Changing Land Use in the Rural-Urban Fringe: A Case Study of Southwest Grand Forks

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CHANGING LAND USE IN THE RURAL-URBAN FRINGE:
A CASE STUDY OF SOUTHWEST GRAND FORKS

by
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Bachelor of Arts, University of North Dakota, 1977

A Thesis
Submitted to the Graduate Faculty
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This thesis submitted by Jane M. Wilson in partial fulfillment of the requirements for the Degree of Master of Science from the University of North Dakota is hereby approved by the Faculty Advisory Committee under whom the work has been done.

[Signatures]

This thesis meets the standards for appearance and conforms to the style and format requirements of the Graduate School of the University of North Dakota, and is hereby approved.

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Title  CHANGING LAND USE IN THE RURAL-URBAN FRINGE: A CASE STUDY OF SOUTHWEST GRAND FORKS

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Studying land use and land cover and ramifications of changes involves examining not only acreage measurements and large-to-medium scale vertical air photos, but also the philosophical framework of the best use of land. One view, which appears in Genesis 1:28, espouses mastery of the earth. "And God blessed them, and God said unto them, Be fruitful and multiply, and replenish the earth, and subdue it . . ."

Another view acknowledges the brief span of human life and advocates land stewardship as a legacy to coming generations. Ralph Waldo Emerson ponders in "Hamatreya."

Where are these men? Asleep beneath their grounds; And strangers, fond as they, their furrows plough, Earth laughs in flowers, to see her boastful boys Earth-proud, proud of the earth which is not theirs;

A similar idea is conveyed in Leviticus 25:23. "The land shall not be sold for ever; for the land is mine; for ye are strangers and sojourners with me."

"Theory," a professor of mine once remarked, "guides work." Awareness of these conflicting ideas on the best use of land has influenced this research indirectly, as a base for inquiry. After all the land use and land cover polygons have been digitized, and the land use and land cover acreage measured, the issue remains to be judged: Is this the best use of land?

This research could not have been completed without the help of some very special people. Special thanks go to Dr. Ralph Brown, thesis
committee chairman, and to Drs. Ted Alsop and Scot Stradley, committee members. Another thank you goes to Mr. Orbin Brandvold of the Soil Conservation Service, Area Office; Mr. Floyd Hickok, UND Department of Geography; Mr. Frank Orthmeyer, City Engineer; Mr. John Bluemle of the North Dakota Geological Survey, and the staffs of the City Engineering Office's Drafting Room and the City Planning Office. Sincere appreciation is extended to the Geology Library, the City Engineering Office and the Soil Conservation Service, Area Office for lending air photos which would have been otherwise unobtainable.
ABSTRACT

Between 1954 and 1980 significant changes took place in southwest Grand Forks. The predominant land use in 1954 was cultivated cropland, which covered 80.5 percent of the total study area. By 1980 cropland had declined to 26.7 percent of the total, with urban land uses such as single family residential, strip development and shopping center making significant increases. As the area became urbanized, problems developed. In 1979 the English Coulee unexpectedly flooded, damaging homes and the acute care hospital in the study area. In 1981 developers owed $2.4 million in delinquent special assessments.

In order to describe the land use and land cover changes between 1954 and 1980, a number of tools and methods were utilized. First a classification scheme was developed. Medium and large scale air photos were used to determine land use and land cover for 1954, 1962, 1970, 1974, 1977, 1979, and 1980. The results were transferred to a base map and then digitized for computer mapping. The area measurements generated by this research support the trend of increased urban land acreage and decreased cultivated cropland.

The problems of development spring from two chief sources: 1) expected growth which did not materialize, and 2) the English Coulee floodplain within the study area.
CHAPTER I

INTRODUCTION

Geography as a discipline is concerned with describing the earth's surface. The chief aims of research in geography are to identify, analyze, and interpret spatial distribution of phenomena and their "areal associations" (Haring and Lounsbury 1975, p. 3). The aim of this research is to identify historical land use in southwest Grand Forks, analyze the process of land use change, and describe the effects of development in the area.

The research method is most heavily influenced by the normative which relies on observation and interpretation of observed processes. To a smaller degree the historical method has also influenced procedure, because of emphasis in the research on land use change.

Between 1954 and 1980 acreage devoted to cropland declined significantly and much formerly cultivated land was converted to urban uses. With the disruption of cropland a pattern of urbanization has emerged. Since 1974 southwest Grand Forks has expanded vigorously. The construction of new single-family and multi-family dwellings, business places, a medical park, a mobile home subdivision and a regional shopping center has altered the physical and cultural landscape.

In the 1970s the Grand Forks City Council approved development on the rural-urban fringe, believing it would attract population to
Grand Forks, create jobs and expand the tax base. Bonds were issued by the City Council to finance expansion of municipal services. In June 1981 payment on these bonds was $2.4 million in arrears (Scaletta 14 June 1981), and by December 1981 over $2.2 million remained to be paid ("2 Developers Pay Land Tax" 9 December 1981).

Study Area

Originally DeMers Avenue marked the northern study boundary, chosen because it is a major artery within the city, serving as a traffic link to and from southern Grand Forks and the University of North Dakota. Study of available aerial photography shows, however, that between 1970 and 1974 the DeMers' route was changed, making the avenue an inconsistent study boundary. Because of that, the northermost track in the railroad yard was selected as a study boundary, since it is a consistently visible cultural boundary. South Washington Street is an important Grand Forks traffic artery, along which exists contiguous linear strip development. The study area's western boundary, the Forty-second Street gravel extension, is easily identified, beyond which lies little existing or planned development. The study area's southern boundary is marked by South Forks Road (formerly Thirty-Second Avenue S.). South Forks Road marks the limits of recent urban expansion, including the southern boundary limits of Columbia Mall. Beyond lie cultivated fields, the original land use of much of the study area (see Map 1).

The literature of farmland loss and preservation; land use case studies, controls, and classification; and the existing Grand Forks master land use plans is reviewed in the next chapter. The geographical
perspective of the research is established and its theoretical and methodological groundwork laid out.
CHAPTER II

LITERATURE REVIEW

The land use changes described in this case study of southwest Grand Forks reflect not only raw measurements of acreage per land use class per study year but also trends of development and its impact. A crucial issue of land use conversion is the debate over the significance of farmland loss. Nationally it is perceived by some to be an increasing problem, yet others citing different data sources dismiss the concern as unsubstantiated.

National Farmland Loss

Passage of the Agricultural Land Protection Act in 1979 ensured Federal funding for a comprehensive study of national agricultural lands, including land tenure patterns; availability, quality and quantity of arable land; the interrelationship of agriculture with energy, the economy and the environment; the impact of suburbanization on soil productivity; and the Federal Government's role of regulating land use (U.S. Congress 1979). Agricultural land is defined in the act as any land (including forest, range land) which can produce "food, feed, fiber or forage" economically and is available for any of these uses (U.S. Congress 1979, p. 4).

In order to justify the National Agricultural Lands Study, which, its authors warned, might raise more questions than it answered,
various estimates and projections were cited. The Soil Conservation
Service (SCS) estimates that 20,000 acres of agricultural land are lost
per week (U.S. Congress 1979). Given this rate of cropland loss, the
Department of Agriculture projects that in ten years only marginal land
will be available to replace high quality land taken out of production.
As more marginal land is brought into production, higher costs for fer­
tilizer, herbicides, and pesticides must be paid, since applications
must be increased to match the productivity of higher quality land. No
significant technological breakthroughs to increase productivity are
expected in the near future and the cost of present technology has
increased sharply. In 1975, for example, it cost $5.75 in fuel to pro­
duce one acre of corn—in 1979 it cost $11.10 (U.S. Congress 1979,
p. 8).

Preliminary reports indicate that one million acres of prime farm­
land are being urbanized and two million acres of lesser quality land
converted to nonagricultural use each year. Citing SCS statistics, the
report affirmed that barely 135 million acres of potential cropland are
available for future cultivation, only 22 million acres of that consid­
ered prime. The combination of prime cropland loss, leveling-off crop
yields and conversion of cropland to other uses will diminish American
food output. Land which is flat or gently rolling with good drainage
and high soil quality is also the best to build on, and the easiest to
develop (National Agricultural Lands Study 1979, p. 12).

The Potential Cropland Study, which surveyed non-Federal land
holdings, estimates that there are 111 million acres with high and medi­
um potential for conversion (U.S. Department of Agriculture 1977, pp.
4-5). Soil classes I through III encompass land which has few soil
restrictions to soils which have severe limits on the types of plants they will support and/or require special conservation practices (U.S. Department of Agriculture 1977). In 1967 potential cropland was estimated at 266 million acres, much of it not converted to agricultural use due to location, tenure or other problems (U.S. Department of Agriculture 1977, pp. 4-5). From 1967 to 1975 about 79.2 million acres went out of production and 48.7 million acres were converted to cropland, yielding a net loss of 30.5 million acres. Of the total, nearly 17 million acres were converted to urban and built-up activities during this period (U.S. Department of Agriculture 1977, p. 1). Urban and built-up land are "areas of intensive use with much of the land covered by structures, for example, cities, towns, shopping centers, highway strip development" (Anderson, Hardy, Roach, and Witmer 1976, p. 67).


Traditionally land use controls have rested in the hands of state and local governments. The Agricultural Land Protection Act states that neither state nor local government has the data needed at present to assess the farmland loss rate or to develop new farmland preservation programs (U.S. Congress 1979). The Federal Government also is a big landowner, possessing approximately 762 million acres, some one-third of all American land. Its lands are exempt from the jurisdiction of this House bill. Committee testimony estimated that the Federal Government was acquiring one million acres per year, while private ownership was declining (U.S. Congress 1979, pp. 31-32).

For some years geographers have been concerned about the significance of conversion of agricultural land to urban and other uses.
Harris (1956, p. 889), did not believe that urban encroachment was a critical problem.

Since the current total residential, industrial, and other urban land needs of mankind amount to only a fraction of 1 per cent of the land surface, it is obvious that neither the present nor potential total land pressures of urban agglomerations are critical.

He maintained that special problems might appear with 1) the type of urbanization of former agricultural land and 2) high-density urbanization in Japan, Great Britain and California where agricultural land is in short supply.

John Fraser Hart (1976, pp. 16-17) writes that urban encroachment on rural areas is no serious problem. He maintains that the U.S. has more rural land than it will ever need for urban development and that only a few million critical acres on the urban-rural fringe will be urbanized shortly. It is the headline hunters, he warns, who have generalized the encroachment problems of New York and California to the entire U.S. In Los Angeles the encroachment of prime agricultural land is a real problem, but as he points out, Los Angeles is thirty-three times larger than a Peoria or a Des Moines and as such has a disproportionate influence on American life and thought.

Until the mid-1970s loss of farmland was not a great concern. Up to that time, the Federal Government subsidized farmers to keep farm-land out of production and also bought commodities. After the 1973-74 grain purchases by the Soviet Union and some crop failures in the world, however, American surpluses began to disappear (U.S. General Accounting Office 1979). Unfortunately the food issue alone cannot resolve the debate over farmland loss. Between 1967 and 1975 cropland declined seven percent. Gross-farm product increased by nine percent
between 1970 and 1978, mostly due to increased application of pesticides and chemical fertilizers. Land under irrigation has increased from 39 million acres in 1969 to 46 million acres in 1974 and improved plant varieties have helped increase yields (Platt 1981, p. 114). In 1978 over 50 million acres were irrigated (U.S. Department of Commerce, Bureau of the Census 1981, p. 9).

As mentioned previously, these technological advances are subject to limits. Potassium and potash, two major ingredients in chemical fertilizer, are in short supply and may be major pollutants of surface waters. Ground water vital to western lands irrigation must be pumped from falling water tables. Salt deposits have contaminated much irrigated land. DDT and other pesticides have been banned, with others less effective on insect pests in some areas (Platt 1981). But demand for U.S. food has tripled over the last ten years, with U.S. farm exports making an important contribution to the balance of payments (U.S. Congress 1979).

Interpretation of different data sources has led researchers to very different conclusions. Reports of the General Accounting Office and the Agricultural Lands Protection Act agree that loss of agricultural land, especially prime, is significant and considerable, citing Soil Conservation Service figures to support their claim. Hart (1976) also cites Federal Government-generated data, on "urbanized areas" published in each census of the population since 1950 and on "urban and built-up" acreage of each county published in the National Inventory of Soil and Water Conservation Needs.

Marion Clawson writes in Suburban Land Conversion in the United States (1971), that data on urban land use tend to be poor. For one
thing the legal city does not cover the same boundaries as the economic or social city. And in collecting data, one must assume one of two views: 1) that of the urban planner, who is concerned with actual land use within the city or 2) that of the agriculturalist who is concerned with land lost to agriculture. As Clawson points out, these areas of land are not approximately the same by definition. In a 1979 survey of conservation districts forty-one percent of the district officials agree that urban encroachment on rural land is a serious problem (Council on Environmental Quality 1980).

The extent of urban encroachment in southwest Grand Forks will be determined utilizing a series of aerial photographs from 1954, 1962, 1970, 1974, 1977, 1979, and 1980. For each study year, land will be classified according to use, those areas measured, and the percentage of land occupied by each use class calculated. Farmland loss can be readily measured using this method, which is suitable for a case study of a fairly small area.

**Land Use: Case Studies and Controls**

A case study in land use dynamics in the Matanuska Valley of Alaska revealed that urban pressure on existing farmland is increasing due to 1) expansion of metropolitan Anchorage and 2) expansion of the petroleum industry. The author's conclusions are drawn from his description of site features, petroleum industry impact and agricultural development (Gjerde 1975). Unfortunately the graphics presented in the article failed to provide the reader a complete assessment of the extent of the urban encroachment problem.
Platt's study of Iowa farmland conversion (1981, p. 113) emphasizes the significance of the loss of prime Iowa acreage. From 1969 to 1974, total acreage in farms decreased by approximately 500,000 acres—this in a state where urban growth is small. After describing Iowa's agricultural output, Platt details sources of encroachment and the forms of public response, land use policies which he believes will help preserve agricultural land.

Sources of encroachment include linear strip development, isolated dwellings, and subdivisions. A common result of residential development is the clash of interests. Noise, chemicals, unpleasant odors and the early hours employment normal to a farming operation may prove offensive to a nearby development resident. Likewise, the interruption of drainage and possible problems of vandalism, trespassing and liability to minors hinders a farmer's work and his enjoyment of rural living. Extending services to isolated subdivisions is more expensive than providing them to compact settlements. Ultimately higher taxes must be assessed both farmland and buildings. Piecemeal encroachment takes place with the construction of shopping centers, schools, roadside businesses, public utilities and small industrial concerns. Expansion of landfill and dumps beyond city limits is common, as is the construction of airports, highways and overhead power lines.

Certain factors such as weather, market prices, international trading policies, cost of seed and fertilizers and the average age of farmers is beyond governmental jurisdiction. To the Federal sphere belong such controls as Federal income and estate taxes, interstate commerce rates, agricultural price supports and national environmental standards. The state can utilize such privileges as 1) "the spending
power," acquisition of interests in land, 2) "the taxing power," taxation of real and personal property, 3) "the police power," regulation of land use in order to promote public health, safety and welfare.

Preferential assessment has been adopted in one form or another in forty-four states. Although it may vary from state to state, its basic feature is to assess farmland at its use value rather than its development value (Platt 1981). To be eligible in most states one need only keep the land in agricultural use. Other forms of differential assessment include deferred taxation and restrictive agreement. Twenty-eight states have adopted deferred taxation, which allows for use value assessment and requires that all or some of the taxes saved be paid back if the participant converts his land to an ineligible use (definition varies from state to state). When the participant terminates his agreement, rollback taxes, i.e., the difference between fair market value and the agricultural use value, covering a prescribed number of years, must be paid. Some states have chosen to enact land use change taxes, which are simple percentages of the fair market value tax.

Restrictive agreements (in the states of New Hampshire and California) are primarily contracts in which the participant agrees not to develop his land in return for differential assessment. In Washington, Hawaii and Pennsylvania owners must also sign such an agreement, but the penalty for conversion is payable in rollback taxes (Regional Science Research Institute n.d.).

Preferential taxation alone is ineffective in reducing the rate of conversion of agricultural land (Platt 1981). Differential taxation is effective in the following cases: 1) when the farmer is able to save enough on taxes to make his operation more profitable, 2) as long
as the farmer need not sell because of retirement, illness, death, urban encroachment or other impinging reasons. Used alone, restrictive agreements, preferential taxation or differential taxation fall short of preserving agricultural land, but utilized in conjunction with agricultural zoning or development rights purchase, they promote equity in taxation and provide incentives for program involvement (Regional Science Research Institute n.d.).

In 1973 a preferential tax bill was passed in the North Dakota State Legislature. It provided for continued classification of agricultural land in an annexed area, so long as that land remained in the same use. The next important feature of the bill is that agricultural land within the city limits, whether platted or not, was to be assessed for ad valorem property taxes. As long as the land remained in agricultural production, the farmer was assured of an assessed value similar to that assessed adjoining unannexed farmland (North Dakota Century Code, Sec. 40-51.2-06. 1981 Pocket Supplement).

In 1981 a bill was enacted which allowed for ad valorem property assessment of agricultural lands whether they were within the corporate limits of a city or not. In order to receive preferential taxation, the agricultural lands must have been platted and assessed as agricultural property before March 31, 1981. Until the lands are put to another use, they will be assessed preferentially (North Dakota Century Code, Sec. 57-02-27. 1981 Special Supplement). A previous version of the bill had stipulated that only unplatted, annexed agricultural land could be preferentially assessed.

Other land preservation techniques include agricultural zoning, purchase of development rights (PDR), and agricultural districting.
Agricultural zoning is not yet common. As of 1968 only twelve percent of all county governments reported using any type of land use controls. The drawbacks of rural zoning are that 1) new residents in developing communities may zone to abate the unpleasant external nuisances inherent in farming, or 2) farmers may zone land for non-agricultural use in order to create more potential for development. Although it is not common to create "agriculture-only" zones, it would be a good way to promote preservation of agricultural land.

PDR provides for a state or local government agency to negotiate with a landowner, who sells the right to subdivide or develop his land. Subsequently all new buyers of the property are prohibited from subdividing or developing. Two major weaknesses of the program are that 1) development rights may be expensive and 2) purchase of development rights does not ensure that active farming will be continued on the property. Agricultural districting involves the creation of land reserves. Participation by landowners in the California program is voluntary. Under the New York state program, land may be included in a reserve without the landowner's consent (Platt 1981).

In 1965 California enacted the Williamson Act, a differential assessment program. Local governments enter into contracts with owners of nonurban land, creating agricultural preserves where land may be used only in "open space" or similar uses for ten years. In return for use value rather than market value assessment, voluntary participants agree not to develop their land. Cancellation of a contract means a landowner is obligated to pay up to fifty percent of the new assessed value of the property unless the penalty is waived by the local government. A combination of tax incentives which are too low and unsystematic
implementation of the program has made it ineffective as a land use
management tool (Gustafson and Wallace 1975). As Gardner points out,
the main idea of tax preference schemes is to lower land use costs for
farmers so that they can afford to keep land in production. If a farmer
can make more by developing or subdividing, however, land use changes
will occur (Gardner 1977).

In 1974 Suffolk County on Long Island instituted its pioneer pro-
gram, utilizing both agricultural districting and PDR. Forming an
agricultural district is a time-consuming, voluntary effort, requiring
the cooperation of grass-roots organizers, state, and local government.
Each district must contain at least five hundred acres and its bounda-
ries are reviewed every eight years. By electing to take part in a
district, a farmer gains assessment at use rather than market value,
and protection from special assessment and local ordinances which extend
beyond the requirements of health and safety.

In semi-rural and semi-suburban areas interest in farmland pres-
servation is greatest. In a semi-rural area, the nonfarm population
outnumbers the farm population by more than ten to one. In a semi-
suburban area, the nonfarm population outnumbers the farm population
by more than thirty to one. The program fails to meet the "trigger
price" level existing already in semi-suburban areas. At the "trigger
price" level most farmers can sell their farmland and make enough to
relocate. This higher-than-farm-value price level is not met in semi-
rural areas, although an occasional high dollar price per acre may be
paid. Because agricultural districting does not solve all semi-suburban
land management problems, Suffolk County engineered a PDR program, with
the provision that the county could acquire land fee simple. In the
short term that county's program has been fairly successful. Long
term success will depend on the taxpayers' willingness to bear the high
cost of development rights purchase (Bryant and Conklin 1975).

In 1961 Hawaii instituted a comprehensive zoning plan. The entire
state was zoned into one of four categories: urban, rural, conserva-
tion, agriculture. In 1974 forty-eight percent of that state's land
was allocated to agriculture. It is possible for landowners to change
use and/or district boundaries by petitioning the Hawaii Land Use Com-
mission. In addition, reduced assessment of farmland is provided for
in two programs: tax deferral and dedication. Under dedication a farm
owner may voluntarily restrict the land use to agriculture for twenty
years (Platt 1981).

Farmers produce two important products: agricultural commodities
and developmental sites. The factor common to both is the farmer's
land. In order to operate, the farm must generate a profit equal to
or greater than the interest returned by selling the land and investing
the capital elsewhere. It is not uncommon for farmers to be squeezed
twice by taxation--once, when the actual market value of land appreci-
ates with nearby development or speculation, and a second time, when
residential growth demands the extension of municipal services (Platt
1976). Agriculture is a very competitive industry. Farmers near
urbanizing areas may choose to compete in agriculture or sell their
land for development. This alternative, write Vogel and Hahn (1972)
leads to little interest in farmland preservation. At best, a farmer
would probably favor preferential tax treatment and protection from
eminent domain and local ordinances until he wishes to sell some land.
Acquisition, regulation and persuasion are the chief methods of public intervention in the private land use decision process. Most land use control takes place at the local level. At this level incentives such as preferential assessment, regulation such as zoning and subdivision controls and acquisition such as voluntary sale and eminent domain would have the most impact on agricultural land preservation (Platt 1976). The decision to preserve agricultural land is dependent upon a number of factors, including 1) the willingness of taxpayers to a) pay for development rights acquisition, b) bear the additional tax burden caused by preferential taxation and the cost of program administration, 2) the cooperation of farmers, 3) a perceived agricultural loss problem.

Prime farmland is described by the SCS as land which has the best combination of physical and chemical features to grow food, fiber, oil-seed crops, and forage. This land may be in pasture, forest, range or crop production but is not urban built-up or water-covered. Because of its soil quality, growing season and moisture supply are adequate if not superlative, it produces high yields economically (U.S. General Accounting Office 1979). The concept of prime farmland, though, is a device which ranks cropland and varies from locality to locality. What is prime in mountainous states of North America would not be considered prime in Iowa or central Illinois. Nationally the greatest urban threat to rural land occurs in the heartland of rain-fed agriculture—in a curve from Norfolk, Virginia westward to St. Louis and Kansas City, northeast to Omaha, Minneapolis-St. Paul and Duluth. In virtually all of this area are urban centers where demand for land has raised land values beyond consideration of agricultural productivity (Raup 1975).
Land Use: Classification

The problems inherent in land classification have been described by Mabbutt, Clawson, Griggs and Westerlund. Land classification, according to Mabbutt (1968, p. 11), involves examining the surface and near-surface characteristics which define a local area, recording and identifying this local character, and establishing its "area of occurrence." A land classification imposes a general framework which identifies and describes common character and similarities, despite geographical separation. Grigg (1965) uses a concept similar to Mabbutt's "common character," explaining that classification groups objects on the basis on common properties or relationships.

In designing a land use classification scheme, Westerlund (1979) points out the importance of weighing the ultimate uses of the information generated by the land use/land cover scheme with the ability of the data source to provide information. The land use scheme, according to Clawson (1969, p. 115), should be flexible in two ways. First, the user should be able to summarize the classification or use it in great detail. Depending upon the user's needs, the classification should be usable for some activities in great detail and yet easily summarized for others. Second, it would be possible to recombine basic information in different ways, in what is sometimes called the "accordion" effect. This kind of flexibility implies that parts of the classification scheme could be greatly compressed and one part expanded in great detail to meet the needs of the user. As Grigg (1965) points out, classifications are not absolute. As more information about the objects under study becomes known, it becomes imperative to adapt the classification.
In reviewing existing land use and land cover classifications for applicability in analysis, Westerlund does not recommend the conventional Standard Land Use Coding Manual (SLUCM) for photo interpretation, because that scheme mixes physical and land activity descriptors. He finds the Land Use and Land Cover Classification System for Use with Remotely Sensed Data valuable in that it is a flexible framework which unlike the SLUCM allows the user to tailor Level III categories as needed and provides a framework for national comparison (Westerlund 1979). It is part of an effort of the U.S. Geological Survey to establish a national land use and land cover inventory. Land cover refers to the type of feature present on the earth's surface, for example, urban buildings, glacial ice, maple trees. Land use refers to the human activity associated with the piece of land, for example, single-family housing (Lillesand and Kiefer 1979).

Other national land use inventories have been established, including the SLUCM in 1965 and the Canada Land Inventory in 1970. The former is an urban land use coding manual and one which is recommended by many planning textbooks. It also, according to Burns, "contains irrelevant detail, that is based on economic activity unrelated to land use, and it oversimplifies rural land use" (Burns 1980). The Canada Land Inventory is a more recent venture, designed for planning purposes at the Federal, provincial and municipal level. Its imagery collection method was not described, however, it does use a computer technique which depicts the land classified according to its capability for use.

The need for a resource-oriented inventory beyond the people-oriented SLUCM was determined. Anderson's U.S.G.S. classification scheme was designed to fulfill a number of functions, including
providing consistency and compatibility within one system (heretofore not possible), providing regional, state and Federal planners with necessary informational links and providing baseline data necessary for environmental monitoring. In order to accommodate the resource orientation of the inventory, classification is based upon land cover. Because remotely sensed data is the chief data base, such an approach is more appropriate, especially when one considers the difficulty of identifying an activity (farming, forestry) compared to a land cover (cropland, forest land) (Anderson and others 1976). See Appendix.

In order to solve the problem of scale, the classification scheme has been divided into four levels. At each level a general remote sensor type has been designated to accommodate the scale of imagery required for the level of information required. Level I data would typically be generated from LANDSAT data, from a height of 918 km (570 miles) at a scale of 1:1,000,000. This data is typically generated from high-altitude imagery at a height of 12,400 meters (40,000 feet), roughly less than a scale of 1:80,000. Level III generally utilizes medium-altitude aerial photography taken between 3100 and 12,400 meters (10,000 and 40,000 feet), producing a scale of 1:20,000 to 1:80,000 (Anderson and others 1976).

At the time Anderson wrote Professional Paper 964 in 1976, he included only the more generalized first and second levels. At these levels the system can serve planners and managers as a framework for land use and land cover classification. Eventually, with refinement, this system will meet the long-term goal of "providing a standardized system of land use and land cover classification for national and regional studies" (Anderson and others 1976, p. 8). Level II is the
keystone of the classification system, considered the "most appropriate for statewide and interstate regional land use and land cover compilation and mapping" (Anderson and others 1976, p. 9).

The Colorado Land Use Classification System published in 1976 required two years to develop and was based on previous Colorado and United States classification. It is essentially a planner's inventory for regional, county and municipal use (Burns 1977), designed to "meet the need of a comprehensive statewide frame of reference for describing and mapping land use." The primary purpose of the inventory is to provide a consistent system for mapping land use (Burns 1977, p. 22). It is a hierarchical scheme, classifying three levels of data, subdividing the first order into subsequent subcategories. Like Anderson's scheme, the first and second order classify regional or county land use and the third order municipal land use (Burns 1977).

Because of widespread acceptance and flexibility, the classification scheme used in research is adapted from Anderson and others'. Originally Level III classes and enumeration were used, since the aerial coverage of the study area supported by ground truth provides the resolution necessary to determine, for example, land occupied by single or multiple-family dwellings. Because the study area is only part of Grand Forks and does not encompass many different types of land use/land cover, it was found that Level III categories went into far more detail than necessary, covering such possible uses under "Residential" as single-family units, multi-family units, group quarters, residential hotels, mobile home parks, transient lodgings and other (Anderson and others 1976). Level II general use categories were used (see Appendix), but as before, there were too many classes inapplicable to the study.
Anderson's form is retained so that this scheme is easily interpreted by anyone familiar with that classification. The Level II categories include residential, commercial and services, transportation, cropland, and streams and canals. Because Anderson's scheme is flexible, the special categories public and idle or vacant land are added easily. Because there are only seven general categories, these are not numbered, but the subcategories under each are, beginning with one.

The Grand Forks Land Use Plans: 1961 and 1979

In 1961 Minneapolis planning consultants Nason, Law, Wehrman and Knight, Inc. (1961) formulated a twenty-year growth plan for the city of Grand Forks. Existing land use patterns were evaluated, projections of future population and space needs made, and recommendations for future expansion written. The comprehensive plan sought to identify areas of sound development, enhance the aesthetics of the community, maintain a high level of public services, and increase "convenience and livability" in Grand Forks proper.

Building a city in the sometimes dry lake bed of glacial Lake Agassiz presents problems and distinct advantages. Because the local topography is uniquely level, the city could grow in three directions—west, north or south. The Red River of the North, which forms the city's eastern boundary, and the English Coulee are the only significant interruptions in otherwise flat terrain. This flatness, though, creates the need for lift stations to carry off storm and sanitary sewer run-off and other facilities to handle surface drainage. The 1961 report of the Minneapolis consultants specifically recommended that the land along English Coulee and the Red River be preserved as a natural community asset wherever possible.
Among the goals of the comprehensive land use plan is the consolidation and grouping of similar uses of land, elimination of mixed uses, and the addition of aesthetic features. Adherence to these general planning principles, it was believed, would encourage compact growth, which would make the extension of public services economical and efficient. By eliminating mixed land uses, conditions which encourage lower land values and ultimate urban decline would be abated. Cluster commercial development is encouraged in the plan while strip and spot commercial use is discouraged (Nason and others 1961).

The Fringe Area Development Study prepared by the Grand Forks Planning Office (1975) identifies many problems similar to those described in the 1961 Comprehensive Plan. The latter, for example, recommends cluster rather than further highway strip development. According to the Grand Forks Planning Office, by 1975, the South Washington Street commercial strip is "uncoordinated, congested, and dehumanized," although compact development was a goal of the 1961 plan, the 1975 report lists scattered fringe development as a serious urban problem, causing increased driving distance, leapfrog development, and excessive city taxation (Grand Forks City Planning Office 1975, p. 3). Like the report which came before it, the 1975 study recommends planned compact development, citing as advantages 1) the preservation of prime agricultural land, 2) prevention of loss of the city tax base, and 3) the protection of rural cultural environment beyond the city limits.

In the update of the 1961 plan, the Year 2000 Land Use Plan, the compact development pattern is again listed as a master plan goal. The Planned Unit of Development (PUD) is encouraged as policy in order to better design and mix land uses on large parcels of property.
Contiguous development, maximization of agricultural land and the avoidance of waste in urban land use are also cited as policy goals. New to the plan is the staged growth concept. Basically it restricts urban development to contiguous city areas and/or fixed amounts of land, saving on extension of public services, utilities and facilities. The concept divides the city into four development tiers, three under the jurisdiction of zoning controls and the fourth, the farmland tier, beyond the city's extraterritorial zoning limit (Grand Forks City Planning Office 1979). The policy is an attempt to avoid leapfrog development, which leads to problems in 1) providing or extending urban services, if the property tax base is low, 2) financing schools in developments without substantial industrial or commercial investment, 3) land left vacant because of speculation (Isberg 1973).

The literature of farmland loss is divided into two points of view. The first point of view describes cropland loss as significant nationally and focuses on ways to prevent further acreage losses. The second views the problem as an issue which is pertinent to only a few localities. Cropland is encroached and converted to other uses through development. The rural-urban fringe is a focus of that kind of activity. Incentives such as preferential taxation, differential assessment, and restrictive agreements may keep cropland in production, if benefits are high enough to offset the potential profit of conversion. The classification scheme is an integral part of this research. It has been adapted from Anderson's scheme, designed to be flexible and describe the land use and land cover within the study area.

The tools and methodology of the study are described in the following chapter. Aerial photos, the measurements made from them,
actual use of the classification scheme and the generation of computer graphics, which depict the land use and land cover changes, are important facets of this research.
CHAPTER III

METHODOLOGY

Two important elements of the research have been explained, including selection of the land use and land cover classification scheme and the determination of the boundaries of the study area. End product of the research is a chronological series of seven computer-generated maps detailing the land use and land cover changes from 1954 to 1980. Tabular data on total acreage per year, land use and land cover class acreage per year and each class' percentage of the total are generated from the digitized base maps.

Aerial Photos

Basic to this research are aerial photos used to compile the computer-generated maps. Important criteria of photo selection include 1) availability and 2) resolution. Air photos ready for use within the geography department and those available on loan from city and Federal offices formed the foundation of inquiry. Ideal air photo coverage would include every five years for three decades. Each air photo in such a perfect scheme would contain the same scale to ensure uniform resolution. Due to cost constraints, research has been pursued with available and existing materials.

Aerial photos from 1954, 1962, 1970, 1974, 1977, 1979 and 1980 provide a mixture of large and medium-scale coverage. Scale for each air photo was calculated utilizing a ground distance measurement (D)
and photo distance (d) measurement in the formula \( S = \frac{d}{D} \). Ground distance was determined by measuring an easily identifiable feature, object, or line on the ground and multiplying that distance by the map or air photo scale (Lillesand and Kiefer 1979, p. 81). In this manner scales were determined and rounded off to 1:20,000 for 1954; 1:16,000, 1962; 1:10,000, 1970; 1:20,000, 1974; 1:9,500, 1977; 1:9,600, 1979 and 1:3,000, 1980.

Resolution, a second major criteria, is defined by Sabins as "the minimum separation between two objects at which the objects appear distinct and separate on an image" (1978, p. 9). Lillesand and Kiefer describe medium-scale coverage (1:20,000 to 1:60,000) as best suited for identification, classification and mapping of land cover (crop and soil types, for example). Large-scale coverage (1:20,000 or larger) which affords "large" resolution, is best suited for intensive monitoring of crop damage or natural calamity. A mixture of large and medium-scaled photos provided the best compromise coverage.

Interpretation of the aerial photos followed the seven basic characteristics described by Lillesand and Kiefer: shape, size, pattern, shadow, tone, texture, and site (1979). The study area was physically field-checked, with reference made to quadrangles and zoning maps to verify cultural and/or natural features. Two U.S.G.S. 7.5 minute, 1:24,000 quadrangles (1963 and 1979) of Grand Forks were used, as were Grand Forks city zoning maps from 1980, 1974, and 1965. The difficulty of matching existing maps to existing air photo coverage presented itself again and when the information could be double-checked, it was used.
Land Classification Scheme

Following interpretation, and references to ground truth, the entire study area was physically field-checked to ensure accuracy of interpretation. With earlier air photos only quadrangles and zoning maps could be used as references when they proved available.

Land within the study area is classified into twenty land use and land cover classes, grouped under the general headings of Residential; Commercial and Services; Transportation; Public; Idle or Vacant Land; Cropland; Streams and Canals. See Table 1.

Multi-family housing is considered, for purposes of classification, to a residence for two or more families. Rural residential is determined by one or two criteria: 1) the existence of outbuildings, 2) close proximity to cultivated cropland. Classification 5, Mixed multi-family and single-family dwellings, is used where neither land use dominates, and both are interspersed.

The rest of the classifications are, for the most part, self-explanatory. Major corridors are distinguished from minor corridors in 1) the condition of the road (improvements, pavement, width) and 2) proximity of commercial services. Idle or vacant land is a class designed to account for 1) agricultural land which is fallow in a given year and 2) land which is transitional, usually between use as agricultural and developed land. Land cover classified as coulee consists of the English and other coulees within the study area which run intermittently. Riparian drainage, for the most part, consists of the floodplains of the coulees within the study area.

With interpretation completed and all areas classified into land use and land cover classes, the information was transferred to the base
### TABLE 1
THE LAND USE AND LAND COVER CLASSIFICATION SCHEME

<table>
<thead>
<tr>
<th>Major Land Use and Land Cover Classification</th>
<th>Land Use and Land Cover Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Single Family</td>
</tr>
<tr>
<td>2</td>
<td>Multiple Family</td>
</tr>
<tr>
<td>3</td>
<td>Mobile Homes</td>
</tr>
<tr>
<td>4</td>
<td>Rural</td>
</tr>
<tr>
<td>5</td>
<td>Mixed Multiple and Single-Family</td>
</tr>
<tr>
<td>Commercial and Services</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Strip Development</td>
</tr>
<tr>
<td>7</td>
<td>Shopping Center</td>
</tr>
<tr>
<td>8</td>
<td>Medical</td>
</tr>
<tr>
<td>9</td>
<td>Light Industrial</td>
</tr>
<tr>
<td>Transportation</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Major Corridor</td>
</tr>
<tr>
<td>11</td>
<td>Minor Corridor</td>
</tr>
<tr>
<td>12</td>
<td>Railway</td>
</tr>
<tr>
<td>Public</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>School</td>
</tr>
<tr>
<td>14</td>
<td>Cemetery</td>
</tr>
<tr>
<td>15</td>
<td>Recreation</td>
</tr>
<tr>
<td>16</td>
<td>Water Holding, Storage</td>
</tr>
<tr>
<td>Idle or Vacant Land</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Idle or Vacant Land</td>
</tr>
<tr>
<td>Cropland</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Cultivated Cropland</td>
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<tr>
<td>Streams</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Coulee</td>
</tr>
<tr>
<td>20</td>
<td>Riparian Drainage</td>
</tr>
</tbody>
</table>
map. Polygons were measured in millimeters using the Michigan Parallax Wedge II and transferred onto the 1:3,000 base map. Air photo distance was multiplied by photo scale and the result divided by 3,000 to yield base map distance.

Computer Mapping

With the base map completed, i.e., containing seven years' data, the next step was to prepare the base map for digitizing. First, points defining the polygons were numbered, an advantage of the CALFORM over the SYMAP program in trouble-shooting. Next the polygons were numbered, so that they may be called up in the program, and the origin (0,0) defined in the lower left-hand corner. Actual digitization involves placing the cursor on a point, and punching the number one on the cursor to measure the point's x,y coordinates (distance from 0,0). After all points are digitized, the data is printed onto cards by the computer, and are used in running the CALFORM computer program.

Using the outline format of the CALFORM program, preliminary base maps for each year of coverage were generated. Throughout the improvement process, the accuracy of polygons represented in yearly base maps was checked against the master base map. When the base maps were in final form, the land use and land cover of each polygon was re-checked and ground truth used to verify classifications where possible.

The next aim of the research was to determine area. Because the original aerial photos were not similarly scaled, the computerized base maps were used since scale was transformed through the digitization process. Area was measured on the digitizer and a scale transformation factor was punched in to yield measurement in acres. First, map scale was divided by 63,360 to yield X. The scale transformation was then
determined in this way: Scale factor = 640 \times X. In order to determine the areal accuracy of the computerized base maps, measurements were taken from one and compared to those taken from the original mylar base map. Area on the computerized base map was found to be about one percent less than the total measured on the master base map. Measurements taken on the computer maps were rounded off to tenths. It is only possible to speculate on the cause of the difference, which may lie in the computer algorithm used in digitizing, the plotter, or the digitizer itself.

The total area encompassed by the study varies slightly in two groups of years. In 1980, 1979, 1977, and 1974, because of the inclusion of the widened South Forks Road and a slight curve in the road which marks the western study limits (Forty-second Street), total acreage is 1,540. In 1970, 1962, and 1954, because these changes are absent, total acreage measures 2,529. Because of this difference in acreage, comparison of total land area devoted to different land use and land covers was made using percentages. Utilizing percentages allows comparisons to be made on a base of one hundred. Due to this difference, percentages of total land area devoted to different land uses and land covers facilitate comparisons between years.

The basis of this research is intermittent air photo coverage over a twenty-six year period. With completion of the interpretation and classification methods outlined above, the acreage of each land use and land cover class was determined. The results are summed in tabular form in the chapter following.
CHAPTER IV

RESULTS

Air photos used in classifying and delineating land use and land cover within the study area form the crux of this research. From these acreage devoted to each land use and land cover class was determined, percentage of total area per class then calculated and results presented in Tables 2 and 3. Through comparison of acreage percentages, it is possible to examine striking land use and land cover changes over this twenty-six year period.

Acreage

Cultivated cropland declined from 80.5 percent of total land use in 1954 to 26.7 percent in 1980. The most dramatic decrease (20.9 percent) occurred between 1974 and 1977 and between 1962 and 1970 (12.9 percent). Residential land use, conversely, rose steadily with the greatest increase between 1974 and 1977 (10.5 percent). Land devoted to commercial and services also expanded over this period, with the most noticeable increase between 1974 and 1977 of 6.9 percent. The transportation network increased slightly, claiming 4.6 percent of the total land area in 1954 as opposed to 6.2 percent in 1980. Land devoted to public use or service increased from 0.7 percent in 1954 to 7.1 percent in 1980, with the greatest change occurring between 1962 and 1970. The relative percentage of land which was idle or vacant was highest in 1977, 1979, and 1980, over 8 percent of the total in those
### TABLE 2

**LAND USE AND LAND COVER CLASSIFICATION: TOTAL ACREAGE PER CLASS**

<table>
<thead>
<tr>
<th></th>
<th>Residential</th>
<th>Commercial and Services</th>
<th>Transportation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1954</td>
<td>103</td>
<td>--</td>
<td>7</td>
</tr>
<tr>
<td>1962</td>
<td>217</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>1970</td>
<td>281</td>
<td>27</td>
<td>78</td>
</tr>
<tr>
<td>1974</td>
<td>336</td>
<td>50</td>
<td>78</td>
</tr>
<tr>
<td>1977</td>
<td>520</td>
<td>132</td>
<td>139</td>
</tr>
<tr>
<td>1979</td>
<td>572</td>
<td>139</td>
<td>152</td>
</tr>
<tr>
<td>1980</td>
<td>572</td>
<td>144</td>
<td>152</td>
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</table>

**NOTE:** See Table 1 for classification scheme.
<table>
<thead>
<tr>
<th>Public</th>
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<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
<th>20</th>
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<tbody>
<tr>
<td>Idle or Vacant</td>
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<td>134</td>
<td>2529</td>
<td></td>
<td></td>
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<td>2036</td>
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<tr>
<td>679</td>
<td>11</td>
<td>76</td>
<td>2540</td>
<td></td>
<td></td>
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</tbody>
</table>
### TABLE 3

LAND USE AND LAND COVER CLASSIFICATION: PERCENTAGE OF TOTAL ACREAGE PER CLASS

<table>
<thead>
<tr>
<th></th>
<th>Residential</th>
<th>Commercial and Services</th>
<th>Transportation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1954</td>
<td>4.1</td>
<td>--</td>
<td>0.3</td>
</tr>
<tr>
<td>1962</td>
<td>8.6</td>
<td>0.2</td>
<td>0.5</td>
</tr>
<tr>
<td>1970</td>
<td>11.1</td>
<td>1.1</td>
<td>0.5</td>
</tr>
<tr>
<td>1974</td>
<td>13.2</td>
<td>2.0</td>
<td>2.8</td>
</tr>
<tr>
<td>1977</td>
<td>20.5</td>
<td>5.2</td>
<td>2.8</td>
</tr>
<tr>
<td>1979</td>
<td>22.5</td>
<td>5.5</td>
<td>2.6</td>
</tr>
<tr>
<td>1980</td>
<td>22.5</td>
<td>5.7</td>
<td>2.6</td>
</tr>
</tbody>
</table>

NOTE: See Table 1 for classification scheme.

*Less than 0.1 percent of total acreage.
**TABLE 3--Continued**

<table>
<thead>
<tr>
<th></th>
<th>Public</th>
<th>Idle or Vacant</th>
<th>Cropland</th>
<th>Streams</th>
<th>Total Acreage</th>
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<td>13</td>
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<td>16</td>
<td>17</td>
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<tr>
<td>--</td>
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<td>0.1</td>
<td>--</td>
<td>1.1</td>
<td>80.5</td>
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<tr>
<td>0.7</td>
<td>0.6</td>
<td>0.2</td>
<td>--</td>
<td>1.2</td>
<td>72.8</td>
</tr>
<tr>
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<td>0.7</td>
<td>4.0</td>
<td>--</td>
<td>4.4</td>
<td>59.9</td>
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<tr>
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<td>0.7</td>
<td>3.9</td>
<td>--</td>
<td>5.6</td>
<td>51.8</td>
</tr>
<tr>
<td>2.2</td>
<td>0.7</td>
<td>4.0</td>
<td>0.2</td>
<td>8.8</td>
<td>30.9</td>
</tr>
<tr>
<td>2.2</td>
<td>0.7</td>
<td>4.0</td>
<td>0.2</td>
<td>8.1</td>
<td>27.5</td>
</tr>
<tr>
<td>2.2</td>
<td>0.7</td>
<td>4.0</td>
<td>0.2</td>
<td>8.6</td>
<td>26.7</td>
</tr>
</tbody>
</table>


years. The decline in stream acreage is attributable to the decrease of land held in riparian drainage, the coulee course change accounting for only a 0.1 percent decline.

These figures also help to explain the trend towards urbanization in the study area. The most obvious is the displacement of cultivated cropland. As stated previously, 80.5 percent of the total land area in 1954 was agricultural land. At the same time, 4.1 percent was utilized for single family housing, 0.4 percent for strip development, 0.3 percent for light industrial, and 4.3 percent for railway. In 1962 cultivated cropland declined to 72.8 percent of the total and railway to 4.0 percent, with an accompanying increase in urban land uses: 8.6 percent in single family housing, 0.2 percent in multiple family dwellings, 1.2 percent in strip development, 1.7 percent in shopping center (South Forks Plaza under construction) and 0.6 percent in light industrial.

In 1970 agricultural declined to 59.9 percent. Single family housing increased to 11.1 percent, multiple family housing to 1.1 percent, strip development to 3.1 percent, and shopping center to 1.9 percent. Light industrial and railway remained the same at 0.6 percent and 4.0 percent of the total.

In 1974 cultivated cropland continued to decline, to 51.8 percent, while urban uses increased. Single family housing continued to increase, to 13.2 percent, as did multiple family housing, to 2.0 percent. Strip development increased to 3.6 percent, while shopping center remained static at 1.9 percent and light industrial at 0.8 percent. Land occupied by railway declined to 3.7 percent. In 1977 single family housing increased at the highest rate, to 20.5 percent.
while cultivated cropland declined at the highest rate, to 30.9 percent of the total. Other urban land uses made a significant jump: multiple family, 5.2 percent; strip development, 5.5 percent; shopping center (now including Columbia Mall and South Forks Plaza), 6.0 percent. Light industrial remained the same (0.8 percent) as did railway (3.7 percent).

In 1979 single family housing increased to 22.5 percent, while cultivated cropland declined to 17.5. Multiple family increased to 5.5 percent, and strip development to 5.9 percent, while shopping center, light industrial and railway remained the same. In 1980 cultivated cropland was 26.7 percent, only slightly larger than the 22.5 percent devoted to single family housing. Multiple family dwellings increased slightly, to 5.7 percent, as did strip development, to 6.0 percent. Shopping center remained stable in 1980, as did railway. The construction of the Medical Complex within the study area also contributed to the urbanization trend. In 1974 the Medical Complex occupied 1.8 percent of the total land area. In 1977 its share of total acreage rose to 2.7 percent, remaining steady in 1979 and 1980.

The period between 1974 and 1977 was crucial to the development of the study area. As pointed out, cultivated cropland dropped significantly between these two years, from 51.8 percent to 30.9 percent. Some urban land uses increased significantly: single family from 13.2 to 20.5, multiple family from 2.0 to 5.2, strip development from 3.6 to 5.5, shopping center from 1.9 to 6.0 and medical from 1.8 to 2.7. Evidence of land use in transition appeared in the disparate idle or vacant land acreage percentages for 1974 (5.6) and 1977 (8.8). As land was developed for urban use, it appeared to leave a higher percentage vacant while in transition from agricultural cultivation.
Expansion of the transportation network within the study area is another indicator of the urbanization trend. In 1954, 1962 and 1970 DeMers Avenue was a minor street, connecting traffic from the railroad yard, light industrial development and single family housing to cultivated cropland and rural residences. By 1974 DeMers Avenue had been widened and improved, serving as a link to Interstate 19, past single-family housing, strip development, railway, light industrial development, land in transition (idle or vacant land) and a golf course. Rural residential remained, though smaller in acreage than previously. In the same time-frame minor arteries also began to expand in the study area to link residential and commercial land use to a new major north-south corridor, Columbia Road, and another Interstate link, South Forks Road.

Land devoted to public use and services also supports the urbanization trend, though less dramatically. Benjamin Franklin School occupied 0.7 percent of the total land area in the 1962 study year. By 1970, Red River High School and Benjamin Franklin School occupied 2.2 percent of the total land area. Sunset Memorial Gardens (cemetery) expanded slightly, from 0.6 percent in 1954 and 1962 to 0.7 percent in 1970 and the following years. With the conversion of agricultural land to golf course (Ray Richards) between 1962 and 1970, recreation occupied 4.0 percent of the total.

Not surprisingly the percentage of land devoted to rural residences declined between 1954 and 1980. Slightly larger in 1962 (2.5 percent), it decreased from 2.2 percent in 1970 and 1.3 percent in 1974 and 1977 to 1.0 percent in 1979 and 1980. Mobile homes have had a rather checkered history, beginning in 1954 with 0.1 percent of total
area, increasing slightly to 0.5 percent in 1962, reaching their apex in 1974 and 1977 with 2.8 percent and decreasing slightly to 2.6 percent in 1979 and 1980. Mixed multiple and single family dwellings did not appear as a land use until 1974, where it occupied 0.1 percent of total land surface. In 1979 and 1980 the total rose to 0.7 percent.

The percentages of land use and land cover devoted to residential, commercial and services, transportation, idle or vacant land, cropland, streams, and public are graphed in Figure 1. This graph dramatically depicts the trend of declining agricultural and increasing residential acreage within the study area. In 1977 acreage devoted to agricultural use was only slightly larger with the two lines meeting shortly thereafter. By 1979 residential acreage was larger, although beginning to level off.

The graph also shows the steady rise of commercial and services property, which increased at the highest rate between 1974 and 1977, and then increased only nominally. The percentage of land left vacant or idle also increased between 1974 and 1977, at nearly the same rate as commercial and services, leveling off thereafter. The only class which declined was streams, which included riparian drainage and coulee.

Overall, the classes which are urban (residential, commercial and services, transportation and public) increases over the twenty-six year period, while cropland and streams decline. (Idle or vacant land, as aforementioned, is composed of idle cropland and land held vacant in transition from agricultural to urban use.)

Land use and land cover within the study areas are depicted in Maps 2 through 8. The twenty classes listed in Table 1 are depicted
Fig. 1. Land use and land cover devoted to residential, commercial and services, transportation, public idle or vacant, cropland and streams (in acres).
Map 2. Land use and land cover: 1954. Major land use and cover classes include 1--Single Family; 3--Mobile Homes; 4--Rural Residential; 6--Strip Development; 9--Light Industrial; 11--Minor Corridor; 12--Railway; 14--Cemetery; 15--Recreation; 17--Idle or Vacant Land; 18--Cultivated Cropland; 19--Coulee and 20--Riparian Drainage.
Scale - 1:20,000
Map 3. Land use and land cover: 1962. Major land use and cover classes include 1--Single Family; 2--Multiple Family; 3--Mobile Homes; 4--Rural Residential; 6--Strip Development; 7--Shopping Center; 9--Light Industrial; 11--Minor Corridor; 12--Railway; 13--School; 14--Cemetery; 15--Recreation; 17--Idle or Vacant Land; 18--Cultivated Cropland; 19--Coulee and 20--Riparian Drainage.
Map 4. Land use and land cover: 1970. Major land use and cover classes include 1--Single Family; 2--Multiple Family; 3--Mobile Homes; 4--Rural Residential; 6--Strip Development; 7--Shopping Center; 9--Light Industrial; 11--Minor Corridor; 12--Railway; 13--School; 14--Cemetery; 15--Recreation; 17--Idle or Vacant Land; 18--Cultivated Cropland; 19--Coulee and 20--Riparian Drainage.
Map 5. Land use and land cover: 1974. Major land use and cover classes include 1--Single Family; 2--Multiple Family; 3--Mobile Homes; 4--Rural Residential; 5--Mixed Multiple and Single Family; 6--Strip Development; 7--Shopping Center; 8--Medical; 9--Light Industrial; 10--Major Corridor; 11--Minor Corridor; 12--Railway; 13--School; 14--Cemetery; 15--Recreation; 16--Water Holding, Storage; 17--Idle or Vacant Land; 18--Cultivated Cropland; 19--Coulee and 20--Riparian Drainage.
Map 6. Land use and land cover: 1977. Major land use and cover classes include 1—Single Family; 2—Multiple Family; 3—Mobile Homes; 4—Rural Residential; 5—Mixed Multiple and Single Family; 6—Strip Development; 7—Shopping Center; 8—Medical; 9—Light Industrial; 10—Major Corridor; 11—Minor Corridor; 12—Railway; 13—School; 14—Cemetery; 15—Recreation; 16—Water Holding, Storage; 17—Idle or Vacant Land; 18—Cultivated Cropland; 19—Coulee and 20—Riparian Drainage.
Map 7. Land use and land cover: 1979. Major land use and cover classes include 1--Single Family; 2--Multiple Family; 3--Mobile Homes; 4--Rural Residential; 5--Mixed Multiple and Single Family; 6--Strip Development; 7--Shopping Center; 8--Medical; 9--Light Industrial; 10--Major Corridor; 11--Minor Corridor; 12--Railway; 13--School; 14--Cemetery; 15--Recreation; 16--Water Holding, Storage; 17--Idle or Vacant Land; 18--Cultivated Cropland; 19--Coulee and 20--Riparian Drainage.
Map 8. Land use and land cover: 1980. Major land use and cover classes include 1--Single Family; 2--Multiple Family; 3--Mobile Homes; 4--Rural Residential; 5--Mixed Multiple and Single Family; 6--Strip Development; 7--Shopping Center; 8--Medical; 9--Light Industrial; 10--Major Corridor; 11--Minor Corridor; 12--Railway; 13--School; 14--Cemetery; 15--Recreation; 16--Water Holding, Storage; 17--Idle or Vacant Land; 18--Cultivated Cropland; 19--Coulee and 20--Riparian Drainage.

The most striking feature of this visual depiction of land use and land cover change is the predominance of cultivated cropland in the earlier study years and the gradual encroachment of the urbanized frontier. Agricultural tracts, for example, are parcelled and converted to other uses, sometimes remaining unused while in transition. In their places appear varied urban land uses: schools, traffic arteries, businesses, single and multi-family residences, a medical complex, recreation areas and shopping centers, in short, all the accoutrements of a developed area.

As the maps show, development expanded southwestward over the twenty-six year period. Percentages of acreage per class reflect the urbanization trend. Land devoted to urban uses (residential, commercial and services, transportation and public) totaled 12.9 percent in 1954, compared to 80.5 percent in cropland. Urban land uses increased steadily, to 21.7 percent in 1962, 32.3 percent in 1970, and 39.8 percent in 1974. In 1977 urban land uses totaled 57.7 percent of the total land use, increasing steadily to 61.8 percent in 1979 and 62.1 percent in 1980. For the most part, it is agricultural land which has been encroached, declining steadily from a high of 80.5 percent in 1954 to 26.7 percent by 1980.
Soil Types

The study area contains three soil types: Colvin silty clay loam, Zell-LaDelle silt loams, the kind which occurs on slopes of one to six percent, and Bearden silty clay loam, which predominates. On Figure 9 Zell-LaDelle silt loams, one to six percent slopes is listed as Zell-LaDelle silt loams. Bearden silty clay loam is formed on glacial lake plains. It is level and thick, but a poorly draining soil, requiring constructed drains in most areas. If left undrained, this soil type remains wet after spring run-off and heavy rainfall, due to its poorly defined drainage patterns. Like Bearden silty clay loam, Colvin silty clay is a naturally poorly draining soil. It appears on broad flats, in seepy areas and in shallow swales on glacial lake plains.

After spring run-off and heavy rainfall, excess water forms ponds in the lower-lying areas for a short period of time. Unlike the other two soil types, Zell-LaDelle is a relatively well-drained soil. It slopes gently, appearing along drainage ways on glacial lake plains.

Bearden silty clay loam is classified as prime farmland, belonging to soil capability class I, which has few limitations for practical use. Its subclass is "e", which means that erosion is a risk without close-growing vegetative cover. Colvin silty clay loam belongs to soil class II, which limits the choice of plant cover somewhat or may require moderate conservation practices. It belongs to subclass "w", which means that plants may suffer from excessive wetness. Zell-LaDelle is a class III soil. Choice of plant cover is severely limited in this class and special conservation practices are required for plant cultivation. Its subclass is "e". The SCS classifies Bearden silty clay loam as prime farmland and includes Colvin silty clay loam as
Map 9. Soil types in southwest Grand Forks.
prime farmland if it is drained.

Most of the study area is Bearden silty clay loam. As farmland it is considered prime, but for building site development, it has certain restrictions. Because it is a poorly drained soil, excavations (five to six feet) are specifically not recommended, because they would require expensive design modifications and would increase the cost of construction and maintenance. With dwellings and small commercial buildings the greatest problem with this soil type is the shrink-swell potential, its tendency to shrink when dry and swell when wet. Building foundations especially are susceptible to damage. Local roads and streets (all-weather surface, carrying auto and light truck traffic all year) are subject to frost action and the soil itself is not strong enough to bear loads.

Some parcels composed of Colvin silty clay loam have been developed. Limitations on shallow excavations are severe due to the tendency of water to remain on closed depressions, that is, ponding. Limitations on small commercial buildings and dwellings with or without basements are severe due to ponding and shrink-swell potential. Local roads and streets are subject to ponding, frost action, and, like Bearden, low soil strength. Zell-LaDelle soil, composed of the well-drained Zell and moderately drained LaDelle, is subject to moderate limitations on building site development (wetness and shrink-swell potential), but is severely restricted on local roads and streets due to low soil strength, and frost action (Doolittle, Heidt, Larson, Ryterske, Ulmer and Wellman 1981).

The acreage breakdowns per class and the land use and land cover maps provide supporting evidence of the urbanization trend within the
study area. Generally, as agricultural land has been encroached, it has 1) been converted to urban uses immediately or 2) been held vacant for a period of time and then converted. Some cropland remains, but because it is surrounded by urban uses, it will probably be urbanized in the future. Existing soil types in the study area restrict certain types of building site development and serve to place limitations on present and future growth.
CHAPTER V

RAMIFICATIONS OF DEVELOPMENT

With development of southwest Grand Forks came encroachment on cultivated cropland and a subsequent transition of some of that land to urban uses. The percentages of acreage explained in the previous chapter reflect the trend of urbanization. The ramifications of development are, however, more difficult to account. Some of the problems of development spring from anticipated demand which did not meet expectations, the reluctance of voters to approve the construction of a north-south overpass and the limitations of soil types and the existence of the floodplain within the study area.

Flooding

In 1979 English Coulee overflowed its banks, flooding homes, disrupting traffic on DeMers Avenue, Columbia Road, and South Forks Road, isolating the Medical Complex and Columbia Mall. One aspect of development did contribute to the problem. Harrison and Bluemle (1980) ascribe the causes of English Coulee flooding to 1) the system of rural roads, which diverted water eastward, 2) culverts existing within Grand Forks were too small to keep up with the flow of floodwater from affected areas, 3) the rebuilding of South Forks Road. When Columbia Mall was built, South Forks Road was widened and lowered several feet so that it no longer acts as a dike to divert north-flowing water eastward, as it had previously. A fourth important point stressed by the authors
is that much of the affected area was marshland or cattail slough before development in the middle and late 1970s. They assert that the area would have flooded even if it had not been developed, but that houses suffer more damage than cattail sloughs. "The area should not have been developed. Without some kind of corrective measures, serious flooding will eventually occur along the English Coulee again" (Doolittle and others 1981, p. 64). The extent of flooding is evident in Figures 2-5, available to the author through the courtesy of Frank Orthmeyer, City Engineer, who took the photos in April 1979.

**Bond Shortfall**

In 1981 much publicity was generated over the $2.4 million owed by developers in delinquent special assessments. On August 3 the City Council passed a twelve percent annual penalty fee (added to the existing eight percent state penalty) to encourage delinquents to borrow money to pay assessments. Parts of two bonds also were refinanced, because the city could not pay $1.5 million due in principal and interest on them over the next eighteen months (Terhaar 4 August 1981).

The City Council approved extensive development on the rural-urban fringe in the 1970s. An expanded tax base, new jobs, and population expansion were expected. Reflecting that optimism, Grand Forks voters approved annexation of 120 acres at South Forks Road and Columbia Road for the construction of a regional shopping center. Land developers bought property near the mall and began promoting construction of residential and commercial sites (Scaletta 14 June 1981).

Grand Forks financed extension of utilities upon petition by the landowners, with the approval of the City Council. Developers did not,
Fig. 2. Flooding on Westward Acres Subdivision and Columbia Road.

Fig. 3. Flooding in the Medical Complex.
Fig. 4. Floodwater west and southwest of Columbia Mall.

Fig. 5. Flooding on South Forks Road.
however, promise to repay the financing. At that time the city was seeking annexation, particularly in areas close to Columbia Mall, in order to keep growth "orderly." Annexation also served to widen the tax base for special assessments. But development of southwest Grand Forks did not fulfill expectations. The kinds of jobs the regional shopping center attracted are the type readily filled by students and housewives, not the type which attracts new residents. Peripheral expansion around the mall did not expand either. A combination of high interest rates and inflation squelched the expansion plans of developers and ultimately left the city with a tax deficit (Scaletta 14 June 1981).

Through careful management of the delinquent assessments problem, Grand Forks has retained its AA bond rating ("Grand Forks Keeps AA Bond Rating" 11 March 1972). The bonding shortfall problem has also created an anomaly: land which was to be developed, was improved with various extensions of services, including curb and gutter, fire hydrants, and street signs, but is vacant. Some of this vacant land is evident around or in the vicinity of Columbia Mall. See Figures 6-9.

**Columbia Overpass**

Columbia Mall and the Medical Complex are two major traffic generators within the city of Grand Forks (U.S. Department of Transportation and others 1980). In a study update of the Grand Forks street network, which was issued after the Medical Complex and Columbia Mall had been built, the following was specifically recommended. Because of expected population increases and projected development by the year 2000, Columbia Road Overpass is considered necessary to insure convenient accessibility and capacity. According to the report, if the
Fig. 6. Land in transition: South Twentieth Street and Thirty-First Avenue South.

Fig. 7. Land in transition: cultivated cropland and Columbia Towers.
Fig. 8. Land in transition: Unextended street east of Columbia Mall.

Fig. 9. Land in transition: cropland and fire hydrant, east of Columbia Mall.
overpass is not built, north-south traffic in Grand Forks will be greatly hindered. It states that South Washington Street will not handle more traffic, since it is presently at capacity and that since Forty-second Street is at the western end of development, and has an at-grade railroad crossing, it cannot handle Columbia Road Overpass traffic (Transportation Services Division, North Dakota State Highway Department 1979).

The following year an environmental impact statement was prepared by the U.S. Department of Transportation, Federal Highway Administration, and the North Dakota State Highway Department (1980) to determine the feasibility of the Columbia Road Overpass. In agreement with the transportation study update, South Washington is seen as presently at capacity. South Forty-second Street will probably not attract much traffic because it is on the western edge of development and has an at-grade railroad crossing. Interstate 19, because of its extreme western location, will probably not attract much traffic either. The University of North Dakota would be divided by the overpass, but emergency vehicles would be assured more direct access to the acute care hospital on the southern side of the Burlington-Northern tracks. Negative visual impact south of DeMers Avenue is seen as minimal, while the UND athletic complex would be divided.

In March 1981 Grand Forks voters disapproved the construction of a four-lane overpass by a vote of 5,340 to 4,700. In a turn-around referendum in March 1981, a two-lane overpass connecting North and South Columbia Roads was approved by a vote of 5,537 to 4,587. Cost of the two-lane overpass is estimated to be $5.25 million, not including compensation to UND. The four-lane overpass was estimated in 1980
to cost $12.2 million (Terhaar 7 April 1982).

Physical and fiscal costs of developing southwest Grand Forks have been high. Flooding in 1979 damaged homes in the area and the United Hospital. During the recent bonding crisis the city was forced to refinance parts of two bonds, due to a shortfall caused by delinquent special assessments payments. In addition, the city assumed the economic and social cost of investing in development by extending utilities. The new development was expected to create new jobs but did not. It will cost $5.25 million to build the two-lane Columbia Overpass, a vital link to Grand Forks north-south traffic.
CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Southwest Grand Forks, to echo Harrison and Bluemle, should not have been developed. The predominant soil type is Bearden silty clay loam, which is not well suited to building or road construction. Because of development, there has been a loss of mostly prime agricultural land—1357 acres in total between 1954 and 1980. This land, when well-drained, is better suited to agricultural cultivation than building site development.

Coulee flooding in 1979 damaged the first floor of United Hospital and surrounding residences. Currently the construction of a dam to control spring run-off has been proposed and is being negotiated by various governmental bodies (Schmidt 18 November 1981). The response of Harrison and Bluemle is probably most appropriate. Cattail sloughs do not have foundations which can be wrecked or basements which may cave in.

There are decisions about southwest Grand Forks which have yet to be made. The threat of flooding must somehow be resolved, either through construction of a dam, or through some other means acceptable to those involved. A second issue facing this area is that of future farmland loss. Undoubtedly the farmland around Columbia Mall will one day be developed. The questions which next follow are 1) how will this development take place? and 2) at what pace? In order to prevent
purposeless farmland loss, it is important that when development takes place, it utilizes land in an efficient manner, so that more need not be converted.

It is difficult to say, with this isolated example, whether the acreage loss of farmland in the rural-urban fringe is significant. Certainly more data is needed, in studies of representative cities, to determine the national trend. As Hart points out, Grand Forks is not a Los Angeles. But the question remains. Is Grand Forks representative on a smaller scale of what is going on in Los Angeles? This is a question worthy of future research.

Other topics worth considering may also be gleaned from this work. It would be interesting and worthwhile to research Charles C. Colby's centrifugal and centripetal hypothesis of urban development, studying the entire city of Grand Forks in a historical series. A statistical analysis of land values within the study area would also enhance the present literature, tracing the impact of such variables as lot size, lot improvements, location, proximity to services and major arteries.

The study area's urban expansion peaked in 1979 and began to level off. An economic analysis of interest rates and their effect on the regional economy would be a worthwhile addition to the literature. Such a study could also include an accounting of the economic and social costs of development, including the payment burden of flood controls, and delinquent assessment payments.

Homer Hoyt's study of residential neighborhoods in American cities would provide an excellent basis for analysis of residential neighborhoods in Grand Forks. The character of older and newer neighborhoods
(such as those within the study area) would differ considerably. In such a study the aims of both master land use plans for the city, their implementation, and the final effect on present neighborhoods could be considered.
## APPENDIX

U.S. Geological Survey  
Land Use and Land Cover Classification System for  
Use with Remote Sensor Data

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81
8 Tundra

81 Shrub and Brush Tundra
82 Herbaceous Tundra
83 Bare Ground Tundra
84 Wet Tundra
85 Mixed Tundra

9 Perennial Snow or Ice

91 Perennial Snowfields
92 Glaciers
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