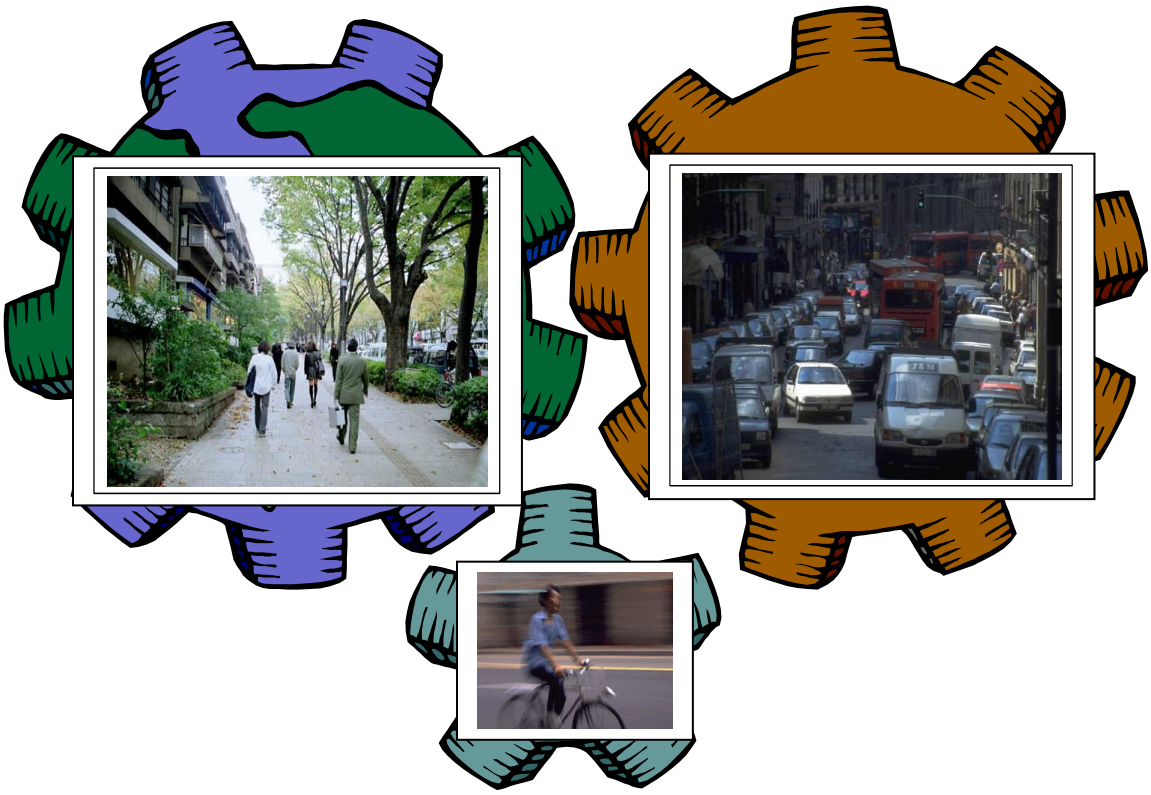
EXECUTIVE SUMMARY

Access Management Awareness Project & Report

Orange Grove Road



Town of Hillsborough

and

Board of County Commissioners
Orange County, North Carolina

March, 2003

VII. Recommendations

The Joint Orange Grove Road Transportation Group recommends the following actions to alleviate unsafe conditions and to manage potential congestion from future development in the Orange Grove Road corridor. The recommendations address five basic issues: 1. obtaining funding for improvements to enhance safety for all modes of traffic; 2. providing pedestrian facilities (sidewalks) in the corridor; 3. implementation of recommendations into local plans and regulations; 4. recommendations for future studies; and 5. distribute the report to community groups for comments.

1. Pursue funding to implement recommendations in this study.

The Transportation Improvement Program (TIP), Spot Safety funds and Small Urban Funds are potential funding sources for roadway improvements. Small Urban Funds may be used for projects within 1-mile outside city limits. Both Small Urban and Spot Safety funding sources are subject to the discretion of the Division's Board of Transportation (BOT) member, and are generally requested for projects in the $50,000 to $200,000 range. The local jurisdiction(s) must request those funds from the BOT member. Transportation Improvement Program, in general, is used to fund projects that cost $300,000 or more. There are also some contingency funds that may be requested through the area's representatives to the State legislature.

The local jurisdictions should pursue funding to advance the following improvements in the Orange Grove Road corridor.

1.1 Pursue funding to widen the bridge on Orange Grove Road over Interstate 40 to include bicycle and pedestrian facilities. North Carolina Department of Transportation estimates the cost to add bicycle and pedestrian facilities to the bridge is approximately $750,000.

1.2 Pursue funding and work with NCDOT to install a crosswalk with a flashing light to warn vehicles of the pedestrian crossing at the bus driveway entrance at Cedar Ridge High School.

1.3 Pursue funding and work with NCDOT to investigate installing a traffic light at the intersection of Oakdale Drive and Orange Grove Road, and to provide right turn lanes on both Oakdale Drive and Orange Grove Road to assist traffic flow through the intersection.

2. Provide pedestrian facilities along Orange Grove Road.

2.1 Research actual right-of-way along Orange Grove Road throughout the corridor study area through land records and pursue feasibility of obtaining the recommended 80' right-of-way through dedication or acquiring easements.

2.2 Investigate installing sidewalks along the north side of Orange Grove Road in the corridor study area including determining the feasibility of construction with respect to changes in elevation along the road and with respect to cost.

2.3 After technical report has been received by both the Hillsborough Town Board and the Orange County Board of Commissioners, if the data indicates that construction of a sidewalk on the north side of Orange Grove Road is not financially feasible, pursue widening Orange Grove Road to 12' lanes with, at a minimum, 4' paved shoulders and preferably with 6' or 8' paved shoulders to allow for a shared bicycle/pedestrian facility.

2.4 Coordinate with the School Board to pursue installation of sidewalks along Orange Grove Road adjacent to the school property, along New Grady Brown School Road and from the proposed crosswalk on New Grady Brown School Road to the Grady Brown School and to Cedar Ridge High School.

3. Implement recommendations into local plans and regulations.

3.1 Include recommendations in this study in the development of Multi-modal Transportation Plans for Orange County and the Town of Hillsborough.

3.2 Adopt recommended cross section for Orange Grove Road into Orange County and Town of Hillsborough zoning ordinances and subdivision regulations.

3.3 Amend each jurisdictions respective land use regulations to support and/or implement recommendations in this study including a provision that any development having ingress/egress off Orange Grove Road in the study area either construct its fair share of recommended improvements or provide payment in lieu of for such improvements.

3.4 Support TIP Project R2825, South Churton Street improvements, by continuing to assign a high priority to that project as a transportation need in the biennial update of the TIP.

4. The following items are recommended for Future Studies.

4.1 Work with the business community through the Economic Development Commission and the Orange County/Hillsborough Chamber of Commerce to implement the recommendations in the Feasibility Study for South Churton Street concerning Daniel Boone Village and to develop access management for other businesses in the South Churton Street corridor.

4.2 Pursue a future study for the Oakdale Drive corridor.

5. Distribute Orange Grove Road Study and Access Management Plan to community groups for comments.

TABLE OF CONTENTS

Project Phases and Work Products

The Access Management Awareness Project is divided into five work phases.

- **Phase I - Project Background and General Goals 1**
- **Phase II - Orange County Case Study 5**
- **Phase III - Access Management: A Review of Recent Literature 17**
- **Phase IV - Access Management: Current Policies and Regulatory Framework.....25**
- **Phase V - Access Management Toolkit.....31**

- **APPENDIX**

  A. Transportation Goals and Policies .....

  B. A Bicycle Transportation Plan .....

  C. Orange County Proposed Priority Bicycle Transportation Routes Map (July 1998) .....

PHASE I

PROJECT BACKGROUND AND GENERAL GOALS

- **TASK FORCE CREATION**
- **ACCESS MANAGEMENT**
- **ACCESS MANAGEMENT TASK FORCE MEMBERS**
- **GENERAL GOALS**
- **SPECIFIC GOALS**

PHASE I

Project Background and General Goals

TASK FORCE CREATION

In March, 2002, the Board of County Commissioners and the Town of Hillsborough established the Orange Grove Road Transportation Task Force as part of its continuing cooperative planning effort. Existing and proposed development activity, as well as, existing public facilities such as schools in this corridor, prompted a review of transportation issues and a discussion regarding the range transportation planning initiatives that can lead to a well-planned, safer, multimodal transportation system. The North Carolina Department of Transportation (NCDOT) is a partner in the effort. The Task Force found that the crux of many solutions was based in access management, so their work was to improve awareness of how access management can lead to safer, better functioning highways, roads, and streets in the Hillsborough area. The Task Force also considered, as a byproduct, the effects that access management projects have on local business vitality.

ACCESS MANAGEMENT

Access management is a process that manages access to land development while seeking to preserve the flow of traffic on the surrounding road system. Sound access management practices can lead to safer roads that provide better service to motorists and a safer environment for pedestrians and cyclist.

ACCESS MANAGEMENT TASK FORCE MEMBERS

Barry Jacobs, Chair	Board of County Commissioners
Stephen H. Halkiotis, Vice Chair	Board of County Commissioners
Michael Gering, Commissioner	Town of Hillsborough
Evelyn P. Lloyd, Mayor Protem	Town of Hillsborough
Craig N. Benedict, AICP, Planning Director	Orange County Planning & Inspections Dept.
Karen Lincoln, Socio-Economic Transportation Planner	Orange County Planning & Inspections Dept.
Margaret Hauth, Director of Planning	Town of Hillsborough
Chuck Edwards, District Engineer	North Carolina Department of Transportation
Dianne Reid, Economic Development Director	Orange County Economic Development Dept.

A. GENERAL GOALS

1. The welfare of the Town and County requires the safe, efficient and economical movement of persons and goods while maintaining livability and environmental quality. It is essential to develop and maintain a complete transportation system (freeways, major streets, public transit, bicycle, and pedestrian ways) adequate to accommodate those needs. The intensity of land development and the travel demand it produces must be in balance with the planned capacity of the transportation system. If this balance is not maintained, the inevitable result is traffic intrusion into residential streets, traffic delays, undesirable business environment, a less safe citizen environment and an overall diminishment of the quality of life.

2. Comprehensive and cooperative planning is essential to the development of a safe, effective transportation system.

3. The development of a draft Bicycle and Pedestrian Master Plan for the Orange Grove Road Corridor with possible application to other areas of the County. An introduction of the needs and format of a master plan is noted below within this phase.

B. SPECIFIC GOALS

Proactively develop a multimodal transportation plan for the area to guide and manage new and rehabilitative development accordingly. These ideas are then implemented with regard to Orange Grove Road corridor.

To accomplish these goals, the Town and County has suggested and is developing more specific goals, objectives and policies regarding transportation in the aspect of vehicles, pedestrians, and cyclists, noted in Phase IV.

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PHASE II

ORANGE COUNTY CASE STUDY

I. BACKGROUND

II. COMPREHENSIVE LAND USE REVIEW

III. ROAD CONNECTIVITY

IV. RECOMMENDATIONS FOR ROAD CONFIGURATION

V. INTERSECTION IMPROVEMENTS AND SIGNALIZATION

VI. ACCESS MANAGEMENT AND RECOMMENDED LAND USE CONTROLS

VII. RECOMMENDATIONS

PHASE II

Orange County Case Study

I. Background

The Orange Grove Access Management Plan is being created by a joint effort between the Town of Hillsborough and Orange County to address development pressures in the Orange Grove Road corridor and corresponding impacts to the safety of bicycle and pedestrian traffic in the corridor. Providing safe access for school children traveling to Grady Brown Elementary School and Cedar Ridge High School and bicycle and pedestrian traffic crossing the bridge over Interstate 40 was a major factor in the appointment of the Joint Orange Grove Road Transportation Group by the Hillsborough Town Board and the Orange County Board of Commissioners. The commissioners, at a joint meeting of the two boards on May 6, 2002, agreed to appoint two commissioners from each jurisdiction to study transportation issues in the Orange Grove Road corridor and prepare a recommendation on ways to address those issues. The group's recommendations are contained in this access management plan for the Orange Grove Road corridor.

The study area for the corridor extends along Orange Grove Road from Churton Street to New Grady Brown School Road and includes the largely undeveloped area bounded by I-40, I-85 and Oakdale Drive. Orange Grove Road is a two-lane, twenty-foot wide shoulder section road. Bicycles must share the 10-foot travel lanes with motor vehicles and there are no sidewalks. The North Carolina Department of Transportation does not own nor have a right-of-way easement throughout the entire corridor for the currently proposed sixty-foot right-of-way.

In the last few years, there have been several proposals for multifamily residential development in the corridor. The Heritage, a 171-unit multifamily development in the corridor, was approved January 2000. The Town of Hillsborough, since then, has received several applications for multifamily developments and anticipates making decisions on applications for two developments totaling 516 units between December 2002 and February 2003.

Roadway improvements in the corridor will be needed to accommodate new development. Development applications that impact the corridor should address dedication of right-of-way, construction of turn lanes, intersection improvements, bicycle and pedestrian needs and other deficiencies that may be exacerbated by the new development.

This document provides guidance for the improvement of the corridor with recommendations regarding road connectivity, road cross section and bicycle and pedestrian access, and land use controls.

II. Comprehensive Land Use Review

The study area lies almost entirely within Hillsborough's land use jurisdiction. Only the portion from Interstate 40 to New Grady Brown School Road is within the land use jurisdiction of Orange County. Orange Grove Road from Churton Street to Mayo Drive is currently zoned for general commercial uses to provide for future expansion of the general commercial district south of the historic downtown area. The remainder of the corridor is zoned for residential uses ranging from low-density agricultural residential zoning to high-density multifamily zoning.

Retail and service operations exist within walking or cycling distance from the residentially zoned property, but there are no roadway connections from the residential areas to the commercial district on Churton Street. This plan recommends several connections that can be realized with future land use decisions.

New Grady Brown Elementary and newly constructed Cedar Ridge High School are within walking and cycling distance from residential areas. The schools are located on New Grady Brown School Road which takes access from Orange Grove Road and Dimmocks Mill Road. Both Orange Grove Road and Dimmocks Mill Road are on adopted bicycle plans for the Town of Hillsborough or Orange County. However, lack of adequate bicycle facilities on those roads and on New Grady Brown School Road present an unsafe environment for using bicycles as a means for transportation to the schools. Likewise, lack of sidewalks throughout the corridor make walking undesirable.

Another major obstacle to the safety of bicycle and pedestrian transportation and the connectivity of the Orange Grove Road bicycle route is the narrow two-lane bridge that carries Orange Grove Road over Interstate 40. Bicyclists and pedestrian must share the roadway with motor vehicles crossing the bridge, as there are no shoulders or facilities for cyclists or pedestrians.

There is a large amount of undeveloped land between the commercial district along Churton Street and the area bounded by Interstate 85, Orange Grove Road and Oakdale Drive. This plan recommends roadway connections that could form a network to provide easy access between development along Orange Grove Road and the commercial areas along Churton Street and also to the schools.

III. Road Connectivity

Access management in the Orange Grove Road corridor includes recommendations for new roadway connections from Orange Grove Road to other major roads in the area as new development takes place. Arrows outlined in white on Map 1. Orange Grove Parcels show potential access points for construction of new roads in the corridor to help manage congestion by limiting the points of access to the corridor. The arrows also indicate where extensions of existing subdivision roads can be used to connect with proposed access points and provide a road network within the area between Churton Street, Orange Grove Road, Interstate 85 and Oakdale Drive. The proposed access points can be used as a guide for the design of future development proposals.

This plan recommends that the Town pursue the realignment of Eno Mountain Road to align with the intersection of Mayo Street at Orange Grove Road to resolve traffic conflicts caused by the close proximity of the intersections of two urban major thoroughfares with another urban major thoroughfare. That intersection would potentially warrant a traffic light.

The plan also recommends the extension of Orange Grove Road from Churton Street to US 70 Business. That connection would provide an alternative access to the US 70 Business/NC 86 corridor and alleviate congestion on Churton Street. The connection would also provide a more direct route to Eno Mountain and western Hillsborough from the US 70 Business corridor.

MAP 1 TO BE INCLUDED IN COMPLETE REPORT

IV. Recommendtions for Road Configuration

The Joint Orange Grove Road Transportation Group recommended several changes to the Hillsborough Transportation Plan regarding proposed roadway sections.

Orange grove road is designated as a major urban thoroughfare with average daily traffic of 4,100 in 2001. The proposed cross section is a two-lane, 24-foot shoulder section within a 60-foot right-of-way. Traffic projections in the corridor do not warrant widening the road since the existing and proposed cross section has adequate capacity (14,000 ADT) to handle the projected average daily traffic at level of service E.

Regional urban highway capacity figures are calculated at level of service E. Level of service E represents operating conditions at or near the capacity level with reduced speeds and difficulty maneuvering within the traffic streams. Operations at level of service E are usually unstable because small increases in flow or minor perturbations within the traffic stream will cause breakdowns.

This plan recommends a cross section for Orange Grove Road that will be adequate to operate in the future at a higher level of service.

The new housing proposals in the Orange Grove Road corridor, all of which could be approved by February 2003, have the potential of creating 4,400 (approximately) trips per day. Traffic generated by the new high school at capacity (1,000 students) could easily create more than 1,0 trips per day during the school year. Traffic from the known development, combined with existing traffic counts in the corridor, will outpace the traffic projected for 2020 in the 1997 *Transportation Plan for the Town of Hillsborough*. That plan projects 8,300 average daily traffic in 2020 and traffic generated by current development proposals may result in average daily traffic over 9,000 within the next five years.

Recommended cross sections for Orange Grove Road are shown in Figure 1. Proposed Street Cross Sections. The recommended cross sections include three shoulder sections (figures 1a, 1c and 1d) and a curb and gutter section (figure 1b).

The recommended shoulder sections require an 80-foot right-of-way to accommodate two 11’ – 12’ travel lanes with a bicycle lane, shoulder and drainage ditch in each direction. Two of the shoulder sections and the curb and gutter section place 5’ sidewalks outside the drainage and utility areas which would allow construction of the sidewalks prior to widening the roadway for bicycle lanes. Placement of pedestrian facilities in that manner, farthest from the travelway, provides more separation between pedestrian and motor traffic and increases safety and comfort level for all traffic.

Figure 1. Proposed Street Cross Sections
Figure 1a.
PROPOSED STREET CROSS SECTION
SHOULDER SECTION

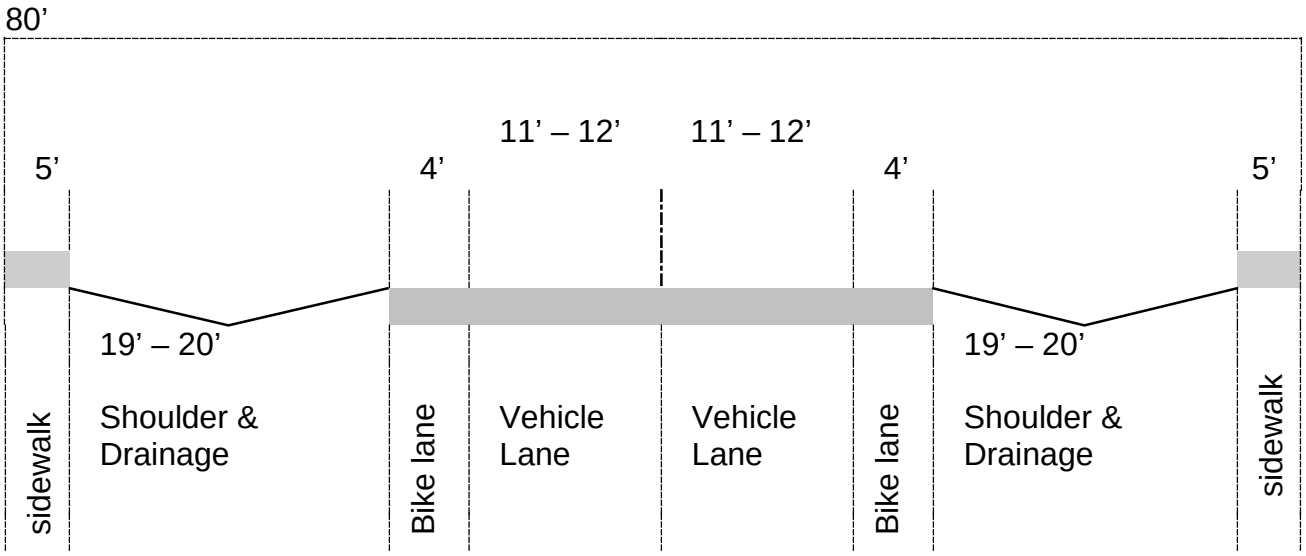


Figure 1b.

PROPOSED STREET CROSS SECTION
CURB & GUTTER SECTION

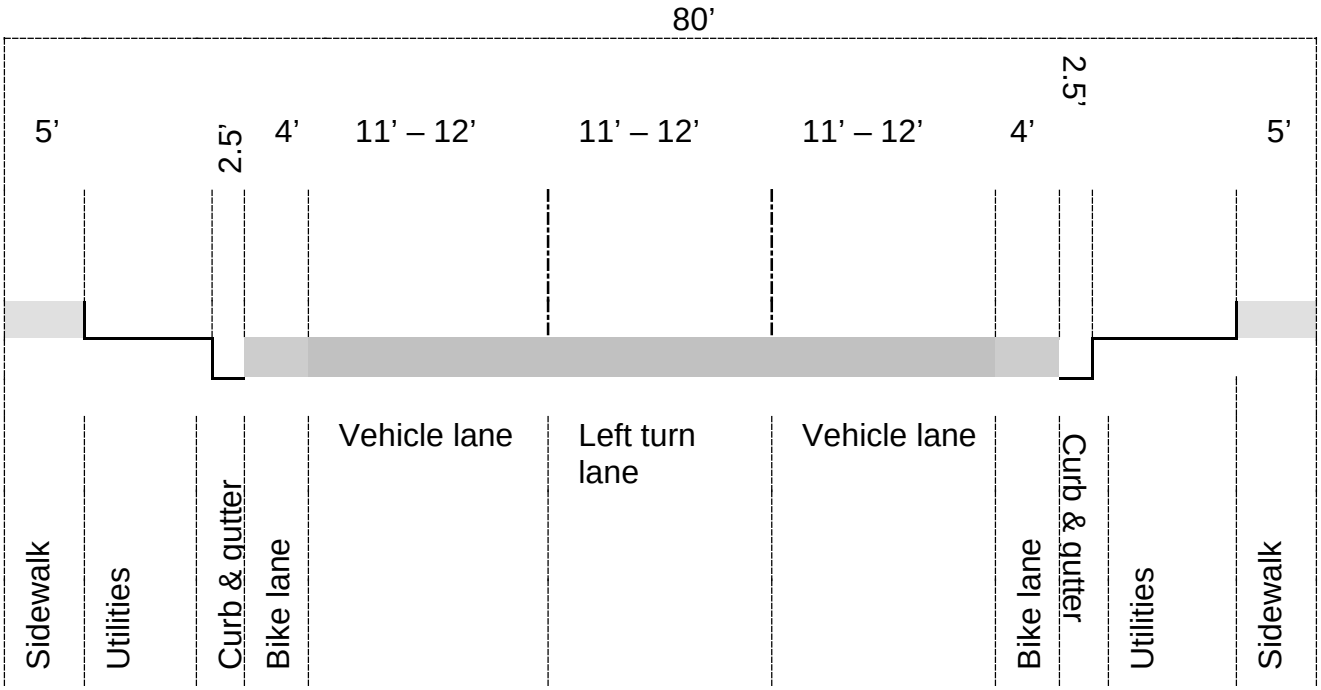


Figure 1c

PROPOSED STREET CROSS SECTION
SHOULDER SECTION

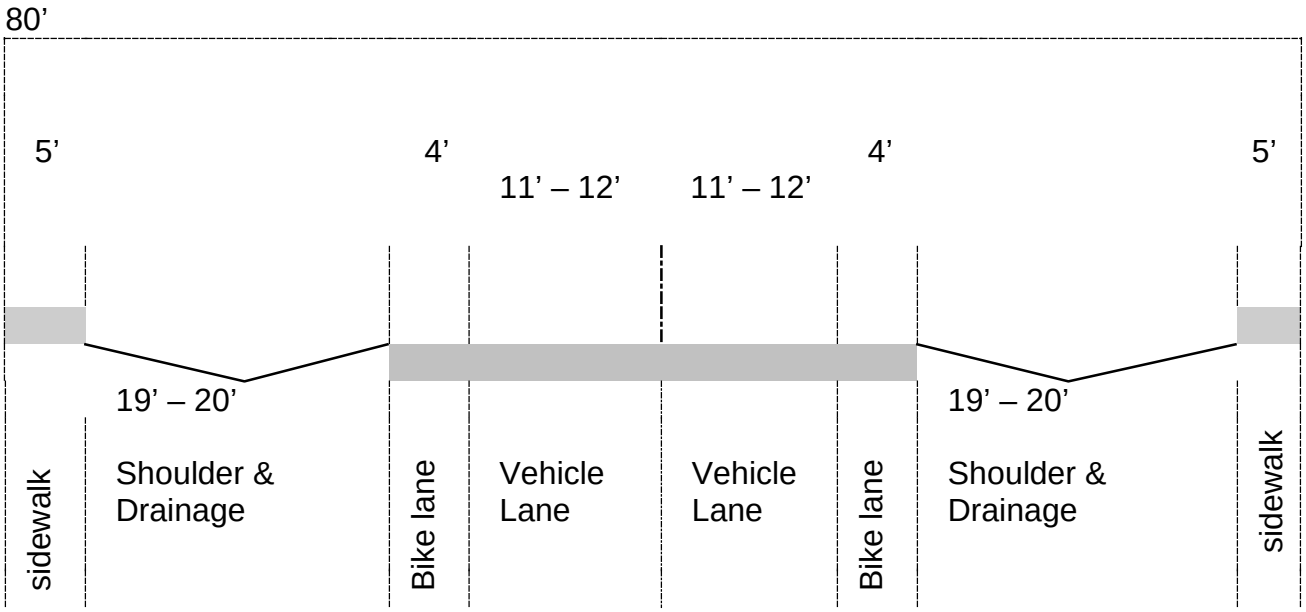
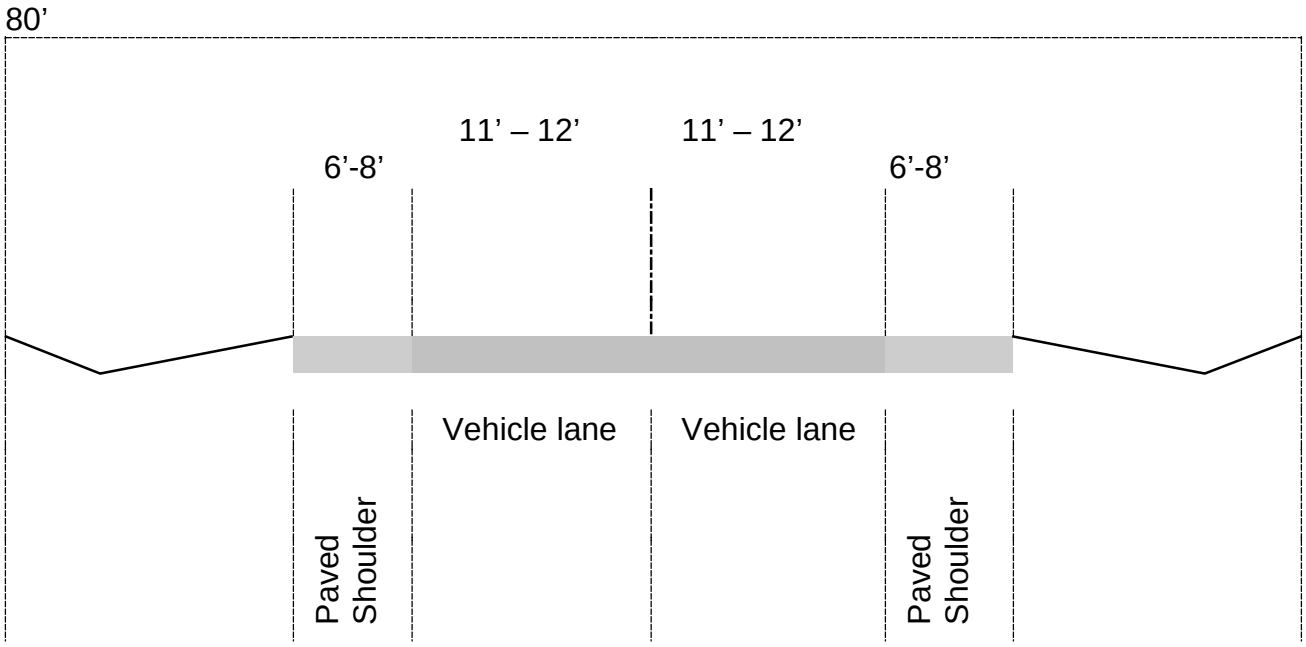


Figure 1d.
PROPOSED STREET CROSS SECTION
SHOULDER SECTION



V. Intersection Improvements and Signalization

Recommended improvements to intersections within the study area are given in the following tables. The numbers of the intersections in the table correspond to the numbers assigned the intersections on Map 2. Hillsborough–Orange County Study Area.

Hillsborough/Orange County Study Area Identification of Intersections

Interstate Interchanges

A	I-40 and Old NC 86 (SR 1009)	
	Existing:	Proposed:
	Four-lane freeway (grade-separated) interchange with two-lane urban major thoroughfare/arterial	Four (or six)-lane freeway interchange with four-lane median divided, bicycle and pedestrian friendly design urban major thoroughfare/arterial.
B	I-85 and Old NC 86 (SR 1009)	
	Existing:	Proposed:
	Four-lane freeway interchange with two-lane major urban thoroughfare having three-lane section at interchange to provide left turn lanes.	Six-lane freeway interchange with four-lane median divided, bicycle and pedestrian friendly design urban major thoroughfare.
11	I-40 and Orange Grove Road (SR 1006)	
	Existing:	Proposed:
	Two-lane major urban thoroughfare bridge over four-lane freeway.	Two-lane major urban thoroughfare bridge with added facilities for bicycles and pedestrians over four-lane or six-lane freeway.

Railroad Intersections

18	US 70A East and newly proposed Orange Grove Road extension	
	Existing:	Proposed:
	Two-lane urban major thoroughfare.	Two-lane (with left turn lanes at intersection) or three-lane (continuous left turn lane) shoulder section urban major thoroughfare with bicycle lanes and sidewalks grade separated crossing.
	Any new crossings of railroads within the Southeastern High Speed Rail Corridor must be grade-separated crossings.	

Intersections With Traffic Lights

4	Orange Grove Road (SR 1006) and New Grady Brown School Road (SR 1221) (western boundary of EDD)	
	Existing:	Proposed:
	Two –lane urban major thoroughfare /collector intersection with two-lane urban minor thoroughfare/major local road.	Two-lane or three-lane (continuous left turn lane) urban major thoroughfare/collector with bicycle lanes and sidewalks (north of intersection) intersection with two-lane minor thoroughfare/major local road with bicycle lanes and sidewalks.

7	Old NC 86 (SR 1009) and Oakdale Drive (SR 1133)	
	Existing:	Proposed:
	Two-lane urban major thoroughfare /arterial (three-lane section at intersection with left turn lanes) intersection with two-lane urban minor thoroughfare.	Four-lane median divided (bicycle and pedestrian friendly design) urban major thoroughfare/arterial intersection with two-lane urban minor thoroughfare (three-lane section with left turn lanes at intersection) with bicycle lanes and sidewalks.

Intersections With Traffic Lights

12	Old NC 86 (SR 1009) and Mayo Street	
	Existing:	Proposed:
	Two-lane urban major thoroughfare (three-lane section at intersection with left turn lanes) intersection with two-lane urban major thoroughfare (three-lane section at intersection).	Four-lane median divided (bicycle and pedestrian friendly design) urban major thoroughfare intersection with two-lane urban major thoroughfare (three-lane section with left turn lane at intersection).

Intersections With Traffic Lights

17	Old NC 86 (SR 1009) and Orange Grove Road (SR 1006)	
	Existing: Two-lane urban major thoroughfare (three-lane section at intersection with left turn lanes) intersection with two-lane urban major thoroughfare (three-lane section with left turn lanes at intersection).	Proposed: Four-lane median divided (bicycle and pedestrian friendly design) urban major thoroughfare intersection with two-lane urban major thoroughfare (three-lane section with left turn lane at intersection) or three-lane (continuous left turn lane) with bicycle lanes and sidewalks.
23	US 70A East and Churton Street	
	Existing: Two-lane urban major thoroughfare (three-lane section at intersection with left turn lane) intersection with two-lane urban major thoroughfare (southbound three-lane section with left turn lane at intersection).	Proposed: Four-lane urban major thoroughfare intersection with four-lane median divided, bicycle and pedestrian friendly design urban major thoroughfare

Intersections Without Traffic Lights

3	Old NC 86 (SR 1009) and Lafayette Drive (within EDD)	
	Existing: Two-lane major urban thoroughfare /arterial (northbound three-lane section with left turn lane at intersection) intersection with two-lane local street.	Proposed: Four-lane median divided (bicycle and pedestrian friendly design) urban major thoroughfare intersection with two-lane urban minor thoroughfare (three-lane section with left turn lanes at intersection).

Intersections Needing Traffic Lights

5	Orange Grove Road (SR 1006) and Oakdale Drive (SR 1133)	
	Existing:	Proposed:
	Two –lane urban major thoroughfare intersection with two-lane local road.	Two-lane (three-lane section with left turn lanes at intersection) or three-lane (continuous left turn lane) urban minor thoroughfare with bicycle lanes and sidewalks intersection with two-lane local road (with left turn lane at intersection) with bicycle lanes and sidewalks. Traffic Light Proposed.
15	Mayo Street and proposed realignment of Eno Mt. Road (SR 1148) with Orange Grove Road (SR 1006)	
	Existing:	Proposed:
	Two-lane urban major thoroughfare (three-lane section at intersection) intersection with two-lane urban major thoroughfare.	Two-lane (three-lane section with left turn lanes at intersection) urban major thoroughfare intersection with two-lane (three-lane section with left turn lanes at intersection) or three-lane (continuous left turn lane) urban major thoroughfare with bicycle lanes and sidewalks.

Proposed Intersections

6	Oakdale Drive (SR 1133) and newly proposed road (north of EDD)	
	Existing:	Proposed:
	Two-lane urban minor thoroughfare.	Two-lane (three-lane section with left turn lanes at intersection) or three-lane (continuous left turn lane) urban minor thoroughfare) with bicycle lanes and sidewalks intersection with new two-lane urban minor thoroughfare/collector (three-lane section with left turn lane at intersection).
	Orange Grove Road and proposed access point (approximately .2-mile northeast of Oakdale Drive) to align access to future developments on north and south sides of Orange Grove	
	Existing:	Proposed:
	Two-lane urban minor thoroughfare.	Two-lane (three-lane section with left turn lanes at intersection) or three-lane (continuous left turn lane) urban minor thoroughfare) with bicycle lanes and sidewalks intersection with new two-lane urban major local road (three-lane section with left turn lane at intersection).

MAP 2 TO BE INCLUDED IN COMPLETE REPORT

VI. Access Management and Recommended Land Use Controls

Land Use controls to restrict driveway access in the corridor and provide for signalized intersections to meter traffic in an efficient manner can be implemented through revisions to Hillsborough's Subdivision Regulations.

This plan describes various access management tools that can be incorporated into land use decisions in the corridor such as:

- Shared driveways and provisions for common access off Orange Grove Road for new subdivisions;
- Connectviity of roads in new development to existing road stubouts;
- Extension of new roads to adjacent areas for future development.

See Phase IV for full list of access management tools.

VII. Recommendations

The Joint Orange Grove Road Transportation Group recommends the following actions to alleviate unsafe conditions and to manage potential congestion from future development in the Orange Grove Road corridor. The recommendations address fIve basic issues: 1. obtaining funding for improvements to enhance safety for all modes of traffic; 2. providing pedestrian facilities (sidewalks) in the corridor; 3. implementation of recommendations into local plans and regulations; 4. recommendations for future studies; and 5. distribute the report to community groups for comments.

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Pursue funding and work with NCDOT to install a crosswalk with a flashing light to warn vehicles of the pedestrian crossing at the bus driveway entrance at Grady Brown Elementary School.

Pursue funding and work with NCDOT to investigate installing a traffic light at the intersection of Oakdale Drive and Orange Grove Road, and to provide right turn lanes on both Oakdale Drive and Orange Grove Road to assist traffic flow through the intersection.

2. Provide pedestrian facilities along Orange Grove Road.

- Research actual right-of-way along Orange Grove Road throughout the corridor study area through land records and pursue feasibility of obtaining the recommended 80' right-of-way through dedication or acquiring easements.

Investigate installing sidewalks along the north side of Orange Grove Road in the corridor study area including determining the feasibility of construction with respect to changes in elevation along the road and with respect to cost.

After technical report has been received by both the Hillsborough Town Board and the Orange County Board of Commissioners, if the data indicates that construction of a sidewalk on the north side of Orange Grove Road is not financially feasible, pursue widening Orange Grove Road to 12' lanes with, at a minimum, 4' paved shoulders and preferrably with 6' or 8' paved shoulders to allow for a shared bicycle/pedestrian facility.

Coordinate with the School Board to pursue installation of sidewalks along Orange Grove Road adjacent to the school property, along New Grady Brown School Road and from the proposed cross walk on New Grady Brown School Road to the Grady Brown School and to Cedar Ridge High School.

3. Implement recommendations into local plans and regulations.

Include recommendations in this study in the development of Multi-modal Transportation Plans for Orange County and the Town of Hillsborough.

Adopt recommended cross section for Orange Grove Road into Orange County and Town of Hillsborough zoning ordinances and subdivision regulations.

Amend each jurisdictions respective land use regulations to support and/or implement recommendations in this study including a provision that any development having ingress/egress off Orange Grove Road in the study area either construct its fair share of recommended improvements or provide payment in lieu of for such improvments.

Support TIP Project R2825, South Churton Street improvements, by continuing to assign a high priority to that project as a transportation need in the biennial update of the TIP.

4. The following items are recommended for Future Studies.

Work with the business community through the Economic Development Commission and the Orange County/Hillsborough Chamber of Commerce to implement the recommendations in the Feasibility Study for South Churton Street concerning Daniel Boone Village and to develop access management for other businesses in the South Churton Street corridor.

Pursue a future study for the Oakdale Drive corridor.

5. Distribute Orange Grove Road Study and Access Management Plan to community groups for comments.

PHASE III

ACCESS MANAGEMENT: A REVIEW OF RECENT LITERATURE

I. BACKGROUND

II. DEFINITION OF ACCESS MANAGEMENT

III. SUMMARY OF THE LITERATURE

IV. LITERATURE REVIEW METHODOLOGY AND SOURCES

V. GENERAL MATERIALS ON ACCESS MANAGEMENT

VI. RESEARCH ON ACCESS MANAGEMENT
- A. Impacts of Access Management on Traffic Flow and Congestion
- B. Impacts of Access Management on Safety
- C. Impacts of Access Management on Business Vitality, Business Customers, and Area Residents

VII. ACCESS MANAGEMENT CASE STUDIES

VIII. ACCESS MANAGEMENT LAWS AND REGULATIONS

IX. ACCESS MANAGEMENT BEST PRACTICES AND GUIDELINES

X. ACCESS MANAGEMENT EDUCATIONAL MATERIALS
- A. Educational Materials Designed Mainly for the General Public and Elected Officials
- B. Educational Materials Designed Mainly for Professionals

XI. PUBLIC AND STAKEHOLDER INVOLVEMENT MATERIALS

XII. ACCESS MANAGEMENT HOT LINKS

PHASE III

Access Management: A Review of Recent Literature

I. Background

The Orange Grove Road Transportation Study Task Force realized that its charge reflected a strong role in Access Management. So often the Orange Grove Road Access Management Task Force is used interchangeably. This group was established as part of the overall cooperative planning effort. The goal of the Access Management Task Force is to develop a program designed to explain and market the concept and benefits of access management to landowners and developers, professional planners and engineers, planning and zoning staff members, appointed and elected officials, and motorists.
The Task Force staff conducted a review of the access management literature to assist it in refining its research agenda. This literature review was to include:

- Studies documenting the level of service, traffic accident and safety, and business "vitality" impacts of access management projects.
- Case studies of rural, suburban, and urban access management projects, including best practices, regulations, and guidelines from around the United States.
- Access management educational tools from other states and localities and materials on public involvement in access management planning and projects.

II. Definition Of Access Management

The Michigan Department of Transportation defines access management as:

"A process that provides or manages access to land development while simultaneously preserving the flow of traffic on the surrounding road system in terms of safety, capacity, and speed."

Access management is pursued through the design and control of driveways, curb cuts, turning movements, interior circulation of parking lots, and public street connections and intersections. Usually, state highways or major urban and suburban arterial streets are the targets of access management projects. Access management is also a concern on main county roads when there is a transition from a rural environment to a town or city.

III. Summary Of The Literature

The literature on access management is extensive and is growing rapidly at this time. This is because access management strategies appear to be both a very effective and very appropriate strategy in these times of limited resources for new roadway construction.

Access management is an important tool for improving both the functioning and safety of highway transportation systems. Research indicates that effective access management programs have the potential to dramatically increase the safety of streets and highways and also to increase roadway capacity, reduce congestion, reduce air pollution emissions, and reduce average travel times for motorists.
Several states have adopted statewide access management policies that should be reviewed for applicability to and similarity to North Carolina and Orange County. Many local governments have also adopted or substantially revised their access management regulations and guidelines in recent years. A considerable number of well documented access management case studies exist which can also provide important ideas and lessons for the Town of Hillsborough and Orange County.

Education regarding, and marketing of, access management are rather new themes. Until recently, public involvement in access management has tended to come late in the planning and design process, usually in the form of public hearings. However, as states and local governments have become more aggressive in promoting and using access management, the need to educate the public and involve them more fully in access management design and implementation has grown. As a result, the literature in this area is expanding.

The amount of literature on access management is voluminous, so only a portion is reflected in this document. For an overview of the subject more quickly, readers may wish to first consult the references pointed out in the document.

IV. Literature Review Methodology And Sources

The literature on access management and access control was researched by the Orange Grove Road Task Force using the following approach to gain maximum results.

- A computer and Internet search of on-line literature on access management.

The major source for the computer and on-line literature review were as follows:

- Several World Wide Web sites on the Internet, including those of the U.S. Department of Transportation's Bureau of Transportation Statistics (BTS), the American Planning Association (APA), the Institute of Transportation Engineers (ITE), and the American Public Works Association (APWA).

This search mechanism yielded valuable results in terms of literature identified. The literature cited in this review covers access management in 25 states and one Canadian province. This indicates that access management has become a pervasive transportation system management strategy nationwide.

V. General Materials On Access Management

Together, these materials provide an overview of the current status and practice of access management in the United States. They present the state of the art in access management in the United States.

- Geiger, David, et. al, "An Overview of Access Management at Selected State DOTs," paper prepared for the 1996 National Access Management Conference in Vail, Colorado. This paper presents the results of a telephone survey of eleven state DOTs prepared for the Michigan Department of Transportation. This included three states (Colorado, Florida, and New Jersey) with formal access management codes. The strengths and weaknesses of various state approaches are discussed.

- Institute of Transportation Engineers, Transportation and Land Development, 1988. The basic reference on how highways and land development interact.

- Levinson, Herbert, "Access Management on Suburban Roads," Transportation Quarterly, Summer 1994. An overview of access management highlighting the actions of leading states of Colorado, Florida, New Jersey, and Oregon.

- U.S. Department of Transportation, Federal Highway Administration, First Annual Access Management Conference Proceedings, Vail Colorado, FHWA-PD-94-010, Washington, DC, 1994. One of the best single references on access management, this 300-page compendium contains over 35 papers, some of which are individually referenced below. The conference was designed to spread awareness of access management innovation, which was then concentrated in a handful of states.

VI. Research On Access Management

Research on access management falls into three distinct categories: impacts on traffic flow and congestion; impacts on safety; and impacts on businesses and area residents. These research studies clearly demonstrate the significant positive impact that access management can have on both traffic operations and accident rates.

- National Cooperative Highway Research Program (NCHRP) Project 3-52, Impacts of Access Management Techniques, is a major research project currently underway and should be available in Spring 1997. It will address both the operational/traffic flow and safety impacts of access management.

A. Impacts Of Access Management On Traffic Flow And Congestion

Available research indicates that application of access management principles can have a significant and positive impact on the functioning of highways and other arterial roadways. Improved functioning can be measured in terms of roadway capacity, level of traffic service provided, delays, or travel time/speed.

- Stover, Vergil, Richard Hawley, Donald Woods, and Richard Hamm, "Access Management as a Congestion Management Measure," paper prepared for the 1993 National Access Management Conference in Vail, Colorado. This paper thoroughly examines the relationship between access management and traffic congestion. It notes that increasing signalized intersection spacing to uniform intervals and installing non-traversable medians will increase the capacity of a four lane arterial by about 50%. This is the same effect as widening the arterial to six lanes.

B. Impacts Of Access Management On Safety

As with traffic operations, research shows that increased access control can play a significant role in reducing both the quantity and severity of traffic accidents.

- Gattis, J. L., "Comparison of Delay and Accidents on Three Roadway Access Designs in a Small City," paper prepared for the 1996 National Access Management Conference in Vail, Colorado. This paper provides an intensive comparison of the accident and other characteristics of three arterial segments within a single small city (Muskogee, Oklahoma). All three segments had four lanes with some sort of median treatment and turning lanes, but differing amounts of access management in place. The segment with the highest level of access control experienced 40 percent lower property damage and injury accident rates than the two with less access control.

- Stover, Vergil, Samuel Tignor and Merton Rosenbaum, Synthesis of Safety Research Related to Traffic Control and Roadway Elements, Volume 1, Chapter 4: "Access Control and Driveways," FHWA-TS-82-232, Office of Research, Development, and Technology, U.S. Department of Transportation, Washington, DC, December 1992. This report chapter provides a general overview of safety issues related to access management. It indicates that management of driveway density and spacing is one of the most effective strategies for increasing traffic safety along with installation of non-traversable medians. Designs such as curbed, painted, raised, and depressed medians are discussed as are continuous two-way left turn lanes (CLTL).

C. Impacts Of Access Management On Business Vitality, Business Customers, And Area Residents

The literature review identified very limited literature on the subject of research on impacts of access management on business vitality, business customers, and area residents. Only a handful of researchers have ever attempted to examine this relationship. All of these studies use Florida examples and data. What seems clear from these references is although access management projects can lead to inconvenience and some business losses, most stakeholders recognize the value of these projects in terms of safety.

- Florida Department of Transportation, Access Management. (various educational materials) Several closely spaced median openings on U.S. 1 in Stuart, Florida were closed to enhance safety; crashes were reduced by 22%. When stakeholders were surveyed, the majority of motorists and local residents expressed support for the project even though they were also inconvenienced by it. Most truckers also favored access control.

- Ivey, Harris & Walls, Inc., Corridor Land Use, Development & Driver/Business Survey Analysis, District Wide Median Evaluation Technical Memorandum, final report prepared for the Florida Department of Transportation, Winter Park, Florida, November 1995. This report includes a number of very well documented corridor case studies involving installation or modifications of raised medians in Florida. It is the only access management research study that includes survey results for both drivers and businesspersons. Postage-paid, mail-back surveys were handed out along the corridors, and a total of 180 were returned by drivers (23% response rate) and 228 by businesses (46% response rate). The driver survey results indicate that most drivers felt the inconvenience caused by raised medians on these corridors was more than offset by positive traffic flow and safety benefits. On the other hand, about 30 percent of the business owners felt that the projects had at least a small adverse impact on their businesses (business volume decline, truck delivery difficulties, etc.).

VII. Access Management Case Studies

There are a number of well-documented access management case studies available from throughout the United States. They help to illustrate in detail various aspects of the process of access management planning, design and implementation. The case studies summarized here were selected because they illustrate typical access management issues and solutions in rural and suburban areas and mid-sized metropolitan areas. Many are from areas with a particularly pressing problem, for instance the need to accommodate growing tourist traffic.

- Urbitran Associates, Inc., I.K. Chan Associates, and Herbert Levinson, Final Report: Route 7 Driveway and Access Management Plan, prepared for the South Western Regional Planning Agency, Norwalk, Connecticut, June 1996. An extraordinarily well-documented access management planning study for the U.S. 7 corridor through a suburban area of Connecticut. It includes a major section on regulatory recommendations for local governments and an extensive number of air photos overlaid with physical planning recommendations.

VIII. Access Management Laws And Regulations

Several states, including Colorado, Florida, and New Jersey, have adopted statewide access management codes. The other references in this section include a variety of access statutes, ordinances, land use and subdivision regulations, administrative rules, design guides, and driveway permit forms, and variance processes from around the nation. Both state and local levels of government are represented.

- Florida, State of, Florida Statute 355--The Access Management Act, undated. This is Florida's statewide access management code.

- Williams, Kristine M. and J. Richard Forester, Land Development Regulations that Promote Access Management, NCHRP Synthesis 233, Transportation Research Board, National Research Council, Washington, D.C., 1996. Both this work and the report cited immediately below are the best references on local land use regulations that support access management.

- Williams, Kristine M., Daniel E. Rudge, Gary Sokolow, and Kurt Eichin, Model Land Development & Subdivision Regulations that Support Access Management for Florida Cities and Counties, Center for Urban Transportation Research, University of South Florida and Florida Department of Transportation, Florida, January 1994.

IX. Access Management Best Practices And Guidelines

Several organizations and government agencies have published papers or guidelines on how best to implement certain aspects of access management. These cover the gamut from system planning and roadway/driveway design to access permitting.

- Institute of Transportation Engineers, Guidelines for Driveway Location and Design, 1987. Recommends in detail guidelines for the design and location of driveways to minimize conflicts and accidents and maximize traffic flow.

- Keopke, F.J. and Levinson, H.S., Access Management Guidelines for Activity Centers, National Cooperative Highway Research Program Report 348, Transportation Research Board, National Research Council, Washington, DC, 1992. The single most complete reference on access management guidelines and best practices.

- Transportation Research Board, Driveway and Street Intersection Spacing, Transportation Research Circular Number 456, National Research Council, Washington, D.C., March 1996. The definitive reference on spacing of street intersections and driveways.

X. Access Management Educational Materials

Materials designed to educate about access management can be subdivided into two categories: materials designed for the general motoring public, landowners and developers, and elected officials and those designed for professional engineers and planners. The first category stresses the "whys" of access management, the latter the "whats" and "hows".

A. Educational Materials Designed Mainly For The General Public And Elected Officials

Florida, Maine, New Jersey, Ohio, and Oregon agencies have prepared materials that could be useful models for Iowa in terms of educating the public and elected officials about access management. The State of Washington is currently producing a 10-15 minute videotape on access management aimed at the general public. The Federal Highway Administration will be releasing a similar video in the late Fall of 1996.

- Florida Department of Transportation, Access Management: An Important Traffic Management Strategy. (slide presentation)

- Sokolow, Gary and Kristine Williams, Land Development & Subdivision Regulations That Support Access Management. This slide show developed by the Florida DOT and the Center for Urban Transportation Research at the University of South Florida explains the benefits of access management and how it can be implemented through land development regulations in Florida. (slide show)

B. Educational Materials Designed Mainly For Professionals

A larger body of materials has been prepared to educate transportation engineers and planners about access management and related land-use issues.

The Florida DOT, spearheaded by Gary Sokolow, has developed a wealth of educational materials on access management mainly written with the professional audience (engineers and planners) in mind. The following are all slide shows (also available in hard copy form) in Florida DOT's Access Management series; all are undated:

- U.S. Department of Transportation, Federal Highway Administration, National Highway Institute, Access, Location, and Design: Participant Notebook, Report FHWA-HI-93-055, Washington DC, September 1993. This notebook is a very large and comprehensive introduction to the practice of access management. (course materials)

- Washington Department of Transportation, Access Management in Washington State, Olympia, Washington, July 1995. (brochure in highway map format with large graphics)

XI. Public And Stakeholder Involvement Materials

There is a growing recognition of a need to involve the public in access management planning more fully and earlier on in the process. One reason for this is that stakeholders' perceptions of the role of roadways may vary greatly. For example, a planner may see a roadway as an arterial street serving intracity traffic; a businessperson may see the same road strictly in terms of bringing customers to his or her door. The traditional way the public and stakeholders are involved is through public hearings on projects rather late in the planning and design process. As several authors note, the result may be an uncomfortable group of stakeholders who do not understand the need for the project. These materials suggest different and more comprehensive approaches.

PHASE IV

ACCESS MANAGEMENT: CURRENT POLICIES AND REGULATORY FRAMEWORK

I. BACKGROUND

II. ACCESS MANAGEMENT LAWS AND REGULATIONS

A. LEGAL CONSIDERATIONS

B. PLANNING AND REGULATORY TOOLS

- Land Division
- Subdivision Regulation
- Access Controls
- Zoning Regulations

C. SUMMARY REPORT

III. CONCLUSIONS

PHASE IV

Access Management: Current Policies and Regulatory Framework

I. Background

Comprehensive access management is a relatively new approach to addressing traffic congestion, accidents, and loss of street capacity. Access management programs address the location and design of street and driveway connections to the roadway, as well as subdivision and site design. Because it involves both land use and transportation, access management requires cooperation among government agencies responsible for land development and transportation decisions.

The state of North Carolina and its cities and counties are legally responsible for providing and managing roadway access to commercial, industrial, recreational, and residential properties within their jurisdictions. Access that is not properly managed can negatively impact safety, increase congestion, and result in an inefficient use of designed roadway capacities. It is important that the criteria and review process for roadway access are understood by landowners, developers, planners, engineers, appointed and elected officials, and members of the motoring public.

The goal of the task force is to develop a program to educate the organizations and individuals responsible for and affected by access management and to market the concept and benefits of access management.

The task force was commissioned to conduct the Orange Grove Road case study regarding the effects of access management on vehicle, pedestrian and cyclist safety and traffic flow. As a result review existing literature on access management, research current access management regulations and practices around the nation, develop and disseminate access management training and educational materials, and effects on local businesses. The literature review was completed in September 2002. This report provides a summary of access management laws, regulations, and current practices within North Carolina and other states. The information assembled on the access management policies and practices of the various jurisdictions will be used to help identify needs for educational materials and policy alternatives.

II. Access Management Laws and Regulations

A review of current legal and regulatory practices reveals four fundamental aspects of access management. First, access management is exerted at the state level through enabling legislation. Second, state-enabling legislation can also dictate the level of power given to local jurisdictions. In the case of North Carolina, cities and counties have significant latitude in access control. Third, there are legal implications of access management. Planning agencies must be cautious of "takings" which result from insufficient compensation to private property owners for use ("taking") of their land for public purposes. Finally, land use planning techniques can be used to promote access management and provide consistency in legal and regulatory practices. The application of access management principles in North Carolina is comparable to that of other states. It appears that coordination of access management policies among local agencies is a challenge for most states currently implementing such programs.

A. Legal Considerations

There are two primary issues related to access management policy: 1) public right to safe and efficient movement and 2) a landowner's right to suitable and sufficient access. This means that in providing for safe and efficient transportation, access management laws and regulations must balance the use of public police power and the protection of private property rights. The takings clause of the Fifth Amendment of the U.S. Constitution is the foundation for the protection of private property rights. When private property is taken for public use, landowners must be justly compensated for their loss. In the process of providing for a greater public interest through regulating access, there must exist a rational nexus between the burden realized by a property owner and the public interest being advanced.

States enable regulatory activity through state enabling legislation for controlled access highways. Local jurisdictions may have greater or lesser degrees of authority than state DOTs in implementing access control policies. In general, with the consent of the citizenry, local authorities may be more restrictive in land use regulation than provided by state code, but not less restrictive. This provides the flexibility for local areas to assert additional control when conditions which diminish public welfare exceed those experienced by other areas within the state. When a conflict arises in the application of access control regulations, generally a property owner must prove the loss of use of their property or diminution of value of their property, while the local government must prove the advancement of public safety and welfare in their actions.

A survey of state rulings on takings cases from various states have shown:

- complete loss of access is always necessary to demonstrate a taking;
- a substantial loss of access to private property may result in a taking and warrant compensation, although no physical appropriation of property has occurred;
- loss of the most convenient access, or increase in circuity of access, is not usually compensable where other suitable access continues to exist;
- governmental actions that diminish traffic flow on an abutting road, such as installation of a raised median, are not takings;
- damages must be peculiar to that property and not common to the public at large for compensation to be paid;
- recoverable damages are limited to the reduction in property value caused by the loss of access but if the property is landlocked the entire parcel may have to be purchased.

Takings cases filed against North Carolina jurisdictions in relation to access management regulations or requirements are limited when background or supportive transportation plans are developed. Enhanced access codes at the state level would also promote local planning. In addition, for at least highway facilities, North Carolina relies on advance acquisition of right-of-way which may minimize conflicts with landowners seeking access improvements. Right-of-way dedications during any development process including exempt subdivisions should also be the promoted course of action.

Along with evaluating the fairness of regulatory impacts on private property owners, courts are placing greater weight on comprehensive plans and planning studies in

weighting the validity of regulatory actions. These planning activities show consistency and forethought in policy implementation. Most planning activities that effect broad land use regulation also require a public participation component. This means that access management strategies that are an element of comprehensive plans and planning studies have achieved at least some level of public acceptance.

B. Planning and Regulatory Tools

Planning and regulatory tools that promote access management have traditionally included zoning, subdivision, and traffic controls. Other tools may require state enabling legislation like cluster zoning or development agreements. Orange County may include an access management element within their comprehensive plan. This represents one method along with this access management that can be implemented at the local level. The following is a brief outline of planning methods that can be used to supplement access management strategies:

- **land division**
    - *lot dimension requirements*

      Lot dimensions can be controlled through minimum lot size, minimum lot frontage, set back requirements, etc. Controlling lot dimensions has an impact on driveway spacing, on-site circulation, and driveway lengths.

- **subdivision regulation**
    - *review process*

      The site plan review process can require documentation of all on- and off-site access points. Documentation of access control facilities (signals, medians, etc.) and on-site circulation controls can be required to ensure that standards are followed.

    - *regulating lot splits and further subdivisions*

      Further subdivision of lots will likely require more access points along a roadway. Permissive subdivision regulations that allow frequent flag lot configurations contribute to a typical problem of inadequate spacing between access points.

    - *subdivision regulation tied to functional class of roads*

      Subdivision regulation can orient lots and access points to local streets and away from high traffic volume arterials.

- **access controls**

    - *location and design*

      It is important to control the location of access points in relation to road deceleration and acceleration lanes to avoid conflict points. Other design issues involve driveway throat length where insufficient length can conflict with flow of off-site traffic and cause on-site circulation problems. Also, driveway spacing requirements, corner clearance, and joint and cross access configurations are important development characteristics.

    - *retrofitting non-conforming access*

      Land development regulations are not retroactive so conformance can be required with new permit requests for new driveways, land use intensity changes, site improvements, etc.

    - *private road ordinances*

      Efficient access management should extend to private roads which would mean that local ordinances would apply to both public and private roadways.

    - *requirements for transit, bicycle, and pedestrian access*

      Effective access management must account for conflict points not only among and between motor vehicles, but also with connections to transit access, bicycle facilities, and pedestrian paths.

- **zoning regulations**

    - *overlay zoning*

      With corridor overlay for access control problem areas, standards can be tailored by priority or intensity of access, safety, and congestion problems.

    - *flexible zoning*

      Flexible zoning can allow for alternative site design, buffering, and screening between incompatible uses.

National experiences with access management activities indicate that to be legally viable and acceptable to the development community, access management programs should promote public involvement at the earliest stages. Conflicts or legal challenges are less likely if stakeholders are involved in the formative stages of program development. Approaching access management as both a transportation and land use issue is a logical and efficient approach. Coordinating legal and regulatory activities through transportation engineering and land use planning strategies have proven effective in numerous states.

C. Summary Report

The primary finding of the interviews with cities and counties is that there is no consistent process used to review local changes in access to roadways. It is common for development plans that involve modification of ingress and egress to undergo review by multiple departments. These departments may each rely upon a variety of codes and design criteria. This increases the difficulty of providing coherent and coordinated information to property owners, developers, and the public regarding access modifications.

Another finding of the interviews is that legal challenges to access changes or access restrictions are very rare. Typically conflicts are negotiated during the design review process or before city or county councils. However, one cannot exclude the possibility of legal action. A master plan showing general benefits diminishes the provincial claims of individual cases. Lawsuits regarding police powers to use private property for public purposes are a possibility unless dedication/compensation is cautiously pursued. The issue does not pertain usually to the design of access facilities, rather, the property owner is contesting the compensation that they received for the condemned property. Overall, it appears that disagreements over the implementation of access controls are handled administratively and have not resulted in court cases.

Finally, nearly all cities and counties contacted expressed interest in how to better administer access management policies. There does appear to be some information sharing among jurisdictions, but usually only for metropolitan cities and counties. Medium or small sized jurisdictions outside of metro areas tend to develop their own policies and procedures, independent of other local jurisdictions. This may indicate that there is a need for a model access permit procedure where jurisdictions can then tailor the model to local conditions. This could potentially save these jurisdictions a significant amount of time in drafting policies and procedures for access management. Through a model ordinance or model permit application process, statewide policies and procedures can also be easily communicated to local jurisdictions. More consistent local regulations may lead to a better understanding of access management and implementation strategies. In addition, access management plans for a specific corridor is strongly suggested.

III. Conclusions

Experiences with access management within the state of North Carolina are very similar to those of other states. Other states have identified a need for local coordination of codes, regulations, and permit processes. A variety of traffic engineering design and land use policy alternatives are being implemented by these states; however, it appears that there are no widespread means by which to share information about these activities. North Carolina is poised through increasing interest in growth management controls to be one of only a few states that have attempted to address access management through a statewide educational program.

PHASE V

ACCESS MANAGEMENT TOOLKIT: ANSWERS TO FREQUENTLY ASKED QUESTIONS

ACCESS MANAGEMENT CONCEPTS

1. Driveway-Related Crashes
2. Driveway Spacing
3. Driveway Density And Driveway Consolidation
4. Intersection Spacing And Traffic Signal Spacing
5. Functional Areas Of Intersections
6. Conflict Points
7. Speed Differential Between Turning Vehicles And Through Traffic
8. Benefits Of Access Management
9. Economic Impacts Of Access Management
10. Access Management And Pedestrian Safety

COMMON ACCESS MANAGEMENT TREATMENTS

11. Driveway Grade
12. Driveway Width
13. Clearing Driveways Away From Corners
14. Shared/Joint Driveways And/Or Cross Access
15. Continuous Two-Way Left-Turn Lanes

16. Three-Lane Roadways With Two-Way Left-Turn Lanes

17. Raised Medians At Intersections

18. Continuous Raised Median

19. Comparison Of Raised Median And Two-Way Left-Turn Lanes

20. Frontage And Backage Roads

21. Dedicated Left And Right Turning Lanes

22. Driveway Turn Radius

23. Internal Circulation In Land Developments

OTHER CORRIDOR DESIGN CONSIDERATIONS

24. Sight Distance

25. Incorporating Aesthetics Into Access Management

26. Clear Zones, Utility Placement And Lighting

Driveway-related Crashes

Much of access management involves managing traffic movements into and out of commercial driveways. The reason for this is that driveway traffic generates a large number of crashes on major roads and streets-arterials and collectors.

What types of accidents occur at commercial driveways?

Several research studies have been conducted on the nature of traffic accidents that occur at driveways. In particular, three-multiyear studies of hundreds of crashes at more than 1,300 driveways in three different communities in Illinois found the following range of crash involvement at commercial driveways:

Turning Movement	Percent of Total Crashes at Commercial Driveways
Left-turning vehicles:	
Entering business driveways	**43% to 78%**
Exiting business driveways	**14% to 31%**
Right-turning vehicles:	
Entering business driveways	**6% to 15%**
Exiting business driveways	**2% to 15%**

Why is this important?
Although the results from Illinois varied widely by community, two main conclusions can be drawn:

1. Left-turning vehicles (exiting and entering) are involved in the majority of driveway-related crashes.
2. The movement responsible for more than 40 percent of all the crashes at a commercial driveway involves entering vehicles turning left.

The Douglas Avenue/Euclid Avenue corridor, which is a main east-west arterial route through the Des Moines, Iowa, metropolitan area provides a good illustration (see photographs). The level of access management varies significantly throughout this corridor. Where access is well managed, such as in the city of Urbandale or in Des Moines just east and west of Interstate 23 5, there are very few left-turn-related crashes. In areas where no left turns are permitted, there are, naturally, no left-turn-related crashes. On the other hand, along sections where there is little access management (no medians or turning lanes and a high number of driveways per mile) there is a high incidence of left turn crashes.

Developing and designing strategies and projects to accommodate and/or manage left turning vehicles needs to be a main concern in managing access on arterial street corridors.

What do statistics about driveway accidents mean for access management projects?
These conclusions show why access management projects that effectively provide for, manage, or even eliminate left turns are so effective. Successful access management projects usually include such measures as driveway consolidation, two-way-left-turn lanes, dedicated right-turn

lanes, and raised medians. Projects or designs that combine two or more means of managing left turns are usually very effective in increasing traffic safety. On the other hand, roads where left turns are not effectively managed may have relatively high crash rates.

Driveway Spacing

Maintaining an adequate spacing between commercial driveways is one of the most critical aspects of access management.

Why is driveway spacing important?
Motorists turn left and right into and out of driveways when permitted. Traffic turning into and out of driveways moves more slowly than through traffic. This speed difference produces conflicts that may lead to broadside and rear-end collisions between vehicles. Traffic safety research commissioned by the Minnesota Department of Transportation shows that roadways with a large number of closely spaced driveways are *always less* safe than similar roads where driveway access is more limited. For example, an urban route with I 00 feet between driveways should experience roughly twice as many accidents as a route with similar turning and through volumes with 250 feet between drives.

What's a reasonable distance between commercial driveways in urban/suburban areas?
Spacing requirements may be based, among other factors, on posted speed limits, the classification of the roadway, or the amount of traffic generated by a development. Spacing requirements should reflect a balance between traffic and engineering conditions and needs, local development objectives, and existing land-use characteristics (such as lot sizes, land-use type, and frontage requirements).

There are no hard and fast guidelines for driveway spacing, and spacing requirements vary considerably from place to place. However, the table below is used by two local governments in Florida and Ohio and is indicative of good practice. As the posted speed limit rises, the recommended spacing between driveways increases and the number of driveways per mile or block falls to accommodate the increased spacing.

Posted Speed on Arterial Street (mph)	Centerline to Centerline Driveway Spacing (feet)	Approx. Number of Driveways per 500-foot Block Face
20	85	About 6
25	105	5
30	125	4
35	150	3
40	185	3
45	230	2
50	275	Fewer than 2

Source: City of Tallahassee, Florida, and OKI Regional Government, Cincinnati, Ohio.

These guidelines are based on the minimum distance needed to reduce collision potential due to overlapping right turns. Since urban and suburban arterials typically are designed to operate at 35 to 45 miles per hour, the desirable minimum driveway spacing will be approximately 150 to 230 feet, allowing for only 2 to 3 driveways per block face. When this range of spacing is not achieved, the result will be a higher traffic accident rate.

What about in rural areas?

In rural areas, the posted speed is usually at or above 55 miles per hour. The higher speeds mean that driveway spacing in rural areas must be longer to provide for a safe driving environment. On state highways, spacing is also longer because the routes are primarily designed to carry through traffic rather than to serve as property access routes. Most states use a hierarchy to apply a driveway spacing standard. The more important a route is to through traffic and commerce, the longer the spacing between driveways. The following table shows Kansas's standards for its highway system.

State Highway Route Type	Minimum Spacing between Driveways (feet)	Approx. Number of Driveways per Mile
Major arterial (National Highway System)	2,640	2
Other major arterial	1,320	4
Minor arterial	660	8
Other (collector, etc.)	500	10

Source: Kansas Department of Transportation.

On county roads, the spacing standard should also depend on the nature of the road (e.g., how important the road is to through traffic). Even the lowest functional levels require driveway spacing standards for traffic safety, as shown in the following table from a county in Wisconsin.

County Road Route Type	Minimum Spacing between Driveways (feet)	Number of Driveways per Mile
Minor arterials	600	9
Collectors	300	18
Local traffic service	75	70

Source: Waushara County, Wisconsin.

Driveway Density and Driveway Consolidation

Driveway density (the number of driveways per block or per mile) and driveway consolidation are very important considerations in access management. These roadway characteristics are basic issues in any access management plan or program.

Why is driveway density important?
Driveway density is important because accident rates increase dramatically as the number of driveways per mile increases along urban arterial roadways (see table below).

Driveways per mile	Approx. Number of Driveways per 500-foot City Block	Representative Accident Rate for a Multilane, Undivided Roadway	Increase in Accidents Associated with Higher Driveway Density
		2,640	2
		1,320	4
		660	8
		500	10

Source: National Cooperative Highway Research Program Report 3-52.

Note that, although 500 feet might be a typical city block length, block lengths vary from place to place. Some older neighborhoods have 400- to 500-foot blocks. Some newer communities use much longer blocks. A common block face in suburban areas is 660 feet (which provides eight city blocks per mile).

What is a reasonable driveway density for urban/suburban areas?
Different states and localities have adopted various driveway density standards for urban and suburban arterial streets. However, many of them recommend 20 to 30 driveways per mile as a maximum driveway density standard. Above this level, accident rates become unacceptably high. This standard applies to commercial driveways on urban, multilane arterials with a posted speed limit of 35 miles per hour. This translates into a desired standard of only two or three driveways per 500-foot city block face.

The Institute of Transportation Engineers (ITE) recommends a maximum number of driveways per commercial property that yields a driveway density similar to those described above. Exceptions to these standards may be required if property ownership is very fragmented and property lot frontages are very short. A potential solution in such cases is shared driveways. ITE's recommendations are presented in the following table.

Property Frontage (feet)	Number of Driveways
0 to 50	1
50 to 165	2
165 to 500	3
Over 500	4

Source: ITE Guidelines for Driveway Location and Design, 1987.

Some states, Kansas for instance, have set minimum property frontage standards for a commercial driveway permit. Along urban arterials, Kansas only allows driveway access on properties with at least 60 feet of frontage.

Driveway densities should be even lower if the posted speed limit is higher or if the roadway is functionally important to through traffic, such as highways designated as part of the National Highway System (NHS) or the Iowa Commercial and Industrial Network (CIN). Driveway densities can safely be higher if they serve residential properties. This is because residences generate far fewer trips per hour than commercial or industrial properties. However, driveways should *never* be located on or close to comers of intersections. They should also never be located within the functional area of an intersection (e.g., along right-turn lanes provided at intersections).

What about in rural areas?
Spacing between driveways and/or farm-field entrances is especially critical in rural areas because travel speeds are high. Higher vehicle speeds mean that driver reaction and stopping distances are longer. In rural areas, a maximum driveway density standard of about four access points per mile per roadway side is appropriate on many arterial roads. (This assumes that driveways on opposite sites of the road are lined up.) However, where stopping sight distances are restricted by curves or hilly terrain, this figure should be lower. It should also be lower on routes of high functional importance, such as NHS or CIN routes.

What is driveway consolidation and why is it important?
Driveway consolidation is the process of reducing the density of driveways along a major roadway by closing driveways, creating alternative access ways, creating shared driveways, relocating entrances to side streets, or promoting cross access. Such projects are generally done to improve highway safety but can also improve traffic flow. Driveway consolidation can be applied as an individual access management strategy, but it is most often done in conjunction with the installation of medians, two-way-left-turn lanes, and/or frontage or backage roads.

A 1992 access management project completed along US 34 in Fairfield, Iowa, showed that simple driveway consolidation can have a dramatic effect on traffic safety. The project closed, relocated, or consolidated eight driveways along a half-mile segment of US 34. After the project, the accident rate fell approximately 3 8 percent. Rear-end and right-angle crashes declined greatly.

Intersection Spacing and Traffic Signal Spacing

Although most discussions about access management focus on the management of private driveways, proper spacing of roadway intersections is an equally important access management issue.

Why is intersection spacing important?
The importance of intersection spacing is similar to that of driveway spacing. As the number of intersections per mile increase, the opportunity for crashes increases. The existence of too many intersections per mile also increases delay and congestion. On the other hand, not providing an adequately dense street network forces motorists and pedestrians to travel farther to their destinations.

What is a reasonable distance between public road intersections?
Street systems in urban and suburban areas consist of streets with different functional classifications, roles, and traffic characteristics (see below).

Roadway Type	Main Purpose of Roadway	Approx. Average Annual Daily Traffic Volume (AADT)	Percentage of Total System Traffic Carried
Freeways	Serve high-speed through traffic	50,000 and over	More than 40%
Arterials	Serve through traffic	15,000 - 50,000	30%
Collectors	Feed through traffic from local streets to arterials; provide limited property access	2,000 - 15,000	20%
Local streets	Provide property access	100 - 2,000	Less than 10%

Intersection spacing along major (arterial) urban and suburban streets should follow the pattern given below. A traditional grid street system provides the ideal method to create this spacing.

Main Roadway	Intersecting Minor Roadway	Recommended Intersection Spacing
Freeway	Arterial	1 to 2 miles minimum
Arterial	Arterial	1 mile or greater
Arterial	Collector	0.5 mile or greater

Freeway intersections should be spaced no less than one mile apart in urban areas. Arterials should intersect with other arterials at no less than one-mile spacing. Collectors should intersect with arterials at not less than one-half mile spacing. The intersection of local roads with arterials is not recommended, but if required should not be less than 500 to 660 feet apart.

What sort of spacing should be maintained in rural areas?
Spacing between intersections is especially critical in rural areas because vehicle speeds are high. In rural areas, it is advisable to keep intersections between public roads at least one-half mile apart. A one-mile spacing between public road intersections is preferred.

How far apart should traffic signals be placed on an arterial?
Traffic signals are used to regulate traffic flow and preserve capacity along arterial routes. The ideal spacing for traffic signals is at least one half-mile apart (2,640 feet), which also corresponds to the preferred spacing of intersections between arterials and collectors. This represents about four to six blocks, depending on the block length. A minimum spacing of one-quarter mile (two to three blocks) should always be maintained. When the spacing between signals falls below one-quarter mile (1,320 feet), the traffic flow along the route may be disrupted. The ability of the route to carry through traffic will decrease, travel speeds may decrease, and delays and queues may develop at intersections. There is also some evidence from research that placing more than three traffic signals per mile on an arterial increases the traffic accident rate.

Functional Areas of Intersections

It is important to protect the functional area of an intersection from driveway access. Driveways located within this area may result in higher crash rates and increased congestion.

What is the functional area of an intersection?
The functional area of an intersection is that area beyond the physical intersection of two roadways that comprises decision and maneuvering distance, plus any required vehicle storage length. The functional area includes the length of road upstream from an oncoming intersection needed by motorists to perceive the intersection and begin maneuvers to negotiate it. The upstream area consists of distance for travel during a perception-reaction time, travel for maneuvering and deceleration, and queue storage. The functional area also includes the length of road downstream from the intersection needed to reduce conflicts between through traffic and vehicles entering and exiting a property.

Driveways should *not* be located within the functional area (see figure below).

Why is the functional area important?
Crashes at intersections are about three times more frequent than those between intersections *(Best Practices in Arterial Management,* New York State Department of Transportation, 1996), and crash rates increase dramatically as the number of driveways per mile increases. Driveways located within the functional area create too many conflict points within too small an area for motorists to safely negotiate. In addition, comer properties typically attract businesses that generate higher volumes of traffic, such as convenience stores, gas stations, and fast food restaurants. Vehicles stopped in the travel lanes waiting to turn into a comer property may, and often do, block traffic on the roadway.

How can the functional area of intersections be protected?
The integrity of functional areas of intersections can be protected through comer clearance, driveway spacing, and intersection spacing requirements. Intersections should be spaced far enough apart so that functional areas do not overlap. This will leave room for an "access window" between intersections.

Approaches for retrofitting existing intersections include (1) consolidating driveways through shared drives and cross access, (2) providing alternative access by relocating driveways to the cross road or a frontage or backage road, and (3) installing raised medians, which eliminate left turns into and out of driveways. Median openings ("breaks") should never be located within the functional area.

CONFLICT POINTS

Conflicts points are commonly used to explain the accident potential of a roadway. Access management strategies are typically designed to reduce the number and density of conflict points.

What is a conflict point?
A conflict point is the point at which a highway user crossing, merging with, or diverging from a road or driveway conflicts with another highway user using the same road or driveway. It is any point where the paths of two through or turning vehicles diverge, merge, or cross (see figure below).

Why are conflict points important?
Conflict points are associated with increased levels of roadway accidents. A motorist can safely negotiate only so many conflict points within a given area. Studies have shown that when driveway access to arterial roadways is granted to too many property owners without considering future traffic volumes and roadway classifications, the extra driveways increase the rate of accidents and decrease the efficiency of the roadway. Although this does not appear to be a simple, direct relationship, reducing conflict points has been shown to significantly reduce the accident rate at case study locations (T. J.

Simodynes, *The Effects of reducing Conflict Points On Reducing Accident Rates,* October 1998).

Other safety-related factors include the type of conflict points that are reduced-different types of conflict points have different propensities for accidents. Studies of hundreds of crashes at more than 1,300 driveways in three different communities in Illinois found that left-turning vehicles (exiting and entering) are involved in the majority of driveway related crashes (Paul Box and Associates, 1998).

How can conflict points be reduced by managing access?
Accessmanagement strategies can reduce traffic conflicts

- by limiting the number of conflict points that a vehicle may experience in its travel
- by separating conflict points as much as possible (if they cannot be completely eliminated)
- by removing slower turning vehicles that require access to adjacent sites from the through traffic lanes as efficiently as possible

Common strategies include relocating, consolidating, and eliminating driveways; promoting shared driveways; increasing comer clearance; improving driveway geometries (radius, width, grade, throat length); prohibiting left turns out of driveways; installing raised medians with left turn lanes; installing two-way left turn lanes; and providing alternative access roads (such as backage roads).

Speed Differential Between Turning Vehicles and Through Traffic

Speed differential is a simple yet important concept that forms the basis for many access management measures.

What is speed differential?
Speed differential is the difference between the speed of vehicles that are continuing along the main roadway versus those that are entering and exiting the driveway For instance, if through traffic generally moves at 35 miles per hour and cars have to slow to 10 miles per hour to enter a driveway, the speed differential at and near that driveway is 25 miles per hour.

Why is speed differential important?
A speed differential above 20 miles per hour begins to present safety concerns. When the speed differential approaches 30 to 35 miles per hour, the likelihood of a collision between fast moving through vehicles and turning vehicles increases very quickly. Rear-end collisions are very common on roads and streets with large driveway speed differentials and a high density of commercial driveways. When the speed differential is high, it is also more likely that crashes will be more severe, cause greater property damage, and result in more injuries and fatalities. Keeping the speed differential as low as possible is very important for safety reasons, as indicated by the table below. Many access management plans and standards strive to keep the differential at or below 20 miles per hour.

Speed Differential Between Turning and Through Traffic	Likelihood of Crashes
10 miles per hour	Minimal
20 mph	3 times greater than at 10 mph
30 mph	23 times greater than at 10 mph
35 mph	90 times greater than at 10 mph

Source: Oregon State University, 1998

What influences speeds at driveway entrances?
Speeds at driveway entrances can be influenced by a number of factors, including

- Driveway turn radius
- Driveway width
- Driveway throat length
- Driveway slope
- Existence of dedicated turn lanes
- Length of sight distance, especially for drivers exiting driveways
- Internal circulation patterns of adjoining parking lots

How can speed differentials be decreased?
In general, the following features will help decrease the speed differential between through and turning traffic:

- Larger turn radii
- Wider driveway throat widths
- Longer driveway throat lengths
- Smaller driveway slopes
- Dedicated turn lanes for both left and right turns
- Adequate sight distance at driveways
- Improved circulation within land developments

Many of these features can easily be provided if there are fewer, higher quality driveways along a roadway.

Benefits of Access Management

An effective, local access management program can play an important role in preserving highway capacity, reducing crashes, and avoiding or minimizing costly remedial roadway improvements. The traveling public would then benefit from faster and safer travel. The great majority of businesses would benefit from increased economic vitality along a well-managed corridor. Taxpayers would benefit from more efficient use of existing facilities. And public agencies would benefit from the relatively low cost of access management; they could then use their resources for other needs.

What are the safety benefits of access management?
Access management is a powerful tool for improving highway safety. All but two of the case studies conducted in Iowa (US 71 in Spencer and Army Post/Southwest 9th in Des Moines) led to an absolute reduction in highway crashes. All resulted in reductions in crash rates per million vehicle-miles of travel- the range of crash rate reductions was from 10 to 70 percent, with 40 percent being a typical reduction post-project. The most significant reductions occurred in terms of property-damage-only crashes, rear-end collisions, and broadside/left-turn collisions. Overall, improvements in safety tended to vary with the degree of access management applied-higher reductions in crash rates were found with the more comprehensive projects that involved a combination of access management approaches, such as those related to turn lanes, driveway management and consolidation, and medians.

What are the operational benefits of access management?
Each new driveway that is located on an arterial reduces the roadway's traffic-carrying capacity. After several new driveways have been installed it often becomes clear that turning traffic has a negative impact on traffic speeds on the arterial. Studies indicate that average travel speeds during peak hours are considerably higher on well-managed roads than on roads that are less well managed, even though the two types of roads carry approximately the same number of vehicles. In Iowa, the series of before and after studies of access management projects found that the level of service was raised one full level during the peak traffic hour at sites studied.

Access management projects in Iowa are typically initiated on routes with moderate levels of traffic by national standards. On the case study routes in Iowa the access management projects resulted in significant increases in the ability of roads to carry traffic at levels of service to motorists that amounts to little or no congestion and delay at peak travel periods (see table).

Project Location	Project Type[a]	LOS Before[b]	LOS After[b]
Ames	TWLTL	C	B
Ankeny	Median	C/D	B
Bettendorf	TWLTL	C	B
Clive	Median	C	B/C
Coralville	TWLTL	D	C
Des Moines, SE 14th	Median	D	B/C
Des Moines, Army Post/SW 9th	Median at intersection	C	C
Fairfield	Driveway	B	B
Mason City	Median at intersection	B	B
Spencer	TWLTL	B	B
West Des Moines/Des Moines	Median	B/C	A

[a]TWLTL = two-way left-turn lane.
[b]Six levels of service (LOS) describe operating conditions: A represents best conditions (uninterrupted flow and very low delay); F represents worst conditions (build-up of queues and delay); other letters identify intermediate conditions; E most often represents flow at or near capacity.

What are the economic impacts of access management?

The most compelling results (besides safety benefits) from the Iowa case studies came in terms of examining impacts on businesses and business customers along the routes. Perceived impacts of access management on adjacent commercial businesses and landowners are often major impediments to projects moving forward. The case studies showed that in fact access management projects are rather benign in terms of business impacts. Access-managed corridors generally had lower rates of business turnover than other parts of their communities. They had more rapid growth in retail sales once projects were completed. When surveyed, far more business owners indicated that their sales had been stable or increased following project completion than reported sales losses.

Economic Impacts of Access Management

Business owners often are concerned that changes in access to their premises will have temporary or permanent impacts on their sales. They are concerned that changes in direct access to their property-such as consolidating driveways or installing raised medians will lead to declines in patronage and sales. Perceived impacts of access management on adjacent commercial businesses and landowners are often major impediments to projects moving forward. In the case of access management, perceptions are often worse than reality.

What are the effects of access management on business vitality?
A business vitality study of nine different access management corridors in Iowa communities examined impacts on businesses and business customers along these routes. In general, these case studies indicated that access management projects are rather benign in terms of business impacts. Access managed corridors generally had lower rates of business turnover than other parts of their communities. They had more rapid growth in retail sales once projects were completed. Far more business owners, when surveyed, indicated that their sales had been stable or increased following project completion than those that reported sales losses. Negative impacts on commerce tend to be confined to a small number of individual businesses. Highlights from the Iowa case studies are as follows:

- There were no particular business categories that consistently decreased in number of establishments for any of the corridors studied. Traffic-dependent businesses such as convenience stores and fast food restaurants did not appear to be affected in a significantly different manner than were all businesses.

- The rates of business turnover in the study corridors ranged from about 2.6 percent to IO percent per year, a range below or equal to the business turnover rate for Iowa as a whole, which is about IO percent per year. Businesses located along the case study corridors turned over less than would normally be expected of retail businesses in Iowa.

- With one notable exception, retail sales for businesses within the case study corridors matched or significantly outpaced sales in their respective communities (see chart). No significant short-term declines in retail activity associated with the access management projects were found. Corridor sales generally outpaced community sales throughout the study period.

- Over 80 percent of all business owners surveyed along the business corridors that had undergone reconstruction indicated that their sales had increased, stayed the same, or that they were uncertain about the impact. Business owners along raised median projects had both the highest percentage responses of both "increased" and "decreased" sales. Five percent of businesses did report decreased sales activity after the access projects were completed.

- Over 80 percent of business owners reported no customer complaints about access to their businesses. About 19 percent of businesses reported their customers complained or reported some difficulty in driving to their businesses after the completion of the access management project. About half of the businesses reporting complaints were the auto-oriented businesses, including gasoline filling stations, convenience stores, and fast- food restaurants. These businesses report complaints at a higher than proportional rate to their numbers.

- Two-way left-turn lanes generally received high levels of support from business owners and generated low levels of customer complaints. Medians at intersections generated similarly low levels of customer complaints, but appeared to receive lower levels of support from business owners. Auto-oriented businesses adjacent to raised medians at intersections tended to be least supportive of such projects. Continuous raised medians generated the most customer complaints regarding access; however, they also appeared to enjoy high levels of support from business owners.

What have other states experienced?

A 1996 study of twelve highway reconstruction projects in Indiana indicated that the average loss of retail sales during a major project was 13 percent, Those businesses experiencing the biggest temporary losses were gas stations, grocery stores, consumer electronics stores, hardware stores, and automotive sales and service fin-ns. The Indiana study indicates that most businesses achieve a full recovery within two years, although 20 percent of businesses did experience a long-term negative impact on their sales. Mirroring the Iowa results, a majority of businesses reported that they benefited from the project improvements. The majority also supported the projects as necessary. This was because traffic flowed better and access to their location was enhanced. Business types most likely to experience long-term negative effects were gas stations, car washes, and other automotive-related businesses. Results from studies in other states are similar.

Access Management and Pedestrian Safety

Access management is usually promoted as a way to improve driving conditions for motorists. Clearly, access management techniques can lead to roads and streets that are dramatically safer and much easier and more pleasant to drive. However, research also indicates that several key access management techniques are just as valuable to pedestrians. These include

- reducing the number of driveways, particularly commercial driveways, within a given distance (per block or mile)
- providing for greater distance separation between driveway
- providing a safe refuge for pedestrian crossings with raised medians

How does access management help improve pedestrian safety?
Every sidewalk or path that crosses a driveway represents at least four potential pedestrian/vehicle conflict points. Reducing the number of driveways per block reduces the number of conflict points proportionally. Greater separation of driveways promotes pedestrian safety by reducing overlap of the operational areas of driveways. Drivers (and pedestrians) have a difficult time mentally processing more than one conflict point at a time; a greater driveway separation helps them concentrate on one problem at a time.

Safety research also clearly shows that raised medians at street intersections and/or at mid-block are a very important design feature for pedestrians. As the table below indicates, roads with raised medians are roughly twice as safe for pedestrians. The intersection crash rate includes crashes that occur at intersections; the mid-block figure includes all other crashes.

Roadway Type	Median	Midblock Pedestrian Crash Rate[a]	Intersection Pedestrian Crash Rate[b]
Undivided four lane	None	6.69	2.32
Five lane (TWLTL)	Painted	6.66	2.49
Divided four lane	Raised	3.86	0.97

Source: Oregon State University, 1998.
[a]Per million vehicle miles.
[b]Per million entering vehicles.

On the other hand, two-way-left-turn lanes (TWLTL) effectively reduce automobile crashes on arterial roadways carrying moderate levels of traffic but offer no refuge for crossing pedestrians. The pedestrian safety characteristics of five-lane TWLTL roads are similar to undivided four-lane roads. In order to be effective as a refuge for crossing pedestrians, a median must be at least four feet wide. A wide, depressed (no raised curb) grass median would be a somewhat less effective pedestrian refuge than a raised median.

What are some other corridor design features that help pedestrians?
Other corridor design and access management features that can help pedestrians include the following:

- Right-turn lanes for high-volume driveways. Right-turn lanes provide a dedicated space for vehicles to decelerate and turn using a minimum turn radius. This reduces turning speeds into driveways and allows narrower driveway crossings for pedestrians.

- Sidewalk setbacks. Sidewalks located several feet from the street protect pedestrians by separating them from the traffic flow. If the buffer strip is of an adequate width, drivers can pull completely out of the traffic stream before yielding to a pedestrian. in addition, a landscaped or other clearly marked buffer helps to visually define sidewalk and driveway locations.

- Clear zone. A clear zone free of visual obstructions such as signs, large trees and bushes, or parked vehicles allows pedestrians to be seen by drivers and to see oncoming vehicles.

- Flat cross grade. A flat sidewalk cross grade improves pedestrian safety and is required by the American with Disabilities Act (ADA).

- Signalized midblock crossings. Where feasible, midblock pedestrian crossings can reduce crashes, travel distance, and inconvenience, especially if the distance between signalized intersections is long (0.5 mile).