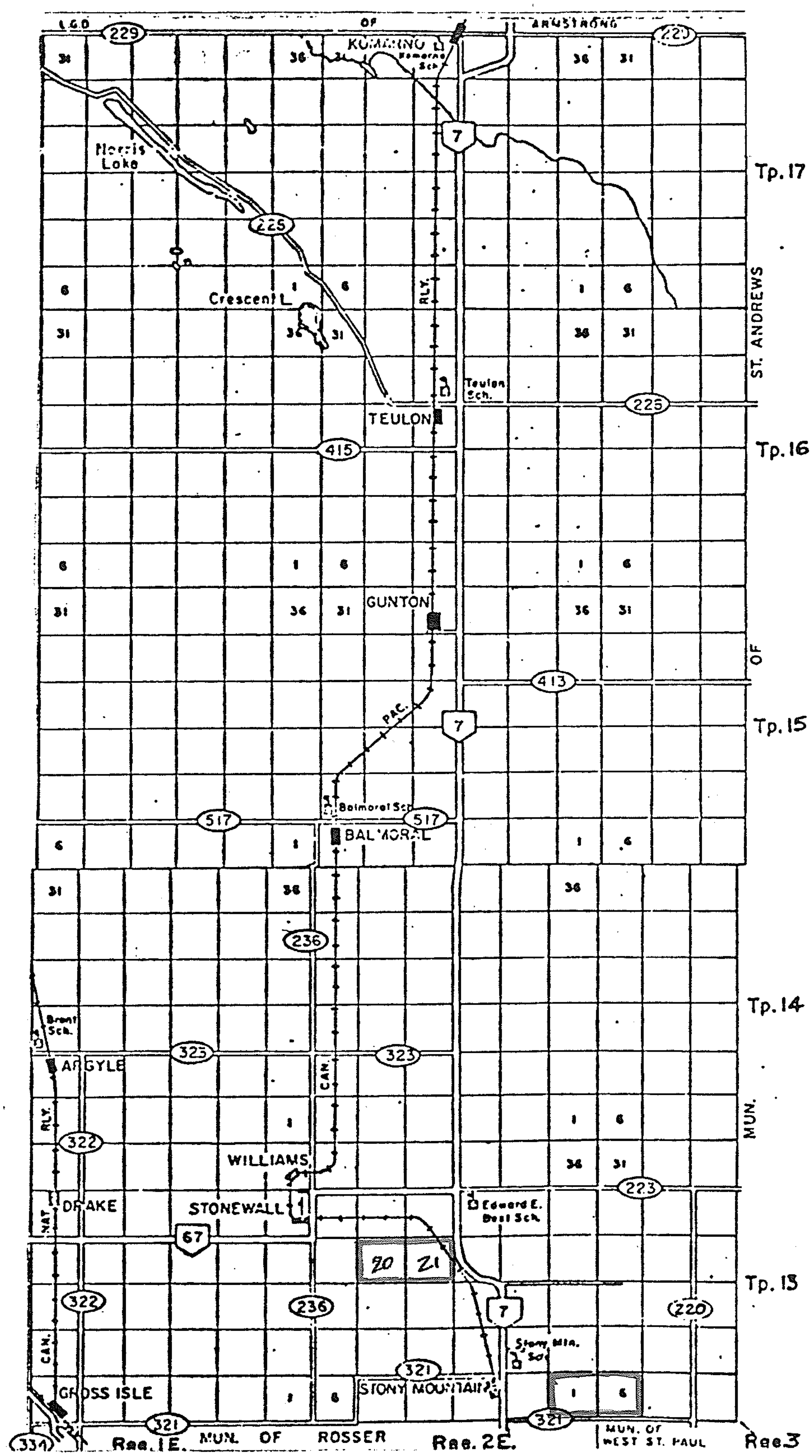


Illustration 6

Stony Mountain Site

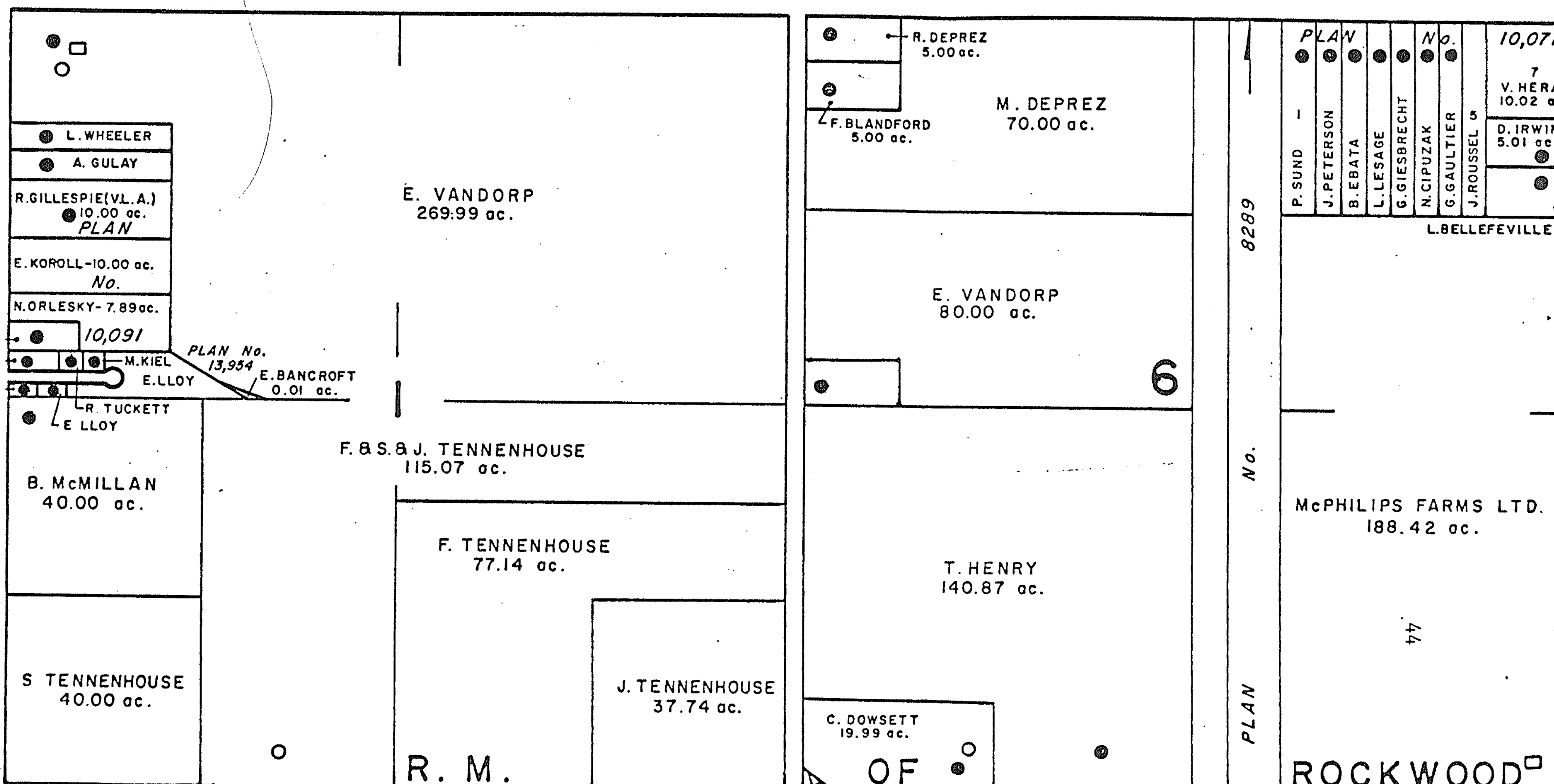
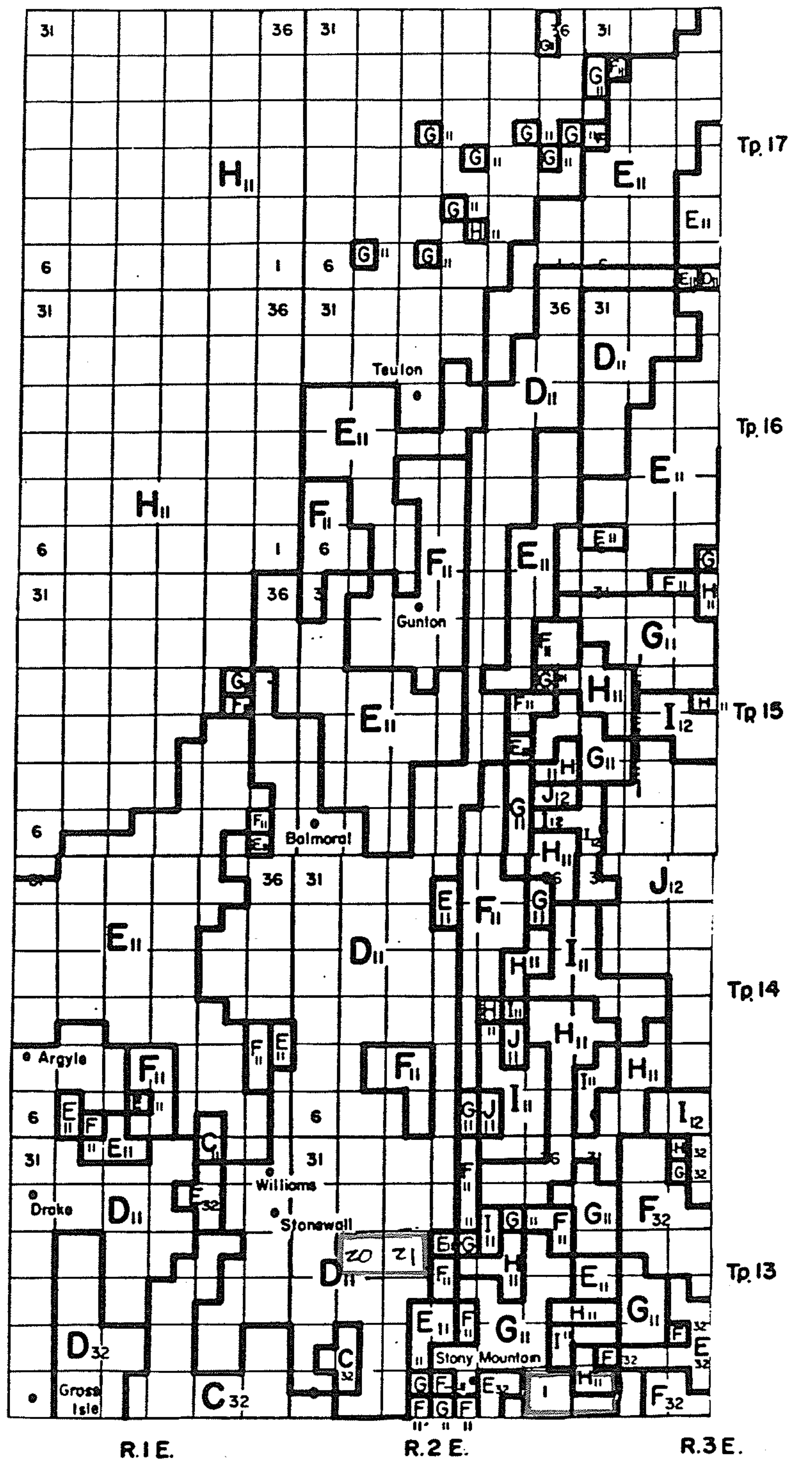


Illustration 7

Crop Insurance Index - Location of Sites



residences located on it and section 21 has twenty-eight (See Illustration 8). The size of the rural residential lots vary from half of an acre to twenty-two acres in size and access is by gravel road. Contrary to the Stony Mountain site the Canada Land Inventory classification is numbered 1 and 2 and the Crop Insurance Rating is D (see Illustration 7). As a result the rural residences on the Stonewall site are located on superior agricultural land.

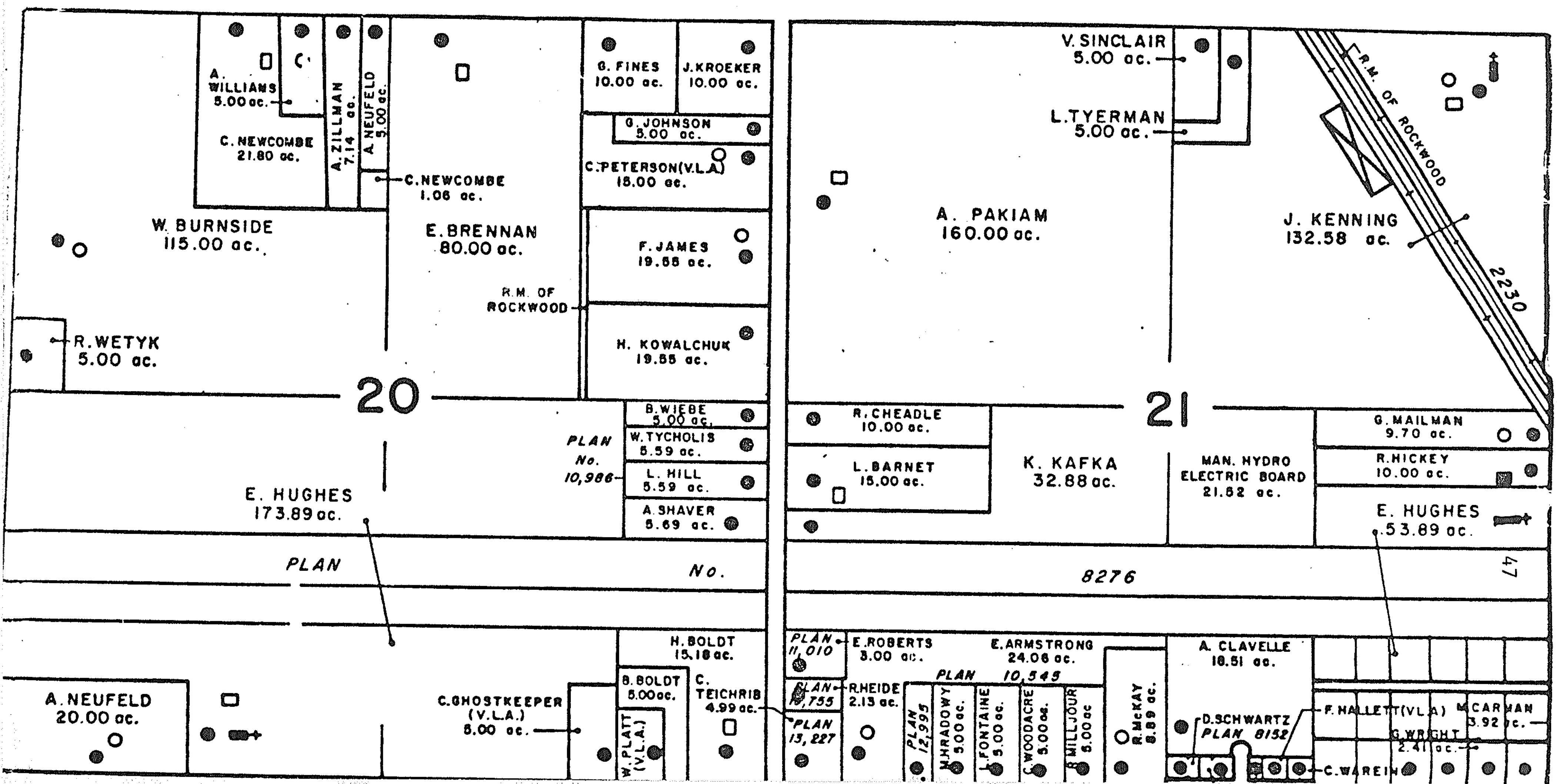
These sites were specifically chosen for their similarities in character excluding agricultural soil quality. Other sites in the municipality were examined, but none matched the similarities these sites shared.

4.4 RURAL RESIDENTIAL CONSIDERATIONS FOR THE MODEL

The Option Demand Model is composed of two sectors. One deals with the costs and benefits associated with rural residential development (development option) and the other deals with the costs and benefits associated with an agricultural use, (preservation option). The following sections discuss those factors which were considered as cost and benefit components of the rural residential section of the model. As a point of clarification, it has been assumed the residences constructed on each site are identical therefore any costs for actual construction of the buildings are equal. Other private development costs and benefits the rural resident incures will however, be explored here.

Illustration 8

Stonewall Site



4.4.1 Culverts

The research revealed culvert costs vary according to the size of unit installed. The size required is not solely related to the site itself, land drainage or productivity classification factors. As a result culvert costs were not considered to be a significant component of the model.

4.4.2 Foundation and Backfill

Backfill is a procedure which entails bulldozing soil against the cured foundation of a house. The soil used is usually that originally excavated for the foundation. Both the foundation and backfill procedures are standard and the costs would vary only if drainage was a serious problem on a site. The reason for this is additional soil would have to be trucked in. This is not the case in the sites examined here.

4.4.3 Water

Wells supply drinking water in this area. In cases where drinkable water is not readily available, water would have to be hauled in by truck. This is a very expensive process therefore areas without an adequate supply of drinking water should not be considered for rural residential development. Since water was readily available in both study site areas this component was not included in the model.

4.4.4 Sewage Disposal

In this area septic fields are the major means of sewage disposal. The research indicated a definite difference in the costs of installing septic fields on the two sites. To illustrate these cost differences the installation process will be discussed.

The first step is to clear the trees and bush from the site. The cost of a bulldozer is approximately $25 per hour and it takes an average of two hours to clear the Stonewall site. The Stony Mountain site does not require bulldozing therefore this cost will not be included in its development cost. The next step is the trenching and installation of the septic field. The labour and cost of the septic field are a fixed price however the cost of gravel and its transportation to the site are extra. Gravel is needed as it provides the base for the septic field distributes the waste coming through the field. The Department of Environmental Control has standards and regulations regarding the installation of septic fields and the amount of gravel required. Manitoba Regulation 8 5/81, Schedule A, Section 14 reads:

The minimum volume of graded media where total area fields are used shall be:

Soil Type	Sand With Gravel	Sandy Silt	Clay
Volume (cu. m.)	30	40	60

The Stony Mountain site is largely composed of sandy silt soil. The Stonewall site is largely composed of clay soil. As a result the Stony Mountain site will not cost as much to install a septic field as the Stonewall site. A survey of companies installing disposal fields in the area indicated the basic cost of a septic field for both sites is $1,000. They indicated the cost of additional gravel required for the Stonewall site is approximately $91 dollars. The cost of the whole system would increase if the site was located on very rocky soil or in areas where there are rock outcroppings. This is because a septic tank opposed to a septic field would have to be installed. The installation costs of a septic tank are higher than those of a septic field especially if rock blasting is needed. The maintenance costs of a septic tank are much higher because the tank has to be pumped out every week. The average yearly maintenance cost would be $520.

This type of system is not needed on either site however since a rock ridge runs through the municipality which could effect other areas considered for rural residential development.

4.4.5 <u>Commuting Costs</u>

In investigating commuting costs, certain assumptions were made. Based on general socio-economic studies and discussions with residents of the two sites it was found that the majority of rural residents work, shop, and socialize in Winnipeg. Since it was unknown how many trips residents take into Winnipeg and since that number would vary per household, it was assumed only one trip per day per household (365 trips per year) would be counted.

Since the residents work in different locations in Winnipeg, one site had to be chosen as a mileage measurement point. The place chosen was the corner of Portage Avenue and Main Street in Winnipeg. The distance from the Stony Mountain site to the employment site was 30.5 km (19 miles) or 22,265 km/yr (13,870 miles/year). The distance from the Stonewall site was 34.5 km (22 miles) or 25,185 km/yr (15,740 miles/year).

In researching the commuting cost differences between the two sites the following things were considered:

1. The energy commuting costs per year or more clearly the total cost of oil and gas for a car per year,
2. The rate of inflation of those energy costs,
3. The rate of fuel consumption for the average car,
4. The rate of reduction in fuel consumption as new, more fuel efficient cars come onto the market,
5. Other variable commuting costs, e.g., maintenance costs.
6. Other fixed commuting costs, e.g., insurance, licence and registration, and
7. The cost of replacing a car once a certain number of kilometers or miles had been logged.

Before several of the above factors could be considered a standard or average car had to be chosen to serve as a benchmark for measuring costs. The car that the Canadian Automobile Association (CAA) used for their <u>1981 Car Cost Study</u> was chosen. This was because CAA had conducted the necessary research and found the type of car the majority of families and companies would own or lease in 1981. The car they chose and the one used in this thesis is a Chevrolet six cylinder (229 cu. in) Malibu four door sedan equipped with standard accessories, radio, automatic transmission, power steering and power brakes, driven up to 24,000 km (15,000 miles) per year. It should be noted that the number of kilometers traveled from both study sites is approximately 24,000 km (15,000 miles) per year.

In order to calculate the gas and oil costs of the above car CAA's calculation of 3.96 cents per kilometer (6.37 cents per mile) was used. To find the total energy commuting costs for 1981 this figure was multiplied by the yearly commuting distance from the two study sites. This resulted in energy commuting costs for Stony Mountain rural residents of $884 and for Stonewall rural residents of $997 for the year 1981.

These energy costs will be increasing through time. The time frame of this study is twenty years therefore these 1981 figures must be inflated by a certain percentage. Based on the current agreement between the Federal Government and the Province of Alberta (1981) oil prices will rise at a rate of 24 percent per year until 1986 and after that period rise with the current rate of inflation. For the purposes of this thesis this energy inflation scenario will be used.

The rate of fuel consumption, another aspect of commuting costs, was explored. The Chevrolet Malibu, chosen as this thesis' study car, was found according to <u>Consumer Report Buying Guide Issue</u> to get 5.1 km/litre (15 miles/gallon) in the city and 11.49 km/litre (32.4 miles/gallon) on the highway. Approximately half of the kilometers traveled to and from the sites are on the highway and the other half are in the city. The kilometer per litre rating that will be used for the purposes of this study will be 8.3 km/litre (23.7 miles/gallon) which is a combination of the two ratings.

These fuel consumption ratings will decrease through time. As mentioned earlier the time frame considered in the model is twenty years. therefore these 1981 figures must be reduced at a specific rate. The Federal government in a press releases on October 6, 1980 set standards for fuel consumption to be met by car manufacturers. All the fuel consumption ratings of the cars produced by car manufacturers must equal on average the ratings set by the Federal Government. This does not mean that individual cars have to meet these standards, but the average of all the fuel consumption ratings of the various type of cars must equal the federal standards. The Federal standards are as follows:

1980	1981	1982	1983	1984	1985
8.4 km/l	9.3 km/l	10.2 km/l	11.1 km/l	11.5 km/l	11.6 km/l

These figures will be used until 1984 however since the study time frame is 20 years other scenarios will be explored.

The commuting rural residents must not only pay for fuel, but for other things such as car maintenance. This includes repairs, tires, and batteries. The Canadian Automobile Association researched these costs for the 1981 Chevrolet Malibu and arrived at a figure of 1.17 cents per km (1.85 cents per mile). In order to translate this into costs for each site, this number was multiplied by the total number of the kilometers traveled per year. The total maintenance costs in 1981 for the Stony Mountain site was $260 per year and for the Stonewall site was $294 per year. Given the time frame of the study an inflationary rate will be built into the model. An examination of the Consumer Price Index indicated the inflation rate for these maintenance costs since 1973 was 6.24 percent. This figure along with the current inflation rate will be taken into consideration when estimating future maintenance costs.

Costs such as car insurance, registration, and licence fees were also examined. It was found these are fixed costs and do not vary for identical cars owned by rural residents residing in the two study sites. For this reason these costs were not made a component of the model.

One set of costs that do have to be taken into consideration are car replacement costs. Over the twenty year study period based on the large number of kilometers that the commuters would be putting onto their cars replacement would be necessary. Assuming vehicles were replaced every 160,900 km (100,000 miles) commutors from the Stonewall site would have to replace their car approximately every six years while those from the Stony Mountain site would be facing an approximate seven year replacement period. In order to calculate the cost of these vehicles in the respective years, the cost of the Chevrolet Malibu in 1981 (list price $9,009) and various rates of inflation will be used.

4.4.6 Benefits of Rural Residential Development

Now that the costs of Rural Residential Development have been discussed the benefits will be examined. The benefits are hard to quantify. Why a person chooses a rural residence opposed to a urban one and why one rural site is chosen over another appears to hinge largely on personal taste and investment potential. Personal taste is very difficult to account for and to measure. It was assumed the only way the benefits of rural residential development could be quantified was in market values. Prior to examining market values, interviews were conducted with real estate personnel in the area. Their general impressions, based on selling rural residences in both study sites, were that sales were based on personal taste, availability of lots, and availability of residences. If there were comparable properties for sale in both study site areas, the real estate people were of the opinion the parcels would sell in the same price range and during the same time frame.

Examination of the sales figures did not specifically indicate this. Three different procedures were used involving the sale price of rural residential land. It should be noted these same procedures were used to examine agricultural land. Since the agricultural section appears later in this chapter only the results will be discussed there and the reader will be referred back to this section for the procedures. The three procedures used were:

1. An examination of residential land sales,
2. An examination of the estimated market value of the land calculated from the land assessment values, and
3. The use of a computer model to analyze land sales.

In the first procedure since only the rural residential land was being examined, only those parcels sold without houses could be considered. Because the value of the house could not be removed from the sale price, land with residences could not be considered. Land sales were collected for the period between 1978 and 1981. Not enough values existed to draw any type of comparison between rural residential land located in one study site or the other. As a result, the second procedure--using assessment values to calculate just the land value of rural residential estates--was used. Before this procedure is discussed the method used to arrive at the assessment values will be examined.

The Assessment Department in Selkirk indicated the base year from which all present values for land in the Rural Municipality of Rockwood were calculated was 1973. The assessment/sale ratio in that year was 40 percent. As the price of land increases each year this assessment/sale ratio decreases.

The assessment value of land was first calculated by the use of a Ready Reckoner. This book has values based on soil quality and distance for hauling grain. From these values points are subtracted for certain conversion factors. For agricultural and rural residential land the conversion factors taken into consideration were frontage, location, paved versus gravel access, size of parcel, number of cultivated acres, standing water versus non-standing water in a slough, stoniness, drainage, salinity, cubing of soil, erosion, and topography. The resulting figure is the assessed land value. Residences and other buildings are assessed separately based on other sets of criteria.

Before the marked value of the land could be calculated sales data for the period from 1978 to 1981 was gathered. All the sale values were multiplied by the appropriate assessment/sale ratio to bring them up to 1980 values. The 1981 figures were not changed as no assessment/sale ratio was available at the time the research was conducted.

The next step was to calculate the price per acre for each parcel of rural residential land. The equation used enabled the market value of the residence--calculated from the assessed value of the residence--to be subtracted from the calculated market value of the residence and land. The result was an estimated market value for each parcel of land. This value was then divided by the number of acres in the parcel resulting in a price per acre value.

The resulting prices per acre were examined for both sites and it was found that no trend for location or size of parcel existed. The reasons for this could be due to the following:

1. There were not enough values taken into consideration;
2. the equation used to ascertain the price per acre did not allow for the full value of the residence to be taken off of the total residence and land value therefore distorting the values; and
3. rural residents did not distinguish between the study areas by paying higher or lower prices for residences located in either area.

As a result of this uncertainty a third approach was attempted. The Land Sales Crop Sectional Model used by Magnusson was utilized to examine even a larger number of land values, (Magnussion 1979). These values were obtained from the Manitoba Assessment Department computer. The model took into consideration the sales price (excluding the value of buildings) and present situation of the site including factors such as tree coverage, total number of acres, and sale date. The results indicated even with a larger data base no trend for location or size of parcel existed. As a result, for the purpose of this thesis it will be assumed the benefits derived from rural residences located on either study site are equal.

4.5 AGRICULTURAL CONSIDERATIONS FOR THE MODEL

In researching the costs and benefits for the agricultural section of the model (Preservation Option) several factors had to be examined. These included the market values of land, crop type, crop yield, grain prices, and crop production costs. Each of these will be discussed in depth in the following sections.

4.5.1 Market Value of Land

The study sites are located on two different qualities of agricultural land and at varying distances from Winnipeg. Different market values would perhaps have to be paid if these lands were to be used for agricultural purposes. If this were so the difference in the land prices could affect the decision as to which site should be preserved and which developed. To ascertain whether this should be a component of the model various approaches were used to determine if location and soil quality affected the market price of agricultural land. These approaches were the same ones used to evaluate the market value of rural residential land. Since the procedures were previously presented they will not be discussed in depth here. Only a brief review and the results will be presented.

The three approaches used were:

1. An examination of agricultural land sales between 1978 and 1981,
2. An examination of the estimated market value of the land calculated from the land assessment values, and
3. The use of a computer model to analyze land sales.

In using the first approach it was found there were not enough sales of land without residences to enable conclusions to be drawn. The second approach enabled the value of the residence to be removed from the market value of both the house and land. As a result more values were available for analysis. The market price per acre of all parcels of agricultural land forty acres and larger were calculated. The results of this approach when cross referenced with soil quality indicated that no clear relationship existed, (see Appendix 1). When the results were cross referenced with location no relationship existed (see Appendix 2). The reasons for this could be due to the following:

1. Not enough sales in the period examined, and/or
2. the equation to ascertain the price per acre did not allow for the full value of the house to be taken off of the total market value.

As a result of this uncertainty another approach was taken. In a thesis by Magnusson a Land Sales Cross Sectional Model was used to examine land values, (Magnusson 1979). After gathering more detailed information from the Assessment Department the model was ran through the computer. The model took into consideration land sale price (excluding the value of buildings), arability, nonarability, yield, size of parcel, and sale date. The results indicated even with a larger data base no market trend existed based on parcel location. The results also indicated there was no explainable relationship for soil quality. Other more broad studies such as Magnusson's thesis have proven this last conclusion to be incorrect, (Magnusson 1979). As a result this thesis will assume the conclusions of the larger scale studies. They conclude the higher the agricultural soil quality the higher the price per acre.

4.5.2 Crop Type and Yield

As discussed earlier the study sites differ in agricultural soil productivity. In debating which type of crop to use to compare the crop yields from the two sites, it was found the issue could be a complex one. From a market perspective if the demand for cereal or oilseed crops is higher in a specific year, the farmers in both study sites would plant the more profitable crop. If however, the quality of soil was lower than that of the study sites, crop type would be an issue. The reason for this is land of lower quality than the study sites is best for forage crops. On the Crop Insurance Index this would be lands classified as "I" or "J." Comparing an oilseed or cereal crop grown on this lower quality land to a crop grown on higher quality land would not be a fair comparison. Net forage crop or cattle profits from the lower quality land would have to be compared to net oilseed or cereal profits from the higher quality land. The model would then have to accommodate all these additional yields and costs.

This could be the situation found in other municipalities, but does not occur in Rockwood. As discussed earlier the "I" and "J" agricultural land in Rockwood is partially owned by the Crown for a wildlife area, partially left fallow, and partially used for forage crops. It has proven to be unsuitable for any other type of development as it will not support buildings, septic fields, or roads, without exorbitant cost. As a result, it can not be used for rural residential development opposed to higher classes of agricultural land.

The study sites can support rural residential development. From an agricultural perspective their best use is for oilseed or cereal crops.

For the purpose of this thesis the average crop yields of Red Spring Wheat will be used to represent the different yields from the study site. The Crop Insurance Index indicates the crop yield for Red Spring wheat from the Stonewall site would be 26.8 kilo/hectares (730 bushels/acre). The crop yield from the Stony Mountain site would be 580 kilos/hectare (21.3 bushels/acre).

Given the rate of technology in the past few years it has been estimated that the rate of crop yield has been increasing at a rate of 1 percent to 2 percent per year, (Veeman, 1981). Given the 20 year time frame of this study it is important to include this factor.

4.5.3 Crop Price

In order to obtain a complete picture of the benefits of agriculture crop price must be included in the study. Crop prices fluctuate largely during the year and also in between years. Analyses of crop prices in the last few years have indicated there is an increasing empirical relationship between average yearly crop prices and time. The crop price chosen for 1981 will be from this empirical relationship (See Illustration 9). Given the 20 year time frame of this study the rate of inflation in crop prices will be also calculated from this graph. This inflation trend has fluctuated between 12 percent and 14 percent.

4.5.4 Crop Production Costs

Concerning crop production costs studies have been conducted in the Northwest Region of the province which includes the Rural Municipality of Rockwood. On a "Cost and Return Summary per Acre Table" (Framingham,

Illustration 9

Price of Red Spring Wheat 1964-1980

Publication pending) all the costs for a wheat crop were listed. These included factors such as fuel and lubrication, fertilizer, chemicals, and seed. Upon close examination of these costs it was found that they would be the same for each study area. For instance, since a wheat plant can only absorb a certain amount of fertilizer it is assumed that no more than this amount will be applied to either study site. Chances are both crops will require herbicides therefore both will be sprayed with the same amount of chemical. The amount of fuel used to fertilize, plant, spray and harvest the crop will also be the same. The amount of fuel required to truck the grain from the combine to the storage facility may be different but that varies with every field regardless of soil quality. As a result it has been assumed that the crop costs would be the same for both study sites.

These costs are also subject to an inflationary trend. Given the twenty year time frame of the study various inflation values will be considered when estimating the future production costs.

4.6 APPLICATION OF THE OPTION DEMAND MODEL

In setting up the model the benefits and costs of both the preservation and development option are calculated. The costs on the development side includes items such as septic fields and tree bulldozing (See Table 2). The costs on the preservation side could include items such as production costs and energy costs. Benefits from either option could be measured as money generated from selling a manufactured or grown product. In this case the benefit from rural residential development is equal for both sites. When this occurs the numbers cancel out in the equations and do not appear in the analysis.

For purposes of explanation, of the two sites to be analyzed, one will be called Site 1 and the other Site 2. The first step is to calculate a stream of net benefits for both the preservation and development options for a specific study period. The net benefits are then discounted into today's dollars. The values for Site 2 are then subtracted from Site 1 (See Table 2). The net differences are then added together. If the results are equal to zero or positive, Site 1 is preserved and Site 2 is developed. This is because the preservation option is larger or equal to the development option. If the resuls are negative then Site 1 is developed and Site 2 is preserved (See Table 2). The reason for this is the preservation option was not as large as the development option.

Table 2

Option Demand Model - Table Structure

	Site 1 Present Value	Site 2 Present Value	Difference Present Value
Development Option	--	--	--
Development Cost e.g., septic field, transporation	--	--	--
Development Benefits e.g., money, personal satisfaction	--	--	--
TOTAL			
Preservation Option			
Preservation Costs e.g., production costs	--	--	--
Preservation Benefits e.g., money from selling grain	--	--	--
TOTAL			--*

* If result is equal to zero or positive - preserve Site 1, develop Site 2. If result is less than zero - develop Site 1, preserve Site 2.

The following is the basic model used for this thesis.

The benefit from rural residential development can be represented as follows:

$$b_d = \underset{\text{Site 1}}{B_d} - \underset{\text{Site 1}}{C_d} - \underset{\text{Site 2}}{B_a} + \underset{\text{Site 2}}{C_a}$$

where:

b_d = net benefit from development alternative

B_d = gross benefit from development of Site 1

C_d = cost of development of Site 1

B_a = gross benefit from development of Site 2

C_a = cost of development of Site 2

In this case the benefit of development from Site 1 and Site 2 are assumed equal therefore B_d and B_a cancel out. The resulting equation is:

$$b_d = -C_d + C_a \text{ or } b_d = C_d - C_a$$

From this equation comes the following equations:

$$\underset{\text{Site 1}}{C_d} = \underbrace{D_1}_{\substack{\text{Development}\\\text{Cost}}} + \underbrace{\frac{\sum_{k=1}^{20} \frac{ECC_1}{FCC} (1+INFE)^k \times \frac{1}{EC_k}}{(1+R)^k} + \sum_{k=1}^{20} \frac{OCC_1(1+INFT)^k}{(1+R)^k}}_{\substack{\text{Transportation}\\\text{Cost}}} + \underbrace{\frac{VRC_{1k}}{(1+R)^k}}_{\substack{\text{Vehicle}\\\text{Replacement}\\\text{Cost}}}$$

$$\underset{\text{Site 2}}{C_a} = \overbrace{D_2} + \overbrace{\frac{\sum_{k=1}^{20} \frac{ECC_2}{FCC} (1+INFE)^k \times \frac{1}{EC_k}}{(1+R)^k} + \frac{\sum_{k=1}^{20} OCC_2(1+INFT)^k}{(1+R)^k}} + \overbrace{\frac{VRC_{1k}}{(1+R)^k}}$$

$$b_d = \underset{\text{Site 1}}{C_d} - \underset{\text{Site 2}}{C_a}.$$

The benefit from preservation can be represented as follows:

$$b_p = \underset{\text{Site 1}}{B_p} - \underset{\text{Site 1}}{C_p} - \underset{\text{Site 2}}{B_a'} + \underset{\text{Site 2}}{C_a'}$$

where:

b_p = net benefit from preservation alternative

B_p = gross benefit from preserving Site 1

C_p = cost of preserving Site 1

B_a' = gross benefit from preserving Site 2

C_a' = cost of preserving Site 2

From the above equation comes the following:

$$\underset{\text{Site 1}}{B_p} = \left.\frac{CY_1(1+RYI)^k \quad CP(1+RICP)^k}{(1+R)^k} + \right\} \text{ Crop Production Benefits}$$

$$\left.\frac{PLA\ (1+RIFL)}{(1+R)}\right\} \text{ Land Revenue}$$

$$\underset{\text{Site 2}}{C_p} = \left.\frac{[b_o + b_1(CY_1)]\ (1+INF)^k}{(1+R)^k} + \right\} \text{ Crop Production Cost}$$

$$B_a' = \left.\frac{CY_2(1+RYI)^k\ CP(1+RICP)^k}{(1+R)^k} + \right\} \text{ Crop Production Benefits}$$

$$\left.PLA - \frac{PLA(1+RIFL)}{(1+R)}\right\} \text{ Land Revenue}$$

$$\left.C_a' = [b_0 + b_1(CY_2)]\ (1+INF)^k\right\} \text{ Crop Production Cost}$$

Preservation Benefit $b_p = \underset{\text{Site 1}}{B_p} - \underset{\text{Site 1}}{C_p} - \underset{\text{Site 2}}{B_a'} + \underset{\text{Site 2}}{C_a'}$

Development Benefit $b_d = \underset{\text{Site 1}}{B_d} - \underset{\text{Site 1}}{C_1} - \underset{\text{Site 2}}{B_a} + \underset{\text{Site 2}}{C_a}$ $\quad B_d = B_a$

Decision $b_d + b_p$ = Preservation or Development Decision
If answer positive or zero preserve Site 1, develop Site 2
If answer negative develop Site 1, preserve Site 2

where:

D is the development costs of bulldozing trees and installing a septic field.

ECC is the cost of oil and gas for a car for a year.

INFE is the inflation rate of oil and gas.

FCC is the fuel consumption in litres per kilometer of the automobile used for commuting.

ED is the rate of reduction in fuel consumption in litres per kilometer of future automobiles.

R is the discount rate.

OCC is the other commuting cost mainly maintenance cost per kilometer.

INFT is the inflation rate of these other commuting costs.

VRC is the vehicle replacement cost.

CY is the crop yield.

RYI is the rate of yield increase.

CP is the crop price.

RICP is the rate of inflation for crop prices.

b_0 is the crop cost for wheat.

PLA is the price of agricultural land

b_1 is the cost for additional unit of crop yield.

RIFL is the rate of inflation for farm land.

INF is the inflation rate of crop production cost.

The following chapter will discuss the results of this application of the model, the sensitivity of the components and the application of this model to other situations.

Chapter V

RESULTS

5.1 INTRODUCTION

Once the variables and their values were determined the results were derived from the model. This chapter will discuss three areas of analysis. First, the results of the case study in the Rural Municipality of Rockwood will be discussed. Second, the components of the model will be tested for their sensitivity in relation to the results of the model. Third, those sensitive variables which have a significant impact on the development decision will be varied. The results of these tests will indicate the parameters of the information this model and program can provide.

5.2 CASE STUDY RESULTS

To place the values of the variables into the computer, a program was constructed. The program allowed the user to define thirty variables each requiring a numerical or alphabetical value, (see Appendix 2). The results of the program were displayed on a table which is composed of three columns, (see Table 3). The first two columns are for the two sites which are being analyzed by the program. The site with the shortest commuting distance always appears in the left column. The development, commuting, and agricultural values for the two sites appear in these columns. The third column indicates the difference between the values listed in the first two columns.

Table 3

Rural Municipality of Rockwood - Case Study

	Present Value Stony Mountain	Present Value Stonewall	Present Value Difference
Development Cost	1200.00	1341.00	-141.00
Transportation Cost	13998.99	15834.95	-1835.96
Vehicle Replacement	20652.51	22983.99	-2331.48
Sub total	35851.50	40159.95	-4308.44
Total Revenue Crops	735.25	1316.54	-581.29
Land Sale Revenue	-3.85	-4.80	0.95
Total			-4888.79

The table is also divided into sections. The top section of the table displays the development option for both sites and the bottom section dispays the preservation option. The development option is made up of the

1. Development Cost,
2. Transportation Cost, and
3. Vehicle Replacement.

The preservation option is composed of the

1. Total Revenue Crops, and
2. Land Sale Revenue.

In Table 3 the Development Cost for the Stony Mountain site is $1,200 dollars, for the Stonewall site is $1,341 dollars and their difference is -$141 dollars. The reason the Stony Mountain site's development cost is lower is no trees had to be removed and not as much gravel was needed for the septic field. The negative difference number (-$141) indicates from a development cost perspective Site 1 should be developed and Site 2 preserved.

The Transportation Cost for both sites included the cost for oil and gas, and for maintaining a car. The present value of the transportation costs for the next twenty years was $13,998 dollars for the Stony Mountain site and $15,834 dollars for the Stonewall site. The difference of -$1,835 is because the Stonewall site is located an additional eight kilometers farther from the employment center than the Stony Mountain site. The employment center in this case is the corner of Portage Avenue and Main Street in Downtown Winnipeg. From the perspective of transportation costs the Stony Mountain site would again be cheaper to develop.

The Vehicle Replacement Cost encompassed the cost of replacing a mid-sized car like the Chevrolet Malibu every 160,900 km (100,000 miles). Because the commuting distance was longer to the Stonewall site, the vehicle used would have to be replaced more often than those used to commute to the Stony Mountain site. Table 3 reflected this assumption as the Vehicle Replacement cost for the Stony Mountain site was $20,652 while the Stonewall site was $22,983. This resulted in a net difference of -$2,331.

This number and the others representing the difference in Development, Transportation Cost and Vehicle Replacement Cost between the two sites, were totaled in the Difference column, (see Table 3). The resulting value was -$4,308. The fact this value is negative indicates from a Development Option perspective Site 1 should be developed and Site 2 preserved.

The Preservation Option of Table 3 is indicated by the Total Revenue Crops and the Land Sale Revenue. Total Revenue Crops indicates the net value of one acre of Red Spring Wheat grown on a specified class of agricultural soil. The one acre size represents the size of the sites in this analysis. The class of agricultural land specified for the Stony Mountain site is Class H which yields approximately 21.3 bushels per acre (Manitoba Crop Insurance, 1981). The Stonewall site has Class C agricultural land which yields 26.8 bushels per acre. This difference in soil productivity was reflected in the Total Revenue Crop figures. The Total Revenue Crop figure for the Stony Mountain site was $7,352 and for the Stonewall site was much higher at $13,165, (see Table 3). This difference of -$5,812 indicates from a Preservation Option perspective, Site 2 is more valuable to preserve than Site 1.

The Land Sale Revenue is the other portion of the Preservation Option. It is composed of the difference between todays purchase price and the present value of the resale value twenty years from now. The Land Sale Revenue varies with the different classes of agricultural land. For instance the Stony Mountain site composed of a low class of agricultural land has a value of -3.85 while the higher classed Stonewall site has a value of -4.80, (see Table 3). The fact these numbers are negative indicates the farmland real estate market is expected to increase in value at a rate lower than the discount rate. The difference of these two numbers (0.95) is small in relation to the Total Revenue Crops Difference (-5,812) therefore it has an insignificant effect on the Preservation Option.

The Total of the Difference Column is the summation of all the numbers in this third column. It is this number which indicates whether the site with the shortest commuting distance, in this case the Stony

Mountain site, should be preserved or developed. In Table 3 the total is -\$4,888. When the total is a negative number the preservation option of the Stony Mountain site was not large enough to overturn the development option. In this case the Stony Mountain site is developed and the Stonewall site is preserved. Had the total been zero or a positive number, it would have meant the preservation option was equal to or larger than the development option. In that case the Stony Mountain site would be preserved and the Stonewall site developed.

The above results were based on the assumption the total number of acres in each rural residential parcel was one. This section will now examine the effect of increasing the size of the sites to ten acres. Table 4 indicated the factors that changed in the Difference column were in the preservation section. The value for the Total Revenue Crop Difference increased to -\$5812 which when compared to the value on Table 3 (-\$581) is a multiples of ten. The Land Sale Revenue also increased by a multiples of ten. Due to this increase the Total of the Difference Column of Table 4 was a larger negative number than that found in Table 3. Since the total was a negative number the decision to develop the Stony Mountain site and preserve the Stonewall site remained the same. From this analysis it can be concluded when a site has the shortest commuting distance and the lower soil quality the results will indicate it should be developed and the other site preserved.

Table 4

Rural Municipality of Rockwood - Case Study - Size of Sites Ten Acres

	Present Value Stony Mountain	Present Value Stonewall	Present Value Difference
Development Cost	1200.00	1341.00	-141.00
Transportation Cost	13998.99	15834.95	-1835.96
Vehicle Replacement	20652.51	22983.99	-2331.48
Sub total	35851.50	40159.95	-4308.44
Total Revenue Crops	7352.48	13165.40	-5812.92
Land Sale Revenue	-38.50	-48.00	9.50
Total			-10111.86

Based on this conclusion the question to be raised is "what happens when the site with the shortest commuting distance has the higher soil quality?" For the purpose of this example the following has been assumed:

1. the Stony Mountain site has a higher quality of agricultural soil than the Stonewall site,
2. the Stony Mountain site has a shorter commuting distance than the Stonewall site,
3. the employment center the rural residents are commuting to is the corner of Portage Avenue and Main Street in Downtown Winnipeg, and
4. the size of each site is one acre.

As a result of these assumptions several of the values placed in the computer program have to be changed. These are in relation to the number of bushels per acre, the development cost, and the price per acre.

Comparing the Difference columns of this analysis (Table 5 and of Table 3), the Transportation Cost and Vehicle Replacement Cost are the same. The Development Cost and Total Revenue Crops however, have become positive and the Land Sale Revenue negative. Due to these changes the summation of the Difference column of Table 5 is a smaller number than the total of Table 3. From these results it can be concluded by interchanging the soil quality of the two sites the development and preservation options will be affected.

Table 5

Stony Mountain Site - High Quality Agricultural Land
Stonewall Site - Low Quality Agricultural Land

	Present Value Stony Mountain	Present Value Stonewall	Present Value Difference
Development Cost	1341.00	1200.00	141.00
Transportation Cost	13998.99	15834.95	-1835.96
Vehicle Replacement	20652.51	22983.99	-2331.48
Sub total	35992.50	40018.95	-4026.44
Total Revenue Crops	1316.54	735.25	581.29
Land Sale Revenue	-4.80	-3.85	-0.95
Total			-3446.09

The results of this analysis were based on the assumption the size of each rural residential parcel was one acre. In this analysis the parcel size will be increased to seven acres. Table 6 indicates the factors that changed in the Difference Column were in the preservation section. The value for the Total Revenue Crops Difference increased to \$4069 which when compared to the value on Table 5 (\$581) is a multiple of seven. The Land Sales Revenue also increased by a multiple of seven. Due to this increase the Total of the Difference column of Table 6 was a positive number opposed to the negative one found in Table 3. This positive number meant the preservation option of the Stony Mountain site was larger than its development option. As a result the Stony Mountain site is preserved and rural residents must commute a longer distance to the developed Stonewall site. In conclusion when the site with the shorter commuting distance has the higher agricultural soil quality certain parcel sizes exist which will cause the Preservation Option to be larger than the Development Option. When this occurs this site should be preserved and the other site developed.

Table 6

Stony Mountain Site - Higher Quality Agricultural Land
Stonewall Site - Low Quality Agricultural Land -
Size of Sites Seven Acres

	Present Value Stony Mountain	Present Value Stonewall	Present Value Difference
Development Cost	1341.00	1200.00	141.00
Transportation Cost	13998.99	15834.95	-1835.96
Vehicle Replacement	20652.51	22983.99	-2331.48
Sub total	35992.50	40018.95	-4026.44
Total Revenue Crops	9215.79	5146.73	4069.05
Land Sale Revenue	-33.6	-26.95	-6.65
Total			36.41

5.3 SENSITIVITY TESTING

There are two factors which explain the sensitivity levels and the degree of influence variables have on the development and preservation options. First, the assumed values of the variables and their relationships defined in the model may affect the results. Second the circumstances of the Case Study may cause some of the variables and their values to dominate the model.

The degree of influence of the components in this Case Study can be seen on Table 7 when the Difference column is examined. The Transportation Cost maks up 43 percent, the Vehicle Replacement Cost makes up 54 percent and the Development Cost makes up 3 percent of the Development Option. The Land Sale Revenue composes only 0.2 percent and the Total Revenue Crop makes up 99.8 percent of the Preservation Option. This latter number is negative (-581) indicating in this case study the site with the shortest commuting distance has the lower quality agricultural soil. Had this number been positive it would have meant the site with the shortest commuting distance had the higher quality agricultural soil. These numbers when positive or negative change the total of the Difference Table. Because of this the percentage each component makes up of the total will vary therefore their influence on the total can not be measured.

Table 7

Base Condition

	Present Value Stony Mountain	Present Value Stonewall	Present Value Difference
Development Cost	1200.00	1341.00	-141.00
Transportation Cost	13998.99	15834.95	-1835.96
Vehicle Replacement	20652.51	22983.99	-2331.48
Sub total	35851.50	40159.95	-4308.44
Total Revenue Crops	735.25	1316.54	-581.29
Land Sale Revenue	-3.85	-4.80	0.95
Total			-4888.79

In order to test the sensitivity of the variables each one was increased by 10 percent then compared to the results for each of the categories (e.g., Development Cost, Transportation Cost, etc.) of the base condition (see Table 7). The figures that changed would be used to calculate the degree of sensitivity. Table 8 illustrates the results. Components with values under 1.0 are not considered sensitive and have a minimum affect on the preservation or development options of the model. The values equal to or greater than 1.0 are sensitive however, may or may not have a significant affect on the preservation or development options of the model. This could be due to the relationship of the variables defined in the model and/or the circumstances surrounding the case study. The sensitivity and reasons for it or the lack of it may change with the case under study.

Table 8 indicates in the Development Cost column only two variables are sensitive. They are the Development Cost of Site 1 and Site 2. A 10 percent increase in them, results in an 8.6 percent and 9.5 percent change in the Development Cost. This may appear to be a significant change however, Development Cost is only 3 percent of the Development Option. These variables may be sensitive, but they are not significant.

In the Transportation Cost column of Table 8 there are nine variables listed. When these variables were individually increased 10 percent the results indicated five were sensitive and four were not. The four variables which are not sensitive are Inflation Rate of Energy after 1986 (.2 percent), Fuel Consumption (.2 percent), Fuel Consumption Decrease (.7 percent) and Rate of Inflation of Transportation (.1 percent). They do not have a significant impact on the Transportation Cost of the Development Option. The remaining five sensitive variables do. They are the Cost per Kilometer for Oil and Gas (2.6 percent), Kilometers Traveled Site 1 (8.7 percent), Kilometers Traveled Site 2 (7.6 percent), Discount Rate (1.1 percent) and Other Commuting Costs (1.1 percent). The variables having the greatest significance on the Transportation Cost are the Kilometers Traveled Site 1 and Kilometers Traveled Site 2. A 10 percent increase in these variables resulted in an increase in them of 8.7 percent and 7.6 percent, respectively. When Transportation Cost composes approximately 43 percent of the Development Option, increases in these variables will create a significant increase in the Development Option.

In the Vehicle Replacement Cost column five variables are listed, (See Table 8), a 10 percent increase in these individual variables resulted in three of them being sensitive and two being insenstive. The Cost of a New Car (.9) and Rate of Inflation of New Cars (.6) are the two insensitive variables which do not have a significant impact on the

Table 8

Rural Municipality of Rockwood - Case Study
Sensitivity Test

	Development Cost	Transportation Cost	Vehicle Replacement	Total Crop Revenue	Land Sale Revenue
Development Cost Site 1	8.6				
Development Cost Site 2	9.5				
Cost Per Km (oil, gas)		2.6			
Km traveled Site 1		8.7	9.1		
Km traveled Site 2		7.6	7.4		
Inflation Rate of Energy After 1986		.2			
Fuel Consumption		.2			
Reduced Fuel Consumption		0.7			
Discount Rate		1.1	1.1	1.1	1.1
Other commuting costs		1.1			
Other Inflation of Transportation		.1			
Cost of New Car			.9		
Rate Inflation of New Cars			.6		
Crop Yield Site 1				3.4	
Crop Yield Site 2				3.2	
Crop Price/Bushel				.9	
Rate of Crop Increase				.1	
Rate Increase Crop Prices				.9	
Cost of Production				.001	
Inflation Rate of Production Costs				.001	
Price of Agricultural Land Per Acre Site 1					4
Price of Agricultural Land Per Acre Site 2					3.4
Rate of Inflation of Land					4.9
No. of Acres Site 1				I.1	1.1
No. of Acres Site 2				1.7	1.7

Vehicle Replacement Cost or the Development Option. The Kilometers Traveled Site 1 (9.1), the Kilometers Traveled Site 2 (7.4), and the Discount Rate (1.1) are sensitive variables. A 10 percent increase in the first two variables results in a very significant impact on the Vehicle Replacement Cost. Since Vehicle Replacement Cost makes up 54 percent of the Development Option these variables significantly affect the Development Option.

On the Preservation section of Table 8 the Total Crop Revenue Column has 10 variables. A 10 percent increase in these variables results in five of them being sensitive and five being insensitive. The Crop Price per Bushel (.9 percent), the Rate of Crop Increase (.1 percent), the Rate of Increase in Crop Prices (.9 percent), the Cost of Production (.001) and the Inflation Rate of Production Costs (.1 percent) are all insensitive variables not having a significant impact on the Total Crop Revenue or the Preservation Option. The Crop Yield Site 1 (3.4), Crop Yield Site 2 (3.2), Discount Rate (1.1), Number of Acres Site 1 (1.1) and Number of Acres Site 2 (1.7) are all sensitive variables. Since Total Crop Revenue composes 98.8 percent of the Preservation Option a change in these variables will significantly affect this option.

The Land Sale Revenue column is composed of six variables. All of them are significant. They are the Price of Agricultural Land per Acre Site 1 (4), the Price of Agricultural Land per Acre Site 2 (1.7). The Land Sale Revenue composes only 0.2 percent of the Preservation Option. Due to this fact the above sensitive variables have an insignificant effect on the Preservation Option.

Of the variables discussed some appear in more than one column. The result of this can be a multiple or cancelation affect on the Development and/or Preservation Option. For example Kilometers Traveled Site 1 and Kilometers Traveled Site 2 appear in both the Transportation Cost and Vehicle Replacement columns of Table 8. When these variables are increased by 10 percent the values appearing in these columns are added indicating the Kilometers Traveled Site 1 has a 17.8 percent impact and the Kilometers Traveled Site 2 has a 15 percent impact on the combined Transportation Cost and Vehicle Replacement Cost. Since the Transportation Cost and Vehicle Replacement Cost has a combined impact of 97 percent on the Development Option this means an increase in the Kilometers Traveled Site 1 and/or the Kilometers Traveled Site 2 will significantly affect this Option and the Development-Preservation Decision.

This multiple affect also occurs in the Preservation Option with the Number of Acres Site 1 and Number of Acres Site 2. Since the percentage of sensitivity is small the additive affect is significant, but not to the degree that occurs to the Development Option discussed in the previous paragraph.

The Discount Rate appears in four columns of Table 8. It is used in the calculation of the Transportation Cost, Vehicle Replacement Cost, Total Crop Revenue and Land Sale Revenue. Because it is used simultaneously and to the same degree to calculate these components its affect on the Development and Preservation Options cancel.

In conclusion the affect variables have on the development and preservation options of the model is not restricted to their influence on individual components such as Transportation Cost. Variables may affect more than one component resulting in a multiple affect on the Development and Preservation Options. These results may not be the same in other cases. If the variables of the model and their relationship to each other change and/or the circumstances of the Case Study change the sensitivity levels and the degree of influence variables have may also change.

5.4 EXPERIMENTS

5.4.1 Introduction

In the last section the sensitivity of the model's components and their impact on the development and preservation options were explored. The variables proving to be sensitive and having a significant impact on the options were the cost per kilometer for oil and gas, the number of kilometers traveled from each site, the crop yield and the site size. These components provided the basis for testing the model. In changing these components certain assumptions have been made which may necessitate the changing of other components so the program will work. Changing just the latter components would not significantly vary the results of the program. Each of the tests done in the following section will indicate what the assumptions are and what components have been changed.

The tests appearing in the following sections will vary:

1. the cost per kilometer for oil and gas,
2. the number of kilometers traveled from the sites to an employment center,
3. the number of kilometers between sites and the site size, and

4. the agricultural soil quality of the sites, the numbers of kilometers between sites and the size of each site.

The results of these tests will indicate the parameter of the type of information this model and program can provide.

5.4.2 Varying the Cost per Kilometer for Oil and Gas

In this section the component titled "Cost per Kilometer for Oil and Gas" will be reduced. As a result the type of car used will be changed from the previously used mid sized Chevrolet Malibu to the compact sized Volkswagon Rabbit. The latter achieves better gas mileage and a lower cost per kilometer for oil and gas. Because a smaller car is being used the values for other components titled the "Cost per Kilometer" and the "Rates of Fuel Consumption Decrease" will be changed. These components are not sensitive, but they must be changed to make the model operate.

The results of changing the cost per kilometer for oil and gas by using a small car are shown on Table 9. Table 10 indicates the results when a mid-sized car is used. Comparison of the tables indicates a small change occurred between the Transportation Costs. This resulted in a change between the "Totals" located in the Difference column of the tables. The percentage difference between the two totals was only 3 percent. From all this information, given the assumptions of the case study, conclusions can be drawn. First, rural residents have an insignificant amount of money to save in the next twenty years by driving small cars opposed to medium sized cars. Second, changing the type of car used therefore the cost per kilometer for oil and gas does not significantly reduce the development option in terms of influencing the decision whether a site should be developed or preserved.

Table 9

Option Demand Model - Small Car

	Present Value Stony Mountain	Present Value Stonewall	Present Value Difference
Development Cost	1200.00	1341.00	-141.00
Transportation Cost	13017.71	14724.95	-1707.24
Vehicle Replacement	20652.51	22983.99	-2331.48
Sub total	34870.22	39049.94	-4179.72
Total Revenue Crops	735.25	1316.54	-581.29
Land Sale Revenue	-3.85	-4.80	0.95
Total			-4760.07

Table 10

Option Demand Model - Mid-Sized Car

	Present Value Stony Mountain	Present Value Stonewall	Present Value Difference
Development Cost	1200.00	1341.00	-141.00
Transportation Cost	13998.99	15834.95	-1835.96
Vehicle Replacement	20652.51	22983.99	-2331.48
Sub total	35851.50	40159.95	-4308.44
Total Revenue Crops	735.25	1316.54	-581.29
Land Sale Revenue	-3.85	-4.80	0.95
Total			-4888.79

If the circumstances and assumptions of this case study had been different the results and conclusions drawn from changing the cost per kilometer for oil and gas also may have been different. For example, by increasing the distance between the sites, the differences in transportation costs between would have been greater and the reduction in fuel consumption may have played a more significant role. Also if a gas using mid-sized car had been compared to a diesel using compact car the differences in fuel consumption would have also affected the transporation costs. In conclusion, the effect of changing the fuel consumption for oil and gas, by changing the size and type of car used, varies given the assumptions of the Case Study. The results found in this example are not necessarily those to be found in other cases.

5.4.3 Variation of the Commuting Distance

In this section the total number of kilometers travel to and from both sites will be the only variables changed. In this analysis the following facts and assumptions should be made.

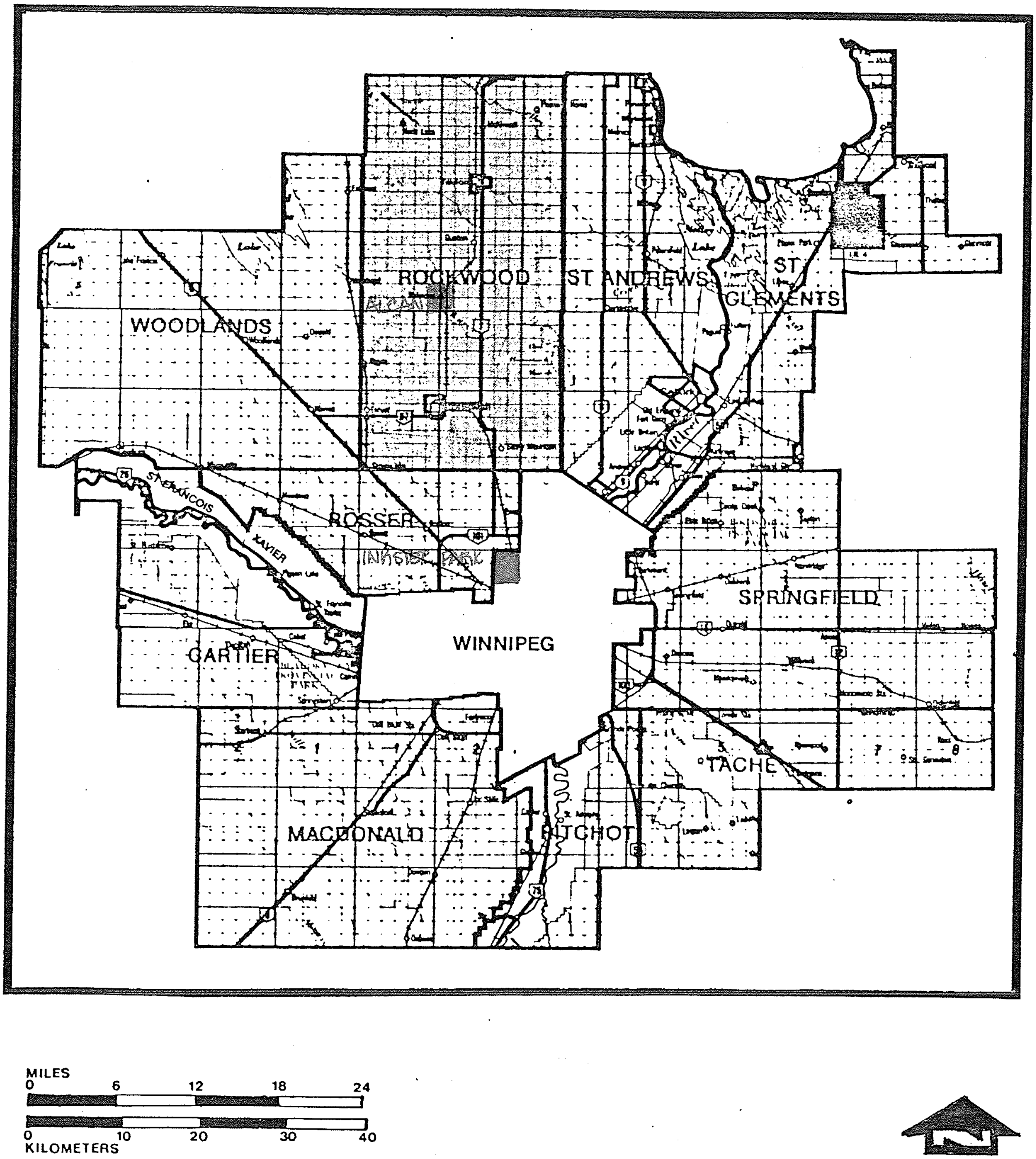
1. The Stony Mountain site is located closer to Winnipeg and has a lower agricultural soil productivity than the Stonewall site,
2. the two sites are located eight kilometers apart,
3. the car being driven by rural residents is a Chevrolet Malibu, and
4. the results of the site with the shortest commuting distance are always placed in the first column of the results table.

Two alternate employment centers were chosen in order to vary the commuting distance. They were the Inkster Industrial Park and the proposed Alcan smelter. They were chosen because they do or will have hundreds of people employed there. Inkster Industrial Park is located in the northwest section of Winnipeg and the proposed location for the Alcan smelter is north of the Stonewall site, (see Illustration 10).

Commuting distance from both rural residential sites to these employment centers are less than the commuting distance to Downtown Winnipeg.

Illustration 10

Location of Employment Centers



The distance to Downtown Winnipeg from the Stony Mountain and Stonewall sites are 61 and 69 kilometers, respectively. From Inkster Industrial Park the distances are 45 and 53 kilometers, respectively and from the proposed Alcan smelter 33.7 and 25.7 kilometers, respectively. The results from commuting to the Inkster Industrial Park, the proposed Alcan smelter, and Downtown Winnipeg are indicated on Tables 11, 12 and 13, respectively. When these results are compared Downtown Winnipeg's Transportation Cost and Vehicle Replacement Cost listed in the first two columns of Table 13 are higher. Comparison of the Difference Column of the three tables however, indicates the Transportation Cost Differences are all equal and the Vehicle Replacement Difference is only slightly different. This slight difference is due to the rounding off effect that occurs when the value of the residual car life is subtracted from the car replacement cost at the end of the study period. This slight difference in vehicle replacement costs explains the differences in the "Total" figures between the Inkster Park results (Table 11) and the Downtown Winnipeg results, (Table 13). The difference is only 3 percent which will not significantly affect a development or preservation decision.

The "Total" figures on the proposed Alcan Smelter Results Table (Table 12) and the Downtown Winnipeg Results Table (Table 5.4.3C) are drastically different.

Table 11

Inkster Park Employment Center

	Present Value Stony Mountain	Present Value Stonewall	Present Value Difference
Development Cost	1200.00	1341.00	-141.00
Transportation Cost	10327.12	12163.05	-1835.94
Vehicle Replacement	15865.02	18346.30	-2481.28
Sub total	27392.14	31850.36	-4458.21
Total Revenue Crops	735.25	1316.54	-581.29
Land Sale Revenue	-3.85	-4.80	0.95
Total			-5038.56

Table 12

Proposed Alcan Employment Center

	Present Value Stonewall	Present Value Stony Mountain	Present Value Difference
Development Cost	1341.00	1200.00	141.00
Transportation Cost	5897.93	7733.85	-1835.92
Vehicle Replacement	10364.72	12767.45	-2402.73
Sub total	17603.65	21701.30	-4097.65
Total Revenue Crops	1316.54	735.25	581.29
Land Sale Revenue	-4.80	-3.85	0.95
Total			-3517.30

Table 13

Downtown Winnipeg Employment Center

	Present Value Stony Mountain	Present Value Stonewall	Present Value Difference
Development Cost	1200.00	1341.00	-141.00
Transportation Cost	13998.99	15834.95	-1835.96
Vehicle Replacement	20652.51	22983.99	-2331.48
Sub total	35851.50	40159.95	-4308.44
Total Revenue Crops	735.25	1316.54	-581.29
Land Sale Revenue	-3.85	-4.80	0.95
Total			-4888.79

This is not due to a difference in the Vehicle Replacement Cost, but due to the soil quality of the site located nearest to the Alcan employment center. It is the site closest to the employment center which is always in the first column of the table. In this case it is the Stonewall site. Because the soil quality of this site is superior to that of the other site the Crop Revenue value listed in the Difference Column of Table 12 was positive. When the Difference Column was added this positive crop revenue figure affects the total. In conclusion, the location of the site with the higher soil quality in relation to the employment center may affect the preservation or development decision. Changing the absolute commuting distance the rural resident must commute does not effect the results of the program nor the preservation or development options.

5.4.4 Distance Between Sites

In this section the number of kilometers commuted from each site will be varied by changing the distance between the two sites. Before the results of this investigation are discussed it is important to note the following assumptions:

1. the destination of all the rural residents is Downtown Winnipeg,
2. the location of Site 1 will remain fixed, have a total commuting distance of 61 kilometers and its highly productive agricultural soil will produce 26.8 bushels/acre of Red Spring Wheat,
3. Site 2 will have an equal or greater commuting distance than Site 1, and its lower quality agricultural soil will produce only 21.3 bushels/acre of Red Spring Wheat,
4. the car being driven by rural residents is a Chevrolet Malibu, and
5. the distance between the two rural residential sites will begin at zero and increase at one kilometer intervals.

Table 14 indicates the program results when both sites have the same commuting distance and are one acre in size. The difference between the Transportation and Vehicle Replacement Costs of the two sites equals zero and the Total of the Difference Column is a positive number. The fact this number is positive indicates the preservation option of site 1 is larger than the development option. As a result site 1 should not be developed, but preserved and site 2 should be developed.

Table 14

Study Sites - Identical Commuting Distance

	Present Value Stony Mountain	Present Value Stonewall	Present Value Difference
Development Cost	1341.00	1200.00	141.00
Transportation Cost	16064.44	16064.00	00.00
Vehicle Replacement	23294.18	23294.18	00.00
Sub total	40699.62	40699.62	00.00
Total Revenue Crops	1316.54	735.25	581.29
Land Sale Revenue	-4.80	-3.85	-0.95
Total			722.29

When the distance between the sites increased by one kilometer such that site 2 had the larger commuting distance, the total in the Difference Column of the Results Table changed to a negative number, (see Table 15). This negative number indicates the preservation option of site 1 was less than the development option therefore in spite of its higher agricultural capability it should be developed and site 2 preserved.

Table 15

Study Sites - Variation of Commuting Distance - One Kilometer

	Present Value Stony Mountain	Present Value Stonewall	Present Value Difference
Development Cost	1341.00	1200.00	141.00
Transportation Cost	16064.44	16523.42	-458.98
Vehicle Replacement	23294.18	23907.84	-613.66
Sub total	40699.62	41631.26	-931.64
Total Revenue Crops	1316.54	735.25	581.29
Land Sale Revenue	-4.80	-3.85	-0.95
Total			-351.29

This situation was considered again however, the parcel sizes were increased to two acres. By doing this the Revenue Crop value increased causing the total in the Difference Column of Table 16 to become a positive number. This number indicated the preservation option was larger than the development option and development would be directed to the lower quality agricultural land of site 2.

Table 16

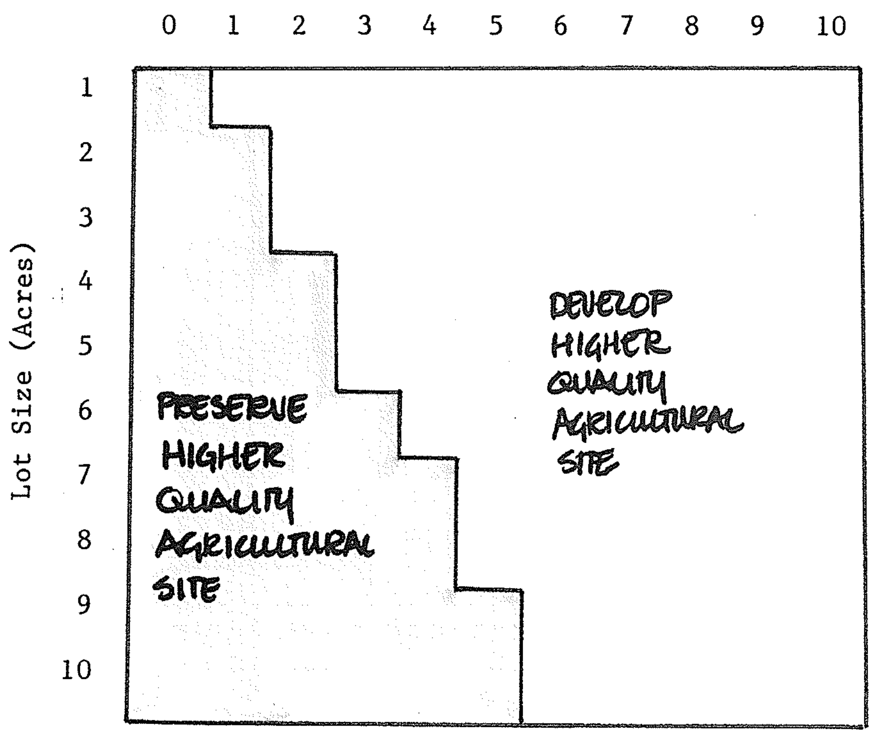
Study Sites - Variation of Commuting Distance - Site Sizes Two Acres

	Present Value Site 1	Present Value Site 2	Present Value Difference
Development Cost	1341.00	1200.00	141.00
Transportation Cost	16064.44	16523.42	-458.98
Vehicle Replacement	23294.18	23907.84	-613.66
Sub total	40699.62	41631.26	-931.64
Total Revenue Crops	2633.08	1470.50	1162.59
Land Sale Revenue	-4.80	-3.85	-0.95
Total			230.00

The distance between the two sites was increased again as was the number of acres in each site. Programs were ran and the results are indicated on Illustration 11. The chart indicates the farther apart the sites are located the larger the parcel sizes have to be to preserve Site 1 and redirect development to Site 2. Any situation that could be classified in the yellow section of Illustration 11 means Site 1 should be preserved and Site 2 developed. For those situations falling in the white section of the chart, Site 1 should be developed and Site 2 preserved. In conclusion, varying the number of kilometers commuted from each site, by changing the distance between the two sites, significantly affects the program's results and the location of development.

Illustration 11

Variation of Commuting Distance and Site Sizes
Difference in Commuting Distance Between Sites
(Kilometers)



5.4.5 Variation of Agricultural Soil Quality

In the previous section the distance between sites affected the location of development. In this section these components will be varied along with the quality of the agricultural land. In setting up the analysis the following assumptions have been made:

1. the destination of all commutors was Downtown Winnipeg,
2. the location of Site 1 will remain fixed, have a commuting distance of 61 kilometers to and from Downtown Winnipeg and its agricultural soil quality will always be higher than that of Site 2,

3. Site 2 will have an equal or greater commuting distance than Site 1 and its agricultural soil quality will always be lower than that of Site 1,
4. the car being driven by rural residents is a Chevrolet Malibu,
5. the distance between the two rural residential sites will begin at zero and increase at 1 kilometer intervals, and
6. in order to differentiate between the soil quality of the two sites, the Manitoba Crop Insurance Index for the Rural Municipality of Rockwood for Red Spring Wheat will be used. The values are as follows:

Class	A	B	C	D	E	F	G	H
Bushel/Acre	30.3	28.8	26.8	26.8	26.8	24.4	21.3	21.3

The following chart lists the combinations of soil qualities that could be placed in the program and the difference in bushel/acre between these qualities.

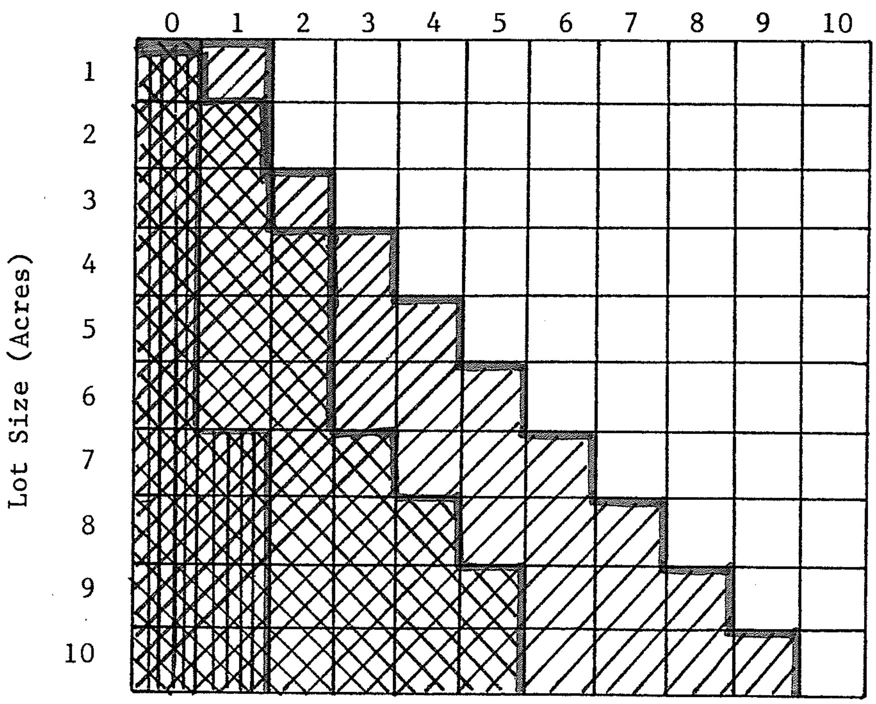
	1	2	3	4	5	6	7	8	9	10
Site 1	30.3	28.8	26.8	24.4	30.3	26.8	26.8	30.3	28.8	30.3
Site 2	28.8	26.8	24.4	21.3	26.8	24.4	21.3	24.4	21.3	21.3
Difference	1.5	2.0	2.4	3.1	3.5	4.4	5.5	5.9	7.5	9.0

The individual tables will not be presented here however, three of the results will be indicated on Illustration 12. The different lines on this chart indicate various soil quality differences that exist between two sites. The individual line represents those points where the development decision for Site 1 has been overturned and Site 2 is developed instead. As the chart illustrates the farther the sites are apart the larger the sites have to be in order to overturn the development decision. Upon examining the chart no indifference lines follow the exact same pattern. The larger the difference in soil quality between the

Illustration 12

Variation of Commuting Distance, Site Sizes, and
Agricultural Soil Quality

Difference in Commuting Distance Between Sites
(Kilometers)



1.5 Bushel/Acre difference between sites, preserve site with higher quality agricultural land.

4.4 Bushel/Acre difference between sites, preserve site with higher quality agricultural land.

9.0 Bushel/Acre difference between sites, preserve site with higher quality agricultural land.

Develop higher quality site.

sites the farther the line appears to the right of the chart. This is because the larger the difference in soil quality, the farther the sites can be apart before the site size has to be increased in order to overturn the development decision on Site 1. From this it can be concluded, the larger the difference in soil quality the more options open to preserving Site 1 and developing Site 2.

5.5 SUMMARY

This chapter has examined the results from the Rural Municipality of Rockwood Case Study, the sensitivity and significance of the variables on the Development and Preservation Options, and the results of varying key variables of the model. The results from the Case Study analysis have indicated when the site with the shorter commuting distance has the lower agricultural soil quality of the two sites it should be developed and the other site preserved. When the site closest to the employment center has the higher agricultural soil quality of the two sites, certain parcel sizes will cause the Preservation Option to be larger than the Development Option. When this occurs this site should be preserved and the other site developed.

The results of the sensitivity testing indicated several variables were not sensitive, others were and of this latter group a minimum number had a significant effect on the preservation and development options. The reason for these results was due to two factors. The assumed values of the variables and their relationships as defined in the model may have affected the results and/or the circumstances of the Case Study may have influenced them. As a result of these factors other case studies will not necessarily have the same sensitive variables or the identical key variables which have a significant effect on the development and preservation options of the model.

Using those key variables, four experiments were set up. These experiments varied:

1. the cost per kilometer for oil and gas,
2. the number of kilometers traveled from the sites to an employment center,
3. the number of kilometers between sites and the site size, and
4. the agricultural soil quality of the sites, the number of kilometers between sites and the size of each site.

By varying the cost per kilometer for oil and gas, given the assumptions of this Case Study the development option was not significantly reduced in terms of influencing the decision whether a site should be developed or preserved. If the assumptions of the case study had been different however, the results and conclusions drawn from the cost per kilometer for oil and gas may have been different.

When the number of kilometers traveled from the sites to an employment center were varied two alternate centers were chosen. One center was loated closest to the rural residential site having the lower agricultural soil quality. The other center was located closest to the rural residential site having the higher agricultural soil quality. These results indicated the location of the site with the higher soil quality in relation to the employment center could affect the preservation or development decision. By varying the commuting distance however, neither the results of the program or the preservation or development options were significantly affected.

In the next experiment, the number of kilometers commuted from each site was varied by changing the distance between the two sites. When the sites had the same commuting distance the site with the lower agricultural soil quality was developed and the other site preserved. As the commuting distance for the site with the lower agricultural soil quality increased while the other site remained stationary, the development option of the latter site became larger than the preservation option. In order to preserve this higher quality site the size of the parcels had to be increased so the preservation option was larger than the development option. From this analysis it was found through changing the distance between the two sites and the size of the parcels the program's results and the location of development could be significantly affected.

The final experiment varied the agricultural soil quality of the sites, the number of kilometers between sites and the size of each parcel. As found in the previous experiment the farther the sites are apart the larger the parcels have to be in order preserve the site with the higher agricultural soil quality when it has the shortest commuting distance. The larger the difference in soil quality between the sites the farther they can be apart before the parcel size has to be increased in order to preserve the higher quality agricultural site. In summation the larger the difference in soil quality between the sites the more options open to preserving the site with the higher quality agricultural soil when it has the shortest commuting distance of the two sites.

In conclusion the assistance the Option Demand Model can give in making preservation and development decisions has been seen. The results of the research explored in this chapter is largely limited to the assumptions made and circumstances of the Case Study. Generally, these results can be used for reference however, can not be unrestrictively applied to any situation. The values of the variables of the model should be checked and changed according to the assumptions and situation of the case at hand. Generally this model is invaluable in deciding between the preservation and development options of agricultural sites.

Chapter VI

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 SUMMARY

The 1970's and early 1980's have witnessed the development of rural non farm residences in the country side surrounding the cities. The motivation underlying this movement is the desire to gain the benefit of a rural lifestyle while enjoying the access to urban employment and other amenities. Rural municipalities have welcomed rural residents because of their spending impact on local communities and the additional tax base they provide. Unfortunately several social, economic and environmental problems are also associated with this development. One major problem responded to by the federal and provincial governments has been the loss of prime agricultural land. The documents and programs these agencies put forward have had limited success and agricultural land continues to yield to other developments such as rural non-farm residences. The significance of this occurance is unknown as the future losses from developing agricultural land has not been successfully measured. Lack of the information also makes it difficult for planners and politicians to reject or redirect development to alternate sites. The objective of this thesis is to provide to planners and politicians a technique and better method of evaluating information to aid them in making better land use decisions.

This technique is the Option Demand Model which in this case quantifies the opportunity cost of agricultural sites versus rural residential development. Previous models heavily discounted or ignored the preservation option biasing the results in favour of development. The Option Demand Model takes into consideration both the preservation and development options. The model was applied to two sites similar except for soil quality in the Rural Municipality of Rockwood. A stream of discounted net benefits over a 20 year period was calculated for both the preservation and development options of both sites. Assuming the legitamacy of rural residential development the net benefits indicated which of the sites should be developed or preserved for agricultural use.

The results from the Rockwood Case Study indicated when the site with the shortest commuting distance has the lower agricultural soil quality of the two sizes examined, it should be developed and the other site preserved. When the site closest to the employment center has the higher agricultural soil quality certain parcel sizes will cause the preservation option to be larger than the development option. When this occurs the site closest to the employment center with the higher agricultural soil quality should be preserved and the other site developed.

The results of the sensitivity testing indicated several variables were not sensitive, others were and of this latter group a minimum number were critical in determining the location of rural residential development. The reason for these results was due to two factors. The assumed values of the variables and their relationships as defined in the model may have affected the results and/or the circumstances of the

Case Study may have influenced them. As a result of these factors other case studies will not necessarily have the same sensitive variables or the identical key variables which have a significant affect on the development and preservation options of the model.

Using the key variables, found in the application of the model, four experiments were set up. These experiments varied:

1. the cost per kilometer for oil and gas,
2. the number of kilometers traveled from the sites to an employment center,
3. the number of kilometers between sites and the parcel size, and
4. the agricultural soil quality of the sites, the number of kilometers between sites and the size of each parcel.

By varying the cost per kilometer for oil and gas, given the assumptions of this Case Study, the development option was not significantly reduced in terms of influencing the decision whether a site should be developed or preserved. If the assumptions of the case study had been different the results and conclusions drawn from the cost per kilometers for oil and gas may have changed.

When the number of kilometers traveled from the sites to an employment center were varied two alternate centers were chosen. One center was located closest to the rural residential site having the lower agricultural soil quality. The other center was located closest to the rural residential site having the higher agricultural soil quality. These results indicated the location of the site with the higher soil quality in relation to the employment center could affect the preservation or development decision. By varying the commuting distance however, neither the results of the program or the preservation or development options were significantly affected.

In the next experiment, the number of kilometers commuted from each site was varied by changing the distance between the two sites. Then the sites had the same commuting distance the site with the lower agricultural soil quality was developed and the other site preserved. As the commuting distance for the site with the lower agricultural soil quality increased while the other site remained stationary, the development option of the latter site became larger than the preservation option. In order to preserve this higher quality site the size of the sites had to be increased so the preservation option was larger than the development option. In summation, the farther the sites are apart the larger they have to be in order to preserve the site with the shortest commuting distance when it has the higher soil quality.

The final experiment varied the agricultural soil quality, the size and the number of kilometers between sites. It was assumed the site with the shortest commuting distance had the higher soil quality. The results indicated the larger the difference in soil quality between the sites the farther they can be apart before the site size has to be increased in order to preserve the higher quality site. In summation the larger the difference in soil quality between the sites being compared, the more options open to preserving the higher agricultural quality site.

6.2 CONCLUSIONS

Before the conclusions to this thesis are drawn it is essential that the following caveats be indicated. First in setting up the model certain assumptions were made concerning the future. Variables which may be relevant later on in the study period could not have ben accounted for in the model. The values assigned to the variables could also be incorrect. For example, the model assumes the continued reliance on oil and gas as a fuel and a certain rate of increase for the price of grains. If alternate sources of energy are used and the rate of increase for grain is larger, the model's results could be completely incorrect. The assumptions made here about the future were based on the best information available at this time.

The second caveat deals with the values of the variables of the case study. Since they are a direct result of the circumstances surrounding the case study the results of the analysis may not necessarily be the same in other case studies. For example, by varying the cost per kilometer for oil and gas, through changing the type of car used, the results of this case study were not affected significantly, (see Section 5.4.2). This meant it did not matter if a medium or small car was used by rural residents for the next 20 years because in this case their costs would be insignificantly different. If another case were considered where the distance between sites was larger the difference in transportation costs between sites may be greater. Contrary to the case examined in this thesis, it could result in the use of different sized cars having a significant affect on the results. The values of the variables of a case study can affect the results of the analysis.

Recognizing these caveats several conclusions can still be drawn from using the sites in the Rural Municipality of Rockwood for a case study. When the site with the shortest commuting distance has the lower quality agricultural soil of the two sites, that site will always be developed and the other site preserved. When the site closest to the employment centre has the higher quality agricultural soil it may be preserved or developed depending on the difference in soil quality between the sites, the distance between them, and their size. Section 5.4.5 indicated in this case study the larger the difference in soil quality between sites the farther the sites could be apart before the site size had to be increased in order to preserve the higher quality site.

The size of rural residential parcels may be restricted in certain provinces, municipalities or districts who have their own planning documents. If the maximum parcel size allowed is two acres, sites having a difference in bushels per acre of 20 percent to 40 percent could only be located up to one kilometer apart before the site with the higher quality agricultural land and shorter commuting distance was developed. If the difference in bushels per acres is only 7 percent the sites can not be even one kilometer apart before this same decision is made. Some municipalities may allow rural residential sites to be five acres in size. Sites with a difference in bushels per acre of 40 percent could redirect development to the lower agricultural quality site located up to four kilometers farther from the employment center than the higher quality agricultural site. As this difference in bushels per acre reduced to 20 percent the additional distance development can be redirected up to two kilometers. As site sizes increase there are more options available for preserving the higher quality agricultural site and developing the lower quality one. Increasing site sizes results in wasting more agricultural land. If site sizes are to be kept to a minimum this restricts the options available. If however, the development option is only slightly larger than the preservation option of the two sites than politicians and planners may recommend the site with the higher quality agricultural soil be preserved not developed. In doing the planners and politicians are allowing the option to be preserved under a wider variety of circumstances.

The reason the number of options available are restricted is because of the significant impact of Fuel Consumption and Vehicle Replacement on the results of the model. If the total commuting distance, cost per kilometer for oil and gas and other factors were different, the Fuel Consumption and Vehicle Replacement Cost may not have as significant an impact. This may allow rural residential sites to be located farther distances apart before the development-preservation decision is reversed.

Where sites and alternate sites are located may affect how the model is used if it can be used. Some provinces restrict development within a certain distance of a city or resource area. Outside of this area if development is not restricted by other planning documents, applications can be submitted to the province for rural residential development. Problems may arise when the two sites to be compared are in opposite directions of the employment center. If the employment center is very large both sites may be impossible to compare and have to be compared to other sites in closer proximity to them. If the employment center is small only one area designated for rural residential development may be required to fulfill demand. In the latter case to compare the sites they must be similar in terms of factors such as distance to amenities, planning legislation, tax structure, and land cost. If comparable sites can not be found the model used in this thesis must be changed in order to take into consideration and weigh the differences between the sites if possible, e.g., distance to amenities, scenic advantages. If the differences can not be successfully quantified for example in monetary terms, the model may not be able to be used.

Even with these restrictions the Option Demand Model is a valuable technique. The results the model provides are only one of several components which must be taken into consideration when decisions concerning rural residential development are made. Information concerning the other social, economic and environmental problems associated with this type of development make up a large portion of the decision making process. For example, if a lower quality site is developed as a result of the informtion provided by the Option Demand Model and the site design is not planned nor the number and location of lots available for development controlled the benefits are lost. Without a site design and lot control rural residences will occur on the perifery of a section of land on lots of various depths and widths. The lack of lot definition makes it difficult for the owner of the property located in the middle of the section to define the property boundaries. Due to the high costs of land surveys these boundaries remain physically undefined. The land is therefore more difficult to farm and often lies idle. If the approval of rural residential development is subject to site design and lot control parcels slated for development and the land located adjacent to it will not be prematurely or unnecessarily taken out of production. These economic concerns and others must be taken into consideration along the results of the Option Demand Model in the decision making process.

Even though the role the Option Demand Model plays in the land use allocation process may be a partial one it is a valuable technique which should not be ignored. It gives politicians and planners means of measuring the preservation option of agricultural land previously discounted heavily or ignored. The results of its application indicate what options are available, the costs of those options, and whether proposed developments should be approved, redirected or rejected. If this model is used in conjunction with other techniques and its results considered with other concerns and information better planning decisions can be made. Planners and politicians still do not have all the information or techniques they need to make the best planning decisions concerning land use allocation however, presentation of the Option Demand Model has brought the achievement of this goal closer.

6.3 RECOMMENDATIONS

The Federal and some of the provincial governments have been involved in land use planning and regulation. One of the objectives of these agencies was to protect prime agricultural land. In doing this a variety of approaches were used. In some cases policies and guidelines were set up while in another the development of agricultural land was frozen. Individual applications were submitted to the approving authorities in order to remove agricultural land from its protection for development.

Several applications were approved and of those initially rejected several were appealed and approved. As a result the initial objectives of preserving agricultural land are being undermined.

One of the reasons politicians give this deterioration in land use allocation is the lack of the necessary information to reject application. It is recommended one of the first things planners and politicians do is research the effects of their past decisions on the agricultural resource base. Perhaps this information alone would cause them to stick by the original objective of protecting agricultural land. Additional information they need applies specifically to the situation under consideration. This new information should also be presented such that it can be understood by the general public. For example, an economic study resulting in dollar and cent results will get more support from local politicians and the public than a document quoting good planning concept and practices. Due to these needs it is recommended more research conducted and information compiled. In several cases the necessary information required to make better land use decisions exists however, a means of compiling at and analyzing it is required. Researching and analyzing information can be lengthy processes however, without acquiring key pieces of information errors are destined to be repeated.

The use of the Option Demand Model assists in filling part of the information void. It should be the policy of provincial planning departments that this technique and others be used in designing development or land use plans for municipalities or districts. The rational for using the model and its results should also be explained in these documents enabling local politicians to understand how decisions evolved. Governments should especially require this technique and others to be used in those areas where no planning document governs development, where general provincial policies or guidelines do and alternate solutions are not usually looked for.

The Option Demand Model should not be restricted to resolving conflicts between agricultural land and rural residential development. This method can be used to calculate the preservation value of recreation lands, wildlife areas, areas of historical significance, and other hard to measure previously ignored land uses. Their development option whether industrial, commercial, or a transmission line can be calculated also. In this manner better land use decisions can be made in all areas. More research involving this model is recommended.

Additional research in other areas of land use planning is also recommended. Researching and the development of new techniques such as the Option Demand Model takes time. Aside from this disadvantage if better information and new techniques are made available perhaps planning decisions will be less subject to political pressure. At least when the Option Demand Model is used the preservation of resources will be valued, alternatives will be examined and the goal of making better land use decisions will be closer.

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Appendix 1

Agricultural Land Matrix

Acres \ Location	TWP 13	Crop Insur.	TWP 24	Crop Insur.	TWP 15	Crop Insur.	TWP 16	Crop Insur.	TWP 17	Crop Insur.
40	281	D	1273	D		D		D		D
		E		E	752	E		E		E
					540	E				
		F		F	870	F	500	F		F
					822	F				
	281	G			201	G	151	G	138	G
60		E		E	205	E		E		E
		F		F	147	F		F		F
	375	G		G		G		G		G
80	400	D		D		D		D		D
		E		E		E	176	E	405	E
							225	E		
							225	E		
							220	E		
							165	E		
		F		F	290	F		F		F
	254	G		G		G		G		G
	1105	G								
		H	336	H	82	H		H	115	H
			314	H	88	H	112	H		H
					124	H	65	H	87	H
							80	H	80	H
							80	H		
100	354	D	632	D		D		D		D
		E		E		E	131	E		E
		F		F		F		F		F
		G		G		G		G		G
		H		H		H		H		H
160	436	D	237	D	442	D		D		D
		E	335	E	348	E	232	E		
			74	E	363	E	265	E		
							75	E		
		F	225	F	270	F		F		F
		G	238	G	185	G		G		G
				G	200	G				
		H	145	H		H	135	H	74	H
					110	H	85	H	58	H
					119	H	85	H	100	H
					223	H	111	H	160	H
					174	H		H	116	H
					182	H	134	H		

Appendix 2

Computer Printout

```
 1 ENTER The name of site1 in quotes                                          : 'STONY MOUNTAIN'
 2 ENTER The name of site2 in quotes                                          : 'STONEWALL'
 3 ENTER The private development costs of rural residents for site1           : 1200
 4 ENTER The private development costs of rural residents for site2           : 1341
 5 ENTER The cost per kilometer(gas & oil) for commuting to work              : 3.96
 6 ENTER The total number of kilometers travelled per trip to work site1      : 61
 7 ENTER The total number of kilometers travelled per trip to work site2      : 69
 8 ENTER The inflation rate of energy under Federal Provincal Agreement       : 24
 9 ENTER The inflation rate of energy after the agreement expires             : 13
10 ENTER Cost per kilometer                                                   : .12
11 ENTER Rates of fuel consumption decrease for the next 20 years             : 9.3
11 ENTER Rates of fuel consumption decrease for the next 20 years             : 10.2
11 ENTER Rates of fuel consumption decrease for the next 20 years             : 11.1
11 ENTER Rates of fuel consumption decrease for the next 20 years             : 11.5
11 ENTER Rates of fuel consumption decrease for the next 20 years             : 12
11 ENTER Rates of fuel consumption decrease for the next 20 years             : 12.5
11 ENTER Rates of fuel consumption decrease for the next 20 years             : 13
11 ENTER Rates of fuel consumption decrease for the next 20 years             : 13.5
11 ENTER Rates of fuel consumption decrease for the next 20 years             : 14
11 ENTER Rates of fuel consumption decrease for the next 20 years             : 14.5
11 ENTER Rates of fuel consumption decrease for the next 20 years             : 15
11 ENTER Rates of fuel consumption decrease for the next 20 years             : 15.5
11 ENTER Rates of fuel consumption decrease for the next 20 years             : 16
11 ENTER Rates of fuel consumption decrease for the next 20 years             : 16.5
11 ENTER Rates of fuel consumption decrease for the next 20 years             : 17
```

11 ENTER Rates of fuel consumption decrease for the next 20 years : 17.5

11 ENTER Rates of fuel consumption decrease for the next 20 years : 18

11 ENTER Rates of fuel consumption decrease for the next 20 years : 18.5

11 ENTER Rates of fuel consumption decrease for the next 20 years : 19

11 ENTER Rates of fuel consumption decrease for the next 20 years : 19.5

12 ENTER The discount rate : 15

13 ENTER Other commuting costs(repairs,tires,battery etc) per kilometer -- SITE1 : 1.17

14 ENTER Other commuting costs per kilometer -- SITE2 : 1.17

15 ENTER The rate of inflation for transportation : 11

16 ENTER The cost of a new car in year one : 9099

17 ENTER The rate of inflation of a new car : 11

18 ENTER The Crop yield per acre site1 : 21.3

19 ENTER The Crop yield per acre site2 : 26.8

20 ENTER The rate crop yields increase per year : .015

21 ENTER The crop price per bushel : 5.50

22 ENTER The rate of inflation in crop prices : 13

23 ENTER The cost of production (b0) : 117

24 ENTER The cost of one additional unit of crop yield (b1) : .1

25 ENTER The inflation rate of crop production costs : 10

26 ENTER The Price of Agriculute land per acre - SITE1 : 443

27 Enter The Price of Agriculture land per acre - SITE2 : 552

28 ENTER The rate of inflation of agricultural land : 14

29 ENTER The total number of acres - SITE 1 : 1

30 ENTER The total number of acres - SITE 2 : 1

	PRESENT VALUE STONY MOUNTAIN	PRESENT VALUE STONEWALL	PRESENT VALUE Difference
Development Cost	1200.00	1341.00	-141.00
Transportation Cost	13998.99	15834.95	-1835.96
Vechicle Replacement	20652.51	22983.99	-2331.48
Total	35851.50	40159.95	-4308.44
Total Revenue Crops	735.25	1316.54	-581.29
Land Sale Revenue	-3.85	-4.80	0.95
Total			-4888.29