

# Use of Geographic Information Systems to Explore and Communicate Transportation and Land Use Relationships in Iowa

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## Summary

Urban sprawl and prime farmland conversion are important public policy concerns in the state of Iowa at present. In 1997, the Iowa General Assembly convened an Interim Study Committee to make recommendations regarding potential legislative and state agency initiatives to address land use and sprawl issues. The Iowa Department of Transportation (Iowa DOT) is a major shaper of urban growth due to its ability to invest or not invest millions of dollars in roadway infrastructure.

The Center for Transportation Research and Education (CTRE) at Iowa State University has been conducting a public policy research and education project on transportation and land use on behalf of the Iowa DOT and organizations it partners with, for instance metropolitan transportation organizations (MPOs) and regional planning commissions (RPCs). The intent of this project is to provide the Iowa Transportation Commission, the DOT staff, and their partner agencies with a more complete understanding of their impact on land use and farmland conversion.

CTRE is utilizing ArcView 3.1 geographic information system software to integrate a variety of secondary spatial data sources and visualize past and likely future transportation and land use trends around the state. Particular emphasis is being given to those counties included in and adjacent to Iowa's eight metropolitan areas. Topics that are being studied using GIS include:

- Past trends (1980s and 1990s) in terms of demographics, housing, retailing, manufacturing and industrial development, agriculture, land use, school enrollment, and transportation system use and development.
- Key economic relationships among variables, for example the tradeoff between housing rent and value and commuting distance.
- Past cropland loss to urbanization and its relationship to improvements to the transportation network.
- Likely future cropland losses given demographic, economic, and transportation trends and forecasts.

CTRE is using a wide variety of secondary data sources in this project; many useful data sources are in the public domain. Key data sources being used include:

- Federal agency data such as Census data, County Business Patterns, Bureau of Economic Analysis (BEA) economic forecasts, and US department of Agriculture (USDA) agricultural production data.
- State agency data, such as property tax assessment data, housing permit data, school enrollment data, and land use classifications from several points in time originally collected to assess wildlife habitat.

- Transportation activity, system characteristic, and system investment data. The Iowa DOT maintains a large transportation management information system, much of which can be depicted in a GIS.
- Proprietary data sources such as Woods and Poole population and employment forecasts and business and industrial directories.

Local government property taxation and parcel records are also available for use in some counties.

A key outcome of this project will be more informed decisions regarding the land use and sprawl implications of major transportation investments on the part of the Iowa Transportation Commission, the Iowa DOT's management and staff, transportation planning organizations, and others.

## The Public Policy Issue

In November 1998, the Iowa Legislature's Commission on Urban Planning, Growth Management of Cities and Protection of Farmland issued a report and a proposal for legislation designed to overhaul land use planning in the state. The Commission was established during 1997 to:

“Study issues relating to land use and planning, and particularly policies and trends which affect development, including but not limited to issues involving the status of farmland and the conversion of farmland into residential, commercial, or industrial uses; associated problems facing cities; the effectiveness of local planning and zoning laws; and a review of model legislation and studies in states which have undertaken reform efforts and have effective land use policies.”

Throughout the Urban Planning Commission's report development process, concerns were expressed about the critical role transportation investments play in shaping urban growth, urban sprawl, and farmland conversion. Several public participants expressed the opinion that the Iowa DOT needs to take the potential land use impacts of its projects into account more and that the DOT should become more involved in local and metropolitan land use planning activities.

The Iowa Transportation Commission has recognized that land use will be an important policy issue for the agency during the next decade. In May, 1998, the Commission held a workshop on transportation and land use that involved not only the Commission, but land developers, realtors, regional planners, zoning officials, farming, and environmental conservation groups. The main conclusions of this workshop were that there is a need for better understanding of the land development process and land use in general by transportation officials and planners and that communication between transportation agencies and land use planning agencies needs to be improved.

## Research and Education Project Overview

The Center for Transportation Research and Education (CTRE) at Iowa State University was contracted to develop an educational program for the Iowa Transportation Commission, Iowa Department of Transportation staff, and metropolitan and regional transportation planners on the role transportation investments play in shaping land use patterns in Iowa. This project is being conducted in cooperation with a complementary project managed by the Public Policy Center at the University of Iowa that is researching past impacts on land use patterns of transportation investments in Iowa.

## Introduction to GIS

A geographic information system (GIS) is an information system that processes spatial data. Spatial data are any data that have some tie to a feature on the earth—a county, a street address, or a zip code, for instance. It is estimated that some 80 percent of all data have some sort of spatial component. This fact makes GIS very valuable in terms of data integration. GIS can be used to bring together a variety of data sources that have been gathered previously for other purposes and apply them to a public policy issue such as transportation and land use. Arc View 3.1 is a commonly-used desktop GIS application. The idea behind a desktop GIS is that it allows the average user of a high-end personal computer to bring together spatial data sources, analyze them, and display them visually.

Arc View and some of its extensions allow a number of visual display techniques to be used, including simple thematic maps and 3-D surfaces derived from data.

## Key Iowa Trends

Iowa is a relatively slow-growing state. US Census Bureau projections show Iowa as the 39<sup>th</sup> or 46<sup>th</sup> fastest-growing state in terms of population between 1995 and 2025 depending on which projection method (Series A or B) is used. The Census Bureau expects Iowa to have between 200,000 to 300,000 new residents by 2025 and a total population of 3.0 to 3.1 million. Iowa's slow growth is in sharp contrast to many other states, which are expected to have millions of new residents during the next twenty-five years. Iowa's rate of growth is expected to be roughly one-third to one-fourth of the national rate of population growth.

Iowa has been following a slow path from rural to urban over the past century. Farm consolidation has been a trend that has persisted since about 1910, when mechanization of agriculture accelerated. At this point, virtually all of the population growth in Iowa is concentrated in its metropolitan areas and counties immediately adjacent to the metro counties. In fact, only ten counties in Iowa (out of a total of 99) will likely account for 95 percent of the growth over the next twenty-five years.

Many rural counties in Iowa are losing population and now have death rates that exceed their birth rates. Some of these counties actually achieved their peak Census population value as early as the 1910 Census or before. For these counties, land use change is not a particularly salient issue. However, in a few counties and three high-growth regions in particular, land use change and how transportation investments drives it and shapes it, is a key planning issue. These three high growth areas, all located along Interstate 80, are:

- The Des Moines/Ames area in central Iowa,
- The Cedar Rapids/Iowa City area in east central Iowa,
- The Quad Cities (Davenport, Bettendorf, Rock Island, Moline) area, which is partly located in Illinois.

In 1997, about 70 percent of all the new housing permit activity in the entire state of Iowa occurred in these three areas, which comprise a handful of the state's counties. Very little new housing construction activity is occurred in the rest of the state. Another area that has not grown rapidly in the past but that is projected by Woods and Poole Economics to grow relatively quickly in the next 20 years is the Sioux City metro area in northwest Iowa; this area also extends into Nebraska and South Dakota.

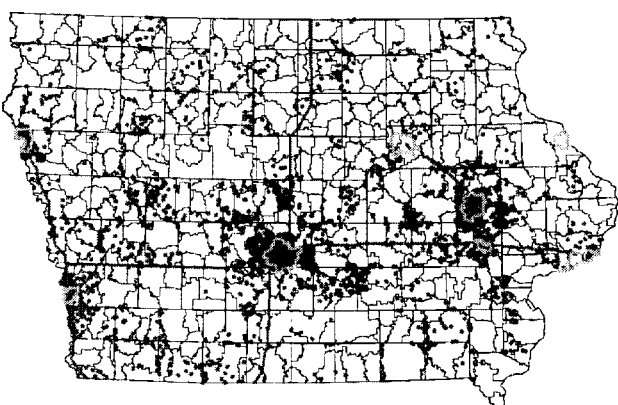
These demographic and housing trends are also reflected in a number of other trends. Median housing value figures for Iowa reflect a surface that is substantially higher in these few growth centers than elsewhere. K-12 school enrollment and retail trade activity are also quickly consolidating in Iowa into these growth areas.



- Incorporated Places Population**
- 7 - 2174
  - 2175 - 6720
  - ◊ 6721 - 20403
  - ⊕ 20404 - 66467
  - ⊕ 66468 - 193187
- Highways**
- ↗ Interstate
  - ↘ Other Primary
  - County
- Home Value Surface**
- Breaklines**
- Hard
  - Soft
- Elevation Range**
- 91111.111 - 100000
  - 82222.222 - 91111.111
  - 73333.333 - 82222.222
  - 64444.444 - 73333.333
  - 55555.556 - 64444.444
  - 46666.667 - 55555.556
  - 37777.778 - 46666.667
  - 28888.889 - 37777.778
  - 20000 - 28888.889



### School District Positive Enrollment Change, 1994-1998



- Urbanized Areas
- School Enrollment Change
- 1 Dot = 5
- County
- Highway
- ↗ Interstates

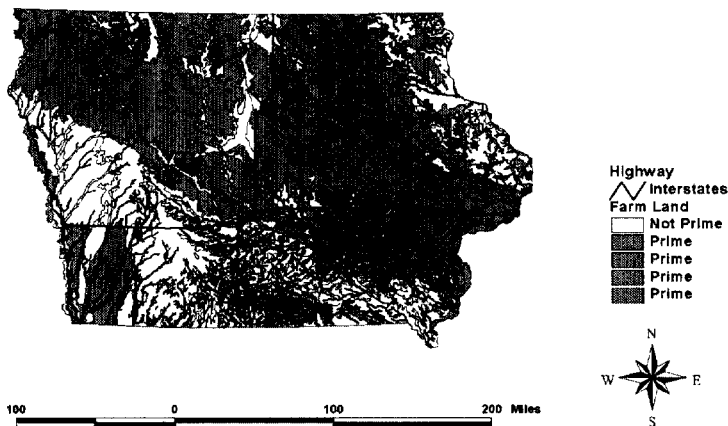


### Prime Farmland in Iowa

Iowa has one of the largest extents of prime farmland of any US state. Almost half of all farmland in Iowa is considered prime, versus about one quarter in the nation as a whole. However, prime farmland is not uniformly distributed within the state. Most prime farmland in Iowa is located north of Interstate 80, which bisects Iowa from east to west. Most, but certainly not all, of the major population centers of Iowa are located within regions made up of prime farmland. On the other hand, the “non-prime” regions of the state (e.g. southwestern Iowa) tend to be sparsely populated. This reflects that fact that Iowa originally

developed as a farm state and that agricultural production and processing are still major drivers of the economy.

## Iowa Prime Farmland



### Patterns of Land Use Change in Iowa

Land use change in Iowa is very much an issue confined to metropolitan and adjacent counties. In 1995 through 1997, 13 counties in Iowa had more than 500 acres of cropland moved out of production. A total of 26000 net acres went out of production in those counties. Almost half that change (over 10000 acres) occurred in and around the three-county Des Moines metropolitan area. Another 7600 acres went out of production in three counties around Cedar Rapids and Iowa City and another 5400 acres in three counties around the Quad Cities. To place those figures into perspective, 26000 acres is about 77 average-sized Iowa farms.

On the other hand, many rural counties in Iowa not adjacent to metro areas had substantial increases in cropland acres between 1995 and 1997. Almost 40 counties in Iowa (out of 99 total) had cropland acreage increases from 400 to 2500 acres during that period (or the equivalent of one to seven average-sized farms.) This shift appears to have been due to changes in federal agriculture programs, especially the Conservation Reserve Program (CRP).

The long-term change in land use in and around Iowa's metro areas is not generally attributable to the expansion of incorporated cities through incorporation. From 1982 through 1992, the rural land area of Iowa dropped by only 57100 acres, or less than one percent. What has driven land conversion in Iowa is the change of land outside of incorporated cities from cropland and pastureland to other uses. Two types of land use conversion seem to be driving this. One is the proliferation of rural subdivisions within commuting distance of major employment centers. The other is conversion from private use (e.g. farming) to public uses (e.g. parklands and highway rights of way.)

### The Role of Transportation in Fostering Land Use Change in Iowa

Transportation literature deems highway infrastructure to be a "necessary, but not sufficient condition" for development. Those major transportation investments most likely to generate land use changes are those associated with adding new capacity (miles or lane-miles) to the system in places that have considerable growth potential (e.g. consumer and business demand for land and buildings). These types of projects include:

- Major capacity improvements along National Highway System (NHS) or other arterial corridors.
- Bypasses or highways located along new alignments.

Iowa, like many other states, has planned extensive improvements to its NHS routes over the next 20 years, particularly in the central and eastern parts of the state, where much of the state's traffic growth is concentrated.

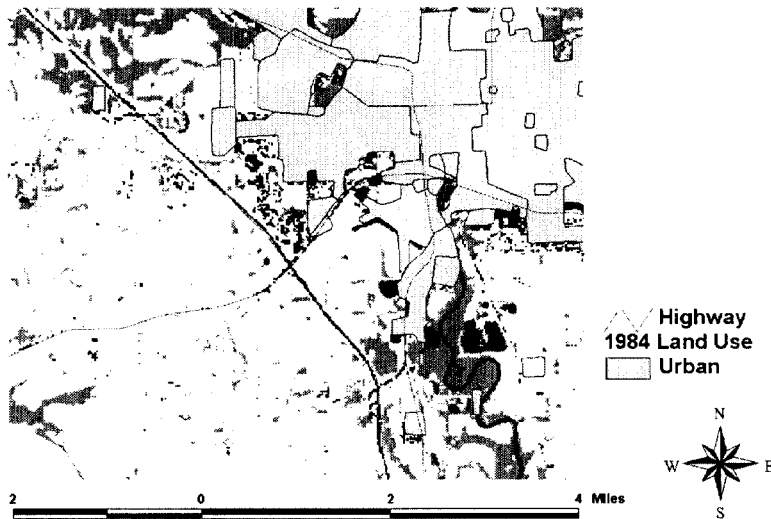
Projects that essentially rebuild sections of the highway system, eliminate spot safety problems, or preserve pavements or structures are likely to have little impact on land use patterns at a regional level. The other type of project that is unlikely to have a great impact on land use is a major project built in an area that has little economic and demographic growth potential.

### Examples of Transportation and Land Use Interactions Illustrated Using GIS

GIS technology is quite valuable for integrating a variety of secondary data sources and then visualizing them. Secondary data sources are sources gathered for a purpose different original purpose. For instance, data originally developed for property tax assessment purposes might later be used to explore land use change.

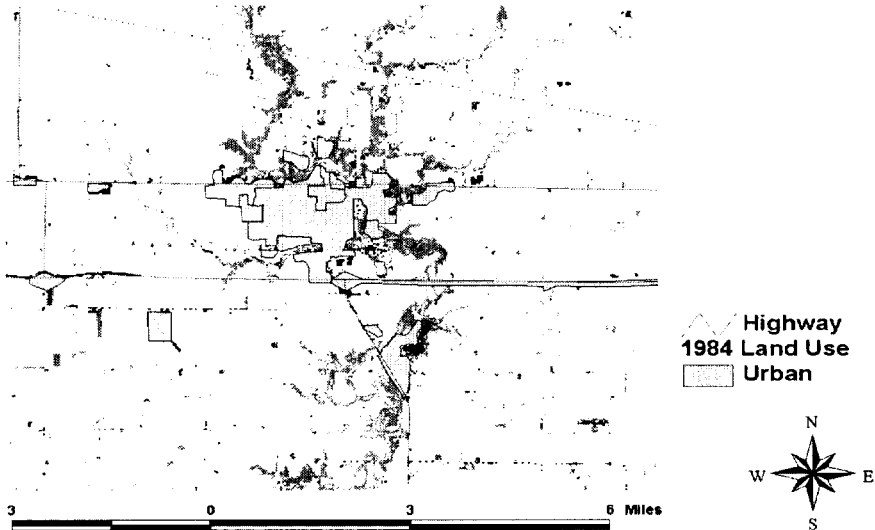
A good example of a transportation investment's impact on land use is the large amount of new urban development (black rectangles) that occurred near a new bypass of fast-growing Iowa City, Iowa between

**1984-1994 Land Use Change  
Near Bypass of Iowa City**



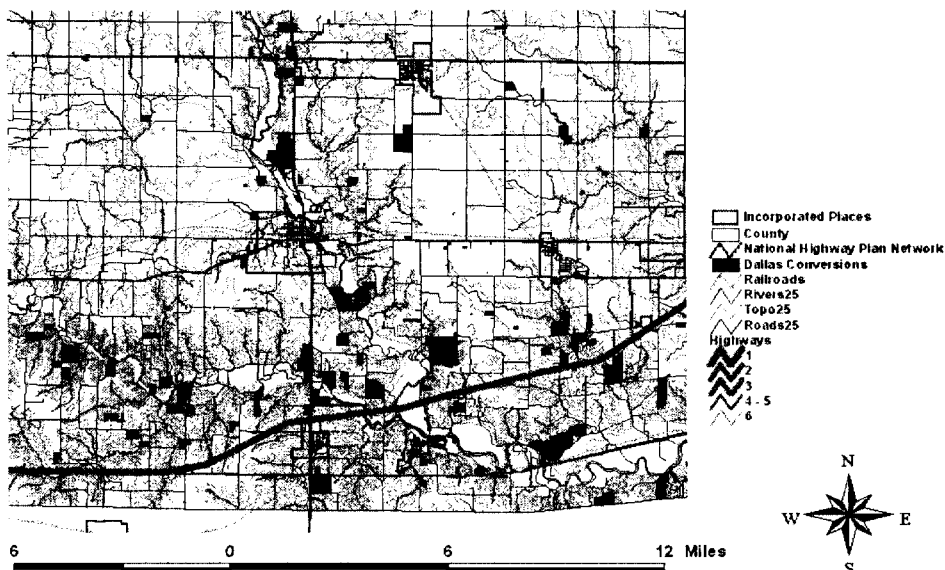
about 1984 and 1994. On the other hand, a very similar transportation investment near slow-growing Webster City, Iowa at about the same time led to very little land use change (black rectangles).

## 1984-1994 Land Use Change Near US 20 Bypass

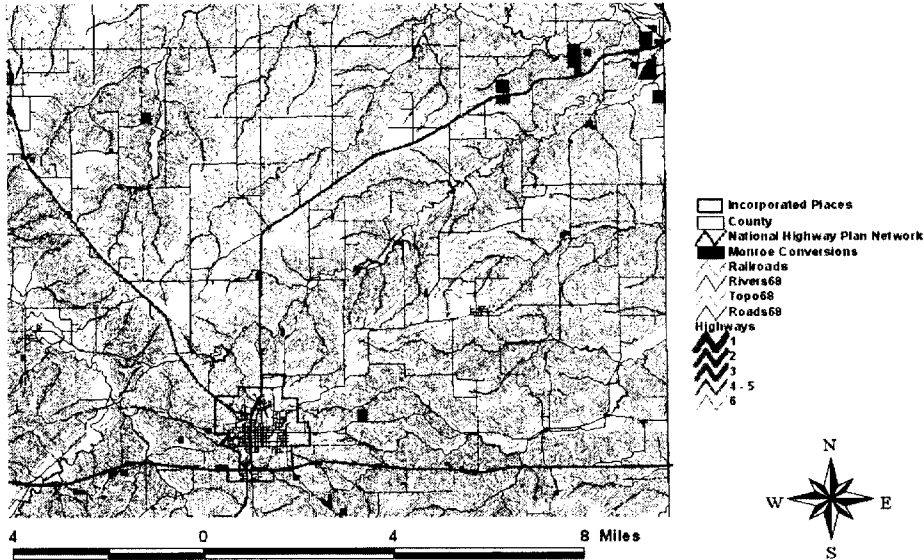


Rural subdivisions exhibit similar patterns of relationship with respect to highway facilities. In rapidly growing Dallas County, Iowa, many rural subdivisions are popping up within five miles of Interstate 80 in areas with hilly topography and water features. Interstate 80 is the main commuting route into the western part of the Des Moines metro area, which is located just east of Dallas County. By contrast, there has been a much lower rate of rural subdivision development in slow-growing Monroe County. Most of these subdivisions are located near the northeast corner of the county, which is near a major highway corridor and a major industrial job generator.

## New Rural Subdivisions In Dallas County, Iowa



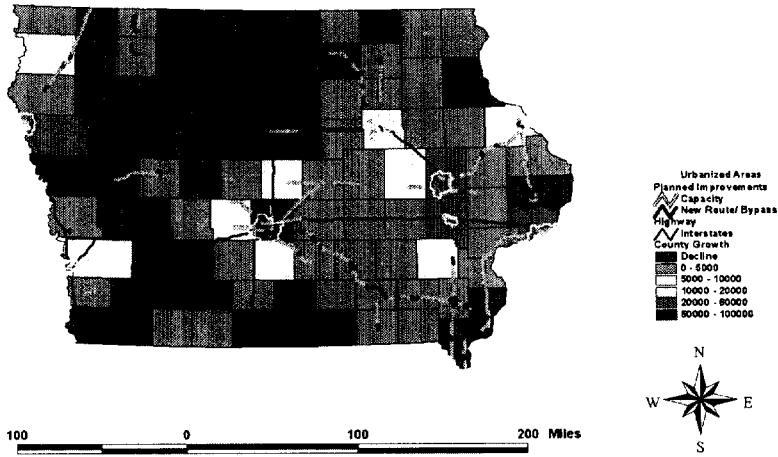
## New Rural Subdivisions In Monroe County, Iowa



### Public Policy Implications

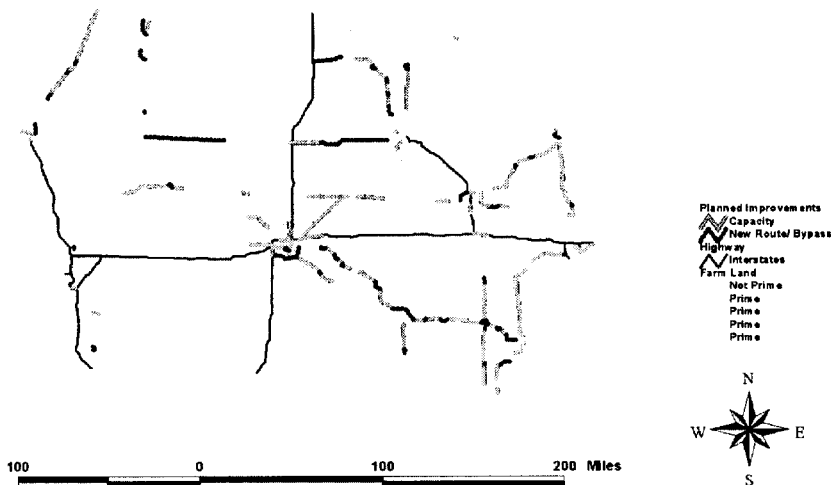
The illustrations for Iowa suggest that the literature is indeed correct. Transportation investments are permissive with respect to land use. A subset of programmed major highway investments are likely to have significant effects on future land use patterns. These are capacity improvements, new alignments, and bypasses in areas that also have a great deal of demographic momentum. There are only six counties in Iowa that are expected to have 20000 or more net new residents by the year 2020. These counties, plus the counties adjoining them are where transportation projects are likely to generate land use changes of a significant magnitude. In these few core and adjacent counties, projects that run near or cross over and extend beyond existing urbanized area boundaries are the most likely to generate wholesale land use changes. These areas can be identified with a GIS using map overlays.

## Programmed Improvements Overlayed On Future County Growth



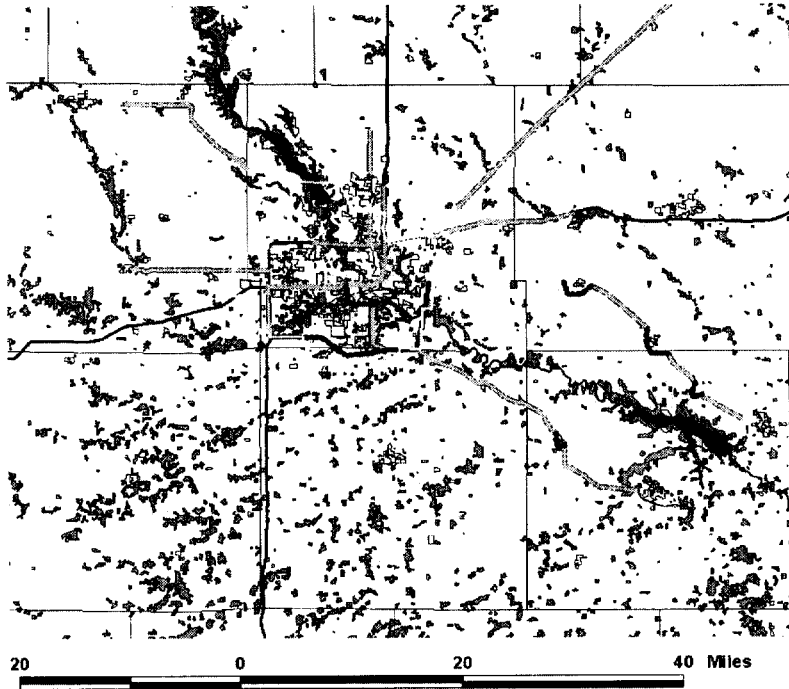
On the other hand, many of the Iowa DOT's major future projects will be located in counties that are likely to continue declining in population or at least are in counties projected by Woods and Poole to have very low growth rates. In this type of situation, wholesale land use changes are very unlikely.

## Planned Highway Improvements Overlayed On Prime Farmland Areas



Considering transportation improvements, demographic momentum, and prime farmland location all at once indicates that only a few major transportation investments programmed by the DOT will be likely to generate major land use changes. For instance, in the rapidly growing central Iowa (Des Moines metro and Ames) area, those projects that radiate outward from Des Moines to the west, north and east are the most likely to generate farmland conversion concerns. Improvements planned to the south of Des Moines should be of less concern, since that area has far less prime farmland.

# Central Iowa Transportation and Land Use Overlay



Urbanized Areas

- ▣ Planned Improvements
- ▣ Capacity
- ▣ New Road/Bypass
- ▣ Priority
- ▣ Priorities

Historic Land Use

- ▣ Urban
- ▣ Cropland
- ▣ Rangeland
- ▣ Woodland
- ▣ Water
- ▣ Wetland
- ▣ Other/None

Farm Land

- ▣ Not Prime
- ▣ Prime
- ▣ Prime
- ▣ Prime
- ▣ Prime

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