Process to Identify High Priority Corridors for Access Management Near Large Urban Areas in Iowa Using Spatial Data

David J. Plazak and Reginald R. Souleyrette
Center for Transportation Research and Education
Iowa State University
2901 South Loop Drive, Suite 3100
Ames, IA 50010-8634
dplazak@iastate.edu, reg@iastate.edu

ABSTRACT

Iowa's highways play a dual role of serving through traffic and providing direct access to adjacent land and development. When access via driveways and minor public roads from arterial and collector roadways to land development is not effectively managed, the result is often increased accident rates, increased congestion, and increased delays for motorists.

Although access management is often thought of as an urban problem, some of the most difficult access management issues occur in areas at and just beyond the urban fringe. Fringe areas are the most rapidly developing areas in Iowa. Like most other states, Iowa is becoming more urbanized, with large urban centers accounting for more and more employment and inbound commuting from rural hinterlands. In urban fringe areas considerable commuting occurs inbound to employment centers within the suburban areas and urban cores. Two-lane and four-lane arterials that were originally designed to serve long-distance, high speed travel may also need to serve growing numbers of commuters and sometimes will also have land development and recreational facilities such as trails and parks in placed alongside. Unless access is carefully managed, such highways can lose their effectiveness in terms of serving through travel. They can also become considerably less safe rather quickly.

Iowa has completed and received national attention for its program of access management research. This research project was conducted to assist the Iowa Department of Transportation in systematically identifying "commuter corridors" radiating out from urban areas that are the most likely to need attention in terms of access management. Existing as well as likely future indicators of access management issues are considered. The project focused on four-lane expressways and two-lane arterials most likely to serve extensive commuter traffic. This research used available spatial and statistical data to identify existing and possible future problem corridors with respect to access management. It involved the development of a scheme for ranking "commuter routes" based on their need for attention to access management. To do this, a number of Iowa Department of Transportation, local government, and other data sources were integrated using geographic information systems technology. Sources integrated included crash data, land use data, U.S. Census data, roadway configuration data, traffic data, and remote sensing data (e.g., orthophotography and satellite imagery.)

Key words: access management—crash analysis—geographic information systems—high priority corridors—spatial data

---

INTRODUCTION

Access management is a process that provides or manages access to land development while simultaneously preserving the flow of traffic in the surrounding system in terms of safety, capacity and speed. Managing access involves the control of spacing, location, and design of driveways, medians/median openings, intersections, traffic signals, and freeway interchanges. The most common access management problem in Iowa involves allowing a high density of direct driveway access via private driveways to commercial properties located alongside arterial highways, roads, and streets (*1*). Access issues are thought to be a contributing factor in over 50 percent of all highway crashes, however this figure is much higher in built-up urban and suburban areas than in rural areas.

This project was intended to produce a strategy for addressing current and future access management problems on state highway routes located just outside urban areas that serve as major routes for commuting into and out of major employment centers in Iowa. There were two basic goals for the research project. They were to:

1. Develop a ranking system for identifying high priority segments for access management treatments on primary highways outside metro and urban areas.
2. Focus on corridors that are the main commuting routes at present and that will be in the future.

The Iowa Department of Transportation (Iowa DOT) wanted to be able to specifically focus on finding a limited number of four-lane corridors with at-grade intersections (expressways) that ought to be given high priority for pro-active attention to access management based on both current safety problems and future growth in traffic and development.

METHODOLOGY

The research methodology consisted of two distinct activities. The first focused on finding corridors that exhibited signs of having access management problems at present. In Iowa, there are a limited number of routes where capacity and operations are issues. Therefore, this stage of the research focused entirely on safety and safety data. This process involved the following steps:

1. Identify non-freeway, state jurisdiction highway segments that represent likely commuter routes. This was accomplished by examining traffic flows and selecting route segments in close proximity (30 minutes or less travel time) to metropolitan areas and other urban places with 20,000 or more population. A total of 109 segments were identified around the state for further examination.
2. Map the 109 segments into ESRI ArcView geographic information systems (GIS). ArcView was used as the analysis platform for the entire analysis.
3. Gather three years of crash and traffic data for all 109 segments from Iowa DOT databases. Iowa DOT has a very comprehensive, GIS-based crash data system with over 10 years of data and approximately 70,000 crash records per year; this system covers all highways, roads and streets in the state (*2*). For the commuting corridors analysis, data from the years 1997 through 1999 were used. Year 2000 data were not yet available for use and 2001 data were still being compiled.
4. Query out those crashes that could potentially involve access points, in particular all crashes that involved left-turning and right-turning vehicles. This was done to avoid including crashes such as animal/vehicle crashes, snow and ice-caused crashes, and single vehicle run-off the road crashes. These are common sorts of crashes in exurban and rural areas, but are not primarily caused by access management problems.
5. Develop four ranking indicators for the corridors that took into account crash frequency, crash

rate, crash severity, and the percentage of total crashes that might be access-related.

6. Calculate indicator statistics for each segment.
7. Rank the segments based on the four indicators.
8. Develop an index for each indicator where 1.00 equaled the highest-ranked segment.
9. Identify the Top 25 segments for each indicator.
10. Develop a listing of segments that ranked high on four, three, and two indicators as a preliminary composite ranking tool.
11. Calculate and assign composite rankings to each of the 109 corridors based on anticipated savings in crashes (and losses) from applying access management treatments.
12. Conduct an illustrated review of each of the Top 25 ranked corridors to identify specific locations where access management issues exist and potential treatments that could be used to mitigate current and future problems. These reviews were completed using a combination of digital video log data and windshield surveys. The Iowa DOT maintains and updates a complete digital video log of its system every other year; the video log system is a very useful tool for access management studies in that it provides a way to view intersections and driveways on all state routes while remaining in the office.
13. Complete an analysis of other corridors that do not currently appear have access related safety problems but that could in the future due to a combination of high forecast commuting traffic growth, proximity to a fast-growing urban area, a high density of private drives and public road intersections, and a low classification on the Iowa DOT access management classification system. (The Iowa DOT uses an access management priority classification system that runs from 1 to 6 where 1 is a completely access-controlled freeway or Interstate and 6 is a route that mainly serves local traffic. Higher driveway densities are allowed on routes that are assigned higher numbers.) This last analysis was conducted so the Iowa DOT districts could work on access management on a pro-active basis rather than wait for safety problems to develop before acting.

The research team and Iowa DOT safety and access management staff met to judge whether the results of step 10 appeared reasonable used this preliminary composite ranking. It was decided that the routes that ranked high were indeed likely to be routes with access management problems. Once the general validity of the results was established, a method of combining the rating factors into a Composite Ranking was developed.

The second major portion of the research involved the development of a statewide commuter traffic model. This was accomplished using an ArcView/TRANPLAN interface that the Center for Transportation Research and Education developed for an earlier Federal Highway Administration funded project (*3*). This model has a number of other potential uses for the Iowa DOT, but was constructed for this project in order to produce estimates of future commuting traffic growth or decline on the 109 commuter routes being analyzed. The statewide model has the following attributes:

- 2940 zones (based on U.S. Census block groups); this is about one zone for every 1,000 persons in Iowa, with about 30 zones per average-sized county in Iowa. The zonal structure is small in metropolitan areas and large in sparsely populated rural areas.
- Trip productions were based on population estimates and forecasts.
- Trip attractions were based on employment estimates and forecasts.
- The model used a 1999 base year and a 2004 forecast year.
- The data source for the productions and attractions was Geolytics Incorporated's CensusCD+Maps Version 3.0 product, which provides Census data and forecasts by Census Tract and Block Group.
- The main focus of the model was on estimating growth and decline in trips, not accuracy in estimating actual trips.

The model network included all Primary (state jurisdiction) and some secondary and municipal roads where needed to fill out the network. Average travel speeds were set at 50 miles per hour on most links in the network, but 30 miles per hour on local roads (connectors) and 65 miles per hour on Interstates. Friction factors for the model were borrowed from the Des Moines Area Metropolitan Planning Organization's model but extended to provide for a practical maximum trip length of 100 minutes. Multi-state flows were not modeled and there were no "external" zones, so absolute traffic estimates in the model are likely to be inaccurate in areas near the state borders. An "all or-nothing assignment" and visual validation were used.

RESULTS

The following ranking indicators were used to initially identify high priority corridors:

- Crash Frequency—This indicator represents the number of crashes that appear to be access-related, in particular those that involve turning vehicles. All turning crashes were included, whether they occurred at private driveways or public road intersections.
- Crash Rate—This indicator is the frequency of access related crashes per million vehicle miles traveled (VMT).
- Crash Loss/Severity—This indicator measures the estimated cost of access related crashes in dollars, including an estimate of the cost of fatalities, personal injuries, and property damage.
- Percentage of Total Crashes That Are Likely Access Related—This indicator represents the percentage of total crashes that appear to be access-related.

The distribution of ranking indicators was compiled for all 109 corridors on each of the four indicators. Access-related crash frequency ranged from a high of 529 over a three- year period down to zero. The mean frequency was 60. Access-related crash rates ranged from a high of 5.61 per million vehicle miles traveled down to zero. The mean rate was 1.21. Access-related crash losses ranged from a high of $43.5 million down to zero, with a mean loss of just over $5 million for a three-year period. The percentage of crashes deemed to be related to access ranged from a high of 33.3 percent to a low of zero percent; the mean value for this indicator was 10.6 percent. The 109 corridors being analyzed are located primarily outside built-up urban areas. If similar percentage calculations were conducted inside urban areas, it is very likely that these percentages would be significantly higher.

Results from the statewide model were used to identify those corridors that should be expected to experience significant changes in commuting travel in the future.

Table 1 is a typical ranking table; in this case, the top 25 corridors in the state based on the percentage of crashes that appear to be access-related is presented. Figures 1 through 4 are maps of the four basic rankings and show all 109 corridors broken down roughly into quartiles. Seven of the 109 corridors ended up ranked in the top 25 on all four indicators; another five corridors ranked in the top 25 on at least two corridors, not counting those that ranked in the top 25 on only frequency and loss.

TABLE 1. Example Corridor Ranking Table for Top 25 Corridors Based on Percentage of Access-Related Crashes

COMM_ID	PERCENTACC	RANK	INDEX
85	33.3%	1	1.00
43	30.2%	2	0.99
71	29.6%	3	0.98
51	27.5%	4	0.97
73	26.8%	5	0.96
42	26.7%	6	0.94
92	26.7%	6	0.94
107	23.7%	8	0.93
32	22.9%	9	0.93
49	22.6%	10	0.92
76	21.9%	11	0.91
7	21.2%	12	0.90
70	20.8%	13	0.89
72	20.8%	14	0.88
4	20.5%	15	0.86
39	20.5%	15	0.86
24	20.0%	17	0.84
54	20.0%	17	0.84
22	18.9%	19	0.83
66	18.8%	20	0.82
75	18.6%	21	0.81
59	18.6%	22	0.80
67	17.9%	23	0.79
34	17.5%	24	0.79
9	16.7%	25	0.78

Iowa Commuter Routes: Frequency Rankings

Final_commuter_routes.shp
1 - 25
26 - 50
51 - 75
76 - 109
Corporate Limits
City Boundaries
State Boundary

90   0   90   180 Miles
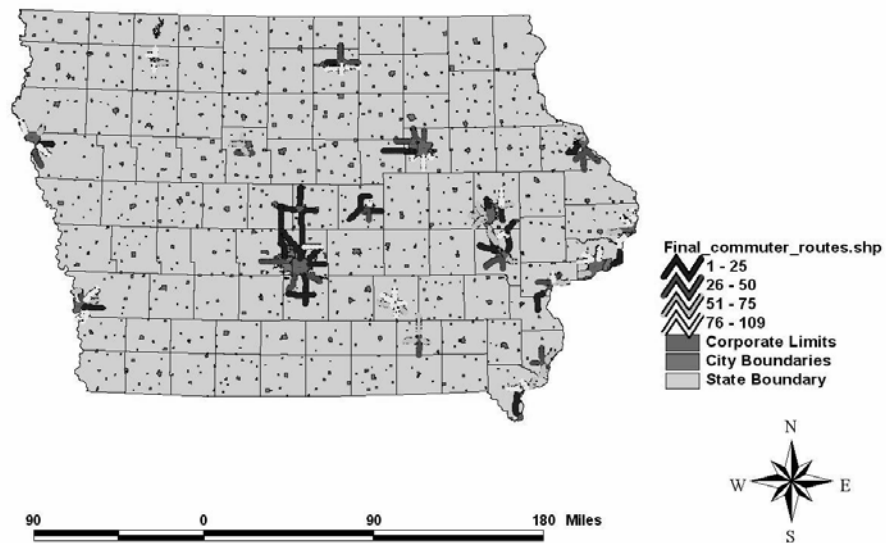
FIGURE 1. Statewide Map of the Corridors Based on Their Rank in Terms of Frequency of Access Related Crashes

FIGURE 2. Statewide Map of Corridors Based on Their Rank in Terms of the Rate of Access Related Crashes
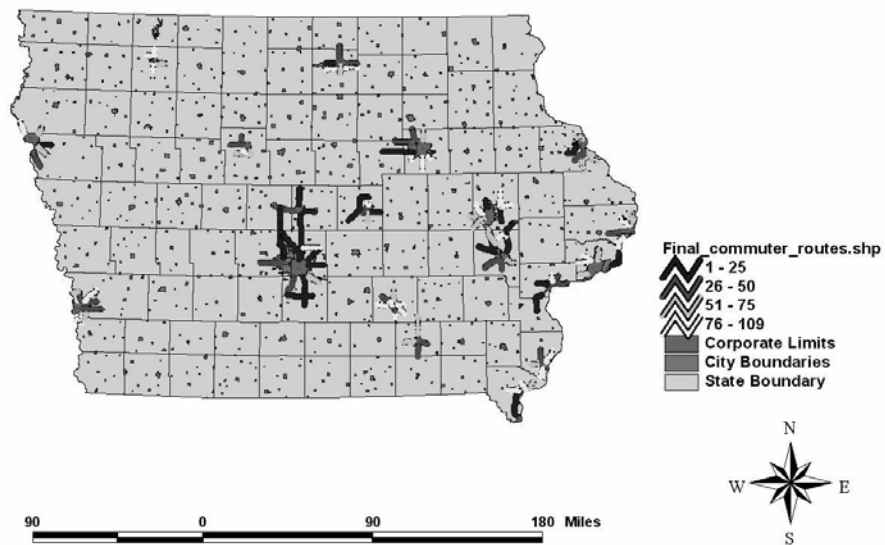

FIGURE 3. Statewide Map of Corridors Based on Their Rank in Terms of Losses from Access Related Crashes

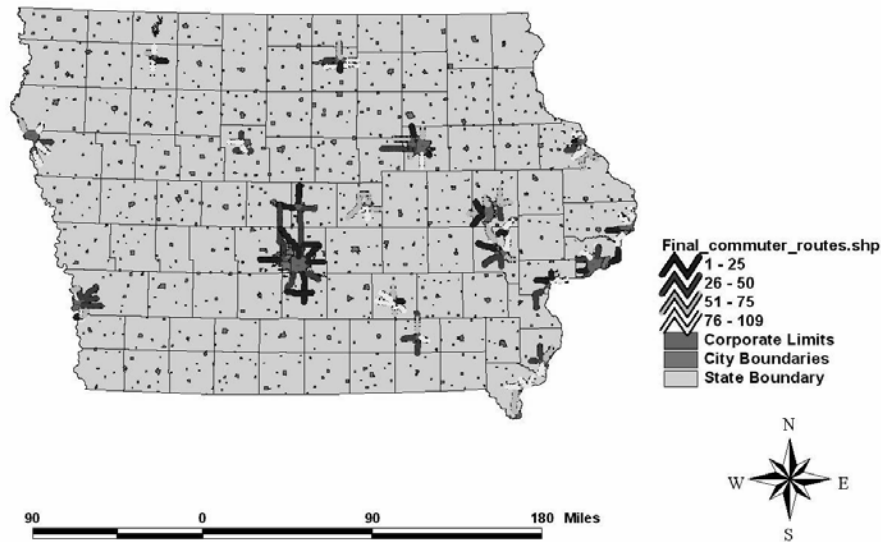## Iowa Commuter Routes: Percent Access Related Crashes Rankings

FIGURE 4. Statewide Map of Corridors Based on Their Rank in Terms of Percentage of Access Related Crashes

Figure 5 provides an illustration of long-term population growth forecasts by county in Iowa produced using data from a private forecasting company, Woods and Poole Economics. Future growth in the state is expected to be largely concentrated in two regions: Des Moines/Ames and Cedar Rapids/Iowa City. Figure 6 shows the mapped results for the base year commuter flow estimate for Iowa from the statewide model. The heaviest concentrations of work travel are in central Iowa (near Des Moines and Ames) and east-central Iowa (around Cedar Rapids and Iowa City). Figure 7 provides an indication of absolute 1999 through 2004 change in commuting forecast by the model. Change ranges all the way from negative on a few routes in isolated rural areas to almost 2000 trips per day increase on a few routes near Des Moines. Figure 8 provides a map of forecast percentage change in average daily commuting traffic. Change from 1999 to 2004 ranges from negative six percent on a few rural routes to almost 20 percent on other routes. The largest percentage changes are actually found outside metropolitan areas near some key rural employment centers that attract many commuters from the surrounding countryside.

Forecast Population Growth By County
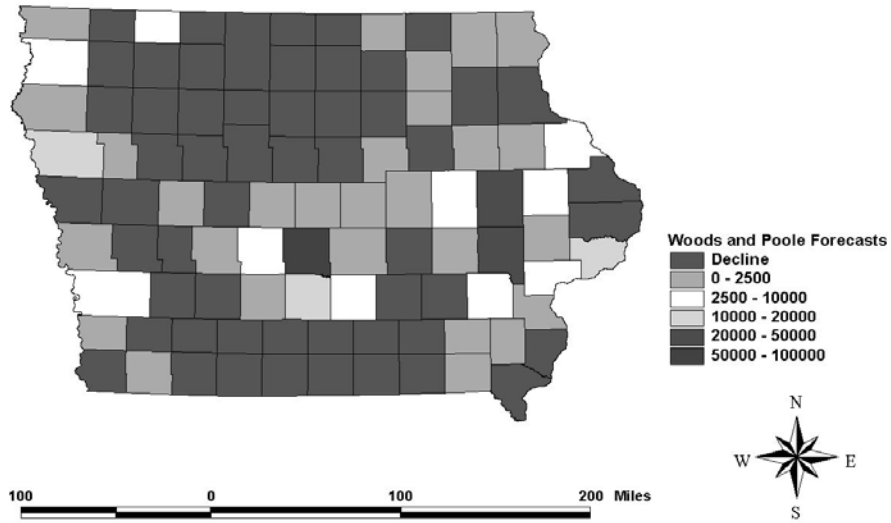2000 Through 2020

Woods and Poole Forecasts
- Decline
- 0 - 2500
- 2500 - 10000
- 10000 - 20000
- 20000 - 50000
- 50000 - 100000

100   0   100   200 Miles

FIGURE 5. Year 2020 Population Forecast Map Produced Using Data from Woods and Poole, Inc.
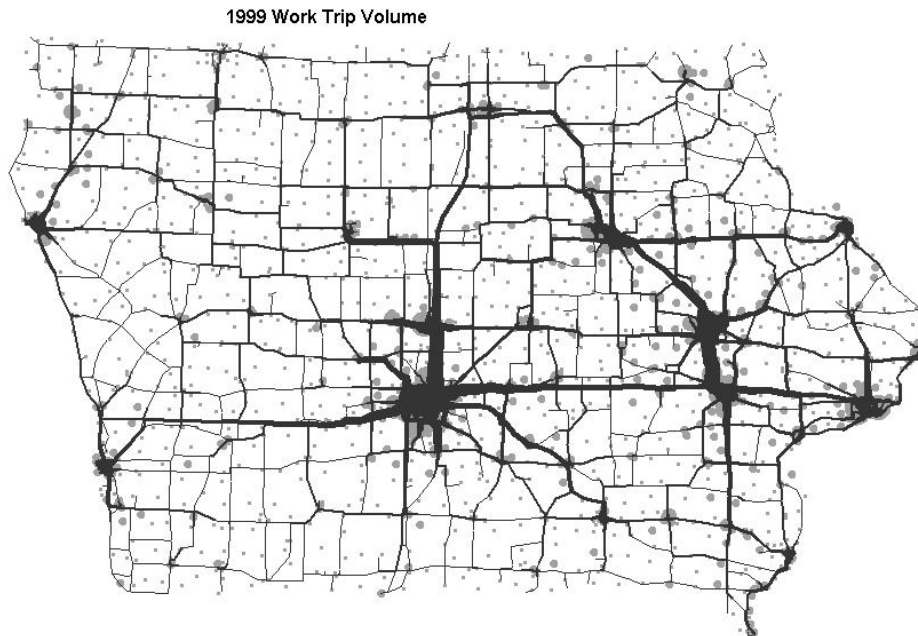
1999 Work Trip Volume

FIGURE 6. Statewide Model Commuting Travel Estimates for Base Year 1999
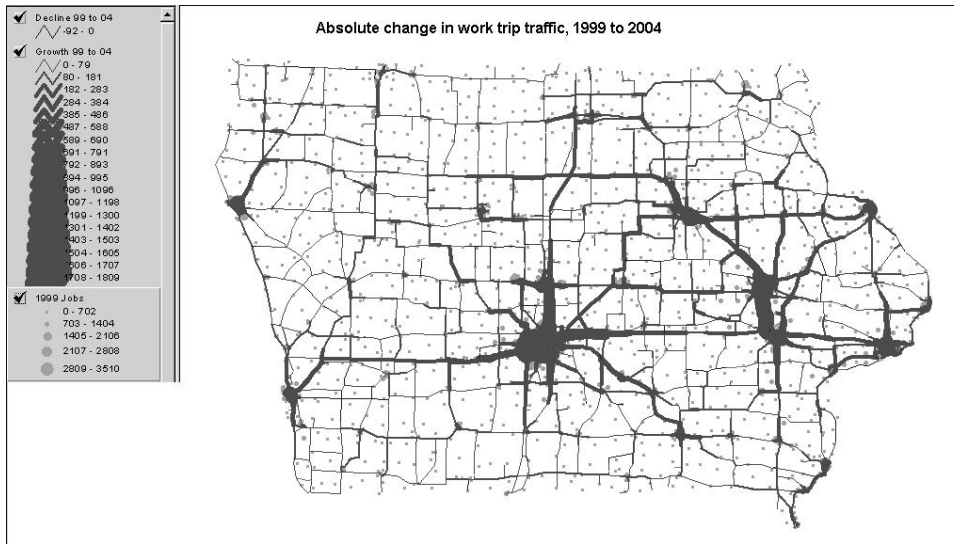
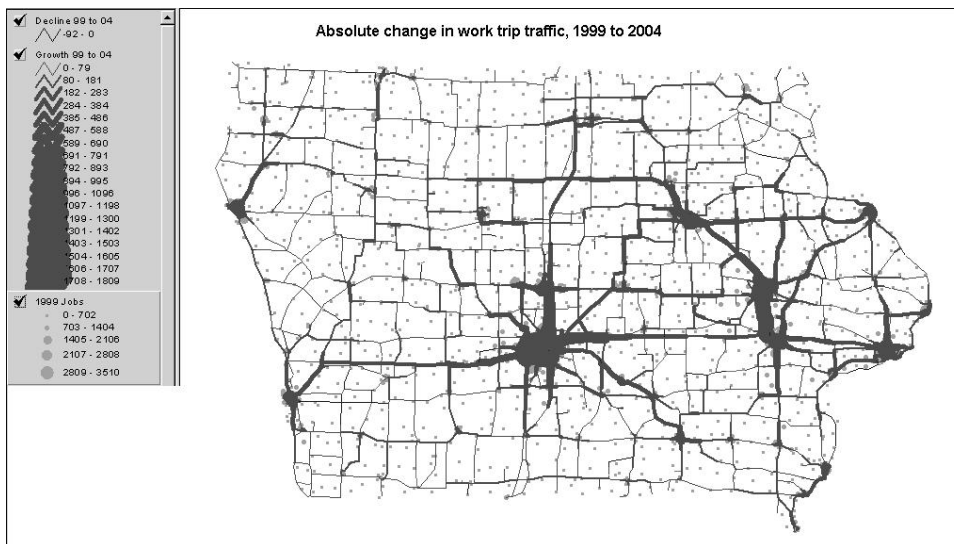**FIGURE 7. Statewide Model Estimated Change in Commuting Travel, 1999–2004**

FIGURE 8. Statewide Model Estimated Percentage Change In Commuting Travel, 1999–2004

Some overall findings of the analysis were as follows:

- Frequency and loss were (as might have been expected since loss is partially a function of crash frequency) highly rank-correlated; because of this, both indicators were not used together in developing final composite priority rankings
- Most of the highest ranked routes were on two-lane rural cross-sections, but a few were four-lane expressways with at-grade private driveways and public road intersections
- Most of the highly ranked corridors in terms of current safety problems were in Central Iowa, near the Des Moines metropolitan area and Ames; this region is the fastest growing region in the state in terms of both population and employment. In fact eight of the twelve corridors that most consistently showed up in the rankings were in this region. The corridors in this region are also forecast to have the most future growth in commuting activity. The Cedar Rapids/Iowa City region had the second largest concentration of problem corridors, accounting for two more corridors. Only two corridors that consistently topped the rankings were from other parts of the state.

APPLICATION TO POLICY AND PRACTICE

To take a more preventive measure towards access-related crashes, the corridors were analyzed to determine if access-related crashes would decrease from a hypothetical roadway treatment to better manage access. For this, a "potential improvement" factor was created, using, among other data, forecast traffic growth data generated from the travel demand model.

The calculations for potential improvement were performed as follows:

- Assume the access-related crash rate will stay the same if no changes to the roadway are made.
- Assume that 50 percent of access-related crashes could be avoided by making improvements in access control. This figure is based on typical results found in Iowa through "before and after" access management safety case studies (*1*).
- Use the percentage annual average daily traffic (AADT) growth rate forecast in the travel demand model to create a VMT Factor, using 20 years (also a variable) as the analysis time period. Example: If annual growth rate is 2%,
  - VMT Factor = $(1.02)^{20}$ = 1.48
  - 1 + (1.48-1)/2 = 1.24 (average)
- Compute the number of expected access-related crashes during the 20 years if there were no road treatment. Example:
  - = 20 * VMT Factor * Access Crash Rate * VMT
  - = 20 * 1.24 * 5 * 36 = 4464 crashes
- Multiply the expected number of access-related crashes with no treatment by 50 percent to calculate the expected number of access-related crashes after road treatment.

The corridors were then ranked by potential improvement, or the reduced cost of access-related crashes with road treatment.

The potential improvement factor development process identified the number of expected future crashes for each corridor, along with the expected number of future crashes for each corridor with roadway treatment to ease access problems plus a crash loss reduction in dollars. These corridors should represent the best opportunities in Iowa for pro-active access management strategies, for example master corridor management agreements between the Iowa DOT, municipalities, and counties.

The "pro-active corridors" were ranked by their potential for improvement in terms of future access-related crash loss reduction; the top 25 ranked corridors are represented in Figure 9. Once again, the highest "potential improvement" or "pro-active" corridors turned out to be highly concentrated in a few geographic areas. For example:

- The top 25 corridors for potential improvement contain all eight of the commuter route corridors near Des Moines; this is a strong signal that most Des Moines commuter routes could significantly benefit from road treatments to ease access management problems
- The top 25 corridors for potential improvement also contain all five of the commuter routes near Ames. Other commuter destination cities in Iowa have no more than two routes each in the top 25 ranked corridors by potential improvement; it is clear that both the Ames and Des Moines areas could both greatly benefit from road treatments aimed at managing access
- The Ames and Des Moines commuting regions together contain seven of the top ten corridors ranked by potential improvement. Many of the highest ranked corridors on this indicator are in a single Iowa DOT district (the most urban and fastest growing district), indicating that a corridor management strategy for that district might be a high policy priority.

FIGURE 9. Top Ranked Corridors for Potential Improvement ("Proactive Corridors")

The final report of this project has been published, and the findings of this project led to a follow-on research project designed to develop a template for corridor management studies and cooperative agreements in Iowa. As of the writing of this paper, two pilot corridor management projects are underway near Dubuque (U.S. Highway 20) and Des Moines (Iowa Highway 163). These corridors were among the highest-ranked "pro-active" corridors identified in the research project.

ACKNOWLEDGMENTS

REFERENCES

1. Maze, Tom, and David Plazak. *Access Management Awareness Program: Phase II Report*. Iowa Highway Research Board Project TR-402. Center for Transportation Research and Education, Iowa State University, Ames, Iowa, December 1997.

2. Souleyrette, Reginald, Tim Strauss, Michael Pawlovich, and Brad Estochen. GIS ALAS: The Integration and Analysis of Highway Crash Data in a GIS Environment. Geographic Information Systems for Transportation Symposium, American Association of State Highway and Transportation Officials, Salt Lake City, Utah, April 20–22, 1998, pp. 411–428.

3. Anderson, Michael D., and Reginald R. Souleyrette. *FHWA Priority Technology Program: Transportation Planning GIS*. FHWA-PT-96-IA (01). Center for Transportation Research and Education, Iowa State University, Ames, Iowa, February 1997.