Third National

Access Management Conference

Conference Proceedings

Fort Lauderdale, Florida

1998

U.S. Department of Transportation
Federal Highway Administration

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Introduction

The 1998 National Conference on Access Management, held in Ft. Lauderdale, Florida, from October 4 to October 7, 1998, was sponsored by the Transportation Research Board's Committee on Access Management and the Federal Highway Administration Office of Technology Applications. The Florida Department of Transportation hosted the Conference.

In attendance were more than 250 professionals representing a wide range of disciplines, organizations and geographical areas. Disciplines included engineers, planners, designers, researchers, right-of-way specialists as well as technical, legal, and administrative experts. Federal agencies, State Department of Transportation, MPOs, cities, counties, universities and private consultants were all represented.

The primary purpose of the Conference was to provide attendees with the latest information on access management by bringing together experts from different areas and providing tutorials and training on the subject in twenty four sessions and with 55 separate presentations. Published papers or abstracts are summarized in these Proceedings.

The published papers were submitted by the authors on diskettes or CDs and then, where possible, formatted with uniform fonts and spacing formats. The papers were not edited for content. In the event no formal written paper was submitted, handouts for the conference were scanned and formatted to fit within the compendium.

Transportation **R**esearch **B**oard **C**ommittee on **A**ccess **M**anagement **(A1D07)**

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Gary Sokolow, *Florida Department of Transportation*
Vergil Stover, *University of South Florida*
John Taber, *Taber Engineering, Park City, Utah*
Kristine Williams, AICP, *Center for Urban Transportation Research, Tampa, FL*
Gail Yazersky-Ritzer, AICP, *Urban Engineering Inc., Pennsauken, NJ*

Conference Summary

The Conference began with a session entitled "Access Management 101." Four experienced access management professionals presented a tutorial on the basics of roadway access management. Vergil Stover, Moderator for the session, opened the presentations with an update of recent findings on access management. His presentation revealed that attitudinal surveys have shown that although there has been substantial opposition to access management changes, the closure or redesign of median openings and installation of non traversable medians have met with acceptance. His presentation also summarized recent findings relating the number of roadway crashes to the density of access connections.

Phil Demosthenes' presentation guided participants in establishing a comprehensive access management program. Mr. Demosthenes, with the Colorado Department of transportation, is credited with establishment of a very successful program in his state. His presentation stressed the need to be reasonable in the number of access classifications, to develop plans dealing with variances, and to provide management "near the action."

Gary Sokolow of the Florida Department of Transportation presented an overview of that department's very successful program. Mr.Sokolow's presentation summarized the basics of access management in terms of street classification, land service versus traffic service, access management principles for site access, and the need for good site access design. Mr.Sokolow has authored numerous documents and has been involved with his Department's program, since its inception.

Arthur Eisdorfer of the New Jersey Department of Transportation made the final presentation in the tutorial session. He presented a variety of tips for a successful program. His presentation stressed the need to "keep it simple" and to always address problems head-on.

Session 1
Opening Session

Opening remarks were made by Joe Yesbeck of the Florida Department of transportation. He gave a twenty-year perspective for access control in Florida. He spoke of the difficulties encountered before today's regulations. In describing lesson learned, he noted the need for flexibility, complimentary consistency, an understanding of the problem to be solved, and an understanding of the local issues.

The Conference's keynote speaker was George W. Black, Jr., with the National Transportation Safety Board. Mr. Black has a lengthy career in traffic and transportation engineering, and discussed access management in context with his experiences.

Session 2
Linking Land Use and Access Management

This session, chaired by Robert Jurasin of Wilbur Smith Associates, stressed the relationship between good land development guidelines and roadway access management.

A presentation by Reid Ewing, of Florida International University examined the need for short-to-medium length blocks in land development. He notes that shorter blocks with lengths from 300 to 400 ft. support walkability and transit use.

Charles Carmalt with Lehr and Associates called for a greater balance between access for automobiles and the needs of pedestrians. His discussion of transportation planning for activity centers noted a need for a hierarchy of streets, with appropriate access management principles to be developed for each street classification. Transportation centers with concentration of trip ends, must support many travel modes, including of course, pedestrians, bicyclists, and goods delivery vehicles while remaining the foci of highway systems. He describes the various types and classifications of roadways, ranging from expressways to boulevards. His paper presents numerous guidelines for good practice, including a concise summary of planning principles.

Kristine Williams of CUTR presented "ten ways to manage roadway access." This presentation stressed corridor access management principles appropriate for land planning and layout of development. Good internal circulation for parcels, regulation of driveway access, and the need for coordination among government agencies was noted.

Session 3
Interchange Management and Planning

This session dealt with a very important principle of access management for major roadways, that of interchange modification and approval of new interchanges. The session, moderated by Dane Ismart of Berger and Associates, contained three presentations on the subject.

The extensive interchange modification and approval process developed by the Florida Department of Transportation was presented by Robert Krzeminski, Manager of that function for the Department. Mr. Krzeminski presented the recent update of the Department's <u>Interchange Request Development and Review Manual</u>, which contains extensive procedures for the issue. His presentation and the Department's policy may be summarized by his summary: *". . . new interchange access should only be approved where it is justified; improvements to existing interchanges should be fully considered before approving a new interchange; protection of the operation and safety of the limited access mainline is essential and any impacts must be mitigated and control of arterial access at the interchange is essential."*

Robert Layton, Oregon State University, presented Oregon's policy on interchange management. His paper, reprinted in the Proceedings, presents standards drawn from a draft handbook developed by the Oregon Department of Transportation. Oregon's standards stress interchange planning as part of the long-term transportation system plan development, as well as integration with other streets and roads near the interchange. The standards include several policies, such as protective buying, balanced design with the mainline, and spacing standards between ramp terminals and nearby intersections and driveways.

Transportation Consultant Herb Levinson discussed several interchange and frontage road concepts and case studies. His paper will be of interest to practitioners as it summarizes several state standards for access separation distances at interchanges, and presents problems and proposed solutions for several interchanges in Florida, New Jersey, Ohio, Virginia and the state of Washington. "Lessons learned," as contained in the paper summarizes several important findings from this research effort.

Session 4
Site Planning Basics Workshop

Vergil Stover, CUTR, presented a well-attended and informative site planning workshop and tutorial for conference participants.

Session 5
Access Management and Non-Auto Modes

This session, chaired by John Taber of Tabermatics, Inc. contained three papers. Two dealt with the relationships between access management and pedestrians and bicyclists, and one dealt with development of a comprehensive statewide access management policy.

Robert Layton from Oregon State University discussed pedestrian and bicyclist impacts of access management as a result of a research project funded through the US Department of Transportation and then underway at the University of Washington. His presentation summarized findings between driveway spacing and speed of turning vehicles.

Another presentation regarding the relationship between access management and bicycle and pedestrian facilities was presented by Xavier Falconi of Falconi Consulting Services. This presentation also discussed Oregon's practices in regard to access management. An interesting portion of the presentation was a discussion of problems encountered with uncontrolled access, particularly in terms of conflicts with bicyclists and pedestrians. Regard for these users near points of vehicular access was called for, as was designated bicycle lanes. Medians were highlighted as a contributor to bicyclist and pedestrian safety. The need for local standards was highlighted.

Charles Carmalt presented an informative report on how the Delaware Department of transportation developed its access management program, using an incremental review process and seven levels of access classification.

Session 6
Safety Research

This session, chaired by Marc Butorac of Kittelson and Associates, contained several papers involving safety issues.

Peter Parsonson's paper dealt with two way left turn lanes with a raised median. This presentation was on access management techniques for a major roadway in the Atlanta, GA. The presentation summarized results over an eight year period and updated a previous report of the project. The subject street, Memorial Drive, is characterized by a decline in commercial activity and a decrease, which the authors attribute to transitioning of the area over time, and not to the provision of the median. The report shows that the crash index for the subject street closely approximates the county-wide rate over several years.

Tarek Sayed of the University of British Columbia reported on estimating the safety of unsignalized intersections using traffic conflicts. Sayed reports on use of a traffic simulation model (TSC-SIM), which in the author's words helps to: *". . . evaluate the safety of traffic operations at hazardous intersections and to help in determining effective mitigation measures."*

Session 7
Managing Corridor Development Workshop

Kristine Williams was moderator for this session, which dealt with how to manage corridor development.

Session 8
Local Government and MPO Forum

MPO and local government access management applications were the subject of this session, moderated by Edward Kant, with the Collier County Florida Transportation Services Department.

Steve Tindale, Tindale-Oliver Associates and Sarah Ward, Pinellas County presented the Pinellas County, Florida Access Management Study. A three-step process was used to develop this county's plan: a review of other access classification methodologies, and initial data sampling and classification, and a full data collection and classification effort for all county roads.

David Plazak, Iowa State University, discussed how to bridge the gap between access management and local land use policies. This effort concentrated on coordination of the different local government agencies involved with access management, and presented recommendations to improve the process. Again, the need for local involvement of business owners was noted.

Session 9
Site Impact Analysis Techniques

Several practical techniques for site access analysis were presented in this session, chaired by Art Eisdorfer, New Jersey Department of Transportation.

John Taber, Tabermatics, Inc. presented a computer methodology oriented to choosing the safest and most appropriate access features.

Steven Tindale and Doug Coxen, Tindale-Oliver, Inc. discussed a simulation model for site access analysis. A CORSIM application for a large development with access on a state road served as the example.

A detailed presentation of traffic impact assessments was made by Arthur Eisdorfer of the New Jersey Department of Transportation. The methodology follows a New Jersey requirement that developers pay their fair share of necessary highway improvements resulting from their development. A traffic impact analysis, a two-step mitigation analysis, and an equitable fair share cost determination are required. A six step fair share determination, based on maintaining Level of Service "E" is described in the paper.

Session 10
Working With the Media Workshop

This workshop, chaired by Steven Hurvitz, Minnesota Department of Transportation, presented techniques to deal with media representatives.

Session 11
States, In a State of Change, Panel Discussion

Phillip Demosthenes moderated this session. Arthur Eisdorfer described proposed changes to New Jersey's practices. Cecil Selness made a similar presentation for Minnesota, dealing with how a legislative mandate to develop an access management policy was being addressed.

Session 12
State "Start-ups" Programs, Part I

This session, one of two parts, was moderated by Robert Jurasin and dealt with how two states were handling start up of access management regulation.

Brad Oswald of the New York Department of Transportation discussed New York's program, which includes corridor preservation, land use, and financial elements. New York is in the third year of its program. The need for a flexible, collaborative approach was stressed, as was the need for training.

Donald Bowman, Virginia Transportation Research Council presented Virginia's program, which expands its site specific permitting process. The presentation included examples of legislative, legal, and transportation planning elements, along with suggestions and guidelines for implementation of such programs in other states and areas.

Session 13
Highway Capacity Manual and Median Analysis Techniques Workshop

This workshop was moderated by Dane Ismart and Gary Sokolow. Ismart's paper, contained in the Proceedings, contrasts results/conclusions resulting from changes in unsignalized intersection analysis methodologies between the 1994 and 1997 Highway Capacity Manual Coordination of access design and intersection design is called for.

Session 14
State "Start-up" and New Concepts, Part II

Jim Gattis, University of Arkansas chaired this session, which was a continuation of Part I.

Dan Scheib, Maryland Department of Transportation, described how access management has evolved in Maryland since a previous report in 1993. Maryland has established an access management program for its state primary system. Elements of this program include purchase of access, and development of a long range access management plan.

Michele Gallant, Carter-Burgess, Inc., spoke on access management as a strategy in a statewide safety goal using Florida's regulations as an example.

David Rose, Dye Management Group, spoke on Montana's access management process.

Experiences in Pretoria, South Africa, were described by H.S. Joubert, African Consulting Engineers. Pretoria uses an access classification system with 10 categories, and is similar to systems in use in the United States, but takes into account local conditions. Design standards are provided for each access management classification.

Session 15
Restrictive Medians and Two-Way Left-Turn Lanes Panel Discussion

Herb Levinson, Consultant; Peter Parsonson, Georgia Institute of Technology; Paul Box, Box and Associates; Ali Eghtedari, Multnomah County; and Wayne Kittelson, Kittelson Associates participated in this panel discussion, which was moderated by Gary Sokolow, Florida Department of Transportation.

Mr. Levinson presented his views of the use of restrictive medians and two-way left turn lanes. He contrasted safety results between undivided highways and those with two-way left-turn lanes and those with non-traversable medians, and provided comparisons of crashes per mile by ADT for the three classifications. He cautioned on the need to carefully deal with left turns, to avoid transferring problems elsewhere.

Mr. Parsonson discussed the influence of signal spacing on arterial traffic progression, indicating system design speeds based both on cycle length and signal spacing for two timing plans. He concluded that a signal spacing of one-half mile is most appropriate for arterials having high speeds and long cycle lengths.

Session 16
The Role of Highway Classification in Access Management and How to Institute a Useful Classification System
Phil Demosthenes presented this session.

Session 17
Working With the Public

Stephen Ferranti, SRF and Associates, moderated this session which contained tips and advice for access management public involvement programs.

A case study of access management rules applied to a major road improvement project was presented by Laura Firtel, Kimley Horn and Associates. The study had involved provision of a non-traversable median at certain locations previously enjoying full access. The road project involved widening of a major arterial roadway in Tallahassee, Florida.

Jerry Schutz, Washington State Department of Transportation, spoke on public involvement in access management projects. His talk was based upon a practitioner survey of public involvement techniques. Information was gathered on what techniques are being used, and how successful those applications have been. The paper presents a discussion of the techniques.

Session 18
Corridor Case Studies, Part I

Ron Giguere, Federal Highway Administration moderated this session containing three case studies.

Kentucky's ongoing experiences with corridor management for several studies in the vicinity of Lexington were presented by John Carr, State Highway Engineer's Office. His presentation included a summary of "lessons learned," which will be useful to others establishing such a program.

Thomas Heydel, Wisconsin Department of Transportation presented an access management case study for reconstruction of 12 interchanges on I-94 in southeastern Wisconsin. The presentation stressed preparation of a work plan, for activities that will continue over the next 20 years. The plan dealt with many issues, among these were dealing with crossroads, frontage roads, public involvement, and use of a multidisciplinary team. The paper contains a copy of the access control policy applicable to the study corridor.

Design issues and public concerns resulting from a raised median project were presented by Richard Brauer, The Sear-Brown Group. The study corridor, New York Route 104 is characterized by dense commercial land use. Several design alternatives are presented in the paper, as well as statistics for other studies. An extensive public involvement process was utilized.

Session 19
Mock Hearing and Trial Workshop

Attorneys Pam Leslie, Florida Department of Transportation, and John Beck, Beck and Barios Law Firm, Tallahassee, Florida presented this mock hearing and provided insight to the audience. Rindy Lasus, New Jersey Deputy Attorney General, moderated.

Session 20
Impacts of Access Management on the Business Climate

Three presentations and a discussion by an attorney with significant experience in business damage litigation were contained in this session, moderated by Eddie Shafie, Rust, Lichliter, Jamerson Associates.

David Plazak, Iowas State University, made a presentation of the impact of access management on business vitality using five case studies and previous research sponsored by the Iowa Department of Transportation.

A survey of business owners for median retrofit projects in the Orlando, Florida area was the subject of a presentation by Gary Dickens, Ivey, Harris and Walls. Median modifications were made in several corridors, and the presentation was concerned with measuring and evaluating the public's response.

William Frawley, Texas Transportation Institute, presented a discussion on determining economic impacts of raised medians on adjacent businesses. The study is an on-going effort, so the presentation dealt with development and testing of the methodology. Measurements of property value, sales, employment trends and other economic indicators are included. Ten sites were chosen for test applications. Both mail-out and personal interview surveys were used, with the study now being in the "after" phase.

Session 21
Corridor Case Studies, Part II

Presentation of particular case studies was continued in this session, moderated by Del Huntington, Oregon Department of Transportation.

Don Nims, Clark Patterson Associates, reported on various approaches to and viewpoints regarding median openings that were considered as part of a seven-mile roadway improvement and widening project in New York State. The authors describe a design harmonization process of ". . . *applied engineering design that addressed technical issues as well as community goals. It was able to do more than make it safe by taking into consideration: sense of place, livability, and land use patterns.*"

The benefits of intergovernmental partnerships were described in a paper presented by Chris Huffman, Kansas Department of Transportation, for a U.S.-numbered highway corridor in Wichita, Kansas. This roadway, a four lane principal arterial, was noted to have a higher than average crash rate. The author discussed the use of digital video logs, motor vehicle crash data, and GPS-based travel time surveys. An interesting presentation on the use of stacked graphs to locate areas warranting improvements was included.

A case study of access management applied to a major airport access roadway in the city of SeaTac, Washington, was presented by Tim Bevan. SeaTac contains the Seattle-Tacoma International Airport, and was incorporated in 1990. The project considered access management within a major widening design for this heavily-commercialized roadway. Driveway consolidations, reductions, medians and provision for U-turns were important measures considered. Several conclusions from the initial phases of this project were presented that will be helpful to practitioners.

Session 22
User's Forum: Access Management Manual Workshop and The Attorney's Role in as Access Management Program.

Ron Giguere, FHWA and Rindy Lasus, New Jersey Deputy Attorney General moderated this session.

Rindy Lasus also discussed legal issues associated with access management, stressing the need for engineers, lawyers, and planners to work as a team. The need for consistency and reasonable regulation was contrasted to arbitrary, capricious and unreasonable decision making.

Session 23
Connection Spacing and Other Issues for Research

This session contained two presentations: one by Paul Box, Paul Box and Associates; and the second by Jerome Gluck, Urbitran Associates.

Mr. Box reported on the effect of intersections on driveway accidents, using here-to-fore unpublished crash data from Illinois. Box cites the need for careful study of crash reports as a precursor to determining crash rates for access analysis, and the need to include every crash in the database. He notes the usefulness of the two-way left-turn lane and medians wide enough to shadow left-turn outbound traffic. He closes his presentation with the interesting observation that *"Permit engineers should have the authority to approve rational departures from the basic guidelines, and should have the common sense needed to exercise appropriate engineering judgment."*

Mr. Gluck reported on NCHRP Project 3-52, Impacts of Access Management Techniques. This National Cooperative Highway Research Project's purpose was *". . . to develop methods of predicting and analyzing the traffic operation and safety impacts of selected access management techniques for different land use, roadway variables, and traffic volumes."* More than 100 different techniques were analyzed, resulting in a series of priority techniques for detailed analysis, ranging from traffic signal spacing to frontage road techniques.

Session 24
Closing Session

Gary Sokolow, Florida Department of Transportation moderated the closing session.

Access Management 101

Moderator: Vergil Stover, Center for Urban Transportation

Participants: Philip Demosthenes, Colorado Department of Transportation
Gary Sokolow, Florida Department of Transportation
Art Eisdorfer, New Jersey Department of Transportation
Rindy Lasus, New Jersey Department of Transportation

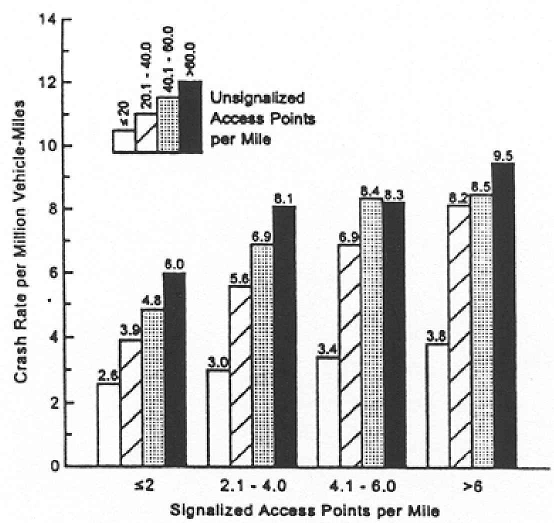
Recent Findings Related to Access Management

Vergil G. Stover, CUTR

Recent research has provided additional insight into the relationship of access spacing and safety and on the operational influences of access drives. Attitude surveys have found that, while there was substantial opposition to the change, closure/redesign of median openings and installation of a nontraversable median have been generally accepted.

Crash rates are related to access spacing and median type.

Figure I shows that for a given signal density, average crash rates increase as the number of unsignalized access connections increases.Also, for a given unsignalized access density, crash rates increase as the number of signals per mile increases. Source: NCHPP Project 3-52.



Average Crash Rates On Suburban and Urban Roadways as a Function of Signal Density and Unsignalized Access Density

Figure 1

Figure 2 summarizes the results of a Washington State DOT study which found a close relationship between the number of crashesand the number of access connections to a highway with strip commercial development.

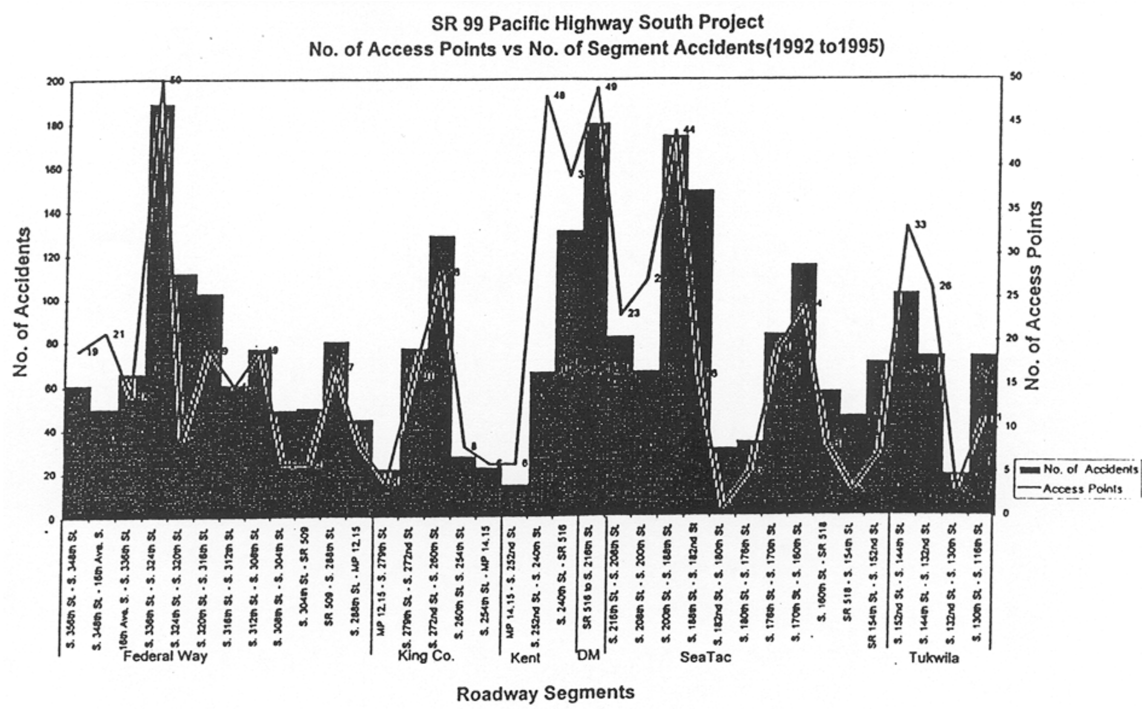


Figure 2

Average crash rates on suburban and urban highways increase as total access density increases for all median types (Figure 3).Additionally, it will be observed that roadways with nontraversable medians have lower crash rates than TWLTL's and that TWLTL's have a lower crash rate than undivided roadways. A similar pattern of crash rates was also found for rural highways (Figure 4).Source: NCHRP Project 3-52.

These relationships by median type (i.e., that TWLTL's have a lower crash rate than undivided highways and that highways with nontraversable medians are safer than those with TWLTL'S) is consistent with the findings in Georgia, Florida and Michigan and by Bowman & Vecellio in a study of three US Metropolitan areas.

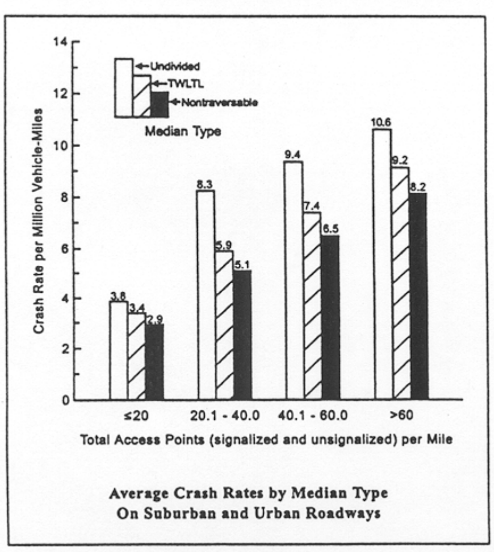


Figure 3

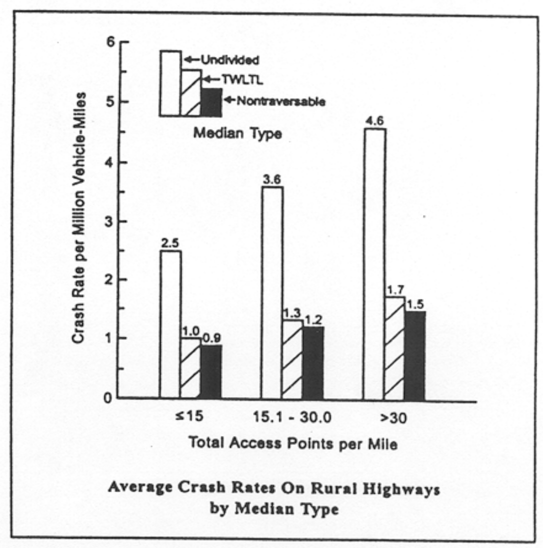
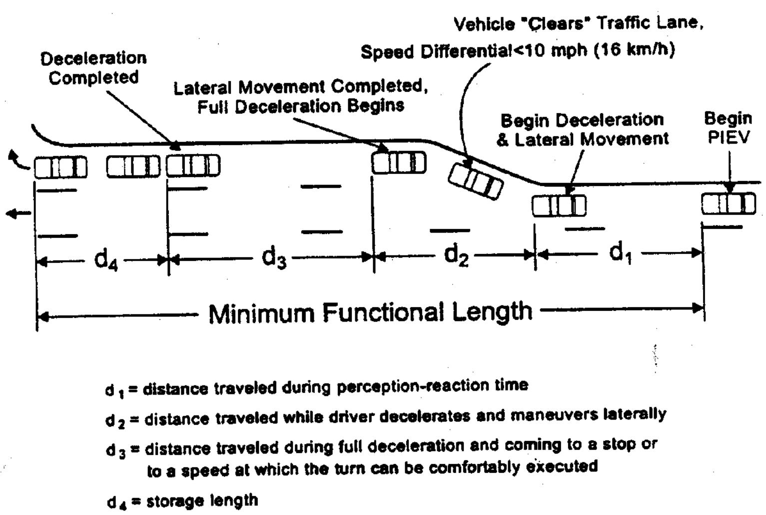


Figure 4

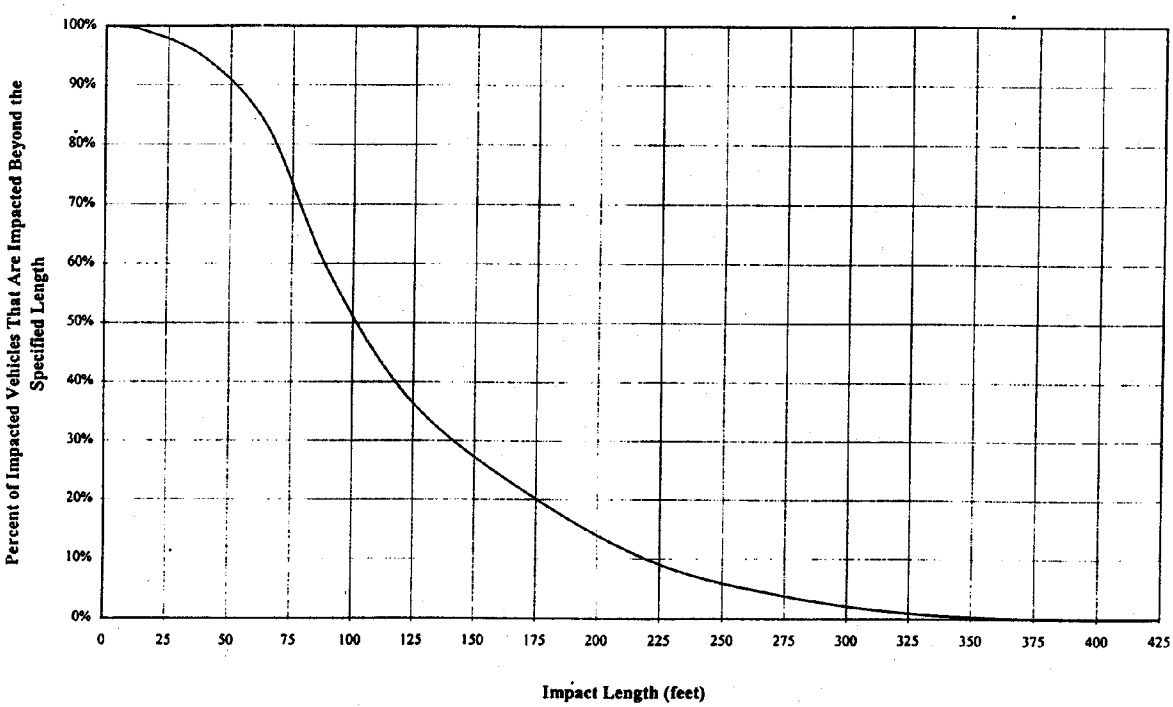
The upstream functional area of an intersection or access drive is very long.

The elements of the functional area are illustrated in Figure 5.



Upstream Functional Intersection Area

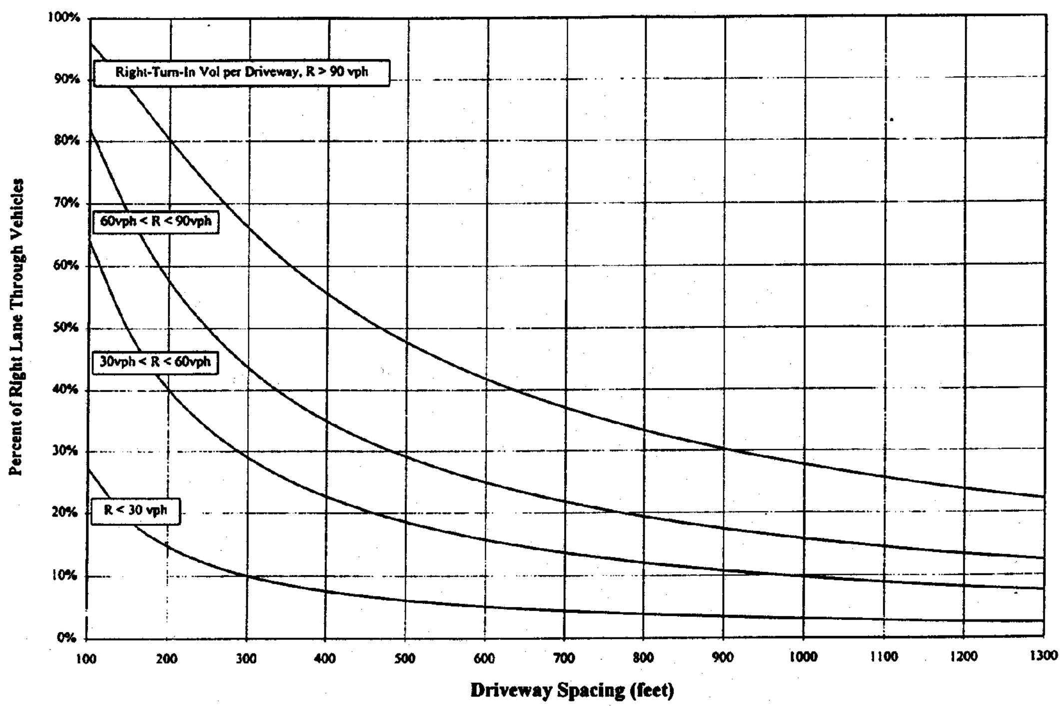
Figure 5



Cumulative Frequency Distribution of Impact Length, 35 mph Average Speed
Figure 6

Field data collected as part of NCHRP Project 3-52 obtained the observed impact of a right-turning vehicle on following through vehicles at 22 sites. Impact was determined by when the brake lights of the through vehicle which was following a right-turning vehicle were activated. The cumulative distribution of impact lengths is given in Figure 6. Because of the manner in which the field data were collected, the actual impact distance and hence, influence distance, (influence distance = impact distance plus distance traveled during driver perception-reaction) is probably longer than that established by the observations. That is, through drivers in the right lane undoubtedly experience some impact of a preceding right-turning vehicle before braking is applied.

The field data permitted the calculation of the likelihood of a through vehicle in the right lane being impacted by a right-turning vehicle as a function of the driveway spacing and driveway volume. This likelihood is shown in Figure 7. Inspection of the figures indicates that for a short spacing (100 ft.) and high driveway volume (> 90 vph) the likelihood of a through vehicle being impacted at least once in a quarter mile approaches certainty. Even at a 500 ft. driveway spacing, the percentage of through vehicles which will be impacted at least once in a quarter-mile is rather large with driveway volumes > 30 vph. The values in Figure 7 are independent of speed as they only indicate the likelihood of an impact - not how far upstream the impact area extends.



Percentage of Right Lane Through Vehicles Impacted at Least Once Per Quarter Mile
Figure 7

Driveway spacing based on speed and the percentage of through vehicles influenced by a right-turn.

The influence area (impact length plus the distance traveled during perception-reaction) increases with speed. The percentage of through vehicles impacted declines as the access spacing increases. Therefore, a selection of an access spacing involves, first a determination of the roadway speed and then a decision as to how much interference to through vehicles is acceptable. Table I gives the percentage of through vehicles influenced for different spacings and driveway volumes for 30 mph. Table 2 gives similar information for 45 mph. These, and similar tables, are used as follows:

- speed = 45 mph
- driveway volume between 30 and 60 vph

- acceptable to interfere with 5% of the through vehicles per quarter-mile
- using Table 3 (45 mph) read down column headed '30 < R < 60 to 5. 1 %; then read across to 450 ft.

Table 4 gives minimum access drive spacing based on influence area for different speeds and the percent of through vehicles that maybe deemed acceptable. Alternatively, Table 3 can be used to estimate the percentage of through vehicles that will be influenced by a right-turn for a selected speed and a given access spacing. Tables 2 and 3 can, of course be used in a similar manner.

Table 1
Percentage of Right Lane Through Vehicles Influenced at or Beyond Another Driveway, Speed 30 mph

Driveway Spacing (ft.)	Right-Turn-In Volume per Driveway, R (vph)							
	R < 30		30 < R < 60		60 < R < 90		R > 90	
	Single Driveway	Multiple Driveways, At Least Once per ¼ Mile	Single Driveway	Multiple Driveways At Least Once per ¼ Mile	Single Driveway	Multiple Driveways, At Least Once per ¼ Mile	Single Driveway	Multiple Driveways, At Least Once per ¼ Mile
100	2.4%	27.3%	7.5%	64.2%	12.2%	82.1%	21.8%	96.1%
150	2.4%	19.0%	7.5%	49.4%	12.2%	68.1%	21.7%	88.4%
200	2.1%	13.0%	6.6%	36.1%	10.7%	52.6%	19.1%	75.3%
250	1.2%	6.0%	3.6%	17.8%	5.9%	27.6%	10.6%	44.7%
300	0.6%	2.8%	2.0%	8.6%	3.3%	13.8%	5.9%	23.5%
350	0.3%	1.2%	1.0%	3.7%	1.6%	6.0%	2.9%	10.5%
400	0.1%	0.4%	0.4%	1.4%	0.7%	2.2%	1.2%	3.9%
450	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 2
Percentage of Right Lane Through Vehicles Influenced at or Beyond Another Driveway, Speed 45 mph

Driveway Spacing (ft.)	Right-Turn-In Volume per Driveway, R (vph)							
	R < 30		30 < R < 60		60 < R < 90		R > 90	
	Single Driveway	Multiple Driveways, At Least Once per ¼ Mile	Single Driveway	Multiple Driveways At Least Once per ¼ Mile	Single Driveway	Multiple Driveways, At Least Once per ¼ Mile	Single Driveway	Multiple Driveways, At Least Once per ¼ Mile
100	2.4%	27.3%	7.5%	64.2%	12.2%	82.1%	21.8%	96.1%
150	2.4%	19.1%	7.5%	49.6%	12.2%	68.2%	21.8%	88.5%
200	2.4%	14.6%	7.5%	40.0%	12.2%	57.5%	21.7%	80.1%
250	2.2%	11.3%	7.0%	32.0%	11.5%	47.5%	20.5%	70.2%
300	1.8%	7.8%	5.8%	23.0%	9.4%	35.3%	16.8%	55.5%
350	1.2%	4.4%	3.8%	13.5%	6.1%	21.2%	11.0%	35.4%
400	0.8%	2.6%	2.5%	8.0%	4.1%	12.9%	7.3%	22.1%
450	0.6%	1.6%	1.8%	5.1%	2.9%	8.2%	5.2%	14.4%
500	0.4%	0.9%	1.1%	2.9%	1.8%	4.7%	3.2%	8.3%
550	0.2%	0.5%	0.6%	1.5%	1.0%	2.5%	1.8%	4.4%
600	0.1%	0.3%	0.4%	0.8%	0.6%	1.3%	1.1%	2.3%
650	0.1%	0.1%	0.2%	0.4%	0.3%	0.6%	0.5%	1.1%
700	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%	0.2%	0.4%
750	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%

Table 3
Minimum Unsignalized Access Spacing Based on Functional Intersection Area

Speed (mph)	Spacing Based Upon Maximum Allowable Percentage of Right Lane Through Vehicles Influenced by Right-Turn in at Least One per ¼ Mile											
	2% Influenced				5% Influenced				10% Influenced			
	Right Turn in Vol. Per D'way, R (vph)				Right Turn In Vol. Per D'way, R (vph)				Right Turn In Vol. per D'way, R (vph)			
	R<30	30<R<60	60<R<90	R>90	R<30	30<R<60	60<R<90	R>90	R<30	30<R<60	60<R<90	R>90
30	320	380	405	430	260	335	360	385	220	290	320	355
35	345	405	435	460	280	355	385	415	235	310	345	380
40	380	460	490	520	305	400	430	465	250	340	380	420
45	430	530	565	610	340	450	495	540	270	380	430	485
50	490	620	665	725	380	520	575	630	285	425	490	560
55	550	725	780	855	420	590	665	740	290	480	550	645

Speed (mph)	**Spacing Based Upon Maximum Allowable Percentage of Right Lane Through Vehicles Influenced by Right-Turn in at Least One per ¼ Mile**											
	15% Influenced				20% Influenced				25% Influenced			
	Right Turn in Vol. Per D'way, R (vph)				Right Turn In Vol. Per D'way, R (vph)				Right Turn In Vol. per D'way, R (vph)			
	R<30	30<R<60	60<R<90	R>90	R<30	30<R<60	60<R<90	R>90	R<30	30<R<60	60<R<90	R>90
30	185	260	295	320	140	245	270	310	110	230	255	295
35	190	280	315	355	140	260	290	330	110	245	275	315
40	195	305	345	390	140	285	320	370	110	265	300	345
45	195	340	385	445	140	315	355	410	110	290	335	385
50	195	380	435	510	140	345	400	470	110	315	370	435
55	195	420	490	580	140	380	445	530	110	330	415	495

Source: NCHRP Project 3-52

Attitudes toward median changes.

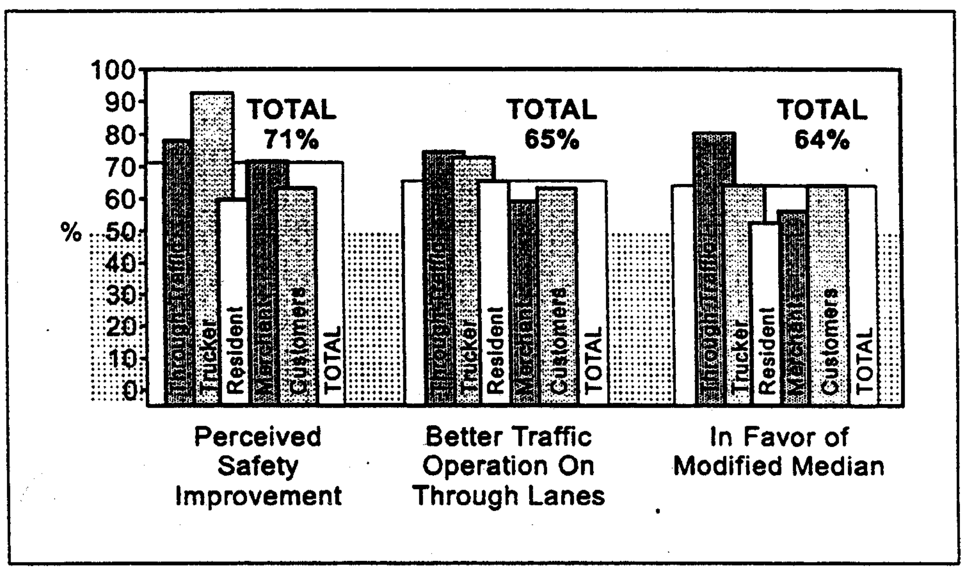
The modification of an existing median and the installation of a median on an existing roadway are often very controversial. It is generally, but not always, recognized that median improvements will improve safety and reduce delays. However, business owners abutting the roadway commonly suffer a loss in business.

<u>Oakland Park Blvd. Fort Lauderdale, Florida</u>

Full median openings at 330 ft. intervals were closed or redesigned as directional openings (left-turns/u-turns) at 660 ft. spacings. A survey found that interest groups had favorable attitudes following the change, Figure S. A majority of owners reported no change in business, Figure 9.

<u>FDOT, District 5, Orlando</u>

Drivers and business owners affected by median changes in 5 corridors where full median openings were closed or redesigned asdirectional openings. Most drivers (Figure 10) favored the change. A majority of business owners did not report problems after thechange; howevei- a sizable proporti on gave negative responses (Figure I 1).



Source: Florida DOT
Figure 8

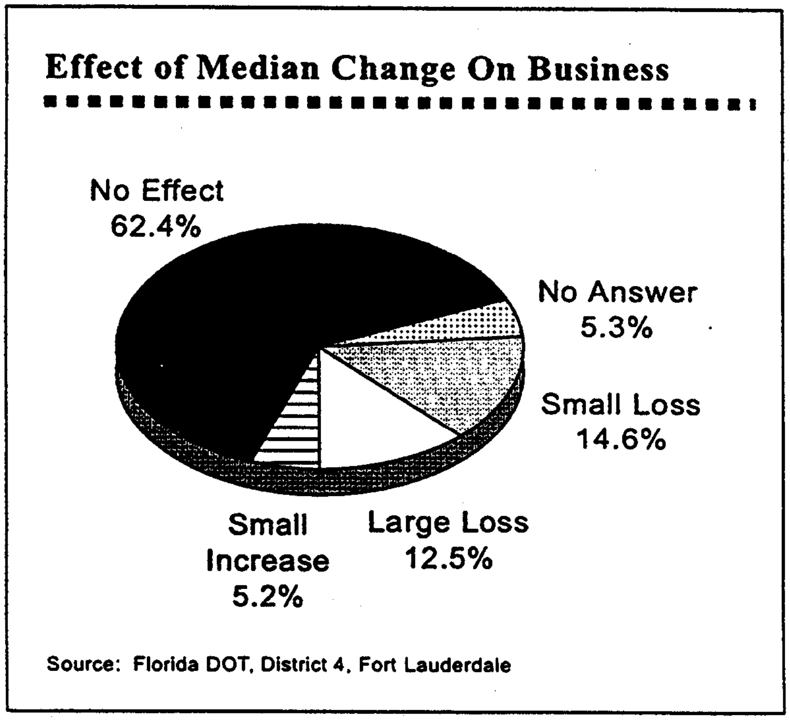


Figure 9

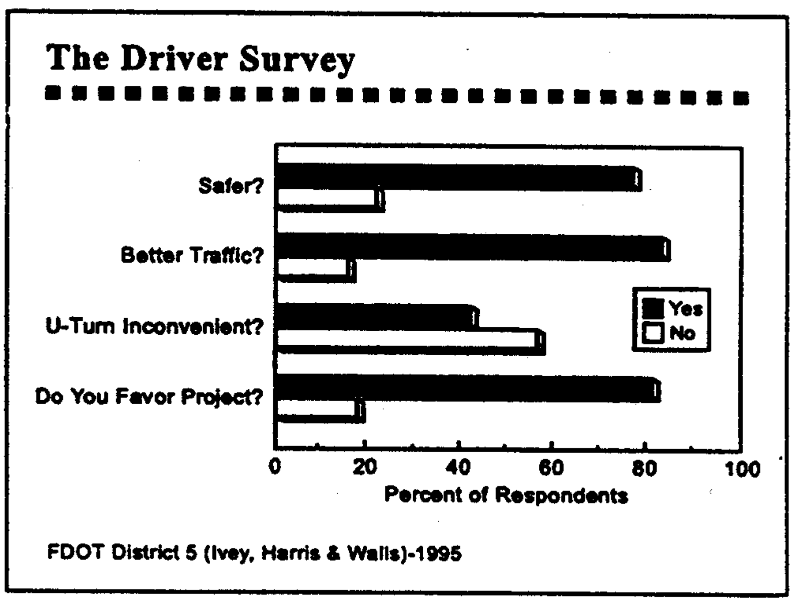


Figure 10

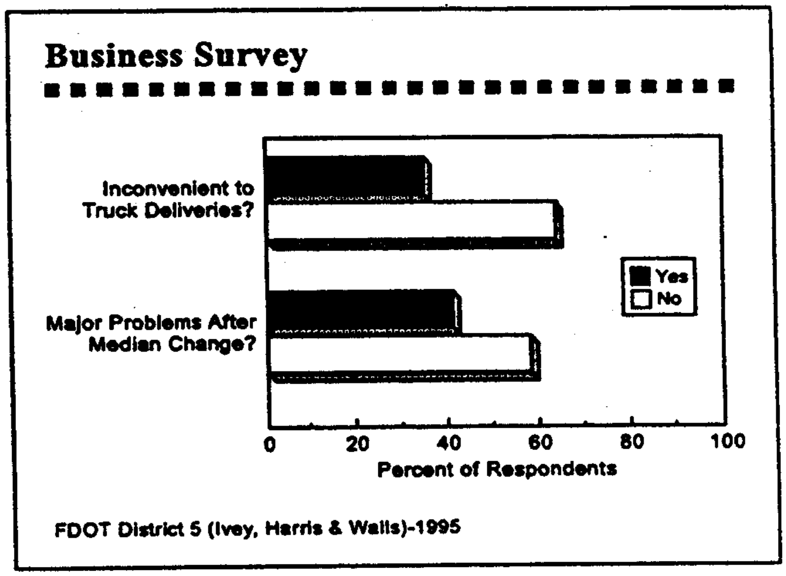


Figure 11

US 101, Lincoln Beach-Fogarty Creek Parkwgy, Oregon

A 2.4 Ian (1.94 mile) section of US 101 between Newport and Lincoln City was reconstructed with a nontraversable, landscaped median in 1992. There are 6 median openings for left-turns, 3 openings are designed for u-turns by large vehicles. A survey conducted in May 1995 found that the various interest groups had favorable opinions regarding the change, Figure 12.

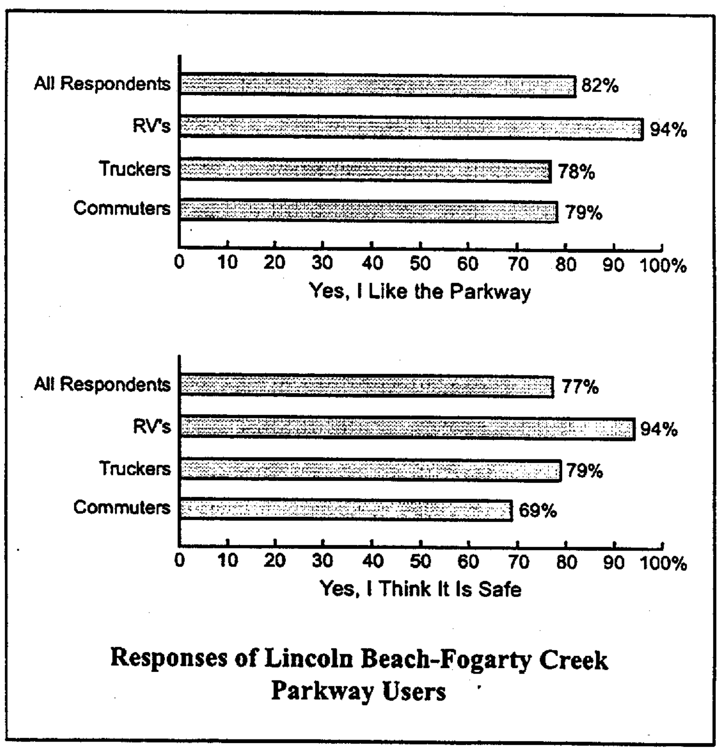


Figure 12

Beginning A Comprehensive Access Management Program

Phil Demosthenes, Colorado Department of Transportation

Beginning A
Comprehensive Access
Management Program

Practical Considerations

Points to Ponder

- What access features will you manage?
- How will you develop a classification system?
- How will you handle variances?
- Who will administer?
- Will you charge fees?

Access Features

- Interchange Spacing
- Driveway Spacing
- Signal Spacing
- Median Opening Spacing
- Restrictive Medians

Classifications

- Needed to establish
  - Desired use
  - establish reasonableness
- <u>Use as few as possible</u>

How Many Classifications???

Colorado	5
Florida	7
New Jersey	6

Classifications

- All recognize the division between:
  - Urban/Developed
  - Rural
- Why?
  - **We can't be as tough where developed**

Variances

- You are going to have to deal with this!!!!
- So, make the forum on variances:
  - Specific

Variances

- Colorado and NJ have special
  - Procedure
  - Forms
- Florida - in Draft Rule
  - Issues of safety outweigh efficiency

Who should administer the program?

- Depends on the following
  - Growth rates of state
  - Focus of Department
    - New construction
    - Maintenance
  - Size of developments

Fees - Should you charge?

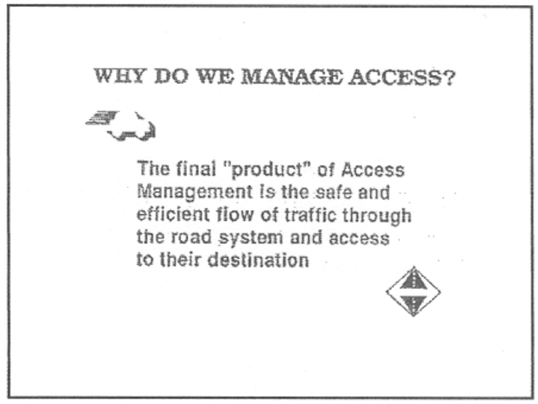
- A source of income
- A source of head-aches
  - Work with Comptroller
  - Do you have a place to store checks?
- What form will you accept money in?

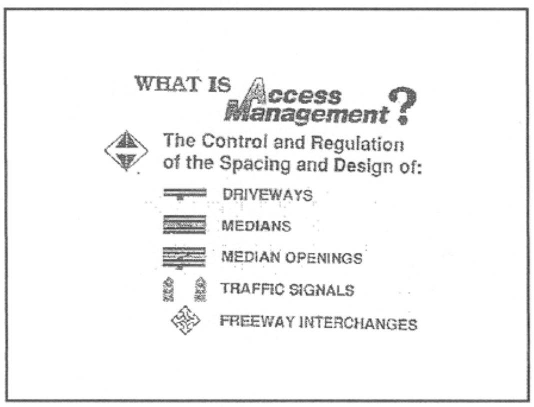
Remember!!!!

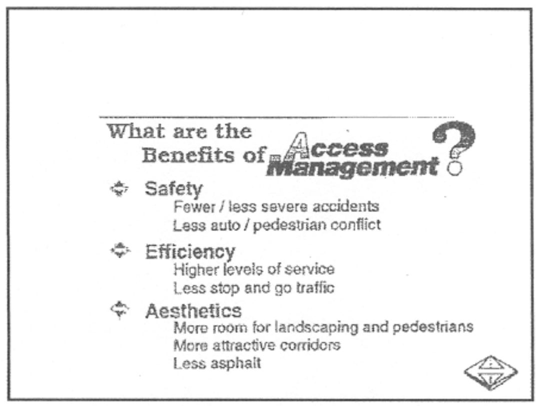
- Choose the features you want to manage
- Keep classifications simple
- Create a Variance Procedure
- Keep the access management function "near the action"

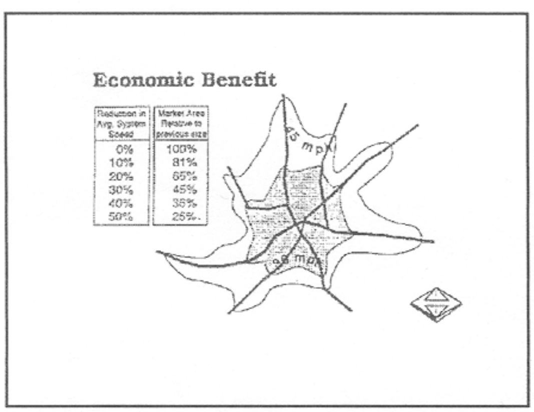
Access Management
An Important Traffic Management Strategy

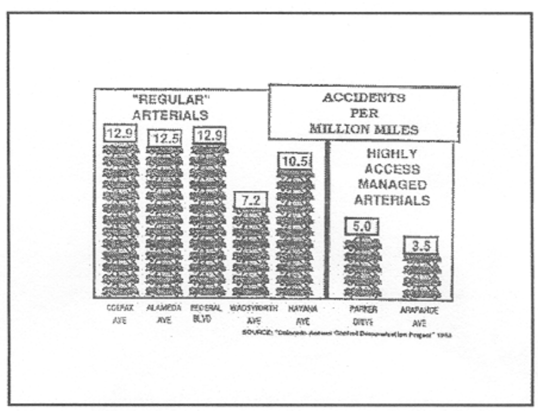
Gary Sokolow, Florida Department of Transportation

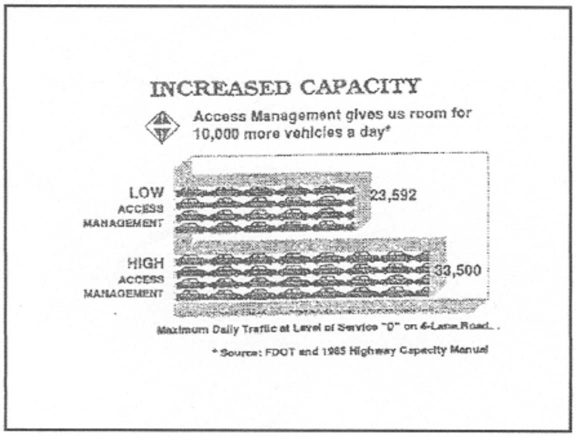


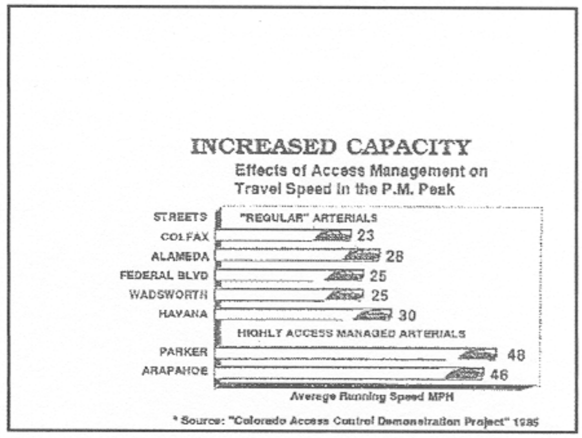


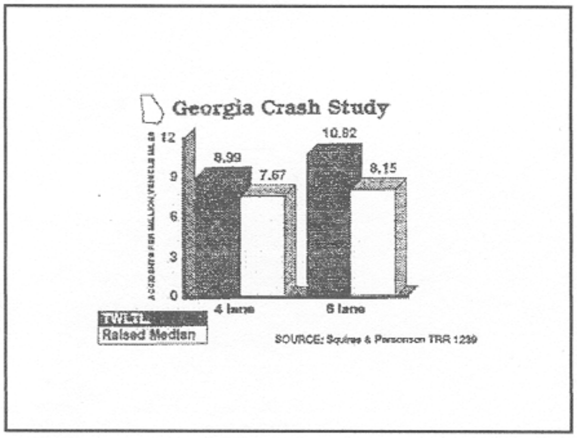


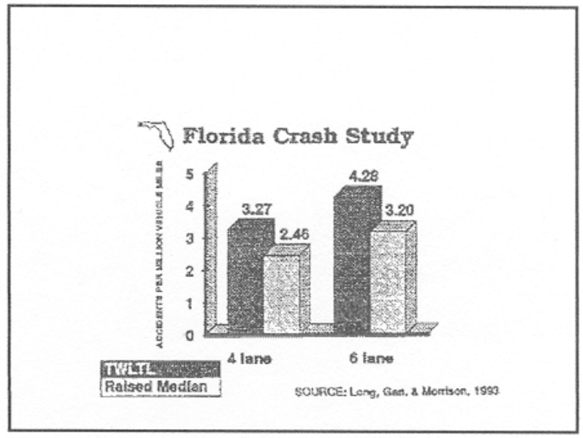


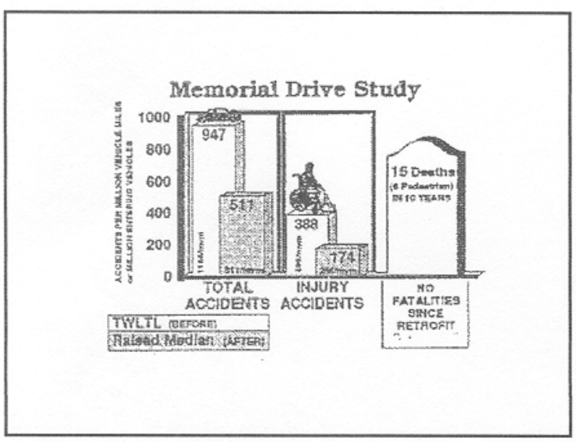


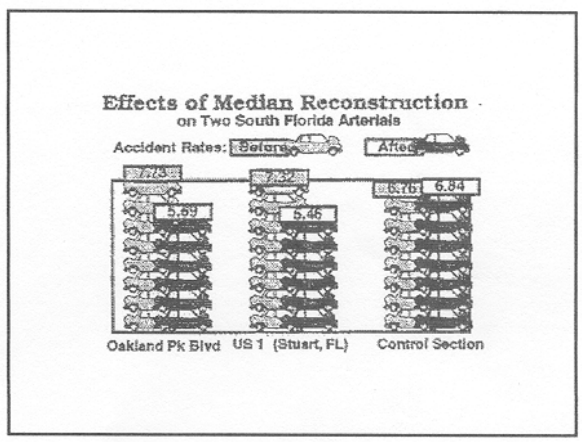

INCREASED CAPACITY
Access Management gives us room for 10,000 more vehicles a day*
LOW ACCESS MANAGEMENT
23,592
HIGH ACCESS MANAGEMENT
33,500
Maximum Daily Traffic at Level of Service "D" on 4-Lane Road
* Source: FDOT and 1985 Highway Capacity Manual


INCREASED CAPACITY
Effects of Access Management on Travel Speed in the P.M. Peak
STREETS
"REGULAR" ARTERIALS
COLFAX 23
ALAMEDA 28
FEDERAL BLVD 25
WADSWORTH 25
HAVANA 30
HIGHLY ACCESS MANAGED ARTERIALS
PARKER 48
ARAPAHOE 46
Average Running Speed MPH
* Source: "Colorado Access Control Demonstration Project" 1985


Georgia Crash Study
ACCIDENTS PER MILLION VEHICLE MILES
12
9
6
3
0
8.99
7.67
10.82
8.15
4 lane
6 lane
TWLTL
Raised Median
SOURCE: Squires & Parsonson TRR 1239


Florida Crash Study
ACCIDENTS PER MILLION VEHICLE MILES
5
4
3
2
1
0
3.27
2.46
4.28
3.20
4 lane
6 lane
TWLTL
Raised Median
SOURCE: Long, Gan, & Morrison, 1993


Memorial Drive Study
1000
800
600
400
200
0
947
517
388
174
15 Deaths
(6 Pedestrian)
IN 10 YEARS
TOTAL ACCIDENTS
INJURY ACCIDENTS
NO FATALITIES SINCE RETROFIT
TWLTL (BEFORE)
Raised Median (AFTER)

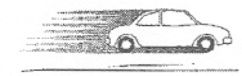

Effects of Median Reconstruction
on Two South Florida Arterials
Accident Rates: Before
After
7.73
5.69
7.32
5.46
6.76
6.84
Oakland Pk Blvd
US 1 (Stuart, FL)
Control Section

What are the effects of NOT managing access?

- Damage to homes and businesses to widen roads
- Damage to established nieghborhoods providing "1-Way Pairs" parallel to overburdened arterials
- Build "Bypass" routes which usually become as congested as the roads they were built to relieve

FUNTIONAL INTEGRITY

Reserving high speed,
high capacity roads
for high speed,
longer distance travel.



Principles of Access Management

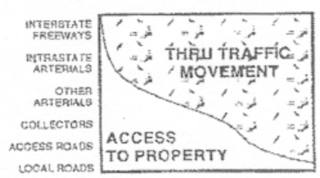
- Access should follow roadway function

Least access on interstate highways

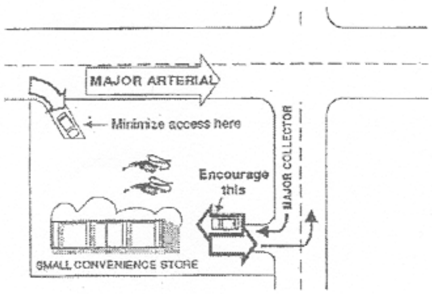
Greatest access on residential streets

- Separate access from intersections or interchanges

Roadway Function Classification



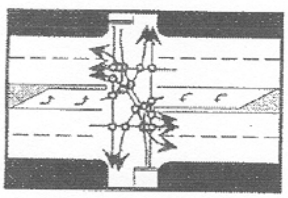
Residential Street Hierarchy



The goals of Access Management

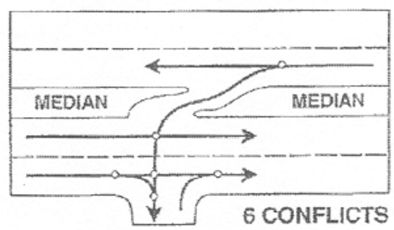
- Limit the number of conflict points
- Separate conflict points
- Remove turning vehicles from through traffic

NORMAL MEDIAN OPENING

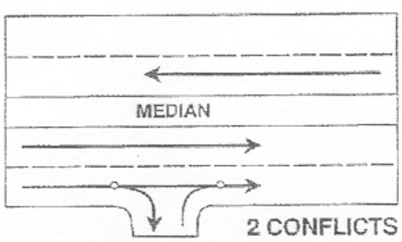


18 MAJOR Conflicts

RIGHT-IN/RIGHT-OUT/LEFT-IN

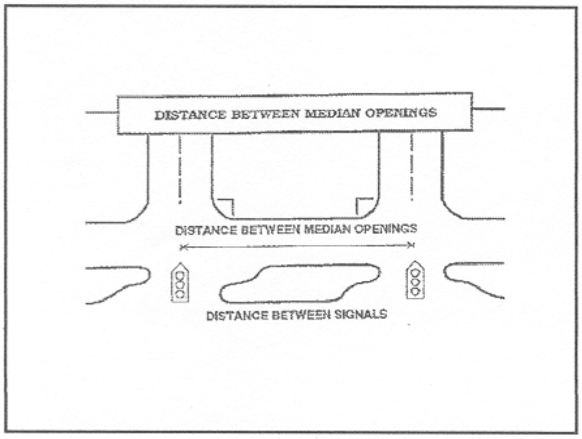


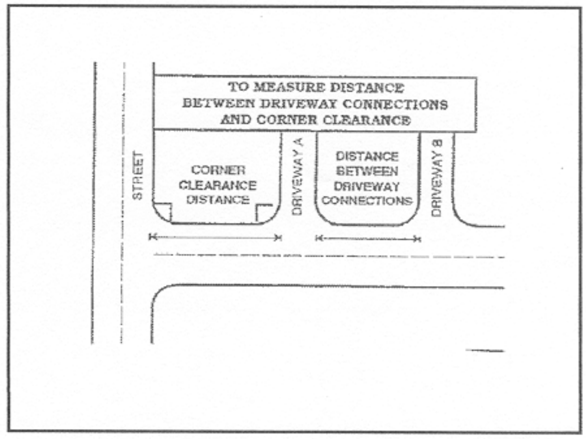
RIGHT-IN/RIGHT-OUT

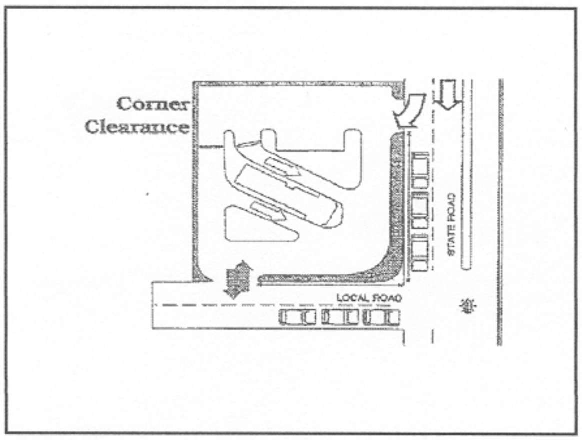


TECHNIQUES TO SEPARATE CONFLICT POINTS

- Driveway Separation Standards
- Corner Clearance Standards
- Median Opening Standards
- Signal Spacing Standards

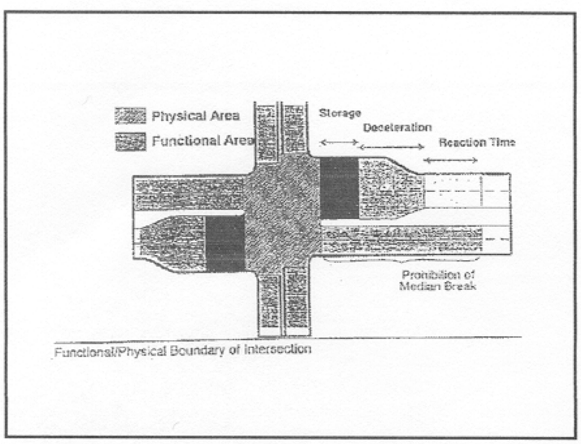






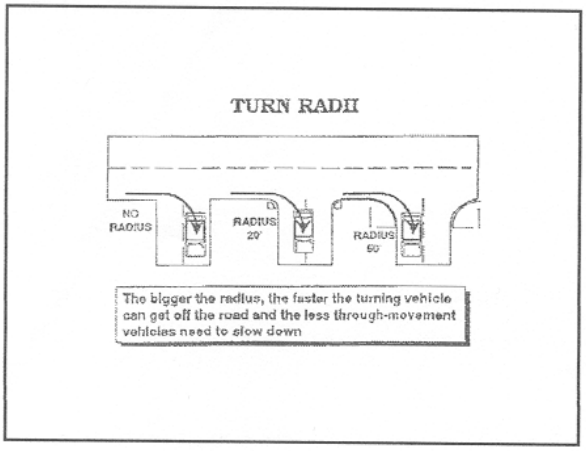
Driveway terminals are in effect at-grade intersections and should be designed consistent with the intended use. The number of accidents is disproportionately higher at driveway terminals than at other intersections; thus their design and location merit special attention.

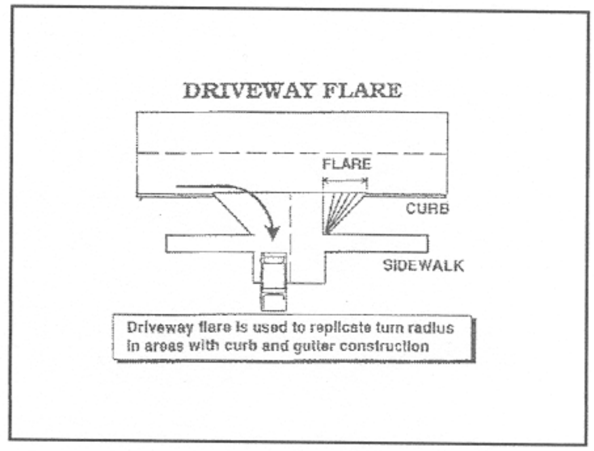
1990 AASHTO Greenbook

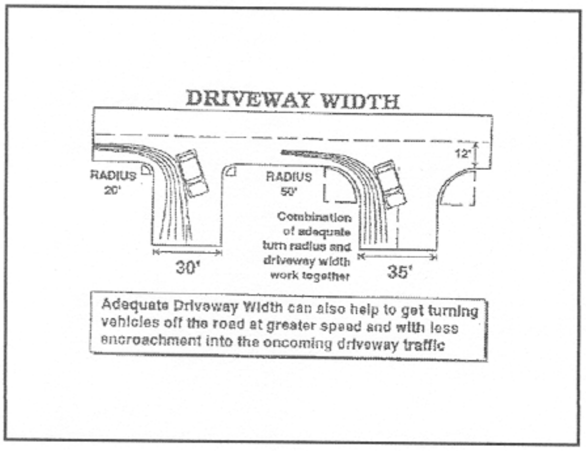


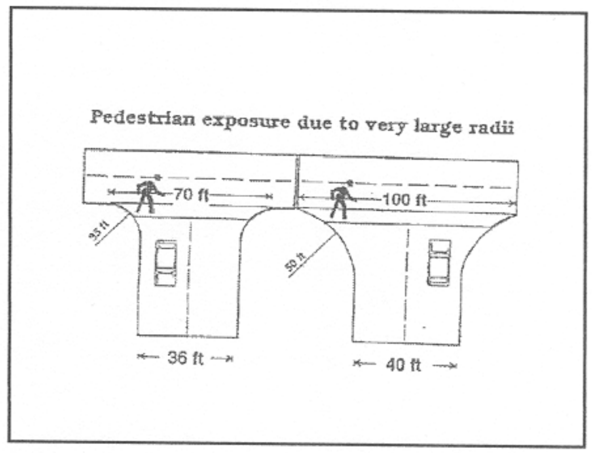
What techniques are available to remove turns and queues from the through movement?

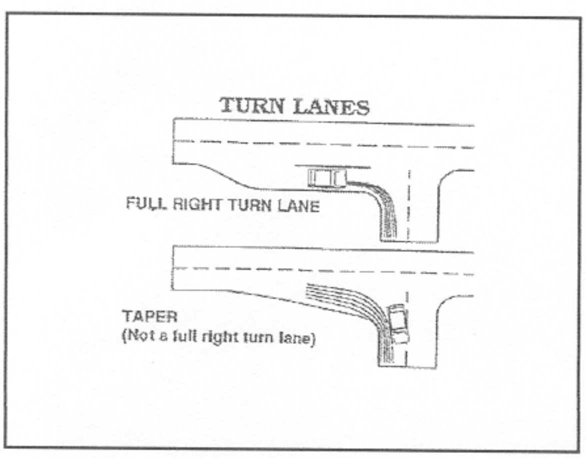
- TURN RADII / DRIVEWAY FLARE
- DRIVEWAY WIDTH
- TURN LANES / TAPERS
- INTERNAL SITE DESIGN

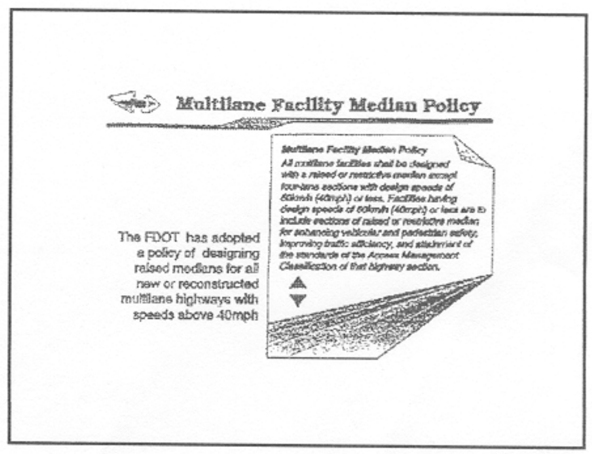

TURN RADII
NO RADIUS
RADIUS 20'
RADIUS 50'
The bigger the radius, the faster the turning vehicle can get off the road and the less through-movement vehicles need to slow down

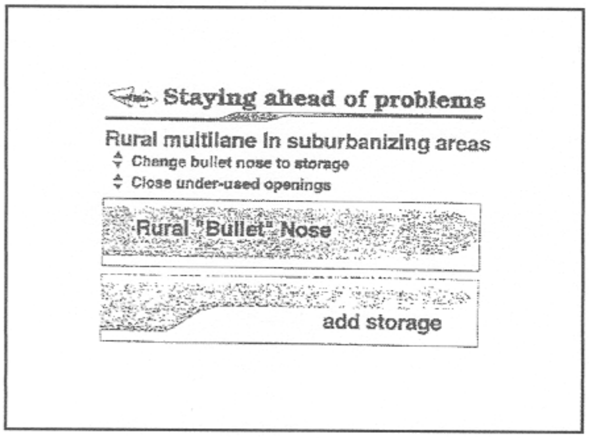

DRIVEWAY FLARE
FLARE
CURB
SIDEWALK
Driveway flare is used to replicate turn radius in areas with curb and gutter construction

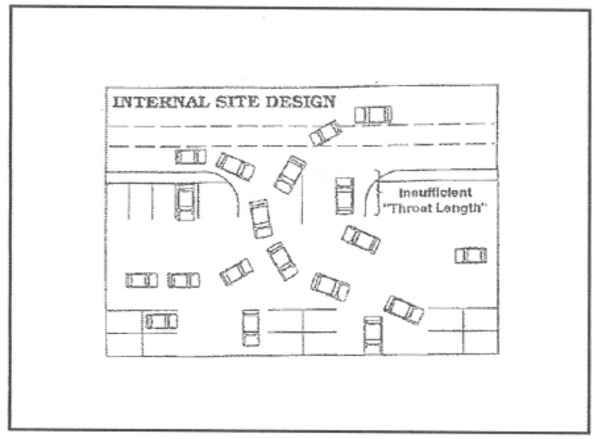

DRIVEWAY WIDTH
12'
RADIUS 20'
RADIUS 50'
Combination of adequate turn radius and driveway width work together
30'
35'
Adequate Driveway Width can also help to get turning vehicles off the road at greater speed and with less encroachment into the oncoming driveway traffic

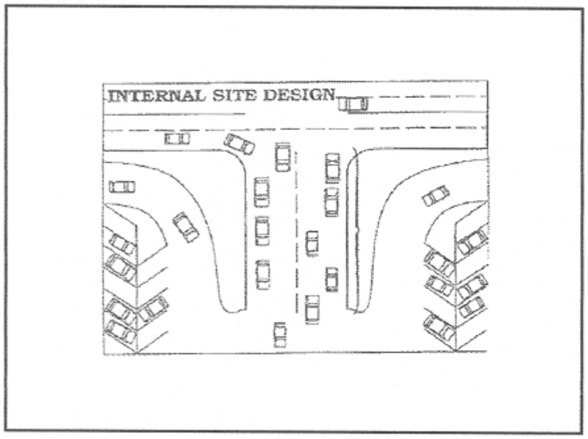

Pedestrian exposure due to very large radii
70 ft
100 ft
35 ft
50 ft
36 ft
40 ft

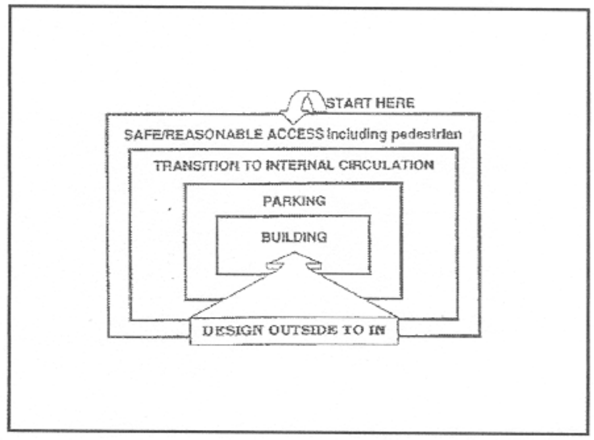

TURN LANES
FULL RIGHT TURN LANE
TAPER
(Not a full right turn lane)


Multilane Facility Median Policy
The FDOT has adopted a policy of designing raised medians for all new or reconstructed multilane highways with speeds above 40mph
Multilane Facility Median Policy
All multilane facilities shall be designed with a raised or restrictive median except four-lane sections with design speeds of 60km/h (40mph) or less. Facilities having design speeds of 60km/h (40mph) or less are to include sections of raised or restrictive median for enhancing vehicular and pedestrian safety, improving traffic efficiency, and attainment of the standards of the Access Management Classification of that highway section.



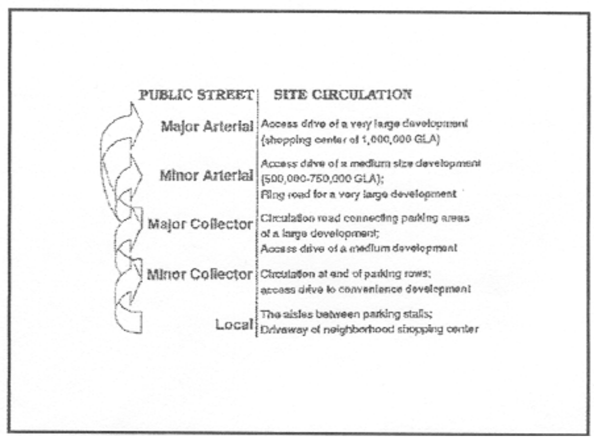






Generally Adequate Driveway Throat Lengths

Shopping Centers > 200,00 GLA	200'
Shopping Centers > 200,000 GLA if dual lefts are needed	250'
Smaller Developements	80'-90'
Unsignalized driveways	2-3 vehicles



Internal circulation should be designed around access points . . .

NOT the other way around!

HOW CAN WE INSTITUTE ACCESS MANAGEMENT?

PERMITTING

- New Developments
- Expanded Developments

HOW CAN WE INSTITUTE ACCESS MANAGEMENT?

ROAD IMPROVEMENTS

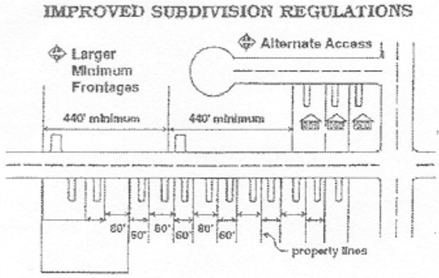
- WIDENINGS
- INTERSECTION UPGRADES
- INSTALLING NEW RESTRICTIVE MEDIANS
- NEW ROADS

HOW CAN WE INSTITUTE ACCESS MANAGEMENT?

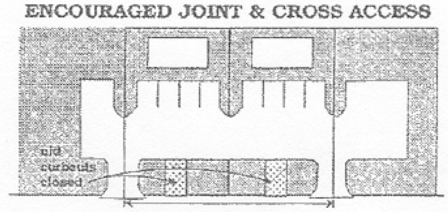
DEVELOP APPROVAL PROCESS IN COOPERATION WITH LOCAL GOVERNMENTS

- SITE PLAN REVIEW
- IMPROVED SUBDIVISION REGULATIONS
  - Larger minimum frontages
  - No more "Flag" lots
- JOINT ACCESS/CROSS ACCESS

IMPROVED SUBDIVISION REGULATIONS



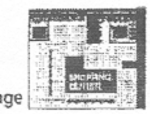
ENCOURAGED JOINT & CROSS ACCESS



The Problem with Outparcels

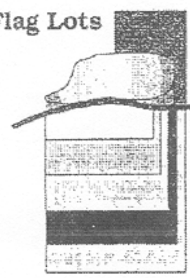
- Increase demand for arterial access
- Site plans often fail to coordinate on-site circulation and access

Improved Outparcel Regulations

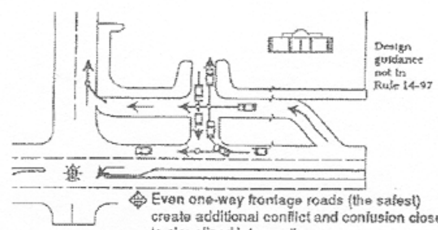


- Use main access drive
- Limit number of outparcels
- Increase minimum lot frontage
- Require unified parking and circulation
- Landscaping and pedestrian systems
- Regulate signage

Flag Lots



- Can be useful in unique circumstances
- Often abused to avoid the expense of platting and providing a road

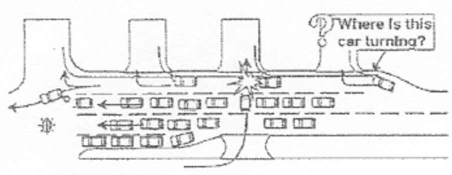


- Even one-way frontage roads (the safest) create additional conflict and confusion close to signalized intersections
- Unless carefully designed and coordinated they work OK until you put traffic on them
- Full of unfamiliar movements

Design guidance not in Rule 14-97

CONTINUOUS RIGHT TURN LANES

- May encourage use as a through-lane
- May lead to confusion where cars will turn right into driveway or street?



Tips For A Successful Access Management Program

Arthur Eisdorfer, New Jersey Department of Transportation

Tip 1

Have a strong leader with high level support

Tip 2

Watch out for competing public goals

Tip 3

More classifications =

More decisions and justifications

Tip 4

Always do the best you can

Tip 5

Address problems head-on

Tip 6

In the event of tie, the government loses

Session 1

Opening Session

Moderator:	Gary Sokolow, Florida Department of Transportation
Keynote Speaker:	George W. Black, Jr., National Transportation Safety Board

Welcome
Opening Remarks

Joe Yesbeck, Florida Department of Transportation

On behalf of Florida Department of Transportation, welcome to Fort Lauderdale and the 3rd National Conference on Access Management. You have an informative agenda over the next three days. You'll get a chance to learn about Access Management techniques used here in Florida and hear about the statutory support we have. This was not always the case.

Almost twenty years ago, I was one of a small group of college graduates who joined FDOT out of college. We began a practice of developing operational improvement projects which included access control. (U.S.1 example) At that time, we didn't have the statutes and rules like today. We learned some very important factors to increase the likelihood of successful implementation. Let me quickly state four of them.

1. **UNDERSTAND THE PROBLEM**
   Is it a safety problem? Application of design standards with a 3R project? What are the operational problems? Trying to implement desired standards when no problems exists is a difficult sell.

2. **FLEXIBILITY**
   Don't just stick blindly to standards. Property owners/residents/business people are very familiar with the traffic flows in their area. Listen to their input, you will be able to make some adjustments that will benefit everyone. If you hide behind a law or directive, the message you're sending is that they need to get the law changed!

3. **CONSISTENCY**
   Apply your design and access management standards in a consistent manner. This isn't contradictory to flexibility, it is complimentary. People want to understand why a certain treatment might work down the street, but doesn't apply to them. Having firm technical justification for the design, including adjustments, is critical in defending against any challenges.

4. **PEOPLE!!!**
   Successful implementation relies as much IF NOT MORE on the people designing and implementing the project. You and your staff must have thorough understanding of the local issues and traffic flows, you must be able to conduct public forums and explain technical rationale in plain English. And you can't be either unyielding or afraid of the controversy often associated with these projects.

Just remember that if a group of recent graduates can implement access control projects here.....<u>then with management support</u>, your organizations can do the same.

Again, we're glad to be hosting this conference. Enjoy your time here in Fort Lauderdale. Be sure to get out to Riverwalk and Las Olas....wonderful restaurants and a very pleasant walking atmosphere. As you drive around the area, take a look at some of the roadways with median control treatments, and let us know if you have any questions. I'll be able to handle the ones about US 1.

Session 2

Linking Land Use And Access Management

Moderator: Robert Jurasin, Wilbur Smith Associates

Participants: Reid H. Ewing, Florida International University
Charles R. Carmalt, Lehr & Associates, Inc.
Kristine M. Williams, CUTR

Pedestrian and Transit-Friendly Design

Reid Ewing, Florida International University

Short-to-Medium Length Blocks

There has been a trend toward longer and longer blocks, and correspondingly fewer and fewer intersections within a given area. This is true not only in the suburbs, where super blocks are the norm, but in central cities where blocks plus interior right-of-way have been consolidated to create larger building sites. "The practice (of block consolidation) contributes to a city scaled to cars and is in grave error," assuming pedestrian-friendliness is a goal.

By mapping different cities at a common scale, Allen Jacobs determined that Venice, Italy, has about 1,500 intersections in a typical square mile, while the City of Irvine Outside Los Angeles, California, has 15 intersections per square mile." Downtown Los Angeles has about one tenth as many intersections as Venice, and 10 times as many as Irvine. People familiar with these three cities would doubtless rank their walkability in same order. Jacobs also found that downtown Boston, as an example, had lost more than one-third of its intersections through block consolidations.

Reasons why walkability depends on block size are numerous. Most obviously, more intersections mean more places where cars must stop and pedestrians can cross. Also, short blocks and frequent cross streets create the potential for more direct routing; this is important to pedestrians much more so than to high speed motorists. Finally, a dense network of streets disperses traffic, so that each street carries less traffic and can be scaled accordingly; this makes streets more pleasant to walk along and easier to cross.

There may be psychological factors at work as well. It his been Suggested that more intersections give pedestrians more sense of freedom and control as they need not always take the same path to a given destination; that more intersections make a walk seem more eventful, since it is punctuated by frequent crossing of streets; that more intersections may shorten the sense of elapsed time on walk trips, since progress is judged to some extent against the milestone of reaching the next intersection."

This feature short-to-medium length blocks goes hand-in-hand with the previous one a mix of land uses. Short blocks create lots of comers that are ideal for small-scale commerce. Residents of adjacent streets can pool their support for neighborhood businesses as their paths come together at intersections."

For a high degree of walkability, block lengths of 300 feet, more or less, are desirable." Blocks of 400 to 500 feet still work well. This is typical of Florida's older urban areas. However, as blocks grow to 600 to 800 feet, or even worse, to super-block dimensions, adjacent blocks become isolated from each other.

If blocks are scaled to the automobile (more than 600 to 800 feet on a side), midblock cross-walks and pass-throughs are recommended."Mind you, these devices are poor substitutes for the real thing: frequent intersections offering directional choices and frequent streets with active uses on both sides. But they are better than nothing.

Long blocks can also be broken up with alley-ways (see Best Development Practices for a discussion of alleys, their pluses and minuses). Again, though, alleys are no substitute for frequent cross streets lined with active users.

Short blocks may be more important for general walkability than for transit ridership. In Appendix C, the number of intersections within the immediate area around bus stops does not emerge as a significant determinant of bus stop ridership in Miami. However, it does correlate highly with other pedestrian-friendly features and is the variable upon which a pedestrian-friendliness factor (extracted through factor analysis) loads most heavily. This takes us back to a previous point-if a transit served area has enough potential riders, the precise layout of the area may matter only a little.

Transit Routes Every Half-Mile

As city blocks have been replaced by super blocks, the spacing of through-streets has increased. Within these large blocks, straight, continuous streets have given way to curving, discontinuous streets. The combination of curvilinear local streets and widely spaced through streets has left few residents within walking distance of transit lines (see preceding illustration).

The old transit industry standard-that transit users will walk a quarter mile, or 5 minutes at 3 mph, to a bus stop-- is better than we might have guessed. Converting reported walk times from the 1990 Nationwide Personal Transportation Survey (NFTS) into distances, and plotting and smoothing the resulting frequency curve, the median walking distance to and from transit stops is almost exactly a quarter mile."Of course, young people may be willing to walk a little farther than older people, and users of premium transit (rail rapid transit, for example) may walk a little farther than regular bus users. But a quarter mile walking distance is a good rule-of-thumb for transit planning purposes.

If a quarter mile is the farthest most people will walk, it follows that transit routes may be no farther than a half mile apart to blanket a service area. This assumes that transit stops are closely spaced along routes, as they usually are in the United States, and that local streets lead directly to. stops, as they usually do in urban settings. If stops are infrequent or local streets are curvilinear, parallel routes must be even closer together

ACCESS MANAGEMENT IN CENTERS

Charles R. Carmalt, Lehr & Associates, Inc.

ABSTRACT

Traditional development patterns evolved around the importance of pedestrian mobility and accessibility. In managing development in hamlets, villages, towns and city centers, a strategic balance needs to be established between the access and movement needs of automobiles and those of pedestrians. In addition, a broad number of additional travel needs must be served on streets in centers including delivery services, bicycle circulation and transit operations.

Centers, like all development areas, require that a hierarchy of streets be identified, and that appropriate access management objectives be assigned to each street. Arterial streets in centers (Main Streets and Broad Streets) are likely to have the most intense commercial land uses, the highest vehicular traffic volumes and the highest pedestrian volumes. On these streets, access management is especially important, and driveway access should be either prohibited or strictly regulated. As on other arterials, these streets require that turning movements be concentrated at controlled locations designed to accommodate the resulting conflicts. In addition, the commercial viability of these streets is maximized when pedestrian continuity can be provided between blocks.

On these streets, a broad set of activities must be supported -- on-street parking, transit access and delivery access are all appropriate. In addition, the aesthetic character of the street environment is of critical importance, requiring that right-of-way be reserved for needed street furniture and for the growing of street trees.

For all of these reasons, access management for streets in centers is of critical importance. Driveways should generally be prohibited on "Main Streets" in centers; motor vehicle access instead should occur via alternative access using streets having a lower functional classification. Access management regulations and local land development regulations should jointly seek to encourage pedestrian activity on these streets.

INTRODUCTION

This paper describes what centers are, the role of different types of roadways in centers and then discusses what role access management should play in controlling development activity in centers to enhance public interests in centers, and in particular promoting pedestrian travel in centers.

Land Use Characteristics of Centers

Centers are places with distinctly different land use and transportation characteristics. These are areas where land uses are concentrated, and as a result, trip ends are also concentrated. Centers also are areas where walking is an acceptable and significant travel mode. Most people will choose to walk to complete most local trips while in a center.

New Jersey, Oregon and some other states have adopted policies and programs that encourage development to be concentrated in centers. Even where such programs and policies have not been established, centers exist and continue to evolve. Centers also are generally favored by public agencies even where formal statewide policies have not been adopted.

On the other hand, transportation and land use regulations frequently have the effect of discouraging the development of new centers or the extension or redevelopment of existing ones. Laws and regulations that seek to separate land uses or that encourage automobile and truck travel can effectively prohibit centers from evolving by removing the concentration of land uses typical of centers or by frustrating pedestrian trips.

Centers include the central business district of a central city or large town where population density frequently exceeds 5,000 persons per square mile and where office trips are concentrated. But centers also include a number of other places that may not exhibit intense population or employment concentration, but are relatively dense compared to surrounding areas and have a more diverse set of land uses. Within urban areas, villages and neighborhood centers are examples of such centers. In rural areas, rural villages and hamlets similarly provide more concentrated settlements where a variety of symbiotic land uses are present.

Pedestrians and Retail Viability

Retail uses within centers are dependent on pedestrian activity -- the most successful shopping areas in centers are those that provide the most comfort and convenience to pedestrians. As a result, interruptions to pedestrian movement should be discouraged. As will be discussed below, vehicular access to properties should be provided via intersecting collector and local streets, and direct motor vehicle entrances onto "Main Streets" should be prohibited.

Transportation Characteristics of Centers

Centers are areas where trip ends are substantially more concentrated than in the areas surrounding centers. Pedestrian trips constitute a larger portion of all travel within centers because of the concentration of trip ends and land uses. Because of shorter distances between land uses, transit and bicycles also may play an important transportation role. In town and city centers, pedestrian trips may represent over half of all daytime person trips in the center.

However, with a high concentration of trip ends, centers remain important foci of highway systems. Motor vehicle trips are attracted into centers; goods are delivered to centers and sent from centers in trucks. Customers and employees must park their vehicles while in a center, if they choose to travel by motor vehicle. More significantly, the most intensely developed sections of centers in the United States are also frequently located along streets having intense motor vehicle travel. Indeed, unlike their counterparts in other countries, urban designers and downtown development specialists in the United States believe that intense motor vehicle travel is a critical ingredient for the economic success of a commercial center.

Centers have evolved with different methods of serving motor vehicles compared to developed areas outside of centers. Parking usually occurs on street or in shared parking lots or garages rather than being accommodated on-site in individual parking lots. Goods delivery frequently also occurs on street rather than off-street. Delivery vehicles are sometimes able to serve two or more businesses or homes at a single stop. Importantly, motor vehicle traffic is usually accommodated on a dense hierarchy of public streets offering redundancy in travel options.

In contrast, in other developed areas, businesses are usually required to provide sufficient loading bays and parking spaces on site to assure that all demand is contained within a development lot. The provision of on-site vehicle storage reduces development densities and encourages the separation of land uses, encouraging customers and employees to drive between land uses. As a result, this non-centered development generates added vehicle trips compared to centers and greater vehicle travel in and out of businesses. At the same time, the number of public roadways available to serve this traffic is substantially reduced, increasing the intensity of travel on commercial highways.

Because of the substantial differences in travel characteristics, both by motor vehicles and pedestrians, arterial streets and highways function differently in centers and as a result must be managed differently, both to facilitate the large number of trip ends and to maximize transit, pedestrian and bicycle movements. Access management remains a critical element of a well ordered street network in a center, but the criteria that should be employed for access management change.

Before discussing the role of access management in centers, however, this paper briefly summarizes the traditional functional hierarchy of the highway system and describes how different roadways should serve centers.

Functional Classification and Centers

Functional classification divides highways into three broad classes of roadways – arterial highways, collector roads and local streets. The chief function of arterial highways is to serve travel corridors where vehicle movement is most intense. In contrast, the chief function of local streets is to provide access to property. Collector roads usually serve an intermediate function.

Arterial Highways

The FHWA functional classification system for highways further divides arterial highways into two broad groups – principal arterials and minor arterials – with principal arterials being a smaller group of roads having the most intense vehicle travel characteristics. Principal arterials include freeways, expressways and other principal arterial highways. For this paper, the other principal arterial highways have been further broken down as described below into strategic arterial highways and other principal arterial streets and highways.

<u>Role of Freeways</u>

Places that have closely spaced streets and high volumes of pedestrians are inappropriate environments for freeways. Freeways can create major barriers, blocking pedestrian trips and disrupting vehicular trips. Disruptions in street patterns created by freeways can make center street patterns difficult to “know”, making centers confusing for both visitors and inhabitants.

Freeways also require relatively wide separation between interchanges. The optimal separation between access points on freeways – two or more miles – is substantially longer than the limits of the intensely developed area of most centers. Where freeways have been constructed to provide multiple entrances and exits into centers, they frequently have resulted in extensive weaving areas, confusing signage systems and general driver frustration. Several cities have as a result chosen not to construct freeways originally proposed as part of the Interstate Highway System, or like Portland and Boston, chosen to remove freeways previously constructed.

In general, freeways should provide connecting links to centers, but need to bypass the actual center. In a few instances, bypasses of city centers have been provided by tunneling under a center (Vine Street Expressway in Philadelphia, Central Artery in Boston). However, the most satisfactory bypasses are constructed on less densely developed land outside of a center. In large city centers, a system of at-grade arterial streets, expressways and boulevards can then be constructed to deliver and disperse motor vehicles into the street system of the center. Smaller town, village and hamlet centers only need to ensure that good access to the freeway system is provided by the general hierarchy of streets and highways.

Since freeways can create major barriers for non-auto travel modes, opportunities should be found to create crossing opportunities when freeways have been constructed or are proposed in or near centers of all sizes. High speed merge and diverge areas create especially risky conditions for bicyclists and pedestrians, both because of long exposure distance and because of the great difference in speed between motor vehicles and non-motorized travel modes. As a result, in centers ramp terminals to freeways should be designed to function like streets rather than highways.

Role of Expressways

Expressways are similar to freeways in that they are designed to exclusively serve a mobility function and do not permit direct motor vehicle access to property. They can serve a critical role in linking the freeway system with centers where major high-speed highways would be inappropriate.

Generally expressways should not actually penetrate the city or town center but instead feed important arterial streets in a fashion that will help drivers become oriented to the center's street system. Landscaped medians, informational signage and other amenities can help to welcome visitors to the center while they are approaching along an expressway. Traffic speed on a linking expressway should gradually decline to help drivers adjust to city traffic conditions. Similarly, signalized intersections should become more closely spaced and be linked to the interconnected signal control system serving the center. Medians should be provided on expressways to facilitate pedestrian crossings. Mid-block pedestrian crossings should be provided as needed, especially in areas where signalized intersections are spaced more than 1000 feet apart.

Role of Strategic Principal Arterial Highways

Freeways and expressways serve as the backbone of the arterial highway system in most states. However, a large number of additional highways also serve a principal arterial highway function. These additional highways can be further divided into two broad categories – Strategic Principal Arterial Highways and Regional Principal Arterial Highways. Strategic Principal Arterials serve transportation corridors with high traffic volumes and relatively long trip distances. In this regard they are very similar to freeways, although the density of travel may be substantially less. Regional Principal Arterial Highways also serve corridors with high traffic volumes. However, a much smaller percentage of trips on these arterials will be statewide or longer; most trips will be contained within the urbanized region and will be shorter than 10 miles in length.

Recognizing the difference between strategic and regional principal arterial highways is critical for access management purposes in centers. All principal arterial highways should provide safe and efficient service for major traffic movements. However, because of the longer travel distances of trips on strategic arterials, high operating speed should also be an important objective of strategic principal arterials. As a result, traffic signals, if provided, need to be broadly spaced. In contrast, on regional principal arterial highways, on which most trips are contained within the urbanized area, reduced operating speeds do not necessarily result in substantial increases in travel time. As a result, street intersections can be more closely spaced. However, with intersections closely spaced, interference from driveways can be of equal or greater concern than on strategic arterials. The role of regional principal arterial highways in centers is discussed further below.

Like freeways and expressways, the high speed of traffic on strategic arterials generally makes them inappropriate for centers. However, many centers in rural or suburban areas have strategic highways passing through them. In these centers a tension necessarily exists between the travel objectives of through motorists and the quality of life objectives of residents and businesses in the center. When a bypass cannot be constructed to serve the through traffic, it is important to manage traffic on these roads to permit community activity to thrive. Techniques of access management for arterials in centers described below can be employed on these strategic arterials as well to seek an effective compromise.

Like expressways, strategic arterials can also link a center with the surrounding freeway system. Generally strategic arterials should not actually penetrate the city or town center but instead feed important arterial streets in a fashion that will help drivers become oriented to the center's street system. Landscaped medians, informational signage and other amenities can help welcome visitors to the center while approaching along a strategic arterial. Traffic speed should gradually decline to help drivers adjust to city traffic conditions. Similarly, signalized intersections should become more closely spaced and be linked to the interconnected signal control system serving the center. Medians should be provided to facilitate pedestrian crossings. Mid-block pedestrian crossings should be provided as needed, especially in areas where signalized intersections are spaced more than 1000 feet apart.

Boulevards

Boulevards are highways in centers divided by a relatively wide, landscaped median. Because they require a relatively wide right-of-way of between 30 and 45 meters (100 to 150 ft), they usually will not generate the intense pedestrian crossing activity of a Main Street. However, as has been demonstrated around the world, they can become highly successful commercial arteries with intense pedestrian volumes.

Boulevards provide an effective method of serving the mobility needs of strategic principal arterial highways when they must pass into or through a center. The median of the boulevard can provide a comfortable refuge for pedestrians crossing the highway. If sufficiently wide the median can in fact become a park within the center. Some boulevards, Commonwealth Avenue in Boston or St. Charles Avenue in New Orleans, have been managed to serve as important transit corridors with light rail lines operating in the landscaped median.

Boulevards can offer greater motor vehicle capacity compared to Main Streets (see below) and often can be allowed to operate at somewhat higher speeds. However, with adequate pedestrian and aesthetic amenities they can also encourage extensive pedestrian activity. As a result, they form a compromise between serving the capacity needs of motor vehicles and creating a strong pedestrian environment. From an access management perspective boulevards need to be treated like Main Streets by restricting direct driveway access, requiring good pedestrian access and considering the use of on-street parking, and by permitting relatively frequent street intersections to intersecting streets.

Main Streets

"Main Street" is one of several terms which we have experimented with to describe the role regional principal arterial highways serve in centers and the broader urbanized area outside of centers. Other terms we have tried have included transit arterial, pedestrian friendly arterial and other principal arterial. Like strategic arterials, regional arterial highways serve high concentrations of motor vehicle trips. Unlike strategic arterials, these vehicle trips have shorter trip lengths, with a majority of trips having both trip ends located within the urbanized region.

Other principal arterials and minor arterials in urbanized areas should be designed to facilitate vehicular movement in a fashion that also supports other travel modes including public transit, walking and bicycling. These roads should be designed to serve and enhance abutting properties while maintaining highway capacity and safety. Reductions in travel speed are acceptable and often are desirable. Transit services are most likely to be operated on these roads. Although these roads should accommodate all travel modes throughout the urbanized area, in centers, where pedestrian activity is concentrated, these roads should be designed to encourage pedestrian mobility and activity.

In a large city center, there may be several parallel or intersecting “Main Streets”, creating a central business district. In a town center, there will usually be a “Main Street” located along a principal or minor arterial highway, with less intense activity spreading out along one or two intersecting streets. In villages, neighborhoods and hamlets only one street will usually provide the focus for business activity and community life, since the level of commercial activity is substantially reduced.

Collector Streets

In centers, collector streets serve a critical function in providing access to alleys and local streets where parking and loading facilities are situated, This is especially important for properties fronting on minor and principal arterial streets on which pedestrians circulation has priority and driveways are prohibited. Collector streets also provide access to surrounding residential neighborhoods and link developments within the center. On street parking on collector streets is both desirable and should be anticipated. This parking augments short-time parking being provided along arterial streets, and often can provide for intermediate parking duration.

Pedestrians use collector streets in centers much the way motor vehicles use them. They are important in getting between development areas, or between parking or terminal facilities and destinations, but they are not the prime pedestrian streets where the highest density of trip ends should be focused. Pedestrians need to be accommodated, but don’t require enhancements other than street trees, good lighting and good sidewalks.

Local Streets

A local road primarily serves the function of providing access to abutting property. Speeds are low and turning movements are expected. Most local streets consist of residential streets since residential land use consumes the majority of land in urbanized areas.

Local streets are essential for access to residential areas and to provide access to parking and loading facilities for commercial properties. Pedestrian activity will not be concentrated on local streets here but will occur regularly and must be accommodated. Pedestrian vehicle conflicts should be managed.

Traffic calming should occur naturally on local streets. If not, implementation of traffic calming measures should be considered. In particular, traffic calming may become necessary to control through traffic that seeks to divert through residential neighborhoods to avoid congestion elsewhere.

In centers, where lots are small, alleys, courts or other methods of concentrating access to parking and loading facilities may be warranted. Alleys can be especially valuable parallel to “Main Streets” to facilitate the provision of truck access to commercial properties. Some cities have utilized alley systems as a means of extending the pedestrian grid as well.

Access Management and Centers

On the highway system as a whole, access management regulations are primarily oriented at controlling access to and from arterial roadways, which should primarily serve mobility functions. Access management supports the concept of an hierarchical approach to roadways, and encourages motor vehicle functions to occur on collector and local streets so that the integrity of arterial highways can be protected.

Access management in centers should similarly support the concept of an hierarchical approach to roadways, and should be designed to encourage motor vehicles to gain access to property via collector and local streets. “Main Streets” serve the major shopping and commerce corridors in a center, regardless of the size of the center. These streets, where the mix of land uses are concentrated and in close proximity to one another, produce high levels of both pedestrian activity and motor vehicle traffic. Remarkably many of the same access regulatory tools required to protect the functional integrity of arterial highways are also required to protect the functional integrity of "Main Streets". Access management and the restriction of direct driveway access is required both to control the intense vehicle trip making that occurs in centers, including high volumes of turning movements, and the intense pedestrian activity in centers. Controlling driveways can also substantially increase the supply of on-street parking.

Prohibit Direct Driveway Access on "Main Streets"

Access management regulations should classify those roads within a downtown that will serve a "Main Street" function and prohibit direct driveway access onto these roads. Instead, access to property for motor vehicles should occur via alternative access, including rear parking lots and loading bays, on street parking where permitted, and off-site parking arrangements.

Because of the tight grid of streets in a center, alternative access is usually available to businesses in a center. Where it is not available, property owners should be encouraged to identify appropriate methods of managing their access requirements so that direct driveway access is not required.

Pedestrian access to buildings

Pedestrians should be encouraged to access buildings on "Main Streets" from the Main Street and not from rear doors. Frequently retail activity in centers can be enhanced through the use of off-site parking arrangements for office buildings. The use of these off-site facilities requires pedestrians to walk through the one or several blocks on a regular basis when traveling between their personal cars and their jobs. This added pedestrian activity increases the amount of foot traffic passing businesses in the center, and it adds to the concentration of pedestrians on sidewalks, the most important method of enhancing the sense of security within a center.

Pedestrian continuity

Pedestrian continuity is a critical objective along "Main Streets". Pedestrian continuity refers to protecting and enhancing the movement of pedestrians. Pedestrian movement is enhanced when interruptions to pedestrian flow by motor vehicles are controlled. As a result, direct driveway access should usually be prohibited to properties on "Main Streets", with all access provided instead via alternative access.

Street intersections on the other hand should be closely spaced, so that pedestrians can conveniently reach other destinations within the grid of downtown streets. Blocks in centers should be between 100 and 250 meters (330 and 820 ft) in length. When blocks are shorter than 100 meters, frequent street intersections interrupt pedestrian and vehicle flows too much. With blocks longer than 250 meters, circuitous travel patterns for pedestrians begin to become onerous. When blocks are longer than approximately 200 meters (660 ft), mid-block pedestrian linkages should be considered to connect pedestrians to adjoining blocks.

Pedestrian continuity also refers to promoting the interest and pleasure of the pedestrian environment. Urban designers strongly encourage retail activity to be concentrated on the principal pedestrian streets of a center. Even a few holes or gaps in the street wall, the presence of uninteresting buildings or buildings that turn their back to the street, will substantially reduce the quality of the street environment. Provision of pedestrian attractions in these spaces -- benches, plantings, food vendors or holiday displays – can sometimes help to fill the gap. However, there is little that can be done to fill the gap created by an automobile or trucking oriented activity such as a gas station, parking lot or large loading bay. These activities should be prohibited on “Main Streets” so that pedestrian continuity can be encouraged.

Of course, as is true with access management generally, the prohibition of direct driveway access and the control of automobile oriented land uses on “Main Streets” requires that other streets be available to serve these functions. As with all access management programs, a hierarchy of streets are essential in a center, and facilities that can conveniently serve utilitarian and automobile oriented functions must be provided. Elizabeth Plater-Zyberg has referred to this and defining Class A, Class B and Class C streets based on the degree to which the streets are managed to serve pedestrian or vehicle access functions.

Street Widths

Narrow street widths can help to encourage pedestrian crossing of streets and can also be used to slow motor vehicle travel to make centers more pedestrian-friendly. A total reduction in street width from building wall to building wall will make buildings on opposite sides of the same street closer, encouraging pedestrians to move from one side of the street to the other. Narrower curb-to-curb widths of streets will encourage slower vehicle operating speeds. Moving curb lines in to increase pedestrian space will provide more room for pedestrian amenities such as street trees, benches, etc. and permit use of wider sidewalks. Use of curb neckdowns at mid-block locations and curb bulbouts at intersections are other methods that can be used to reduce the effective width of streets for pedestrians.

Building Setbacks

Because of the importance of maintaining a street wall along a “Main Street”, local governments should be encouraged to adopt zoning regulations that require buildings to front either directly on the right-of-way line or a prescribed minimal distance back of the right-of-way line. (A small front yard area can be valuable in permitting the establishment of outdoor eating and merchandising areas.) Use of front yards for vehicle storage, including parking, should be prohibited.

Sidewalks

Relatively wide sidewalk areas should be provided within centers. In addition, local governments should establish regulations assuring that a clear width will be available to serve anticipated pedestrian flows. Usually a minimum clear width of two meters (6.6 ft) is required to assure pedestrian movement, and a clear width of 2.5 meters (8.2 ft) is desirable. A total sidewalk area of 3 to 6 meters (10-20 feet) can accommodate other sidewalk features such as street trees, light posts, newspaper machines and phone booths, etc.

Doorways to buildings should be designed to assure that pedestrians entering onto the sidewalk area will have time to merge into the flow of pedestrians on the sidewalk.

Signalization and Signal Spacing

Many street intersections in city centers will be signalized. With shorter signal cycles and slower operating speeds, signal spacing distances of 800 to 1,000 feet can often be introduced, at least for a short distance. However, because of the close proximity of street intersections in larger centers, one way traffic patterns are often required to facilitate progression. One-way streets can also help to minimize the total right-of-way width of a street.

In town and neighborhood centers, only the most important intersections will warrant signalization. Signals will usually be more widely spaced than in cities. In hamlets and village centers there may be only a single signalized intersection or none at all. Because of the absence of signals, other traffic engineering and roadway engineering techniques may need to be employed to assure low vehicle speeds.

Wherever signals are provided in centers, they should be managed to limit disruptions to pedestrian flow. In general, short signal cycles with only two phase operation should be encouraged over long signal cycles with multiple phases. Pedestrians will benefit most with pretimed signals rather than activated signals. Many pedestrians, including traffic engineers, fail to use push buttons to activate pedestrian signal phases. Short frequent signal crossing opportunities providing adequate crossing time for pedestrians minimizes pedestrian waiting times and usually also provide maximum vehicular capacity in a low speed center environment.

Traffic Calming

Traffic calming measures to assure low operating speeds on "Main Streets" may be needed. Techniques must be sensitive to the high volume of traffic on "Main Streets" as well as the presence of substantial numbers of trucks, buses and bicycles. As a result, the use of speed humps or raised intersections should only be used where determined essential in managing speed or protecting pedestrians. Where employed, long ramps with small vertical curves should be used in lieu of ramps utilizing intersecting vertical tangents.

Traffic calming on these arterial streets frequently is better served through such psychological devices as narrower lanes, changed paving materials and aesthetic improvements that clearly establish an urban texture to the roadway. In addition, horizontal deflections through the use of circles or medians can help to control speed at critical locations.

The use of traffic calming measures to slow traffic speeds is usually most critical in neighborhood centers, villages and hamlets where the physical size of the center is small. Motorists need physical messages that they are arriving in a center and that slower speeds are required. Speed limit signs are seldom adequate by themselves. The use of gateways near the boundaries of a center and more substantial controls within the center, as described above, can be effective in assuring motorist respect.

Aesthetic Character

The aesthetic quality of highways as they pass through centers deserves extensive attention. Street trees, street hardware, paving materials, ornamental lighting and signage should all be designed to create an urbane environment that will provide definition and presence for the center. Maintenance of these facilities is just as critical as their provision. Residents and business tenants should be encouraged to feel that they have ownership in this public street environment. The level of aesthetic improvements provided should relate to the intensity of the land uses.

Summary of Access Management Measures for Centers

- Establish a hierarchy of streets within the center and classify streets according to their access function

- Limit interruptions to pedestrian continuity by motor vehicles on "Main Streets"

- Prohibit direct motor vehicle driveway entrances on "Main Streets"

- Prohibit motor vehicle oriented functions and land uses on “Main Streets”
- Provide vehicular access via intersecting collector and local streets
- Authorize the use of off-site parking and loading facilities
- Authorize and manage the use of on-street parking
- Locate motor vehicle oriented land uses on collector streets or on streets outside of the center
- Manage “Main Streets” to encourage pedestrian circulation
- Require buildings to have main pedestrian entrance on “Main Street”
- Encourage block lengths of between 100 and 250 meters in length (330 – 820 ft)
- Consider pedestrian linkages when block lengths are longer than 200 m (660 ft).
- Facilitate pedestrian street crossings
- Provide mid-block crossings with neckdowns
- Provide curb bulbouts at intersections
- Establish zero or short setback requirements for buildings on “Main Streets”
- Minimize pedestrian delays at signals – use short signal cycles and two phase signals
- In hamlets, villages and neighborhood centers where signals may not be warranted employ other measures to assure appropriate vehicle operating speeds
- Freeways, expressways and strategic arterial highways should not be located within centers, but instead provide convenient access to centers
- When a multi-lane strategic highway must pass through a center, consider creating a boulevard with land uses and signal spacing managed similar to a “Main Street”
- Two lane highways passing through centers should be managed as “Main Streets”

Ten Ways to Manage Roadway Access in Your Community

Kristine Williams, CUTR

Costly improvements are not always the solution to safety and congestion problems. Roads, like other resources, also need to be carefully managed. Corridor access management strategies extend the useful life of roads at little or no cost to taxpayers. Following are ten ways that you can make the most out of your transportation system.

(1) Lay the foundation for access management in your local comprehensive plan.

To assure that your roadways are managed properly ,your comprehensive plan needs to address certain key issues. *First,* include goals, objectives, and policies related to access management in the plan. Tailor policy statements to advance the access management principles in this brochure. For example, a policy could be adopted promoting interconnection of adjacent developments along major roadways.

Second, make sure that your local transportation plan classifies roadways according to function and desired level of access control. This hierarchy of roadways is reinforced through roadway design and access standards in your land development code. For example, arterials require a much higher level of access control and different design standards than collectors or local streets. Some roadways require special attention because of their importance, the need for additional right-of -way, or due to significant access problems. These areas may be designated f or special treatment in the comprehensive plan.

Third provide for a greater variety of street types with varying design standards. Options could include access lanes, alleys, variations in on-street parking, and so on. This reduces development costs, promotes compact development, increases opportunities to interconnect streets, and helps save your major thoroughfare system. Many communities have only a few residential street design options that apply whether a subdivision has 8 homes or 80. Lack of design flexibility impedes in fill development and results in a monotonous street layout. it can also cause a proliferation of substandard and inadequately maintained private streets.

(2) Restrict the number of driveways per lot.

Establish a basic requirement that driveways are limited to one per parcel, with special conditions for additional driveways. Lots with larger frontages, or those with needs for separate right and left-turn entrances, could be permitted more than one driveway, in accordance with driveway spacing standards. Limitations on new driveways may be established using a 'corridor overlay' approach, which adds new requirements onto the underlying zoning (see Figure l).It is necessary to first identify and map the boundaries of all existing lots and parcels along the corridor. Then you could assign one driveway to each mapped parcel by right. This land may be further subdivided, but all new lots would need to obtain access from the existing access point.

(3) Locate driveways away from intersections.

Setting driveways and connections back from intersections reduces the number of confIicts and provides more time and space for vehicles to turn or merge safely across lanes. This spacing between intersections and driveways is known as corner clearance. Adequate corner clearance can also be assured by establishing a larger minimum lot size f or corner lots. You could impose conditional use limitations where ad-equate corner

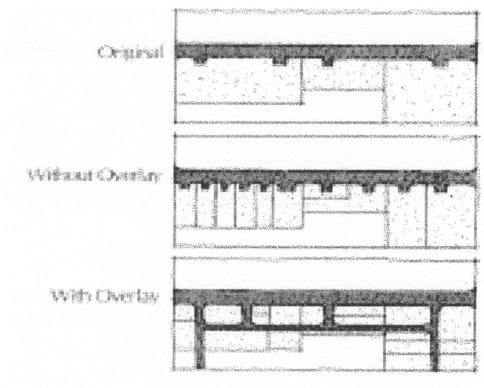


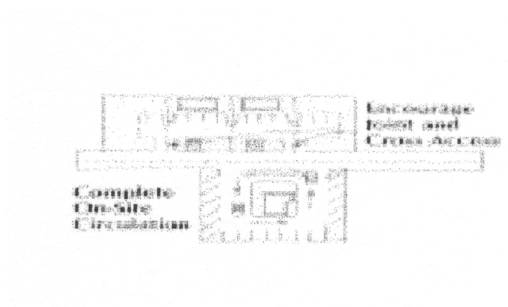
Figure 1. Corridor overlay

Figure 2. Inadequate corner clearance.

clearance cannot be obtained. This helps as-sure that corner properties do not experience access problems as traffic volumes grow.

(4) Connect parking lots and consolidate driveways.

Internal connections between neighboring properties allow vehicles to circulate between businesses without having to re-enter the major roadway (see Figures 3 and 4). Joint and cross access requirements in your land development code can help to assure connections between major developments, as well as between smaller businesses along a corridor.



F,ig.ure 3. Joint and cross access

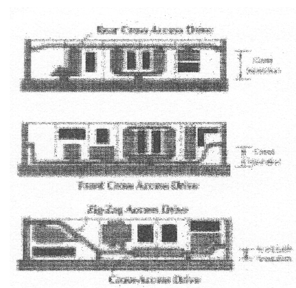


Figure 4. Cross access

Cross access also needs to be provided for pedestrians. Sidewalks are typically placed far away from buildings on the right-of -way of major roadways, or are not provided at all. Pedestrians prefer the shortest distance between two points and will walk if walkways are provided near buildings. Joint and cross access strategies help to relieve demand on major roadways f or short trips, thereby helping preserve roadway capacity. They also help to improve customer convenience, emergency access, and access f or delivery vehicles.

(5) Provide residential access through neighborhood streets.

Residential driveways on major roadways result in dangerous conflicts between high-speed traffic and residents entering and exiting their driveway. As the number of driveways increase, the roadway is gradually transformed into a high speed version of a local residential street. Subdivisions should always be designed so that lots fronting on major roadways have internal access from a residential street or lane (also known as 'reverse frontage'-see Figures 5 and 6). Minor land division activity can be managed by establishing a restriction on new access points and allowing land to be further subdivided, provided all new lots obtain access via the permitted access point. A variation of this approach is to allow lot splits on major roadways only where access is consolidated. Another step is to prohibit 'flag lots' along major thoroughfares. Some property owners subdivide their land into lots shaped like flags to avoid the cost of platting and providing a road. Instead, the

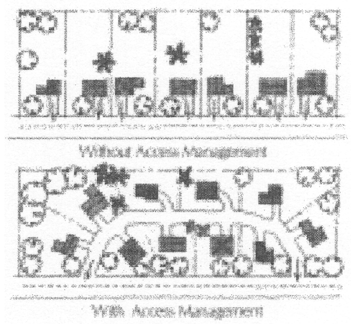


Figure 5. Shared Access

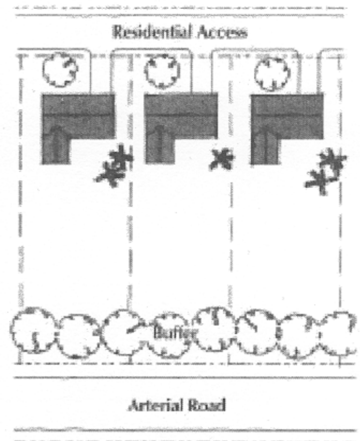


Figure 6. Reverse Frontage

Instead, the f lag lots are stacked on top of each other, with the 'f lag poles' serving as driveways to major roads (see Figure 7). This results in closely spaced driveways that undermine the safety and efficiency of the highway. Eventually, residents may petition for construction of a local public road passing the cost of providing a subdivision road onto the community.

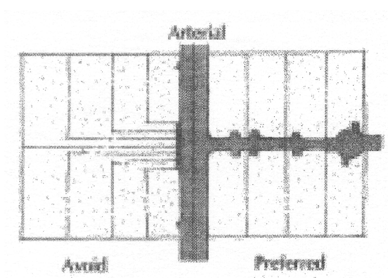


Figure 7. Avoid flag lots

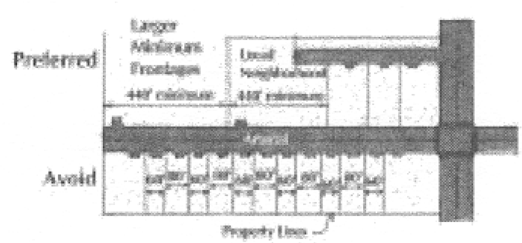


Figure 8. Lot frontage requirements

(6) Increase minimum lot frontage on major roads.

Minimum lot frontages need to be larger for lots that front on major roadways, than those fronting on local roads. Narrow lots are a problem on major roads because they result in closely spaced driveways. Lots need to be deeper and wider along arterials to allow adequate flexibility in site design and to increase separation of access points (see Figure 8). Assuring an adequate lot size also protects the development potential and market value of corridor properties.

(7) Promote a connected street system.

As communities grow and land is subdivided for development, it is essential to assure continuation and extension of the existing local street system. Dead end streets, cul-de-sacs, and gated communities force more traffic onto collectors and arterials. Fragmented street systems also impede emergency access and increase the number and length of automobile trips. A connected road network advances the f ollowing growth management objectives:

- fewer vehicle miles traveled
- decreased congestion
- alternative routes for short, local trips
- improved accessibility of developed areas
- facilitation of walking, bicycling, and use of transit
- reduced demand on major thoroughfares
- more environmentally sensitive layout of streets and lots
- interconnected neighborhoods foster a sense of community
- safer school bus routes

Connectivity can be enhanced by a) allowing shorter blocks (600 ft.) and excluding cul-de-sacs from the definition of intersection; b) requiring stub streets to serve adjacent undeveloped properties; c) requiring street connections to nearby activity centers; d) requiring connections to or continuation of existing or approved public streets; and e) requiring bicycle/pedestrian access-ways at the end of cul-de-sacs or between residential areas and parks, schools, shopping areas or other activity centers. It *is* also important to allow a greater variety of street types.

(8) Encourage internal access to out parcels.

Shopping center developments often include separate lots or 'outparcels' fronting on the major roadway. The outparcels are leased or sold *to* businesses looking for highly valued corridor locations. Access to these outparcels should be incorporated into the access and circulation system of the principal retail center. This reduces the need f or separate driveways on the major road, while maintaining overall accessibility to the site. To accomplish this, establish that development sites under the some ownership or those consolidated for development will be treated as one site for the purposes of access management. Then require a unified traffic circulation and access plan for the overall development site.

(9) Regulate the location spacing and design of driveways.

Driveway spacing standards establish the minimum distance between driveways along major thoroughfares (see Figure 9). These standards help to reduce the potential for collisions, as travelers enter or exit the roadway. They also encourage the sharing of access for smaller parcels, and can improve community character by reducing the number of driveways and providing more area for pedestrians and landscaping. The location of driveways affects the ability of drivers to safely enter and exit a site. If driveways do not provide adequate sight distance, exiting vehicles may be unable to see oncoming traffic. In turn, motorists on the roadway may not have adequate time to avoid a crash. Driveway design standards assure that driveways have an adequate design so vehicles can easily turn onto the site. Standards also need to address the depth of the driveway area. Where driveways are too shallow, vehicles are sometimes obstructed from entering the site causing others behind them to wait in through lanes. This blocks traffic and increases the potential for rearend collisions.

(10) Coordinate with the Department of Transportation.

Adopt minimum spacing standards for driveways

Reinforce with minimum lot frontage and joint access requirements

The Florida Department of Transportation is responsible for access permits along state roadways. Local governments oversee land use, subdivision, and site design decisions that effect access needs. Therefore, State and local coordination is essential to effective access management. Lack of coordination can undermine the effectiveness of regulatory programs and cause unnecessary frustration for permit applicants.

Timely communication is key to an effective review procedure. Begin by establishing a coordinated process for review of access permits along state highways. The state permitting official could have applicants send a copy of the complete permit application to the designated local reviewing official. Prior to any decision or recommendation, the state permitting official could then discuss the application with the local reviewing official.

Property owners also may be required to submit the necessary certificates of approval from other affected regulatory agencies, before a building permit is issued. In Florida, this should include a "notice of intent to permit" from the Florida Department of Transportation where access to the state highway system is requested. An effective method of coordinating review and approval between developers and various government agencies is through a tiered process. The first stage is an informal meeting and 'concept review" period, which allows officials to advise the developer about information needed to process a development application. This includes information on required state and local permits, and any special considerations for the development site.

The concept review provides the developer with early feedback on a proposal, before the preliminary plot or site plan has been drafted, Once the preliminary plan is drafted, it can be checked to determine if additional conditions are required for approval. The f inal plan that is formally submitted should then require only an administrative review.

Local governments could also request a response from the FDOT prior to approval of plats on the state highway system. Applicants could be required to send a copy of the subdivision application to the state access permitting official. This should occur early in the plat review process, preferably during conceptual review. Early monitoring of platting activity would allow the Department of Transportation an opportunity to identify problems and work on acceptable alternatives.

Intergovernmental agreements or resolutions can facilitate coordination between the state and local governments on access management. These tools can be used to clarify the purpose and intent of managing access along major thoroughfares, roadways that will receive special attention, and state and local responsibilities for advancing access management objectives.

Additional References

"Model Land Development Regulations that Support Access Management," Center for Urban Transportation Research, 1994.

Williams, K., Marshall, M. "Managing Corridor Development," Center for Urban Transportation Research, 1996.

Williams, K., Forrester, R., 'NCHRP Synthesis 233; Land Development Regulations that Promote Access Management." Transportation Research Board, Washington, D.C.: National Academy Press, 1996.

Training Opportunities

"Access Management: Site Planning," FC)OT 1997 (A Training Unit), available through Gary Sokolow.

'Land Development Regulations that Support Access Management,'FBOT 1997 (A Training Unit), available through Gary Sokolow.

Visit our Web Page at:

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Session 3

Interchange Management And Planning

Moderator: Dane Ismart, Louis Berger and Associates

Participants: Bob Krzeminski, Florida Department of Transportation
Robert Layton, Oregon State University
Herbert Levinson, Consultant

Access Management Approval of New Interchanges and Interchange Modification

Robert J. Krzeminski, P.E., Florida Department of Transportation

The management of access to our freeways through the approval of new interchanges or modifications to existing interchanges is critical their operation and safety because:

- it is almost impossible to close an interchange
- the need is often created by development resulting in additional traffic to the mainline
- a large number of short trips (one - two interchanges are often added)
- arterial access can “foul up” an interchange
- a new approved, but unbuilt interchange can become a property right
- State and Federal Policy is to limit new access

Three particular points of access must be fully considered in making the access approval decision. First, the access connection to the freeway must be considered. This involves a thorough analysis of the merge, diverge and weave movements for vehicles entering or leaving the freeway. Of critical importance is ensuring that departing traffic will not “back up onto the mainline lanes at exit ramps causing a safety problem. A thorough queue analysis is often necessary, in particular when considering peak hour traffic.

A second consideration is the access connection of the ramp terminals with the intersecting arterial. This intersection may be free flow or may be signalized. Signals up and down stream from the intersection often have to be considered in this analysis as signal timing may affect the ability of the exiting traffic to enter the arterial flow and not back up on the mainline. In addition, improper signal timing or other problems can cause entering traffic to create flow problems on the arterial, thus cutting down on its capacity.

A third consideration are the additional signalized intersections in the immediate vicinity of the interchange and the driveway and unsignalized median openings in the interchange area. Additional signalized intersections in the vicinity of the interchange can cause the intersections at the ramps to not unction properly unless signal timing is properly coordinated. Driveways and median openings often present weaving problems which could result in a safety problem.

To ensure proper consideration and analysis of proposals for new or modified interchanges the Florida Department of Transportation has developed and adopted the Interchange Request Development and Review Manual. This manual is on the CD give as part at this conference.

In summary new interchange access should only be approved where it is justified; improvements to existing interchanges should be fully considered before approving a new interchange; protection of the operation and safety of the limited access mainline is essential and any impacts must be mitigated and control of arterial access at the interchange is essential.

Access Management Approval of New Interchanges and Interchange Modifications

Presentation to the Third National Access Management Conference

By Robert J. Krzeminski, P.E.

Florida Department of Transportation
Systems Planning Office

Access Issues

- Impact of New or Modified Interchange
- Arterial Access in Vicinity of Interchange

Florida Department of Transportation
Systems Planning Office

Importance

- Almost impossible to close an existing interchange
- Need created by development--leading to more traffic/congestion
- Often used for "short" local trips
- Arterial access can "foul up" interchange
- Approved but not built interchange can become "property right"
- State and federal policy

Florida Department of Transportation
Systems Planning Office

Florida's Policy

- Minimize new access to protect operations / safety
- Protect Inter and Intra State movements
- Advance State Land Use Planning Goals and Policies
- Approved only when justified. Criteria includes :
  - Operational / Safety
  - Geometric
  - Spacing
  - Land use , Environmental, and Multi Modal Consideration

Florida Department of Transportation
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Interchange Request Development and Review Manual

- Two Volumes
  - Volume 1 - "How To"
  - Volume 2 - "Prototype" Reports

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Interchange Request Development and Review Manual

- Follows FHWA requirements *(8 Points)*
- Defines process / role and responsibilities
- Establishes standards
- Defines analysis techniques
- Establishes relationship to :
  - Master Plans
  - NEPA Studies

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Criteria

- Needed - Existing system *(interchanges)* cannot handle demand)
- Alternatives - Location/design, TSM options assessed and provided for
- Impact - No significant adverse impact on operation / safety
- Connection - To public road and accomodates all movements

Florida Department of Transportation
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Criteria

- Local Transportation Plans - Consistency required
- Multiple interchanges - Requires comprehensive network analysis
- Coordination - Development and system improvements considered
- NEPA Process - Information on status of environmental processing required

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Process

- Detailed methodology development
- Early involvement of approval authority
- Early on built-in "Stop Points"
- Sequential review / approval
- Exception identification / approval
- Coordination with Master Plans & NEPA

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Standards

- Ranges for traffic factors
- Spacing / Access Management
- Exception process

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Analysis Techniques

- Based on HCM and operational models
- Level of analysis based on complexity
- Criteria for more refined analysis defined

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Summary

- New access approved only where justified
- Improvements to existing interchanges preferred
- Protection of operation/ safety is essential
- Impacts to mainline must be mitigatated
- Control of arterial access at interchange is essential

Florida Department of Transportation
Systems Planning Office

PREFACE

The Florida Department of Transportation (FDOT) *Interchange Request Development and Review Manual (IRDRM*), Second Edition is published as a two-volume document. Volume I provides the user with detailed information regarding the processes, requirements and documentation criteria for an Interchange Proposal. Volume 2 provides the user with completed sample documents.

The *IRDRM*, Second Edition incorporates several basic changes from the original Manual. These changes include:

- incorporating policy and process updates,
- eliminating duplication,
- providing the Applicant with an easier to use document,
- providing criteria for non traffic demand justified interchanges, and
- providing a process for the development of System Access Modifications Reports(SAMR).

Volume one consists of eight units. Units 1, 2 and 3 provide the Applicant or reviewer with an overall understanding of the process and procedure to be followed for approval consideration. Units 4, 5 and 6 provide the specific technical analysis criteria that must be followed. Unit 7 provides a detailed checklist, cross referenced to other units, defining the sequence and specific process requirements. Unit 8 provides sample documents required in the process.

- Volume 1, Unit I-Summary provides a brief explanation of the Interchange Proposal approval requirements and the process to be followed for proposal consideration leading to an approval decision. This unit is designed to serve as a "pull out" for potential Applicants.

- Volume 1, Unit 2-General Procedures and Guidelines provides specific information regarding statutory authority, rules, policies, procedures and standards to be followed. The Applicant and review/approval agency roles and responsibilities, intergovernmental coordination and the relationship between the Interchange Proposal, the Master Plan and project development process is also provided.

- Volume 1, Unit 3--Request Development and Review Process provides detailed information on the process and technical procedures for preparing an Interchange Proposal for new access, an Interchange Justification Report (IJR) or for modified access, an Interchange Modification Report (IMR) to FIHS limited-access facilities.

- Volume 1, Unit 4--Alternatives details the process for initial identification and selection of network and land use alternatives for analysis in an Interchange Proposal.

- Volume 1, Unit 5-Technical Requirements provides the modeling, design traffic and operational procedures to perform the analysis required for determination and evaluation of viable alternatives during the development of an Interchange Proposal.

- Volume 1, Unit 6-Financial Feasibility provides the user with information regarding analysis requirements for determining the financial feasibility for the recommended technically viable alternatives.

- Volume 1, Unit 7--Checklist provides a checklist that is cross referenced to the appropriate units and sections of the IRDRM to assist in the preparation or review of an Interchange Proposal.

- Volume 1, Unit 8-Documentation Requirements provides descriptions and formats of how information required at each process stage should be documented.

- Volume 2-Sample Documents provides examples of typical documents required in the Interchange Proposal process.

The *IRDRM, Second Edition* will be maintained by FDOT's Systems Planning Office of the State Transportation Planner. The Manual will be made available to all Interchange Proposal preparers and reviewers.

The term "Applicant" appears throughout this Manual and refers to Applicants both internal and external to FDOT. In addition, the term "Interchange Proposal" refers to all proposals for either new access (Interchange Justification Reports) or modified access (Interchange Modification Reports) to limited-access facilities in the State of Florida.

Oregon's Policy and Handbook On Interchange Management

Robert Layton, Oregon State University

Background

This paper draws on a draft Interchange Management Policy that was prepared in 1989 by Oregon Department of Transportation. The primary focus of this paper is interchange management within the context of access management, it does not deal with all the interchange funding, approval, design and construction issues necessary for planning and design of future interchanges.

Purpose

The purpose of this paper is to provide direction for the planning, design and access management of interchanges, particularly where they connect to the crossroads. The guidelines and standards established will be employed in the review, evaluation and design of new interchanges, modifications to existing interchanges and cross road operation, design and access control.

Definitions

The following definitions are used in this policy:
Crossroad - the lower functional classification facility of the two facilities an interchange connects.
Expressway - a divided major roadway for through traffic with partial control of access and generally with interchanges at major crossroads.
Freeway - an expressway with full control of access. Full control of access means that the authority to control access is exercised to give preference to through traffic by providing access connections with selected public roads only and by prohibiting crossings at grade or direct private driveway connections.

Interchange - a system on interconnecting roadways in conjunction with one or more grade separations that provides for the movement of traffic between two or more roadways or highways on different levels.

Interchange management area - the area defined by a distance along the mainline and crossroads in all directions extending beyond the end of the interchange ramp terminal intersections or ramp or speed change lane tapers.

> For crossroads it is the crossroad on both sides of the interchange to the nearest intersection with a public street. The distance on either side should not be less than 1,320 ft. and generally not more than 2,640 ft.
>
> For non-freeway mainlines in either direction it is the shortest distance to: the nearest interchange; 1320 ft. from the beginning or end of speed change lanes; or the nearest public road intersection. For freeway mainlines, it is the distance to the ramp or speed change lane tapers of the next interchange in either direction.

Mainline - the higher functional classification facility of the two facilities the interchange connects.

Management Strategies

Interchange plans are part of the long-term transportation system planning effort and must have effective strategies for 20-30 years in the future. They also need to consider potential need for transit, and park and 6de facilities. Management strategies can use transportation system operations/control, land use, and circulation elements to achieve the intent of the interchange operation priorities. These include:

A. **Traffic Controls** . Traffic controls that may be considered as part of management strategies include: signal phasing, intersection channelization, turn restrictions, traffic queue detection, traffic signal interconnection, and ramp metering.

   1. Traffic signals on the cross street should be interconnected and operated to assign vehicle right of way with priority placed on moving traffic off the main highway or freeway and away from the interchange area, consistent with safety considerations.

   2. Improvements may be needed to supplement the physical capacity of conflicting, yet important traffic movements through the interchange on the local facility or from the local facility to the main highway. This may require the restriction of access to properties within the interchange area or the separation of local and interchange access traffic through the construction of circulation/distribution systems discussed below.

   3. Ramp metering may be necessary to ensure efficient operation on the main highway by reducing merge conflicts, eliminating the platooning effect created by ramp terminal signalization, and reducing short distance travel on the freeway where the available capacity is limited. Operations and access on the crossroad may be affected by queue spillback from the ramp metering location.

B. **Access Control** . Access to the cross street must be controlled a sufficient distance on either side of the ramp connections to reduce conflicts and protect the ramp operations. Control may include spacing of public and private access points to the crossroad facility, and the use of a physical median barrier. Distances are provided in Attachments A and B.

   The distance to the first signalized intersection should be at least 1320 ft.(1/4 mi.) beyond a ramp intersection or a free flow ramp terminal, as shown in Attachments A and B.

C. **Circulation/Distribution System** . Development of a system of streets around the interchange shall be encouraged to circulate and distribute traffic to land uses in the area with a minimal impact on the mainline and crossroad. This system should be designed to direct traffic returning to the interchange to a signalized or full intersection at least 1320 ft. (1/4 mi.) from the ramp intersections.

D. **Land Use Controls** . The comprehensive plan and zoning designations should acknowledge the function and role of the interchange and the spacing standards. Future right of way needs should also be included in the comprehensive plan.

E. Protective Buying and Sale of Excess Property

1. Strategies should be developed to insure property necessary for future expansion of the interchange is available and at the least relative cost. The strategies must be compatible with pertinent federal and state requirements.

2. When feasible, protective buying should be done if it is deemed more cost effective than alternatives or found to be more cost effective than buying the property in the future.

F. Grade Separated Crossings . Grade separated crossings, without ramps, may be used to:

2. Keep low volume intersecting roadways open for effective service.

3. Avoid having interchanges too close to each other.

4. Connect to existing or planned local connectors.

5. Provide crossing corridors that relieve traffic demand on crossings at interchanges.

G Balanced Interchange Design with Ultimate Mainline Facility . The interchange design must be consistent with the plan for the mainline as expressed in the corridor plan, taking account of:

1. Level of service (LOS) operating standards in the LOI policy.

2. The selection of mainline and other interchanges that would be affected by the interchange over the planning period.

3 Future improvements in corridor plan: number of travel lanes, auxiliary lanes, high occupancy vehicles (HOV) lanes, exclusive transitways, modifications to existing interchanges, and planned new interchanges.

4 Projected LOS considering planned facilities, projected mainline traffic volumes, traffic generated by build-out of the interchange vicinity,anticipated changes in local travel resulting from the installation of a new interchange.

3. Planned surface street improvements that would relieve the freeway.

The interchange shall not be constructed or improved unless necessary supporting improvements identified in the corridor plan are inplace or firmly committed to construction when needed.

H. Relieve Off-Ramps

8. Design, operation and management of the interchange shall give primary emphasis to off-ramp movements so traffic does not back up onto the freeway.

9. Consideration must be made for handling special events which may exceed what otherwise may be suitable design hour conditions, i.e., fairs and sporting events. Location and design of access facilities to special event land uses must take account of the potential queuing, increased delays and safety impacts, and may require larger than typical spacing standards.

I. Frontage Road Relocation/Closure

1. Frontage roads which are closer than the spacing standards for access to cross streets shall be either relocated or closed. Where feasible, local streets should be planned and built to provide for adequate access to adjacent property without interfering with the operation off the interchange ramps.

J. Closure of Interchange or Ramps

1. Certain ramps of the existing interchange or the entire interchange maybe removed when the existing interchange is substandard or where better interchange facilities are already or can be developed in the area. To serve the area formerly served by the interchange, connecting roads will be provided to adjacent interchange facilities.

K. Local Street System

1. Interchanges shall connect to an adequate arterial street system with the necessary frontage roads, cross streets, channelization, access control, etc. In most cases the cross road should be a major or minor arterial. The connecting road design shall meet all applicable design standards.

2. The cross streets at interchanges should meet the following requirements:

    a. The cross street must have sufficient capacity in either direction for a distance of 2,640 ft. (1/2 mi.) from the end of the interchange ramp or speed change lane tapers at level of service"C" in rural areas and "D" in urban areas. This is to assure the cross street is able to carry all the traffic that the interchange will present to it and insure adequate traffic movement away from the interchange facility.

    b. The cross streets shall serve a reasonably large area, not just the area immediately around the interchange. The cross streets shall serve at least a minor artedal function in the area street system.

    c. Except as provided below, no public or private access shall be allowed on the cross street for a distance of at least 660 ft. from a ramp intersection or ramp or speed change lane taper. Where distances are less than 660 ft., access points shall generally be confined to right turns in/out. This may require construction of a physical median barrier.

Multilane Cross Road Criteria

A. Spacing Between Ramp Terminal and Nearest Major Intersection

There are a number of factors and considerations that dictate the spacing to the nearest major intersection. These include the needed distance to accommodate the weaving maneuvers from free flow off-ramp onto the cross road facility to the left turn bay at the intersection. The weaving maneuvers must be completed by the time the end of the queue at the intersection is reached. Therefore, the spacing to the nearest major intersection is the weaving distance plus the queue length at the intersection. This distance is shown as distance Y on the left side of Attachment A. Figure I shows the results of analysis that evaluated the weaving distance and the queue length for urban, suburban and rural conditions. The conditions assumed for the analysis are shown below. The volumes are assumed to be typical of the area and volume labels.

Table 1. Typical Operating Conditions Assumed for Analysis

Area	Speed	Cycle	Yellow	# of Phases	Cross Road Volume, $\left(\frac{veh}{hr} / lane\right)$			Off-Ramp Volume (vph)
					High	Moderate	Low	
Urban	35 mph	120^s	3^s	4	1000	800	600	600
Suburban	45 mph	90^s	4^s	3	500	400	300	300
Rural	55 mph	60^s	5^s	2	300	200	100	100

The analysis of the weaving distance is based on the Weaving Method by Leisch, given in Figure 1. Table 2 summarizes the analysis of weaving distance. An assumption is made that 50% of the left turns at major the intersection is contributed by off-ramp traffic. The results are not very sensitive to this assumption because the weaving traffic includes all the cross road volume.

Table 2. Weaving Distances for Four Lane Cross Road with 10 and 20% Left Turns

Area	Volume Level	Cross Road Volume, vph/lane	Off Ramp Volume, vph	Weaving Volumes		Weaving Distance	
				10% LT	20% LT	10% LT	20% LT
Urban (35 mph)	High	800	600	1710	1820	900	920
	Moderate	700	500	1495	1590	790	830
	Low	600	400	1280	1360	660	710
Suburban (45 mph)	High	500	400	1070	1140	1300	1380
	Moderate	400	300	855	910	1030	1100
	Low	300	200	640	680	750	820
Rural (55 mph)	High	300	150	637	675	2100	2200
	Moderate	200	100	425	450	1350	1500
	Low	100	50	212	225	600	650

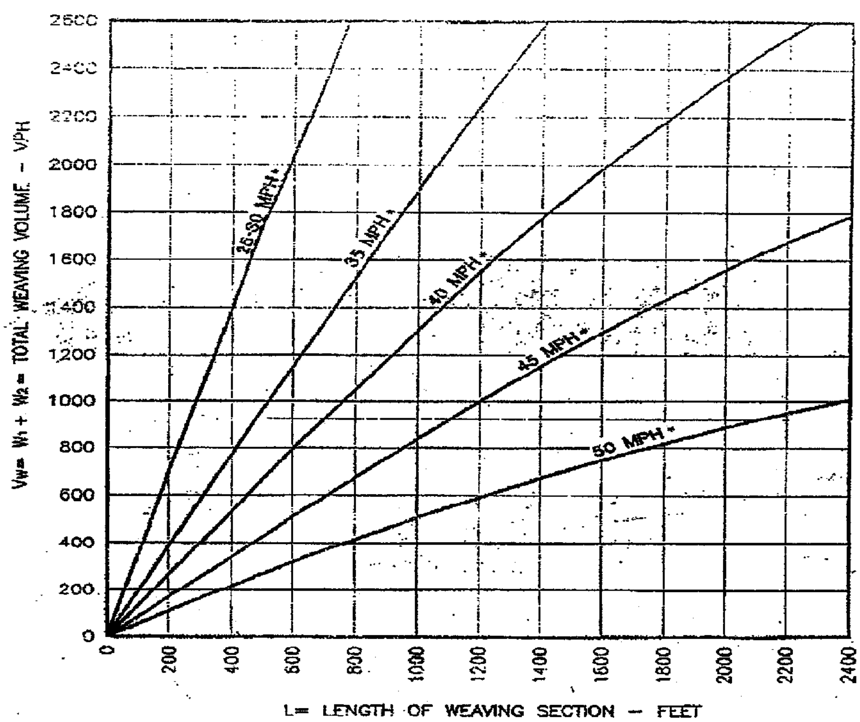


Figure 1. Analysis of Service Road Weaving Conditions
- adapted from "Procedure for Analysis and Design of Weaving Sections," FHWA Project DTFH51-82-C-00050 by Jack E. Leisch, 1982.

The queuing distance must also be taken into account to assure that vehicles have adequate distance to weave comfortably to the left before being trapped in the right lane by vehicles queuing back from the intersection. Otherwise, forced lane changes to avoid the queuing vehicles can result in both operations and safety problems.

This queuing distance can be determined using the deterministic queuing analysis approach by:

$$Q = pqt$$

where q = flow rate in vehicles/sec.

t = period of queuing, sec.

p = randomness factor

The randomness factor recognizes the peaking or randomness of vehicles arriving at a location. A factor of 1.5 is sometimes used with high volumes as might be seen on a major arterial, with a factor of 2 used at locations where a higher degree of randomness is expected. Oregon Department of Transportation has adopted a randomness factor of 2.

The time period, t, refers to the amount of time that the vehicles are arriving at the intersection, and are not being served, i.e., not receiving a green phase. For purposes of this analysis an unblocked condition is assumed for the phasing strategy, that is, the vehicles for the through phase can arrive and be served on a green phase. Therefore, the time period is the cycle length minus the green time:

$$t = cy - G$$

where t = time period for queuing per cycle

cy = cycle length, sec.

G = green time, sec.

It is also possible to estimate the amount of queuing based on the Poissin distribution, which is a statistical mathematical distribution used to describe the occurrence of rare, random events.

$$Pr(n, q/t) = \frac{e^{-qt(qt)\,a}}{n!}$$

where Pr (n,q/t) = probability of n vehicles arriving in time period, t, w ith volume of q

q = flow rate, veh/sec

t = time period, sec

n = number of vehicles in time period

This analysis is represented by Figure 2.

A comparison of the queue sizes determined for high volume shows that the use of the deterministic queuing method with a randomness factor can give very erroneous results. The randomness factor only gives acceptable results for very low volumes, as seen in Tables 3 and 4.

The queuing conditions estimated from the Poisson distribution yields the most realistic results. In fact, the deterministic method with the randomness factor is attempting toapproximate the results of the probabilistic based analysis using the Poisson distribution. Consequently, the queue sizes based on the Poisson distribution are used here.

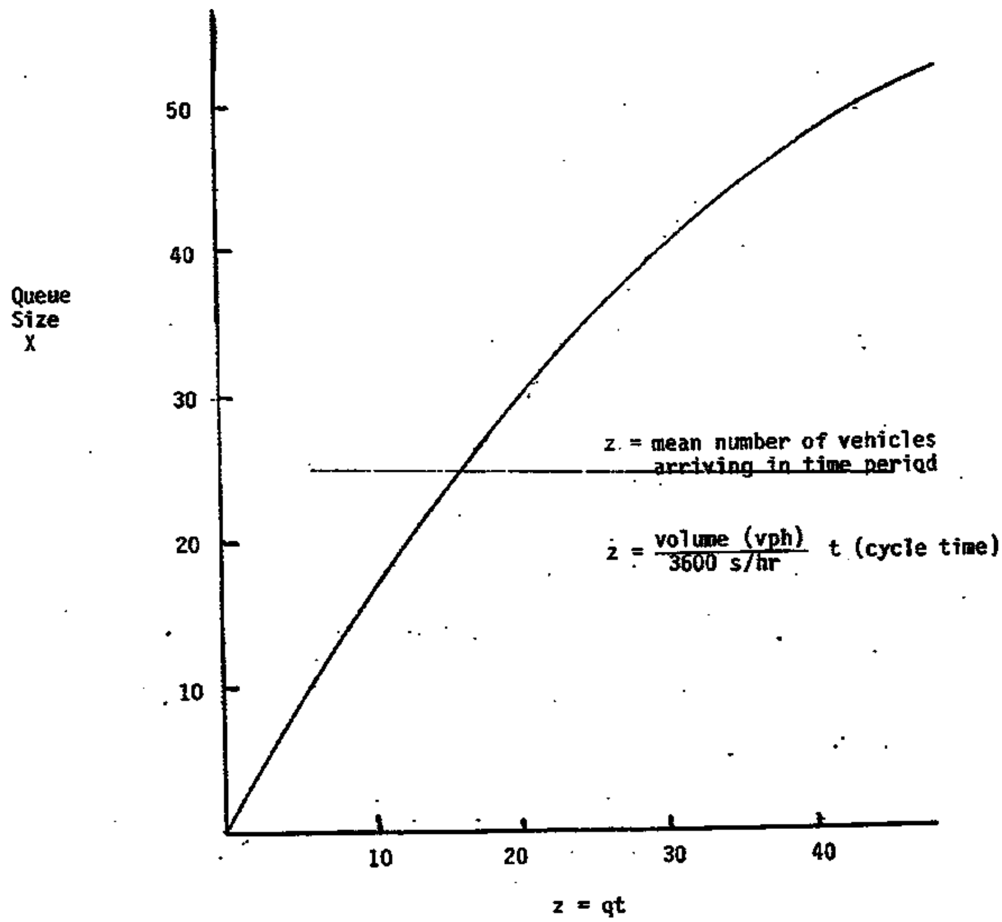


Figure 2. Queue Size Based on 95% Confidence Level Cumulative Poisson Probabilities

Table 3. Queue Sizes for Urban, Suburban and Rural Conditions by Deterministic Queuing and Probabilistic Poisson Analysis with 10% Left Turns

Area Type	Through Volume (2 lanes) vph	Typical Ramp (2 lanes) vph	Total Queuing Volume vph	Cycle sec	Through Green sec	Left Turn Green sec	Yellow sec	Phases >	t sec	Queue Size, veh			Queue Length ft
										1.5 qt	2.0 qt	Poisson	
Urban (35 mph)	1600	600	1980	120	60	13	3	4	60	25	33	25	625
	1400	500	1710	120	52	12	3	4	68	24	32	24	600
	1200	400	1440	120	44	11	3	4	76	23	31	23	575
Suburban (45 mph)	1000	400	1330	90	42	10	4	3	48	14	18	15	375
	800	300	1045	90	42	10	4	3	48	11	14	12	300
	600	200	760	90	42	10	4	3	48	8	10	9	225
Rural (55 mph)	600	150	713	60	25	■	5	2	35	5	7	7	175
	400	100	475	60	25	■	5	2	35	4	5	5	125
	200	50	238	60	25	■	5	2	35	2	3	3	75

Table 4. **Queue Sizes for Urban, Suburban and Rural Conditions by Deterministic Queuing and Probabilistic Poisson Analysis with 20% Left Turns**

Area Type	Through Volume (2 lanes) vph	Typical Ramp (2 lanes) vph	Total Queuing Volume vph	Cycle sec	Through Green sec	Left Turn Green sec	Yellow sec	Phases >	t sec	Queue Size, veh			Queue Length ft
										1.5 qt	2.0 qt	Poisson	
Urban (35 mph)	1600	600	1760	120	54	19	3	4	66	24	32	24	600
	1400	500	1520	120	46	18	3	4	74	24	32	24	600
	1200	400	1280	120	39	14	3	4	81	22	29	23	575
Suburban (45 mph)	1000	400	1260	90	35	17	4	3	55	15	20	16	400
	800	300	990	90	35	17	4	3	55	12	15	13	325
	600	200	720	90	35	17	4	3	55	9	11	10	250
Rural (55 mph)	600	150	676	60	25	■	5	2	35	5	7	6	150
	400	100	450	60	25	■	5	2	35	4	5	5	125
	200	50	225	60	25	■	5	2	35	2	3	3	75

The distances for weaving and queuing are combined to give the required spacings tothe next major intersection from a free flow off ramp terminal. These values are given inTable 5 and are then shown graphically in Figure 3.

Table 5. Queue Sizes for Ur ban, Suburban and Rural Conditions by Deterministic Queuing and Probabilistic Poisson Analysis with 10% Left Turns

Area Type	Volume Level	Weaving Distance		Queuing Distance		Spacing	
		10% LT	20% LT	10% LT	20% LT	10%	20%
Urban (35 mph)	High	900	970	625	600	1525	1570
	Moderate	790	830	600	600	1390	1430
	Low	660	710	575	575	1235	1285
Suburban (45 mph)	High	1300	1380	375	400	1675	1780
	Moderate	1030	1100	300	325	1330	1425
	Low	750	820	225	250	975	1045
Rural (55 mph)	High	2100	2200	175	150	2275	2350
	Moderate	1350	1500	125	125	1475	1625
	Low	600	650	75	75	675	725

The analysis were performed for both 10% and 20% left turn at the major intersection, and were not found to change the results significantly. A summary of the analysis is presented in Figure 1. As can be seen from that figure, a spacing of 1320 ft., or 1/4 mi.,is a minimum spacing for moderate volumes for urban, suburban and rural conditions and speeds. However, this only provides for low volume conditions, a spacing of 1/2 mi. would accommodate all conditions, or 2,000 ft. would handle all but high volume urban conditions.

The situation with a signalized intersection, as the off ramp terminal, also yields a minimum spacing to the major nearest intersection of 1320 ft. This is the minimum spacing that can be used, and still provide coordinated progression between the intersections. This is described in the discussion paper on Access Management Classification and Standards.

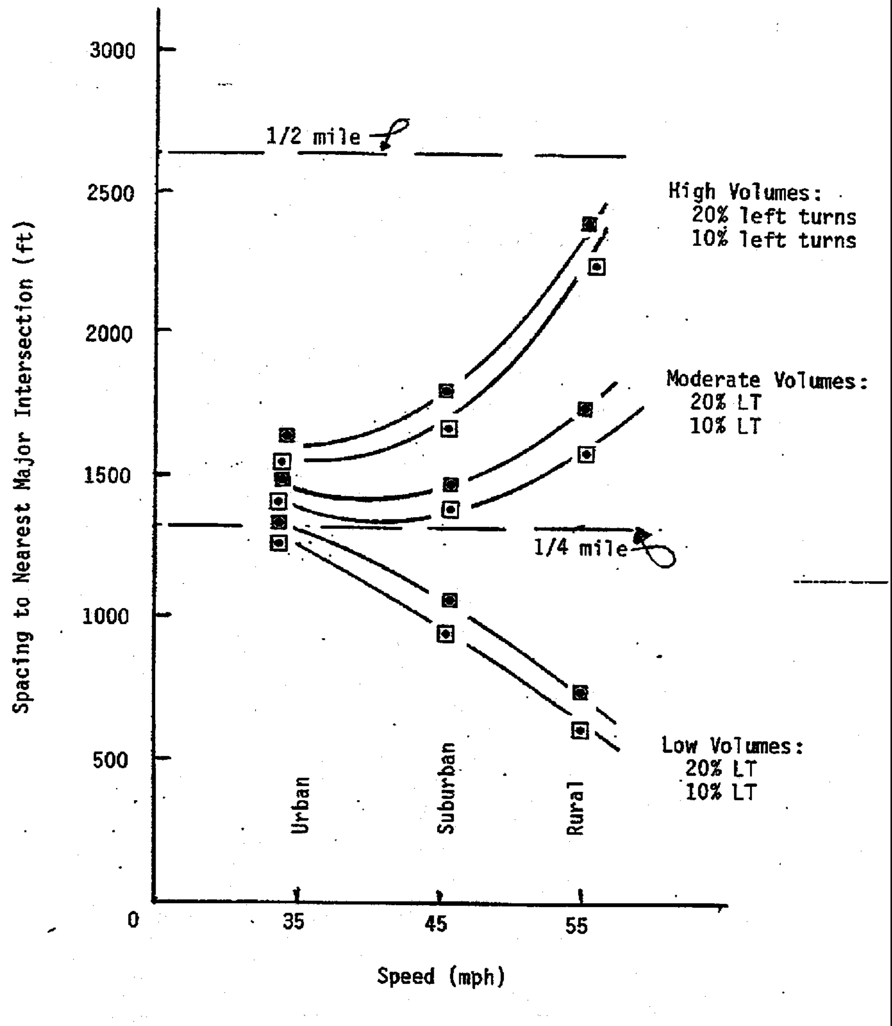


Figure 3. Spacing to Nearest Major Intersection from a Free Flow Off Ramp Terminal

B. Spacing to First Drive/Access from Off Ramp

1. *First Drive /Access on the Right from Off Ramp*. This is the distance from the ramp terminal to the first drive/access approach. This is shown as the distance "X" on Attachments A and B. The spacing to the first drive/access approach could be based on a number of operations or safety criteria. The three most logical criteria are presented in the following.
   a. Stopping Sight Distance. The stopping sight distance to the first or second access or drive may be used to determine the spacing to the first drive/access from the off ramp. Figure 4 demonstrates the logic behind the use of the stopping sight distance for the right turn conflict. With the single right turn conflict it is assumed that the driver must have enough distance once entering the roadway to see operations and vehicles at the next drive with enough distance to stop. The double right turn conflict assumes drivers are keeping track of conditions at two drives. With the driver arriving on the cross road from the off ramp or passing the ramp terminal, only the single right turn

conflict criteria, or desirable stopping sight distance to the first drive is logical. This is based on the desirable stopping sight distance from the 1990AASHTO Greenbook.

Table 6. Desirable Stopping Sight Distances

Area	Speed, mph	Sight Distance, ft
Urban	35	250
Suburban	45	400
Rural	55	550

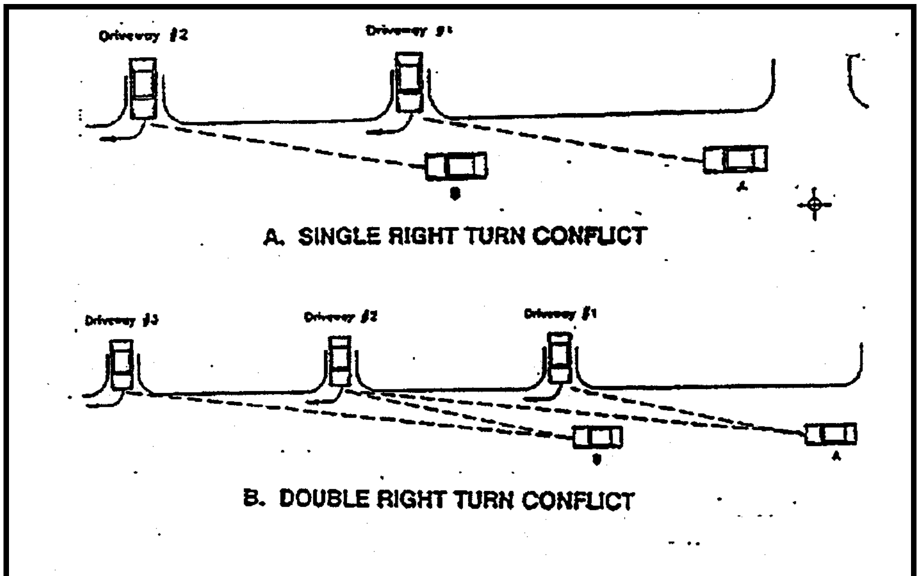


Figure 4. Schematic Illustration of the Right Turn Conflict Overlap

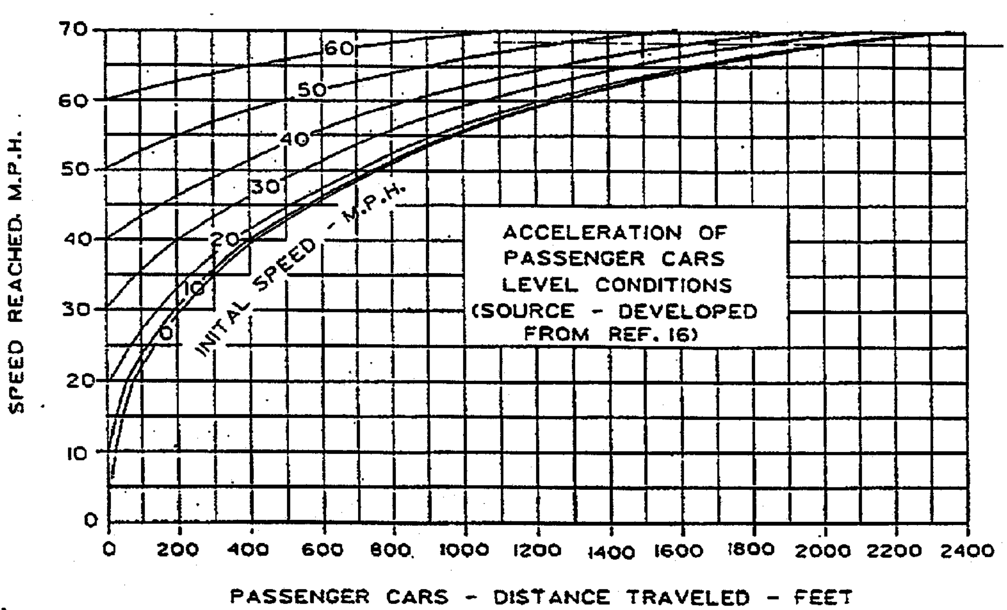


Figure 5. Acceleration of Passenger Cars on Level Terrain

b. Minimum Access Spacing to Maximum Egress Capacity. This criteria uses 1.5 times the distance to accelerate from 0 to through traffic speed, based on the acceleration data from the 1990 AASHTO Greenbook, p.749, shown in Figure 5. This criteria is based on research performed by Major and Buckley' which reported that driveways spaced at distances greater than 1.5 times the distance required to accelerate from zero to the speed of through traffic will reduce delay to vehicles entering the traffic stream and will improve the traffic absorption characteristics of the traffic stream. Spacings based on acceleration distances for passenger cars on level grades are given in Table 7.

Table 7. Minimum Access Spacing to Provide Maximum Egress Capacity

Area	Speed	1x Acceleration Distance	1.5x Acceleration
Urban	35 mph	300 ft.	450 ft.
Suburban	45 mph	575 ft.	860 ft.
Rural	55 mph	1000 ft.	1500 ft.

c. Decision Sight Distance Criteria. This criteria is based on the 1990 AASHTO Greenbook on decision sight distance. This provides the driver with adequate sight distance to perceive and react to unexpected, unusual,and/or complex conditions. The decision sight distance varies with the area character and the type of maneuver required to negotiate the location property. The maneuvers include (1) stopping on rural or urban roads and, (2) a speed, path, and/or direction change on urban, suburban or rural roads.

Table 8. Decision Sight Distance Criteria

Area	Speed	Stop	Speed/Path/Direction –
Urban	35 mph	620 ft.	710 ft.
Suburban	45 mph	640ft.	810 ft.
Rural	55 mph	590 ft.	870 ft.

Based on 1990 AASHTO Policy on Geometric Design

The operations on crossroads in the vicinity of on-ramps and off-ramps are complex and often unlike the operation throughout the rest of the road/street system. Drivers are exiting or entering a facility that is higher speed, access controlled and often divided. The entrances and exits are presented in many different configurations, therefore drivers must discern the appropriate entries or exits from other drives and approach facilities. This requires greater perception-reaction time to sort out the more complex situation. Further,

' I.T. Major and D.J. Buckley, "Entry to a Traffic Stream", Proceedings of the Australian Road Research Board, 1962.

driver's expectations on freeways and expressways are quite different than on surface streets and two lane roadways. The driver anticipates fewer distractions and access points along these roadways.

The spacing to the first drive or access road must take account of decision sight distance. A spacing of 660 ft. provides a distance slightly greater than the decision sight distance for stopping on both rural and urban roads. Decision sight distance provides an increase in perception-reaction time as the situation complexity increases, therefore, the perception-reaction time is longer for urban areas with the increased complexity of traffic operations and land use.

The braking distance is greater on higher speed rural facilities than urban. Consequently, the decision sight distances for stopping for both rural and urban facilities sums to about 660 ft. Also, this is half of 1320 ft.(1/4 mi.) which places the drive/access approach halfway between the ramp terminal and the nearest signalized intersection, or major intersection.

2. *First Median Opening from Off Ramp Terminal - Access to First Drive on Left.* The location of first median opening, or access to a left drive/access, from a free flow off ramp requires adequate distance for weaving maneuvers to be made. Based on typical volume conditions and vehicles emitting the intersection area for the various areas, the weaving distances are shown in Table 9, based on Figure 1.

Table 9. Minimum Weaving Distance to First Median Opening and First Drive/Access on Left

Area Type	Volume Level	Through Volume (2 lanes), vph	Typical Ramp Volume, vph	Total Weaving Volume, vph	Weaving Distance, ft
Urban (35 mph)	High	2000	800	2001	1050
	Moderate	1600	600	1601	830
	Low	1200	400	1201	620
Suburban (45 mph)	High	1000	400	1001	1200
	Moderate	800	300	801	950
	Low	600	200	601	700
Rural (55 mph)	High	600	150	601	2220
	Moderate	400	100	401	1250
	Low	200	50	201	520

The slowing of vehicles as they enter the turn bay or median opening impaction operations and safety. However, some of this effect is taken into account in the weaving operations. Desirably, the median opening will serve well as an area develops, perhaps from rural to suburban, and ultimately, urban. A distance of 1200 - 1250 could serve typical rural and suburban locations, up to high volume conditions. This is roughly 1/4mile, which fits well with other requirements of both intersection and median spacings.

3. **Spacing Between Nearest Access Drive and the On-ramp Terminal**

The primary concern in determining the location of the last access/drive before an on-ramp is the necessary decision sight distance for a speed, path or direction change in a complex situation. Since the access/drive interrupts the drivers attention, the drive should be placed at least a distance equal to the decision sight for the type of area upstream of the taper to the on-ramp. These are shown in Table 10.

Table 10. Decision Sight Distance for Speed/Path or Direction Changes

Area	Typical Speed	Decision Sight Distance
Urban	35 mph	710 ft.
Suburban	45 mph	810 ft.
·Rural	55 mph	870 ft.

A secondary effect is the weaving between vehicles entering from the drive /access and the vehicles destined for the on-ramp. The effect is difficult to analyze because both typical on-ramp volumes and volumes from the drive/access must be known. The higher these volumes, the greater effect of the weaving operations. The vehicles in the left lane can be assumed not be involved in the weave unless they are on-ramp vehicles. Using the typical volume conditions, the required weaving distances can be estimated as shown in Table I 1. For purposes of this analysis, assume 50 vehicles/hr from the access.

Table 11. Required Weaving Distances between an On-ramp and the Nearest Access/Drive

Area Type	Through Volume vphpl	Typical Ramp Volume, vph	Access Volume, vph	Total Weaving Volume, vph	Weaving Distance, ft
Urban (35 mph)	1000	800	50	1850	975
	800	600	50	1450	750
	600	400	50	1050	550
Suburban (45 mph)	500	400	50	950	1150
	400	300	50	750	900
	300	200	50	550	650
Rural (55 mph)	300	150	50	500	1700
	200	100	50	350	1000
	100	50	50	200	500

Based on these decision sight distances for speed, path or directionchange, Table 10, and the weaving distances, Table 11, it can be seenthat any access closer than 1000 ft. can potentially disrupt operations and safety with even a low entering volume from the access. These controls of decision sight distance and weaving distance both must be provided, but are not additive.

Two Lane Cross Road Criteria

C. Spacing to Nearest Major Intersection with Two Lane Cross Road. Driver expectancy is a major concern with two lane cross roads because the drivers present have varying levels of expectations. The drivers exiting from the freeway/expressway have higher levels of expectations based on the higher levels of speeds, design, operations, and access control they have been experiencing. The drivers on the two lane cross road naturally have lesser expectations. The mix of drivers, complexity of the interchange area and uniqueness of the operations, ramp layouts and design elements requires more time for drivers to perceive and react property. Consequently, decision sight distance must be provided and is a major factor in assuring smooth operations and safety.

A second major factor is the queuing distance required to accommodate all of the vehicles waiting to enter the nearest intersection. With a two lane facility near an intersection this must be accommodated in one lane for all vehicles entering the intersection from the interchange, unless a wider section of roadway with a left turn lane is provided at the intersection. Obviously, weaving is not an issue.

The stopping sight distance to the back of queue must Use the decision sight distance for a stop condition rather than stopping sight distance because the conditions are complex, unexpected and somewhat unique. The operations around interchange ramps may be different than those experienced on typical roads and streets. The decision sight distance for a stop condition is given in Table 12.

Table 12. Decision Sight Distance for the Stop Condition

Area	Speed	Decision Sight Distance
Urban	35 mph	620 ft.
Suburban	45 mph	640 ft.
Rural	55 mph	590 ft.

Based on 1990 AASHTO Policy on Geometric Design

The analysis of queuing conditions for two lane cross roads uses the same assumptions for volume and operating conditions assumed as typical previously for multilane highways. The results of the queuing analysis are summarized in Table 13.

Table 13. Queue Size for Two Lane Road for Urban, Suburban and Rural Conditions by Deterministic Queuing and Probabilistic Poisson Analysis

Area Type	Through Level	Through Volume vph	Typical Ramp Volume vph	Total Queuing Volume Þ vph	Cycle sec	Through Green sec	Yellow sec	Phases >	t sec	Queue Size, veh			Queue Length ft
										1.5 qt	2.0 qt	Poisson	
Urban (35 mph)	High	800	600	1050	120	65	3	3	55	24	32	24	600
	Moderate	700	500	900	120	56	3	3	64	24	32	24	600
	Low	600	400	750	120	47	3	3	73	23	31	23	575
Suburban (45 mph)	High	500	400	675	90	35	4	3	55	16	21	17	425
	Moderate	400	300	525	90	35	4	3	55	12	16	13	325
	Low	300	200	375	90	35	4	3	55	9	12	10	250
Rural (55 mph)	High	300	150	337	60	25	5	2	35	5	7	6	150
	Moderate	200	100	225	60	25	5	2	35	4	5	5	125
	Low	100	50	113	60	25	5	2	35	2	3	3	75

Þ Assumes 25% left turns which are accommodated by a separate left turn bay. This result is insensitive to the % of left turns assumed. For example, if 35% left turns is assumed, a queue size from the Poisson distribution of 24 vehicles also results for the high volume level with urban conditions.

In summary, the spacing to the next major intersection is determined from thesum of the decision sight distance to stop and the queuing distance, based onthe Poisson distribution. These results are shown in Table 14 and Figure 6.

Table 14. Spacing to Nearest Major Intersection from Free Flow Off Ramps for Two Lane Cross Roads

Area Type	Volume Level	Decision Sight Distance to Stop ft	Queuing Distance (Poisson based) ft	Spacing ft
Urban (35 mph)	High	620	600	1220
	Moderate	620	600	1220
	Low	620	575	1195
Suburban (45 mph)	High	640	425	1065
	Moderate	640	325	965
	Low	640	250	890
Rural (55 mph)	High	590	150	740
	Moderate	590	125	715
	Low	590	75	665

D. Spacing to First Drive on Right from Free Flow Off Ramp. The conditions are very similar to those experienced on a multilaned cross road for the first drive on the right. Consequently, the same criteria should be applied as for multilaned cross roads.

E. Spacing to First Drive on Left f rom Free Flow Off Ramp. The conditions for this spacing are the same as for the first drive on the right. The driver must have adequate time/distance to discem the vehicle is stopping, or is stopped to turn left. This should also provide the decision sight distance for the stopping condition.

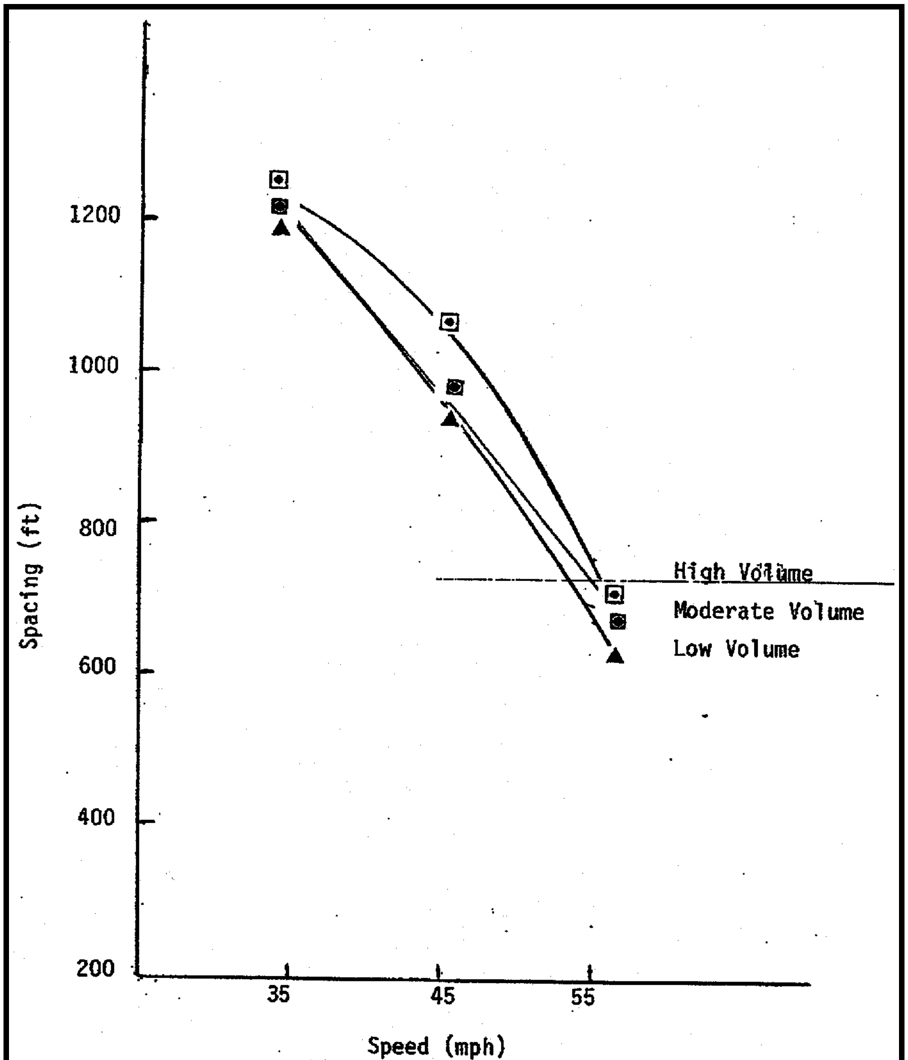


Figure 6. **Spacing to Nearest Major Intersection from Free Flow Off Ramps for Two Lane Crossroads**

Table 15. Decision Sight Distances for the Stop Condition

Area	Speed	Decision Sight Distance	
		to Stop	to Change Speed/Path/Direction
Urban	35 mph	620 ft.	710 ft.
Suburban	45 mph	640 ft.	810 ft.
Rural	55 mph	590 ft.	870 ft.

However, this drive is also the drive/access upstream of the on-ramp for which the decision sight distance for a speed, path, or direction change must be made. These criteria require longer spacings, and thus will control.

Attachment A

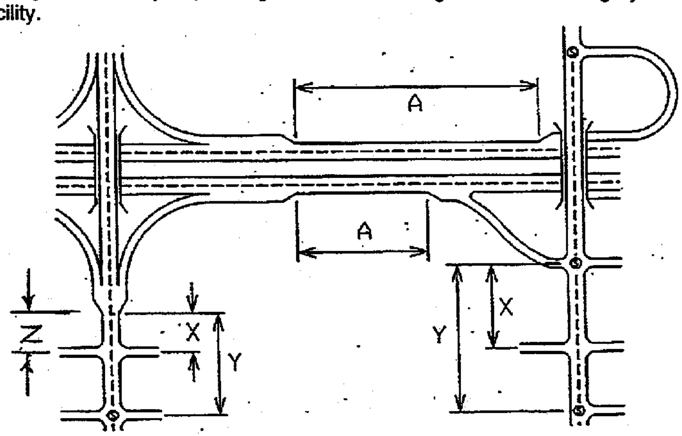
Minimum Spacing Standards Applicable to Freeway Interchanges with Two Lane Cross Roads

Category	Area Type	Spacing Dimension			
		A	X	Y	Z
Freeway	Urban	1 mi.	660 ft.	1320 ft.	660 ft.
	Suburban	1 mi.	990 ft.	1320 ft.	990 ft.
	Rural	2 mi.	1320 ft.	990 ft.	990 ft.

Minimum Spacing Standards Applicable to Freeway Interchanges with Four Lane Cross Roads

Category	Area Type	Spacing Dimension			
		A	X	Y	Z
Freeway	Urban	1 mi.	660 ft.	2640 ft.	1320 ft.
	Suburban	1 mi.	990 ft.	2640 ft.	1320 ft.
	Rural	2 mi.	1320 ft.	1320 ft.	1320 ft.

Notes: If cross street is a state highway, these distances may be superseded by Access Management Policy depending on LOS and assigned access category for cross street facility.



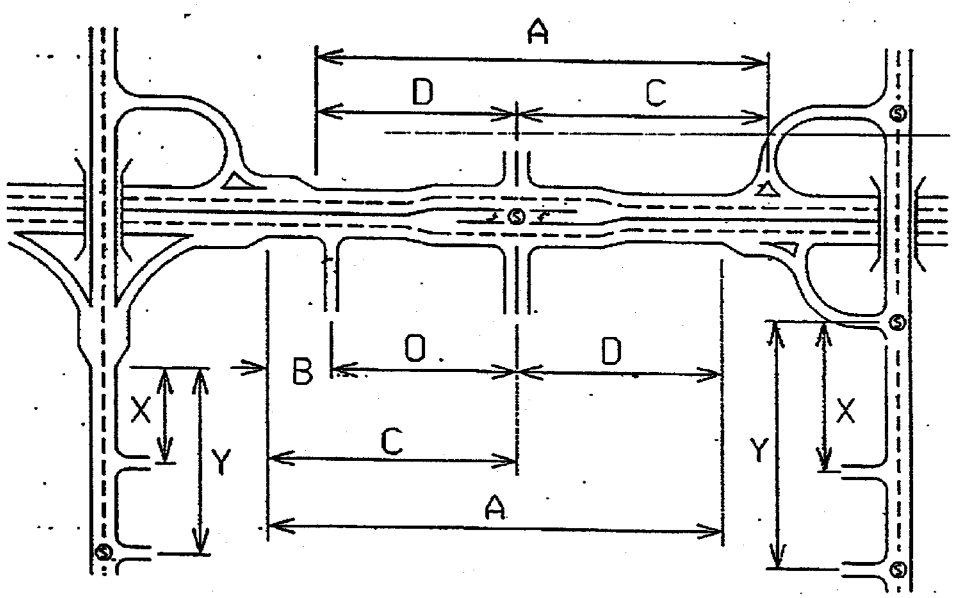
Attachment B

Minimum Spacing Standards Applicable to Non-Freeway Interchanges

Category of Mainline	Area Type	Free Flow Speed of Mainline	Spacing Dimension						
			A	B	C	D	O	X	Y
Expressway	Urban	45	1 mi.	1/2 mi.	1/2 mi.	1/2 mi.	☞	660'	1320'
	Rural	55	2 mi.	1/2 mi.	1 mi.	1 mi.	☞	660'	1320'

☞ Determined by Access Management Policy

Notes: If cross street is a state highway, these distances may be superseded by Access Management Policy depending on LOS and assigned access category for cross street facility.



Interchanges and Frontage Roads Concepts and Case Studies

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ABSTRACT

As part of NCHRP 3-52, access management practices around freeway interchanges were explored. This paper presents some lessons learned from the examples studied, and some emergent access concepts.

INTRODUCTION

Interchanges between freeways and arterial streets have become important focal points of activity in urban, suburban, and even some rural locations. They have become magnets for traffic, and they have stimulated roadside development in their environs. Where intersections are too close to the ramp termini of the arterial/freeway interchange, heavy weaving volumes, complex traffic signal operations, frequent accidents and recurrent congestion have resulted. These problems could be avoided by assuring that access to development adjacent to interchanges is sufficiently separated from ramp terminals.

Although access is controlled on the freeway within the interchange area, there is often little, if any, access control along the arterial roads. Existing arterial street intersections are often located very close to interchanges. In addition, curb cuts and median breaks for large and small traffic generators alike compound the problem. There are also land-use issues that arise in how an interchange relates to the surrounding community, how new land development conflicts with existing activities, and how improper use of the land will affect its future potential. These too affect, or may be impacted by, access separation distances.

Accordingly, as part of NCHRP 3-52, data on access separation distances at interchanges in 21 states or provinces were assembled, 9 case studies of access spacing practices were analyzed, previous studies of access separation were reviewed, and access spacing requirements and guidelines were developed. This paper focuses on five of the case studies. For each, it summarizes the state access management practices, describes the case study problems/conditions, and presents the emergent interchange/access spacing concepts.

State Policies

Access separation policies are contained in various AASHTO publications and in state DOT design policies. The AASHTO booklet, *A Policy on Design Standards - Interstate System, July 1991* (9-2), for example, states that "control should extend beyond the ramp terminal at least 100 feet in urban areas and 300 feet in rural areas...However, in areas where the potential exists to create traffic problems, it may be appropriate to consider longer lengths of access control." Many states, therefore, have established more stringent policies. Table 1 summarizes access separation distances reported by some 21 state (or provincial) Departments of Transportation. Separation distances in rural areas range from about 300 to 1,000 feet, and those in urban areas range from 100 to 700 feet. The guidelines generally are less than some of the access spacing requirements that are needed to ensure good arterial signal progression and to provide adequate weaving and storage for turning traffic -- left turns in particular.

Case Studies
Nine case studies of access separation distances were analyzed for interchanges located in Florida, Michigan, New Jersey, New York, Ohio, Pennsylvania, Virginia, and Washington. Table 2 summarizes their separation distances and characteristics. A detailed description of five of the case studies follow.

1. **I-75 and Jacaranda Boulevard, Exit 35, Sarasota County, Florida.** The case study site is located in a fast-growing community on the outskirts of Venice, Florida. Figure 1(A) shows the anticipated 2010 traffic volumes, and Figure 1(B) shows the observed problems and actions taken.

    a. **Applicable Standards**: According to Florida Department of Transportation Rules, Chapter 14-97.003, there must be at least 1,320 feet from the end of the egress ramp taper to the full median opening along state highways. The case study shows the southbound exit ramp is located too close to the nearest intersection.

    b. **Case Study Details:** The current configuration includes a high speed, right-turn lane that allows traffic leaving the interstate to merge with southbound Jacaranda Boulevard traffic. The ramp has a large radius and long taper that bring the terminus very close to an approved median opening and access point. Development in the Sarasota area is resulting in large annual growth in traffic volumes on both Jacaranda Boulevard and I-75. The Jacaranda Commercial Center to the west of the Boulevard and the Sarasota County Interstate Business Center to the east promise to generate high volumes of turning traffic at an intersection just 450 feet west of the end of the existing Southbound off ramp.

    The projected 2010 AM peak hour traffic volumes show 1,900 eastbound vehicles using the I-75 ramp to turn onto Jacaranda Boulevard. The southbound volume at the entrance to the two commercial centers would exceed 2,500 vph, of which about 600 would turn left into the Sarasota County Interstate Business Center. The increased weaving movements along southbound Jacaranda Boulevard has created a potential southbound safety problem. Accordingly, the Florida DOT is realigning the southbound off-ramp to a new signalized intersection opposite the southbound on-ramp. Costs of the ramp reconstruction will be split between developers and the state.

TABLE 1

Access Separation Distances at Interchanges

State	Rural	Urban
1. Alabama	300 feet to access	100 feet to access
2. Alberta	425m from signal to access 150m from ramp to access	Same
3. California	125m minimum distance from ramp to nearest intersection	Same
4. Florida	1,320 feet to access	Same
5. Illinois	500 to 700 feet	Same
6. Iowa	200 m rural primary highway 100m other road or street	50m urban
7. Kentucky	300 feet to access	100 feet to access
8. Maryland	Based on geometrics, speeds, volumes, presence of signals and queuing	Same
9. Michigan	30m to access	90m to access
10. N. Dakota	AASHTO guidelines (300 feet)	AASHTO guidelines (100 feet)
11. Ohio	600 feet for diamond interchange, 1,000 feet for cloverleaf.	
12. Oregon	300 feet from frontage road 500 feet from ramp (suggested)	Same
13. Pennsylvania	AASHTO guidelines (300 feet)	AASHTO guidelines (100 feet)
14. South Carolina	500 feet desirable, 300 feet minimum	300 feet desirable, 150 feet minimum
15. Texas	AASHTO guidelines (300 feet)	AASHTO guidelines (100 feet)
16. Utah	300 feet to access	150 feet to access
17. Virginia	200 feet from entrance ramp	Same
18. West Virginia	300 feet to access	100 feet to access
19. Washington	300 feet to access	300 feet to access
20. Wisconsin	1,000 feet to access (500 feet - minor roads)	500 feet to access
21. Wyoming	300 feet to access	150 feet to access

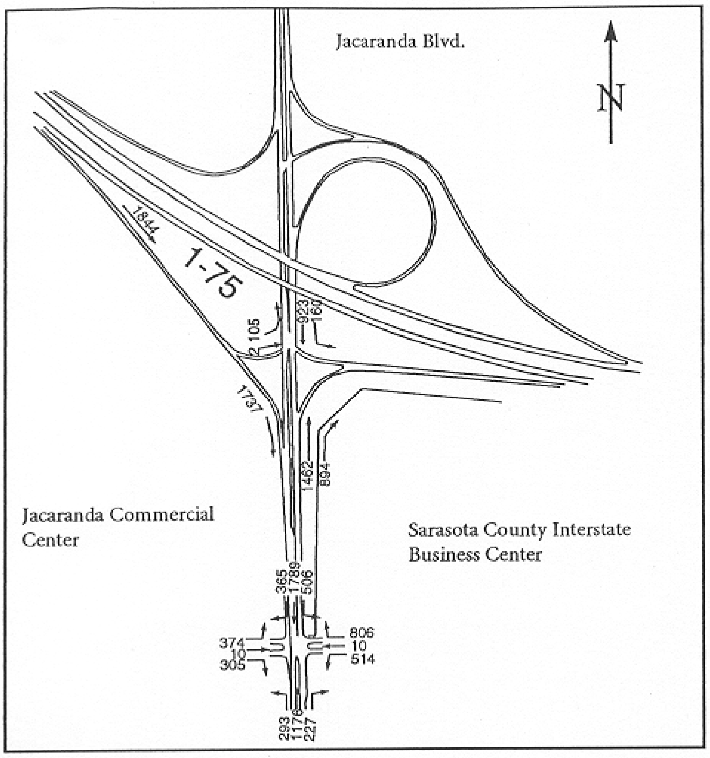
Source: Urbitran Surveys.

TABLE 2

Case Studies of Access Separation Distances at Interchanges

Case Study	Separation Distance	Comments
1. I-75 / Jacaranda Blvd. Sarasota Co., Florida	480 feet before 1,000 feet after	Ramp relocated and signalized to eliminate weave
2. Route 46 / Union Blvd. Passaic, New Jersey	750 feet	Frequent offset driveways, short weaves for left-turns
3. I-77 / SR 18 Summit County, Ohio	Varies; 120 to 300 feet	Heavy left-turns require short weaves beyond cloverleaf interchange - with frequent congestion
4. I-295 / US 360 Richmond, VA	Varies; 600 to 750 feet	Weaving conflicts and backup onto ramp from signalized intersection
5. I-5 & Harrison Avenue Centralia, Washington	300 feet	Frequent curb cuts and short separation distances; congestion at signalized intersections

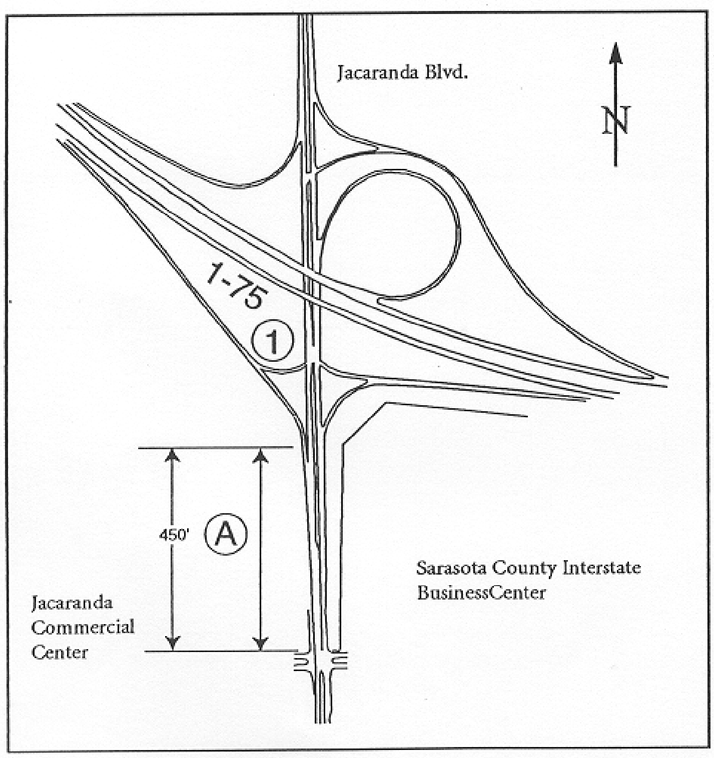
Source: Urbitran Interviews and Analysis



A. TRAFFIC VOLUMES

Projected 2010
PM Volumes

Source:
Florida Department of Transportation



B. OBSERVED PROBLEMS AND PLANNED IMPROVEMENTS

OBSERVED PROBLEMS:

A. Intersection proximity to southbound off-ramp allows insufficient distance for existing vehicles to weave into left lane

PLANNED IMPROVEMENTS:

1) Move ramp terminus further north and signalize. Eliminate free-flow right turn.

I-75 & Jacaranda Boulevard, Venice, Florida
Figure 1

Local Experience: In this case, the State found itself in a position of being forced by evolving land development to make improvements. Because right-of way acquisition was limited on either side of the interchange, the State could not extend access control on Jacaranda Boulevard for any significant length.

c. Access Management Implications: The redirection of the I-75 eastbound off-ramp into a signal-controlled intersection eliminates the serious weaving problem that would otherwise exist. Coordinated land-use and transportation planning for the entire area might have allowed interchange design that better accommodated high-volume turning movements without double loading Jacaranda Boulevard. Such advance planning has applications elsewhere in Florida. To be pro-active, right-of-way control should be secured along intersecting arteries at the time that the interchanges are planned or constructed.

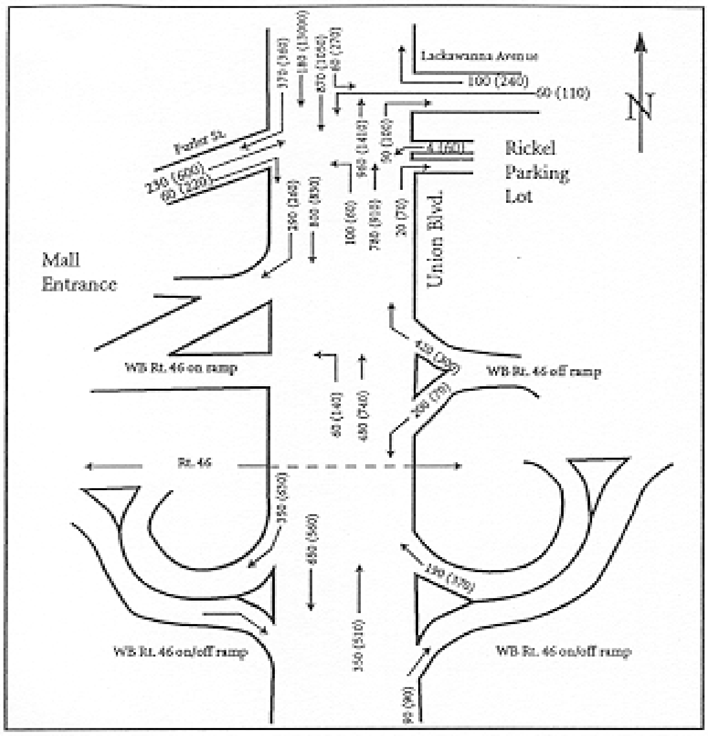
2 <u>Route 46 at Union Boulevard, Passaic County, New Jersey</u>. This interchange is located in Passaic County, New Jersey. Union Boulevard is a major north-south arterial providing access to Route 23 and Route 46, as well as I-80 which runs north of and parallel to Route 46. Route 46 is an east-west multi-lane highway with access to adjacent commercial properties in the vicinity of the interchange. Figure 2(A) shows the 1991 AM and PM peak hour traffic volumes, and Figure 2(B) shows the roadway geometry, observed problems, and possible improvements.

a. Applicable Standards: Chapter 47 of the <u>New Jersey Administrative Code, Title 16</u>, is the "State Highway Access Management Code". For access applications for large traffic generators, the Access Code has general LOS standards for uninterrupted-flow, signalized intersections, unsignalized intersections, weaving areas and ramps.

b. Case Study Details: The Route 46/Union Boulevard interchange was constructed in the 1940's and was rebuilt in the 1950's. It is a full interchange with movements provided by slip ramps and by loop ramps in the southeast and southwest quadrants. There are two signalized T-intersections on Union Boulevard, intersecting with Furler Street and with Lackawanna Avenue, between Route 46 and I-80. Northbound traffic on Union Boulevard approaching the Furler Street intersection is approximately 900 vph in the morning peak hour and 1,000 vph in the evening peak hour. Southbound traffic approaches 1,200 vph in the AM peak hour and 1,400 vph in the PM peak hour. There are heavy turns to and from the north between US 46 and both Furler Street and Lackawanna Avenue.

The heavy through traffic on Union Boulevard in both directions during the peak periods results in short gaps for left-turning traffic from Union Boulevard northbound to the Route 46 westbound entrance ramp, and from the Route 46 westbound exit ramp to Union Boulevard southbound. Traffic volumes for these movements are 140 and 70 vehicles, respectively. As a result, traffic backs up along the Route 46 westbound exit ramp to the Route 46 mainline. In addition, the Route 46 westbound ramp and Union Boulevard intersection operates at a reported v/c ratio of greater than 1.2. By 2015, NJDOT expects these volumes to increase to 160 and 80 vehicles, respectively, exacerbating the problem.

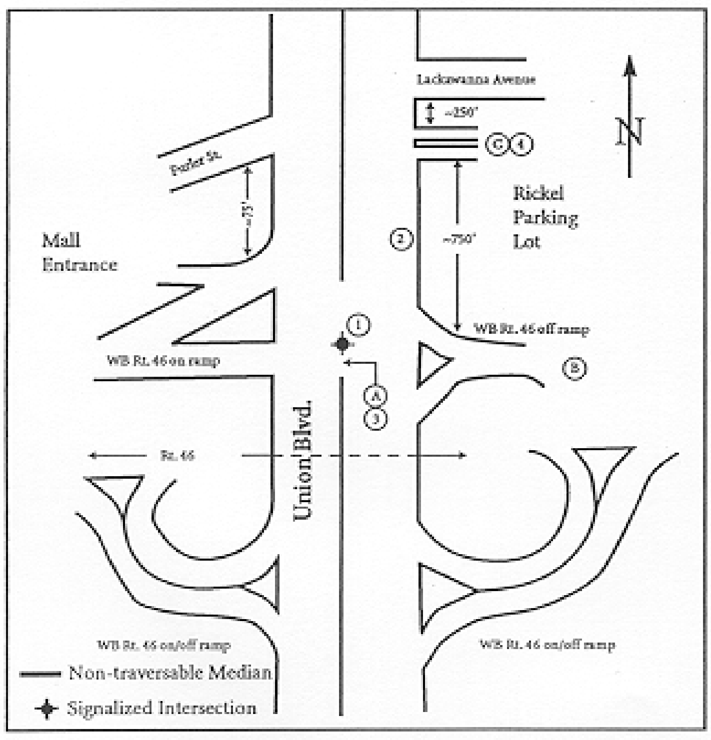
The exit and entrance ramps of westbound Route 46 are located across from each other but are off-set, creating both operational and safety concerns. A number of right angle accidents have been reported involving vehicles turning left onto Union Boulevard from the westbound Route 46 exit ramp and northbound through Union Boulevard vehicles. Ingress and egress movements for the Rickles commercial drive, located approximately 750 feet north of the westbound Route 46, may contribute



A. TRAFFIC VOLUMES

1991 7:30-8:30 AM
4:30-5:30 (PM)

Source:
Technical Memorandum "Recommended Improvements, Route 46 at Union Boulevard Interchange" Howard Needle Tammen & Bergendoff, October 1993



B. OBSERVED PROBLEMS AND PLANNED IMPROVEMENTS

OBSERVED PROBLEMS:

A. Heavy traffic on Union Boulevard makes NB left turns onto the entrance ramp of Route 46 difficult and dangerous
B. Heavy traffic on Union Boulevard makes WB left-turns from the exit ramp of Route 46 difficult and traffic backs up traffic onto Route 46 mainline.
C. Location of commercial drive may interfere with the exit ramp and Lackawanna Avenue movements.

PLANNED IMPROVEMENTS:

1) Revise intersection signal timing to provide ade quate time for all movements and realign intersection
2) Provide additional Northbond lane along Union Blvd to allow a free-flow right turn from WB Route 46 exit ramp.
3) Provide exclusive left-turn lane for NB Union Blvd. left-turns.
4) Close drive - access is provided along Lackawanna Avenue.

Route 46 & Union Boulevard Passic County, New Jersey
Figure 2

to problems for northbound through traffic attempting to access Lackawanna Avenue (located approximately 250 feet north of this commercial drive) and traffic exiting westbound Route 46 attempting to travel northbound on Union Boulevard.

From an access management perspective, the Furler Street, Lackawanna Street and Rickles access drive are located too close to the Route 46 ramps.

c. **Local Experience:** NJDOT developed two improvement schemes to provide relief for some of the operational and safety problems experienced by motorists using the interchange; the "Optimum Scheme" and the "Alternative Scheme."

The Optimum Scheme would prohibit left turns from the westbound Route 46 exit ramp by redesigning it as a loop ramp, redesigning the westbound Route 46 entrance ramp and widening Union Boulevard. Some of the nearby existing driveways along Route 46 would be closed, but all of the affected businesses would have alternative access.

The Alternate Scheme reduces the impacts on right-of-way and local businesses. It would (1) redesign and signalize the intersection of the westbound Route 46 exit ramp and Union Boulevard, and (2) widen the northbound Union Boulevard pavement and close the Rickles commercial drives between the exit ramp and Lackawanna Avenue, and (3) relocate or remove the commercial drives along Route 46 near the interchange.

The operational and design deficiencies at the Route 46 and Union Boulevard interchange are addressed by both of the improvements schemes. The Alternate Scheme was recommended since it provides adequate relief and improves traffic operations with significantly lower impacts on existing commercial facilities and lower construction costs; and is the scheme shown on Figure 2(B).

d. **Access Management Implications**: Whenever possible, nearby exit/entrance ramps where opposing movements are permitted should either be aligned or spaced sufficiently apart so as not to interfere with each other. This was not the case with the Route 46 westbound entrance and exit ramps and Union Boulevard. In addition, providing enough pavement width at an intersection to allow separate left-turn bays and/or free-flow right turns reduces conflicts with through movements and reduces congestion and improves safety. Eliminating the Rickles commercial drive located between the westbound Route 46 exit ramp and Lackawanna Avenue allows for pavement widening and provides safer and more efficient movement along Union Boulevard near the interchange.

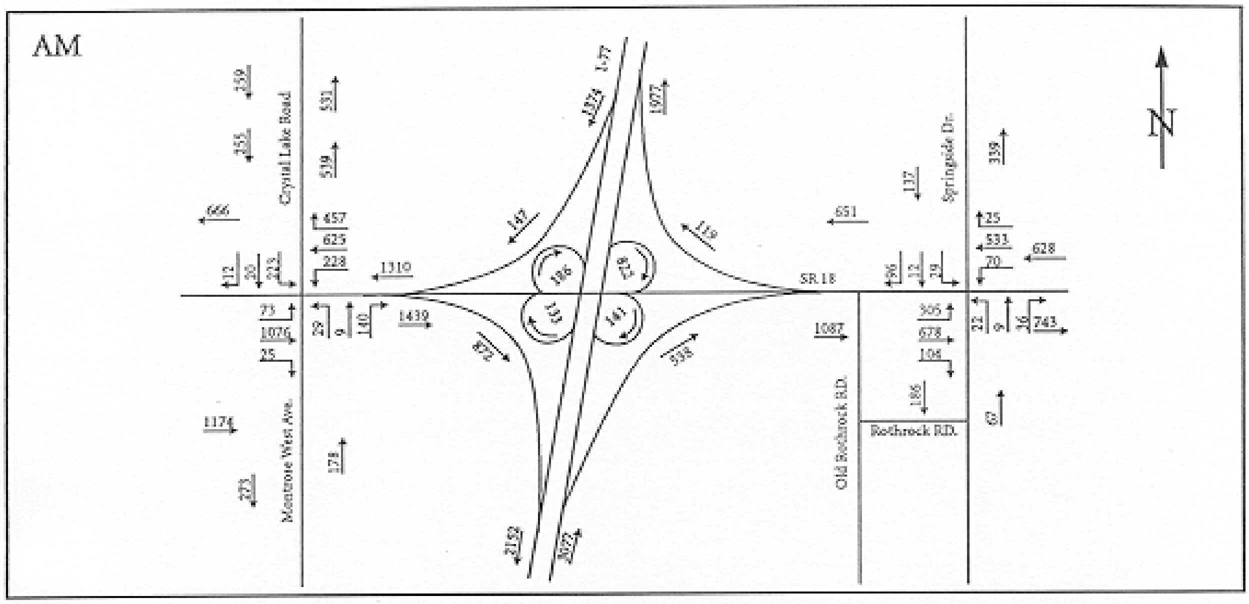
3. **Interstate-77 at State Route 18, Summit County, Ohio**. This cloverleaf interchange is located about a mile to the north of the I-77/SR 21 interchange in Bath Township. State Route 18, Market Street, connects I-77 with Fairlawn and Akron to the east and Medina to the west. West of I-77, SR 18 is a four-lane divided highway with two through lanes in each direction and left-turn lanes at most major intersections. To the east of I-77, it is a five-lane section with two through lanes in each direction and a continuous center two-way left turn lane. SR 18 serves as both a commuter link between the Akron urban core and the outlying residential areas in western Summit County, and as a commercial corridor containing businesses on both sides of the road. There is extensive commercial and residential development on both sides of I-77. Figure 3 shows the 1994 AM and PM peak hour traffic volumes. Figure 4 shows the roadway geometry, observed problems and possible improvements.

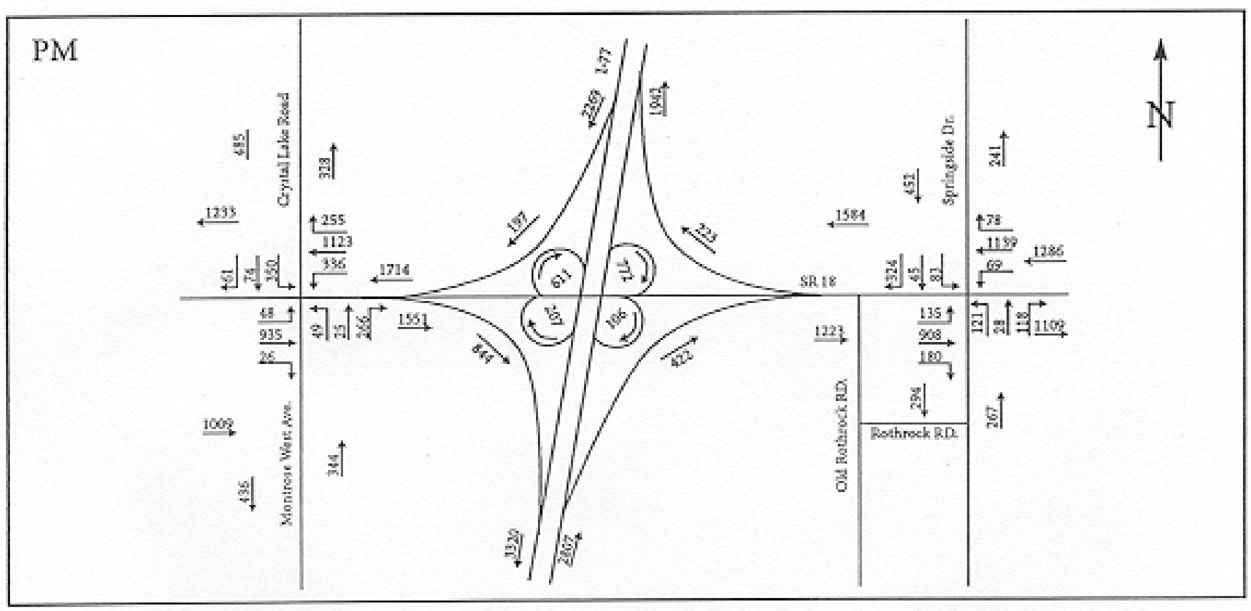
TRAFFIC VOLUMES

1994 AM and Pm Peak Hours

Source:

"SUM-18-0.00 Corridor Study,"
MS Consultants, Inc.





I-77 - SR18, Summit County Ohio Traffic Volumes

Figure 3

OBSERVED PROBLEMS:

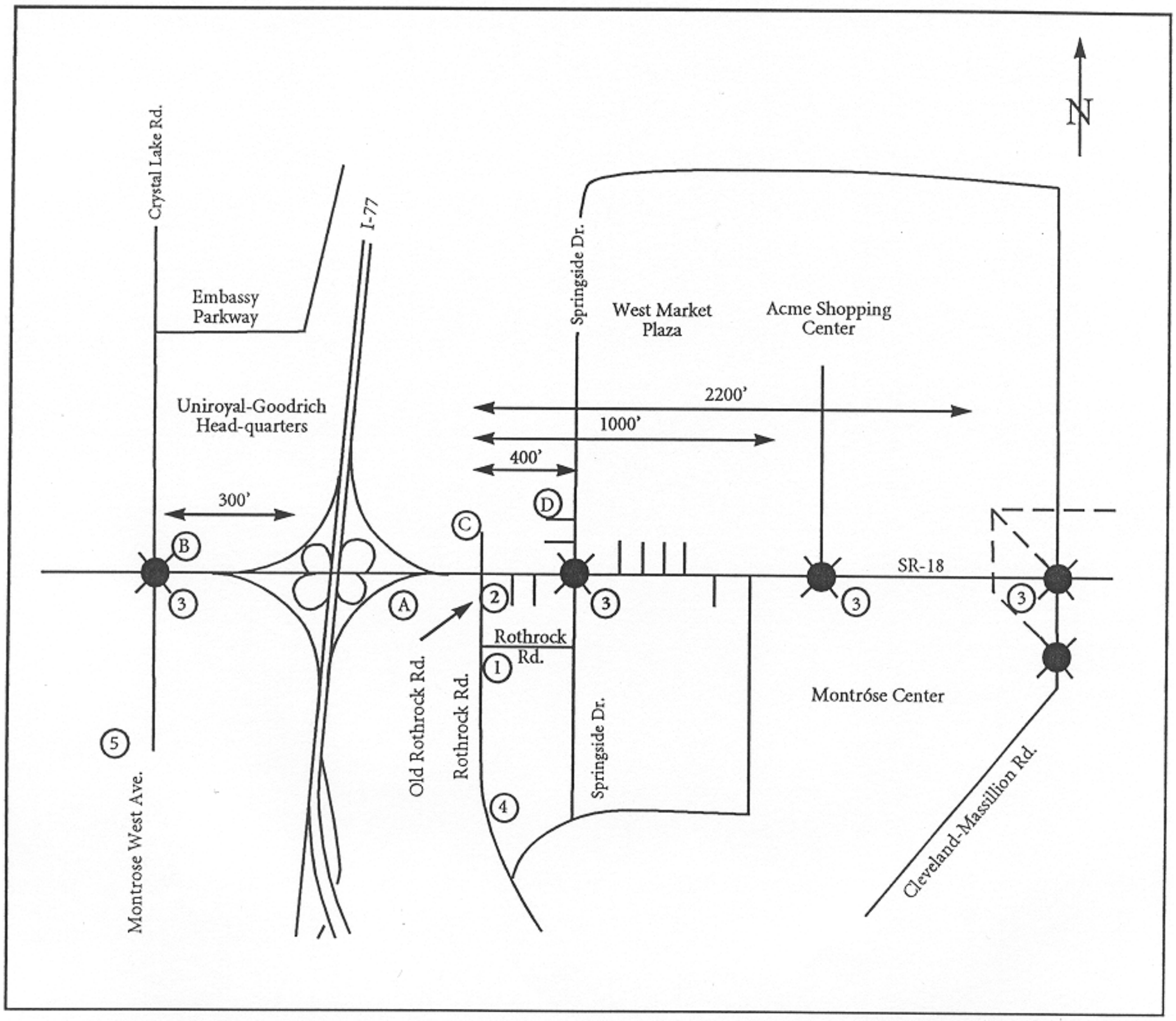
A. NB Rothrock Road left-turns conflict with EW through traffic in close proximity of I-77 NB on-ramp.

B. Heavy turns at signalized intersection close to I-77 off-ramp results in weaving congestion and a large number of rearend accidents

C. Access located too close to interchange.

POSSIBLE IMPROVEMENTS:

1) Direct Northbound left-turn traffic to the Springside Drive/SR18 intersection.
2) Prevent Northbound left-turns onto SR 18
3) Create one single traffic-responsive "closed-loop" signal system.
4) Possibly close access onto SR 18 and reroute via SpringsideDr.
5) Provide outlet to south for Montrose West Avenue traffic.



I-77 - SR18, Summit County Ohio

Figure 4

a. Applicable Standards: According to the Ohio Department of Transportation's *Guidelines for Interchange Development* (dated December 30, 1965), the control of developments adjacent to cloverleaf type interchanges on limited access highways can be effectively controlled by county, regional or city planning commissions. This is done through subdivision controls, building developments, and local zoning commissions as to zoning regulations. County commissioners or township trustees may exercise similar controls in the absence of planning and zoning commissions. ODOTs suggested guidelines is to locate drives a minimum of 1,000 feet away from the interchange ramp, outside of the state limited access right-of-way. Subsequent drives should be located at least 600 feet apart.

b. Case Study Details: The interchange is located in a growing residential area. To the east of the interchange, the unsignalized intersection of Old Rothrock Road and a commercial drive with SR 18 is less than 150 feet from the I-77 interchange ramps, at the end of the eastern limits of the Limited Access Right-Of-Way. The first signalized intersection (Springside Drive/SR 18) is located approximately 400 feet from the ramps. In between these two intersections there are two full movement commercial drives. Commercial development with at least one drive each continues for a half-mile to the east. Springside Drive was recently signalized and a connector road between Rothrock Road and Springside Drive was constructed to reduce the amount of through traffic on Old Rothrock Road. Because northbound left-turns from Old Rothrock Road onto SR 18 to access I-77 are still a safety problem, the Department of Transportation plans to prohibit the left-turn at Old Rothrock Road. DOT will, as an alternative add guide signing at key locations on Rothrock Road to direct traffic to use the signalized intersection at Springside Avenue and SR 18, for access to I-77 via SR 18.

The SR 18 and Crystal Lake Road/Montrose West Avenue intersection is located approximately 300 feet to the west of the interchange ramps, at the end of the western limits of the Limited Access Right-Of-Way for the I-77/SR 18 interchange. A high number of westbound rear-end accidents have been reported at this intersection. The westbound approach is influenced by several factors, including the congested I-77/SR 18 westbound interchange weaving area and the southbound-to-westbound off-ramp. Currently, the signal system to the east of the interchange is using time-based coordination. A closed-loop system has been recommended along SR 18 east and west of the interchange and at adjacent signals on crossroads. Although ODOT initially anticipated using separate signal systems on each side of the interchange, the need to coordinate all the signals along SR 18 and adjacent streets into one system will be especially critical if any ramps at the interchange are signalized in the future. This coordination would reduce accidents at the SR 18 and Crystal Lake Road/Montrose West Avenue intersection by controlling westbound traffic through the area.

There is extensive commercial development in the environs of the interchange. Several shopping centers are located along Market Street east of I-77 including West Market Plaza, Montrose Centre and Summit Mall. Monroe West Avenue has no southern outlet and is lined with corporate offices. The Uniroyal Goodrich corporate headquarters is located in the vicinity of the Crystal Lake-Embassy Parkway.

The high concentration of commercial development has resulted in heavy traffic volumes and turning movements along SR 18 and the intersecting roads. Peak-hour, peak-direction traffic volumes on SR 18 range from 1,500 to 1,700 vph east and west of the I-77 interchange. Turns from westbound SR 18 onto Montrose West Avenue/Crystal Lake Road account for about 50 percent of the AM traffic and 35 percent of the PM traffic. Similarly, eastbound turns onto Springside Drive account for about 40 percent of the AM traffic and 25 percent of the PM traffic.

These traffic volumes, together with the proximity of traffic signals to the interchange, have resulted in recurrent congestion and increased collisions. Safety and operational problems are compounded by commercial drives located along SR 18. Thirty distinct access points exist along the half-mile section of SR 18 east of the I-77 interchange. While some connections exist between commercial parking areas on both sides of SR 18, it is frequently necessary for motorists to use SR 18 for short trips between adjacent facilities. Roadway capacity for longer trips has decreased due to an increased number of short commuting and shopping trips. Average daily traffic on SR 18 near I-77 is 37,140.

c. Local Experience: An Ohio consultant group (MS Consultants, Inc.) researched the areas transportation needs, current deficiencies and anticipated growth. According to their interim report, planning documents were reviewed and field investigations were used to verify or update existing information. Data collection and evaluations were coordinated with various public-sector entities with interests in the corridor, including the Ohio Department of Transportation, the Summit County Engineer Department and the Akron Metropolitan Area Transportation Study. Access separation distances and problems at the I-77/SR 18 interchange were included in the report. The Ohio Department of Transportation works closely with the County Engineer and the MPO and holds public meetings to discuss access management along SR 18.

d. Access Management Implications: The problems in the environs of this interchange stem from the unanticipated commercial growth and the inability to develop a supporting street system that is adequately separated from the interchange ramps. The problems are compounded by the multiplicity of access drives along Route 18. Expanded developments result in traffic congestion in areas near the interchange. For example, the unsignalized intersection of Old Rothrock Road and a commercial drive with SR 18 is less than 150 feet east of the I-77 interchange ramps, at the end of the eastern limits of the Limited Access Right-Of-Way. This commercial drive is too close to the I-77 northbound on-ramp and should be closed. Since this property is located on the corner of SR 18 and Springside Drive, there is potential for alternate access to this development on Springside Drive.

There is an urgent need to improve operations at the Montrose West Avenue interchange by relocating the road away from the intersection and providing a good southern outlet for Montrose West Avenue traffic. There also may be merit in connecting the east-west freeway (I-77 east of Route 21) westerly with ramps connecting to Nametown Road and Montrose West Avenue. The multi-jurisdictional nature of the SR 18 corridor, with state, county and township involvement, requires a cooperative effort in establishing standards that all jurisdictions can enforce fairly and effectively or that one agency take the lead in the establishment and enforcement of better standards.

4. **I-295 at US 360, Richmond, Virginia**. This full cloverleaf interchange is located approximately five miles northwest of downtown Richmond, Virginia. I-295 is part of the interstate loop around Richmond that intersects with I-95. U.S. 360 connects Richmond with the Chesapeake Bay area. The area in the immediate vicinity of the interchange is generally suburban residential in the northwest, northeast and southwest quadrants. The southeast quadrant is primarily commercial in character including a Wal-Mart adjacent to the interchange, with residential land uses beyond. Figure 5 shows the roadway geometry, observed problems, possible solutions, and 1995 average annual daily traffic.

a. Applicable Standards: Virginia DOTs policy requires 300 feet of separation between the end of the acceleration lane and the driveway or intersection. In some instances, the state has installed channelization and barriers to prevent multiple lane weaving maneuvers by ramp traffic.

<u>Case Study Details</u>: I-295 is primarily used for travel around the City of Richmond. U.S. 360 is used mainly for commuters traveling between outlying residential areas and downtown Richmond. AADT in the vicinity of the interchange is 51,000 on I-295 and 36,500 within the vicinity of the interchange. U.S. 360 has a non-traversable median that limits cross movements between signalized intersections.

The nearest access point east of the interchange is the signalized entrance to the commercial area at Sandy Lane. This intersection is located approximately 750 feet from the northbound

I-295-to-eastbound U.S. 360 off-ramp, but the distance between the end of the ramp and the start of the right turn lane taper into the commercial development is just 200 feet. The traffic exiting from northbound I-295 must merge into the eastbound lanes of U.S. 360. This merge is complicated by weaving maneuvers of through traffic moving right, across the merge path, into the deceleration lane for Sandy Lane. The numbers of vehicles making the right turn, and therefore the potential for conflict, is likely to be large because of the concentration of retail activity located in this area. Those drivers exiting I-95 that turn left have just 200 feet to weave across two lanes to reach the left turn lane.

The nearest access point to the west of the interchange is an unpaved road located at least 600 feet from the northbound I-295 to eastbound U.S. 360 exit ramp. There are only two homes along the road so traffic is minimal. Just north of the road is a large residential area that does not have direct access to US 360. Residential developments on either side of the U.S. 360 are generally accessed via Routes 640 and 156.

c. **Local Experience:** The Virginia Department of Transportation indicates that the intersection of U.S. 360 and Sandy Lane is a high accident location because of the weaving maneuvers. In addition, because of high volumes and the close proximity of the ramp to the signalized intersection, during the PM peak hour (4:30-5:30 pm), traffic on the I-95 northbound to U.S. 360 eastbound exit-ramp backs up from the U.S. 360/Sandy Lane intersection to at least half way up the exit-ramp.

d. **Access Management Implications:** The I-295/U.S. 360 interchange illustrates both good and poor access spacing and management practices. Although there is residential and commercial development adjacent to the interchange, there is only one unsignalized access point located near an on/off-ramp and the traffic along this unpaved road is very light. Local traffic must access the residential areas via alternate routes. Should this dirt road be paved and serve additional residential development, it may be desirable to relocate it further west.

Although the commercial uses along US 360 share one signalized access point, this intersection is located a short distance from the interchange ramp. The high concentration of retail activity and through volumes make this weaving area a potential safety and operational problem. This condition would be improved if Sandy Lane were relocated further to the east. Additional green time for U.S. 360, along with selected widening would reduce existing traffic backups onto the ramps during the peak hours.

TRAFFIC VOLUMES

1995 AADT

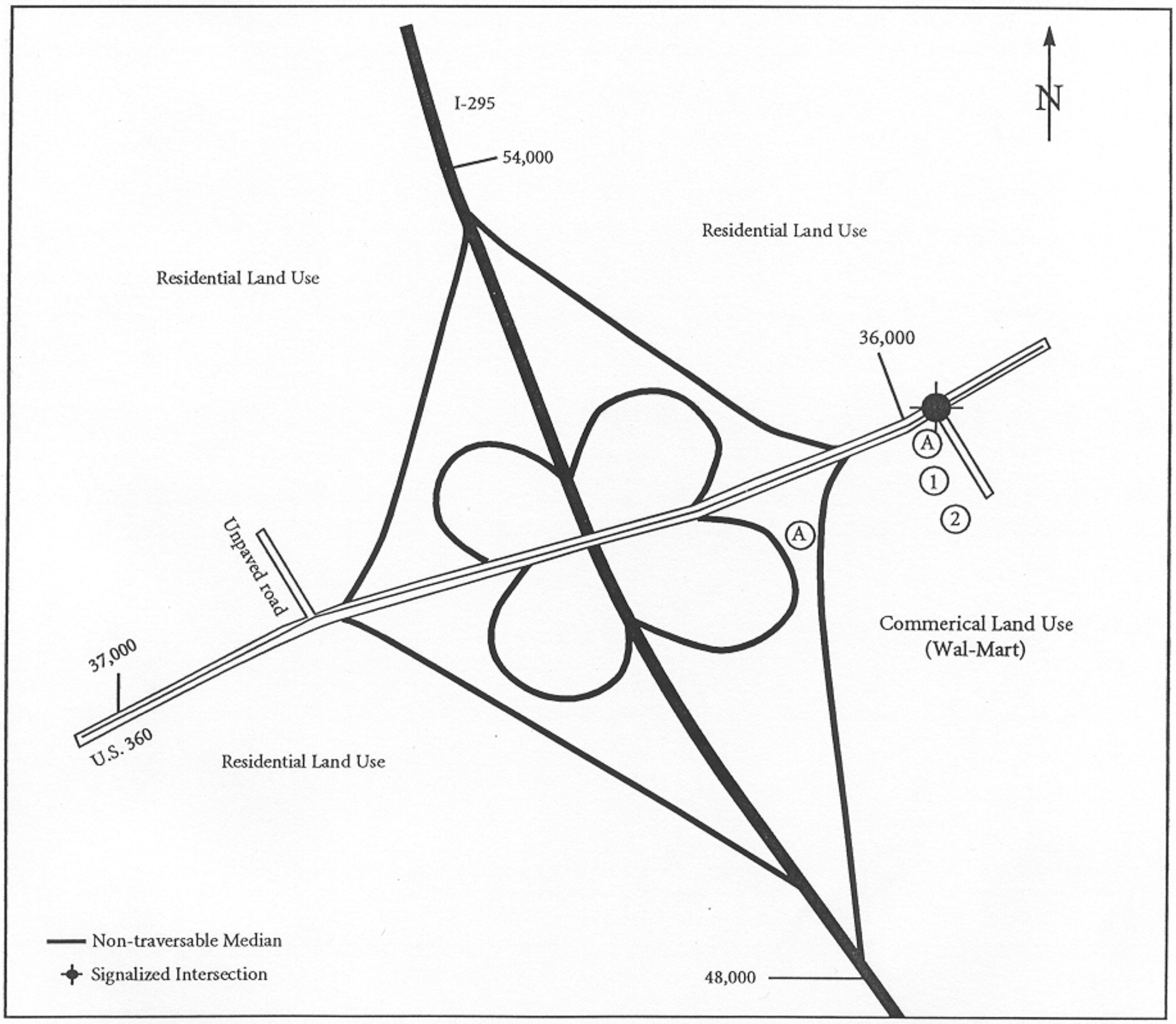
Source:
Virginia Department of Transportation

OBSERVED PROBLEMS:

A. Traffic backs up onto ramp from signalized intersection during peak hours

POSSIBLE IMPROVEMENTS:

1) Relocate Sandy Lane further to the East
2) Expand lenes and increase US 360 green time.



I-295/U.S. 360 Richmond Virginia
Figure 5

5. I-5 and Harrison Avenue, Centralia, Washington. This diamond interchange is located in the northwestern part of Washington state along the I-5 corridor. I-5 connects a string of small, but growing communities, with the larger cities of Seattle, Tacoma, and Olympia to the north. The area in the immediate vicinity of the interchange is suburban in character with clusters of retail and commercial buildings closest to the interchange. Centralia is known as a local outlet shopping center. Figure 6 shows roadway geometry, observed problems and possible solutions, and PM peak hour volumes.

a. Applicable Standards: Limited Access Highways are regulated under Chapter 468-58 of the Washington Access Code. Section 468-58-080 applies specifically to control of access on crossroads and interchange ramps. It requires that full control on access to the crossroad be exercised for the first 300 feet from the centerline of the ramp at its terminus or terminus of the transition taper. DOT can, however, allow for full control of curb cuts for only the first 130 feet and partial or modified control for the remaining 170 feet.

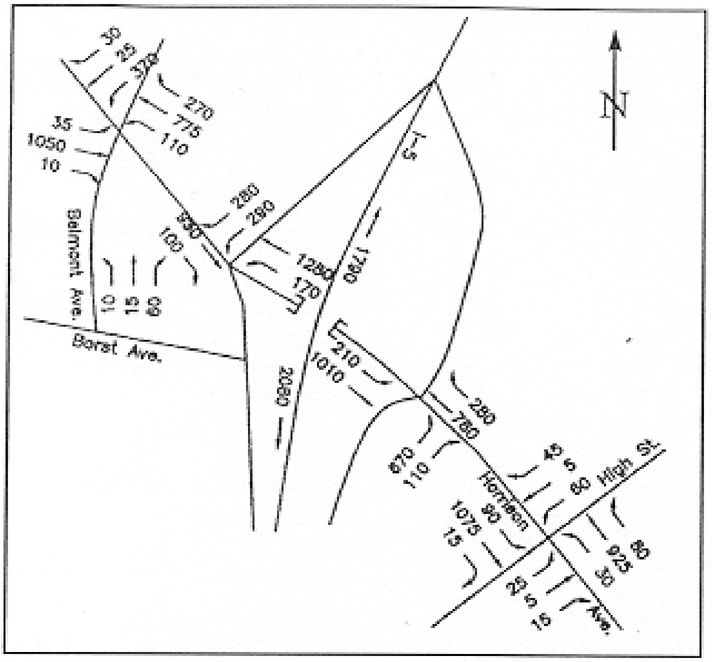
b. Case Study Details: The I-5 ramps at Harrison Avenue are heavily utilized and congestion occurs at nearby intersections. Harrison Avenue itself provides two lanes in each direction and carries between 1,200 and 1,400 vehicles per hour in each direction during the PM peak hour. This results in levels of service of E and F on major intersection approaches. The northbound and southbound I-5 off ramps have volumes of 840 and 570 vehicles respectively in the PM peak hour. Over the next 30 years, Washington DOT expects considerable growth in both population and employment, adding further to congestion levels.

In addition to the congestion on the ramp approaches, there are also geometric problems along Harrison Avenue. Drivers exiting northbound from I-5 and then turning right (southeast) on Harrison Avenue have less than 200 feet to cross two lanes of traffic if they wish to enter the left-turn lane at the first intersection, High Street/Eckerson Road. Curb cuts are located within 275-300 of the ramp ends. Southbound exiting vehicles face similar geometric conditions. The transition for the left turn onto the southern extension of Belmont Avenue begins almost opposite the ramp terminal. This leaves virtually no weaving distance for vehicles that have turned right (northwest) from the ramps. Again, there are curb cuts within 300 feet of the ramp end. The motel adjacent to the interchange has access only from Eckerson Road.

b. Local Experience: The Washington DOT indicates that the ramps on Harrison Avenue are one of their higher accident locations. However, in the context of Centralia, local traffic planners do not consider the stretch of Harrison Avenue, a local road, as one with high accident rates. The main concern, from the local point of view, is traffic congestion on Harrison Avenue and trucks bound for the port area to the northwest.

Locally, the access situation is considered adequate. Accident rates are not viewed as excessive and do not raise local concerns. To the west of the interchange, the number of left turns onto the southern extension of Belmont Avenue is relatively light (110 vph) and weaving from the southbound off-ramp is not viewed as a problem. Although drivers can use this section of Belmont to reach Borst Avenue, most turn left at Johnson Road which, unlike Belmont, is signalized. To the east of the interchange, the orientation of the motel access toward Eckerson Road is cited as a positive. Weaving conflicts are not considered a concern in this section of Harrison Avenue.

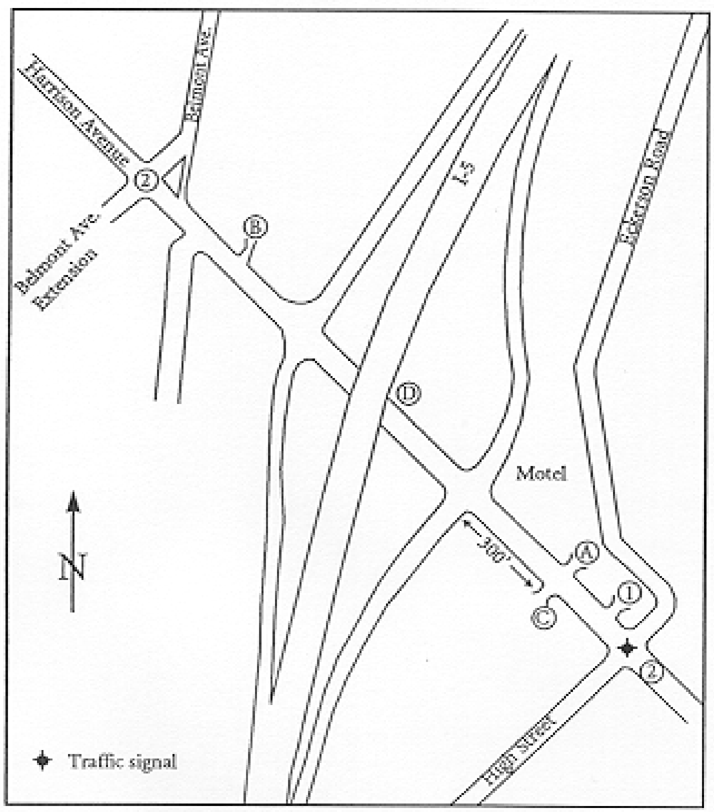
A study by David Evans and Associates indicates that volumes along Harrison Avenue could be reduced by building a new interchange further north on I-5. Washington State DOT had plans to construct a new interchange just over two miles to the north, but apparently the decision has not been finalized.



A. TRAFFIC VOLUMES

1992 5:00-6:00 PM

Source:
"Interchange Feasibility Study, North Lewis County Interchange", David Evans and Associates



B. PROBLEMS AND POSSIBLE IMPROVEMENTS

OBSERVED PROBLEMS:

A. Intersection proximity to northbound off-ramp allows insufficient distance for exiting vehicles to weave into left-turn lane.
B. Similar problem as #1 above, for southbound off ramp
C. Driveway to major shopping facility creates right-lane demand at merge/weave point for northbound exiting traffic.
D. Distance between ramps are too short. Queues of entering vehicles waiting to turn left some times backup beyond end of left-turn lane storage space.

PLANNED IMPROVEMENTS:

1) Close curb cut
2) Privide additional lanes on ramps and Harrison Ave.

I-5 & Harrison Avenue Centralia, Washington

Figure 6

d. **Access Management Implications:** The street and ramping systems were adequate when I-5 was first built. However, as development, volumes and access points increased, peak hour congestion intensified. Two factors contribute to this congestion: (1) the diamond interchange with closely spaced signals along Harrison Avenue and (2) the frequent curb cuts and left-turns along Harrison Avenue.

Possible improvements include closing curb cuts closest to I-5 and requiring access from side streets, and providing additional lanes on ramps and Harrison Avenue. In addition, northbound left-turns onto Belmont Avenue could be prohibited and diverted to Johnson Street.

Lessons Learned

The following implications are apparent from the case studies of access separation distances.

1. The proximity of traffic signals to upstream ramps, especially free-flowing or yield-control ramps, results in congestion with spillback onto ramps.

2. Movements from free-flow ramps into left-turn lanes pose two problems: (a) weaving distances are usually inadequate, and (b) heavy left-turn movements impede artery traffic. These conditions can be alleviated in part by signalizing the ramp terminals (subject to progression considerations) and/or increasing the separation distances; this was done at several interchanges in Florida.

3. Often, the arterial roadway functions as a distributor for freeway-to-activity center traffic. This double loads the artery by superimposing short trips and turning movements onto the normal artery traffic. Alleviating this condition calls for restructuring both street and interchange patterns.

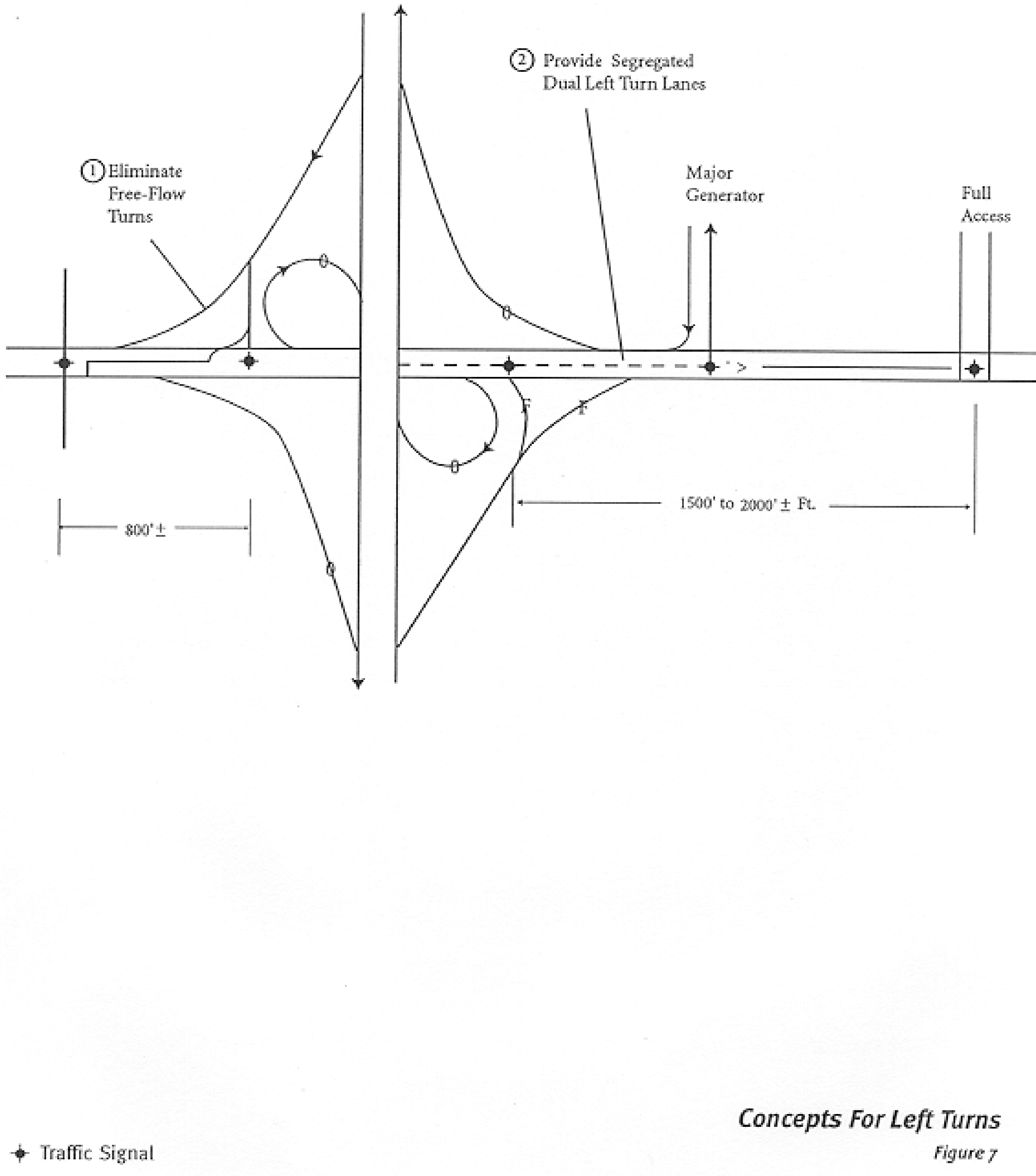
   Arterial traffic access, operations and safety in the environs of interchange can be enhanced by improving left-turn treatments, modifying interchange designs, and setting access spacing standards.

   a. **Improving Left-Turns**: The arterial left turn problem at interchanges can be alleviated in several ways. These include (1) converting free-flow right-turn ramp terminals to signalized junctions, (2) separating ramp and arterial left turns into major developments (see Figure 7). (The latter treatment has operated successfully at South Shore Plaza, Braintree, Massachusetts for more than a quarter century.)

   b. **Modifying Interchange Design:** Interchanges have become magnets for both land development and traffic. Many of the problems result from forecasts and designs that did not fully anticipate the changes resulting from improved accessibility. There is a need for more realistic properties of land use impacts and volumes wherever interchanges are built. Interchange and arterial design concepts must be more cognizant of development potentials and access needs. Several opportunities exist, both in retrofit and new development situations.

      (1) Frontage roads along freeways can be better integrated with ramps at interchanges so that one rather than two roads intersect the arterial in each direction of travel. In addition, a continuous system of frontage roads can provide additional property access and reduce reliance on arterial road access.

      (2) Interchange configurations can be developed and modified to provide direct access to major streets or developments, thereby avoiding double loading arterials and reducing weaving and turning volumes.



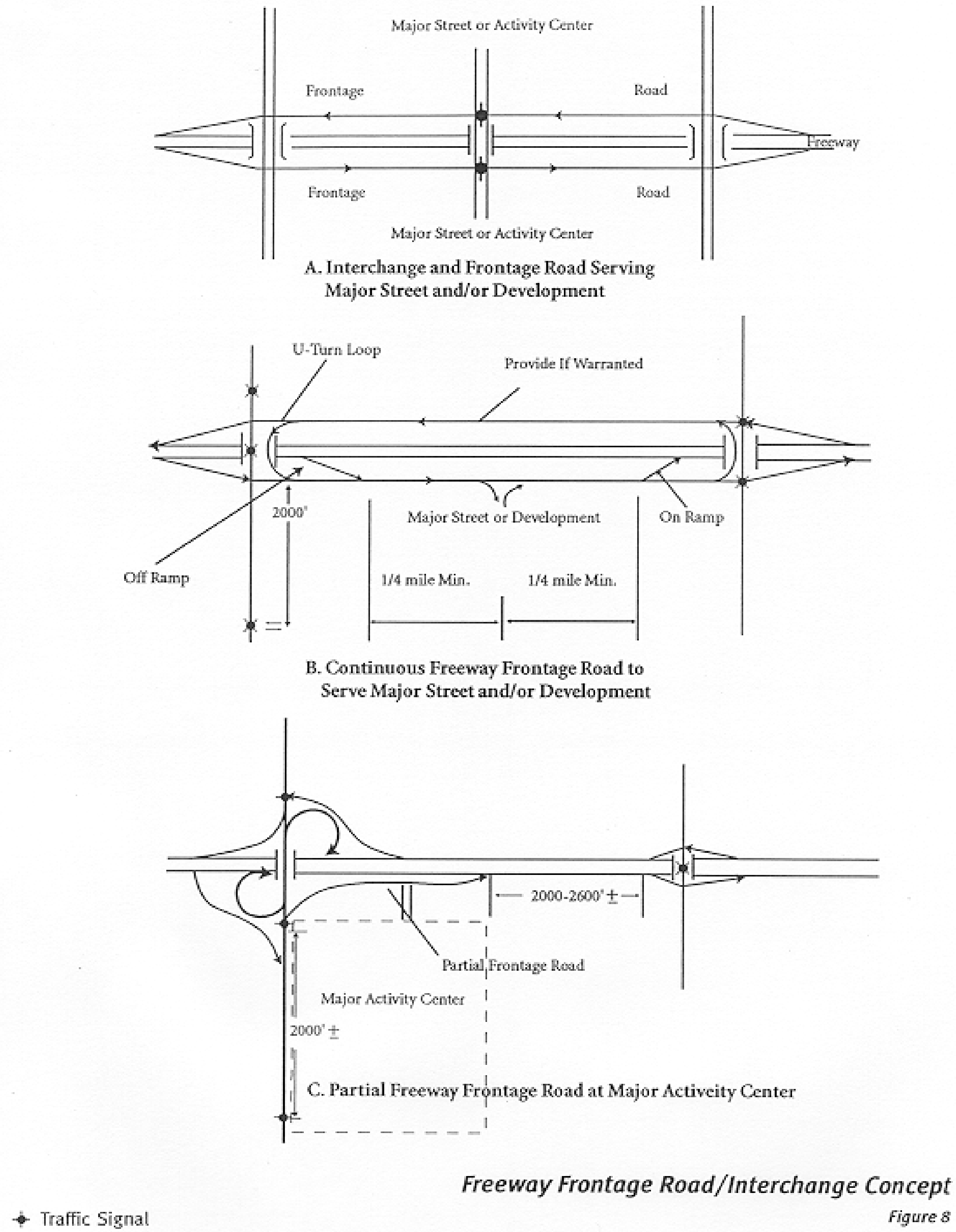
Concepts For Left Turns

Figure 7

(3) Frontage roads along freeways and expressways are used in many urban, suburban, and even rural settings to maintain the integrity of the local street system and to provide access to adjacent land development. The frontage roads can be integrated with the interchange and ramping system to alleviate congestion on interchanging arterials near major streets and activity centers, and to increase the connectivity and access opportunities for developments that front along freeways. Figure 8 illustrates freeway frontage road/interchange concepts. Figure 9 shows a partial frontage road ramp extension that was installed in Mystic, Connecticut to reduce left-turn volumes and provide more direct access to major land developments.

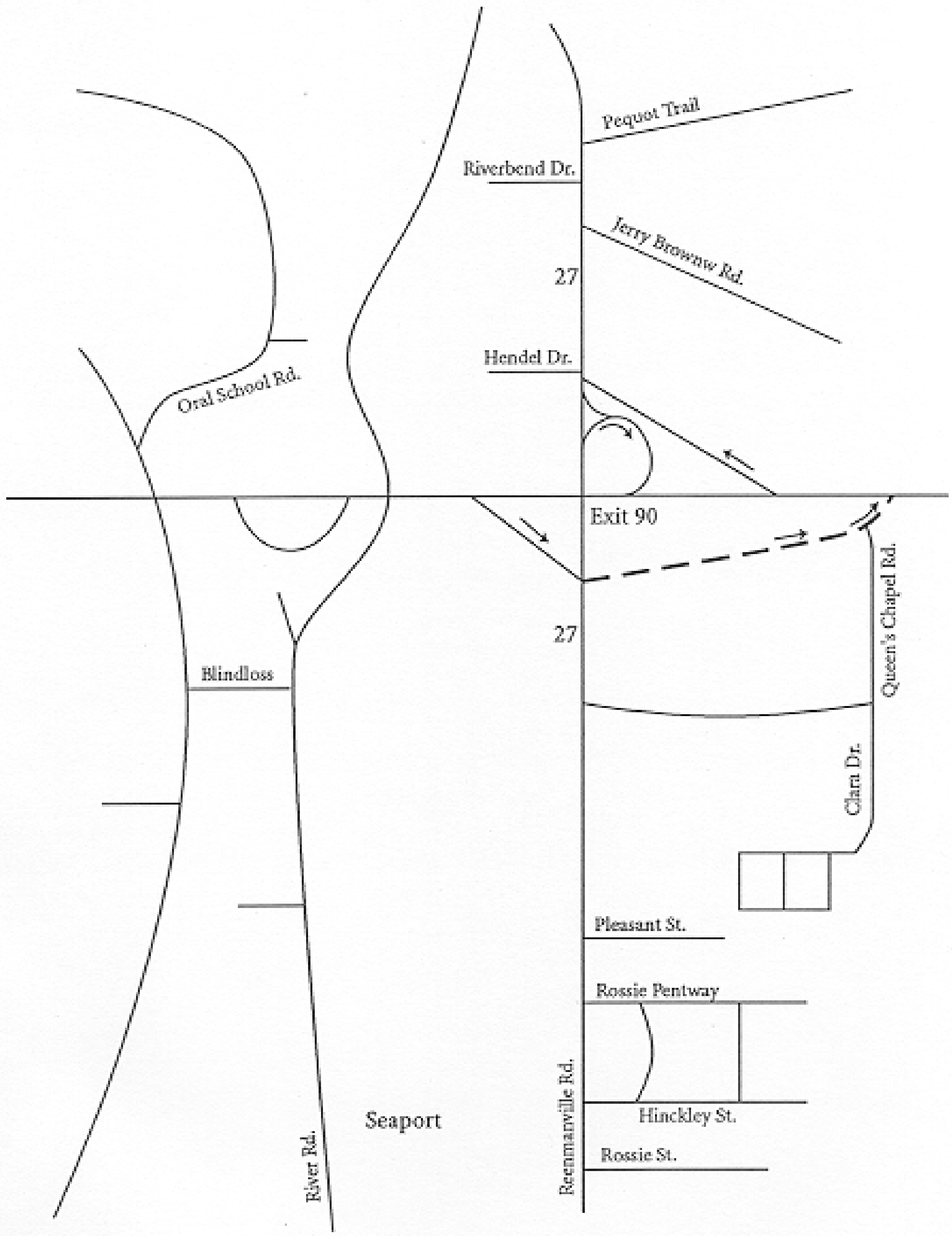
c. **Setting Spacing Standards:** Access spacing standards should be established for arterials, especially in undeveloped and developing areas. From an access management and spacing standpoint, the many different kinds of interchanges can be generalized into the two basic types shown in Figure 10 those with signalized and free-flow ramp terminals, respectively. For signalized ramps, signal spacing criteria from the artery should govern where intersections are signalized. For ramps with free-flow entry, or exit, access separation distances to the first downstream median opening or signalized intersection should consider the various movements and operations involved. These include: the merge where the ramp traffic enters the artery; the weaving movements to enter the median lanes; the transition into left-turn lanes; and the required storage length.

Providing adequate separation distances along arterials, and improving interchange design best can be achieved in the initial interchange planning and location process as part of a joint land use and transportation planning effort. The product of such an interchange access management plan would be more rational arrangements of streets and development, better access separation distances, and preservation of mobility and safety over the long run.



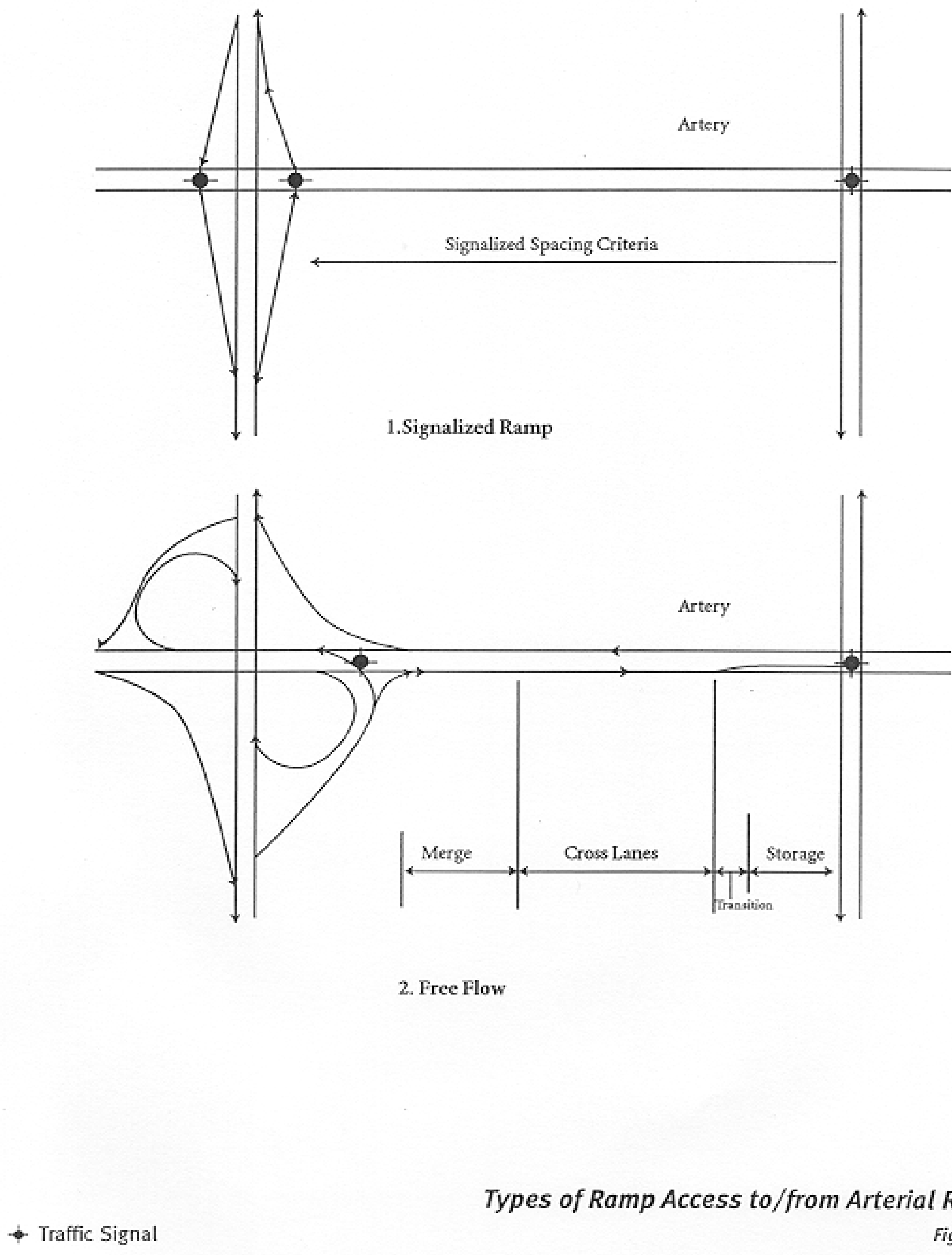
Freeway Frontage Road/Interchange Concept

Figure 8



Ramp Extension At Mystic CT To Reduce Left Turns

Figure 9



Types of Ramp Access to/from Arterial Roads

Figure 10

Session 4

Site Planning Basics Workshop

Moderator: Vergil Stover, CUTR

Session 5

Access Management And Non-Auto Modes

Moderator: John Taber, Tabermatics, Inc.

Participants: Robert Layton, Oregon Department of Transportation
Xavier R. Falconi, Falconi Consulting Services
Charles R. Carmalt, Lehr & Associates, Inc.

Pedestrian and Bicyclist Impacts of Access Management

Robert Layton, Oregon State University
Glen Hodgson, Oregon State University
Kate Hunter-Zaworski, Oregon State University

Abstract

The objective of this paper is to analyze and evaluate the impacts of access management from the perspective of the pedestrian, bicyclist or transit user, and where possible, suggest modifications in design, control or planning strategies to minimize or eliminate those impacts.

Some of the conditions for automobiles that generate conflicts are high speed operations, impaired visibility, high volume operations and unexpected presence of pedestrians and bicyclists. Pedestrian and bicyclist crossing locations are major conflict areas. Some obvious conflicts occur due to driveway approach design where flat radius curve returns generate conflicts between the pedestrians and entering vehicles with longer crossing distances, higher speed and impaired visibility. Modification to the driveway design standards to minimize these impacts are proposed.

The location of transit stops also create potential problems due to the conflicts in bus/automobile operations and the pedestrian access of transit users, both on the street and to adjacent developments. Location of crosswalks, walkways and the normal desired routes for pedestrian travel all must be taken into account to assure driveways and off-street parking are located and designed properly.

CONTENT

This paper summarizes the literature, issues, data collection and findings on the impacts of access management design features, operations and operational strategies on pedestrians and bicyclists.The findings discussed in the paper are the result of a research project funded through the U.S.D.O.T. Universities Research Program through the Transportation Northwest Program at the University of Washington, Seattle, Washington. The study is still underway.

ISSUES

The primary issues addressed in this paper include more than safety issues. Safety for pedestrians is important, as are the safety impacts on vehicular traffic due to accommodation of pedestrians.However, the convenience for pedestrians also is of major importance, including travel time, delays and out-of-direction travel. Pedestrian behavior is more variable and more difficult to control than drivers, and their characteristics, abilities and knowledge are more diverse and vary more. Pedestrians need to be well protected where they cross the major streets. Where vehicles cross pedestrian facilities, the design should accommodate vehicles at low speeds. Driveway and approach road design must meet ADA and other local design requirements.

PEDESTRIAN AND BICYCLIST CHARACTERISTICS

Pedestrians, generally, are slow, unprotected and less familiar with traffic laws than drivers. Their ages cover a wider spectrum from young children to frail elderly, and they do not understand or accept control as well as drivers do. A wider range of disabilities exist in the pedestrian population, including persons with visual impairments, people who use mobility aids, hard of hearing and intellectually challenged individuals.

Pedestrians are more difficult for drivers to see and avoid due to their size, color and lack of caution. Also, to assure safe operation, drivers focus on avoiding other vehicles, rather than pedestrians. Further, pedestrians may wear dark unreflective clothing and often do not carry lights, so they are very vulnerable in poor lighting conditions.

Bicyclists have many of the same characteristics as pedestrians, but to a lesser degree. Their age range is not broad and they accept control better than pedestrians do. Further, fewer disabilities are present in the bicyclist population. Their operating speeds are higher and some of them have lights.

SPEED EFFECTS OF DRIVEWAYS

The speed profile of driveway traffic shows that vehicles begin to decelerate beginning 250 ft or more upstream, depending on the approaching vehicle's street speed, as developed by Stover et al.As shown in Figure 1, the driveway traffic travels at a forward speed of 15 to 25 km/h (9 to 14 mph) as it enters the driveway regardless of the design geometries, except where an added right-turn lane is used.

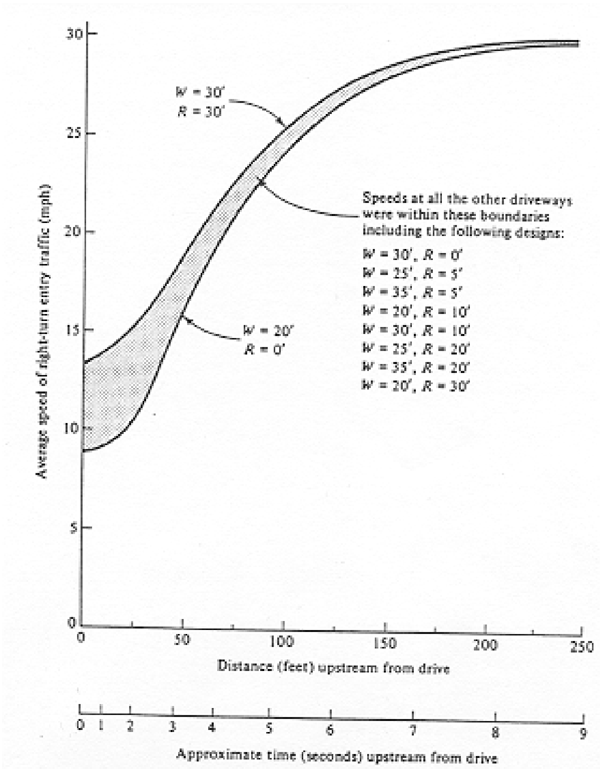


Figure 1. Speed Profile of Vehicles Upstream of Driveways

The speed vector parallel to the through traffic lane ranges from about 2.5 to 5.0 km/h (1.5 to 3.0 mph) as the vehicle clears the through traffic lane when making a 90' turn. The high speed differential between the exiting driveway vehicles and the major roadway traffic can result in serious accident potential, as shown in Table I following. This implies that vehicles traveling at 55 km/h (35 mph) less than the major roadway traffic would have 90 times the likelihood of an accident as a vehicle traveling 15 km/h (10mph) less than normal traffic.

Table 1: Relationship between Speed Differential and Accident Potential

Speed Differential (mph)	Relative Accident Potential
-10	1
-20	3.3
-30	23
-35	90

Source: V. Stover and F. Koepke, *Transportation and Land Development*, I.T.E., 1988

Vehicles entering also are likely to conflict with the major roadway traffic, since normal acceleration rates are quite low, in the range of 1-1.25 m/seC (3-4 ft/SeC2) With speeds between 25km/h and 80 km/h (15 and 50 mph). It takes significant time and distance for these vehicles to achieve the speeds of the through vehicles; consequently, shock waves develop, delays occur, conflicts result and collision may occur. The higher the volume of through traffic and the greater the driveway demand, the greater the conflicts and impacts.

IMPACTS OF DESIGN AND OPERATIONAL STRATEGIES

Virtually all access management designs and operational strategies impact pedestrians and bicyclists to some degree. There are a number of design features, operations, controls and operational strategies that impact pedestrians and bicyclists very significantly.These include

- Driveway spacing

- Driveway horizontal profile

- Driveway vertical profile

- Sidewalk locations at driveways

- Added right-turn lanes at driveways

- Median use, design and opening location

- Left-turn lanes

- Off-road interparcel circulation

- Signalized intersection spacing

PEDESTRIAN IMPACTS

DRIVEWAY SPACING

At every driveway there are at least four potential pedestrian-automobile conflicts. A reduced number of driveways reduces the conflicts and increases the safety. Pedestrians have right-of-way where driveways cross sidewalks, but drivers may be distracted or ignore the pedestrian's right-of-way. A longer separation of driveways eliminates the conflicts and confusion that result from overlapping driveway operations. The severity of the conflict increases as the speed of vehicle crossing a sidewalk increases.

The reduced number of driveways from increased spacing clearly reduces the number of conflicts. However, the number of total events of exiting vehicles remains unchanged for a block face.The land use in the block generates essentially the same number of trips regardless of how many driveways are present. So, the pedestrian impacts due to driveway spacing are not changed, unless the driveways are allowed to be so close as to have overlapping driveway operations. Driveway spacings specified in a prudent access management program would not allow driveways close enough to experience overlapping driveway operations.

DRIVEWAY HORIZONTAL GEOMETRICS

The speeds of operation of vehicles entering driveways are potentially a major safety impact for pedestrians and bicyclists. The speeds of entrance are influenced by the driveway radius, throat width and throat depth; they typically range from 16 to 24km/h (10 to 15 mph) even though the driveway radius may be up to 10 m (35 ft), as shown in Figure 2. Only very flat radii, say 15.2m (50 ft) or more, may result in the entrance speeds of more than 24 km/h (I 5 mph). Such radii are very unusual, even on approaching public streets.

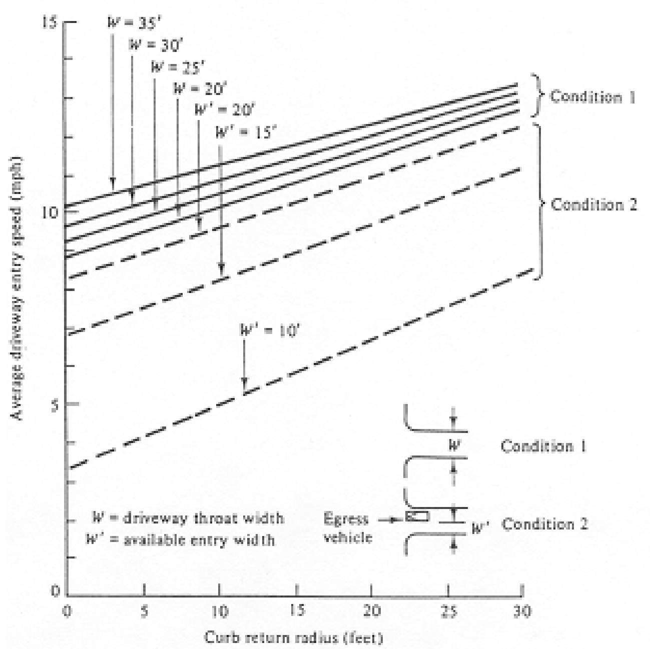


Figure 2. Driveway Entering Speeds versus Curb Return Radius and Throat Width (source: Stover and Koepke, *Transportation and Land Development*)

The potential safety impact to pedestrians for speeds of this magnitude at driveway/sidewalk crossing is put in perspective when it is realized that the maximum speed in school zones in most states is 32 km/h (20 mph). Speeds of 32 km/h (20 mph) are not experienced at most driveway locations.

Data were collected at eight sites in four different cities in the Willamette Valley in Oregon to determine the speeds of vehicles entering driveways with pedestrians present or not present. Speeds were measured when the vehicles were at an angle of approximately 45 degrees from the alignment of the street.

This study showed that the speeds do not change significantly when a pedestrian is present; drivers do not slow as a precautionary measure with pedestrians at the driveway. Table 2 shows only one of the eight the sites where the speeds changed significantly with pedestrians present, and there the speeds increased.

The significant increase in speed for vehicles entering driveways with pedestrians present occurred because drivers were attempting to enter the driveway before the pedestrian can cross the driveway. The driveway at this location is 13.6 m (45 ft) wide with three lanes. When exiting vehicles are not present, drivers were observed to speed up and drive across the exit lanes to avoid pedestrians.

Table 2. Average Speeds Entering Driveways

Driveway Type	Width (ft)	Speed (mph) No Pedestrian Present	Pedestrian at Far Side	Pedestrian at Near Side
1. Dustpan	30	9.4	8.6	10.5
2. Dustpan	45	6.8	9.1*	—
3. 25' Radius	42	12.8	—	11.4
4. 20' Radius	42	11.9	11.4	12.1
5. Dustpan	42 42	7.0 7.2	6.6 7.9	6.7 8.0
6. Dustpan	36 36	7.2 10.6	— 10.0	6.8 —
7. 20' Radius (1 way)	25	11.1	—	10.7
8. 20' Radius (1 way)	25	9.6	—	9.5

*Significantly different at 90% level.

It should also be noted that the average speeds with"pedestrians present" ranged from 10.6 to 19.4 km/h (6.6 to 12.1 mph), while the average speeds with "no pedestrians present"ranged from 10.9 to 20.5 km/h (6.8 to 12.8 mph.) The dustpan and 6.1-7.6 m (20-25 ft) curb return radius designs with widths for the sites in the sample are very typical. The low speeds measured with pedestrians present indicate that vehicular speeds are not a major safety problem at driveways.

DRIVEWAY VERTICAL PROFILE

The presence of pedestrians does not seem to alter speeds of vehicles approaching a driveway. Lower speeds reduce the degree of hazard of the conflict between vehicles exiting a driveway giving more time to react and reduce speed of impact. The driveway profile can control speeds to reduce hazards to pedestrians; however, this increases the speed differential on the main roadway and increases the accident potential.

Data were collected at four different sites to evaluate the effect of driveway profile on speeds for vehicles entering the driveway. The movement most affected is the left-turning entering vehicle. A maximum algebraic difference in grade of 12-14% is found to be the limiting condition for many vehicles to avoid scraping the front or rear bumpers.

The impact of driveway vertical profile on the speed of vehicles entering the driveway is shown in Table 3 and Figure 3.

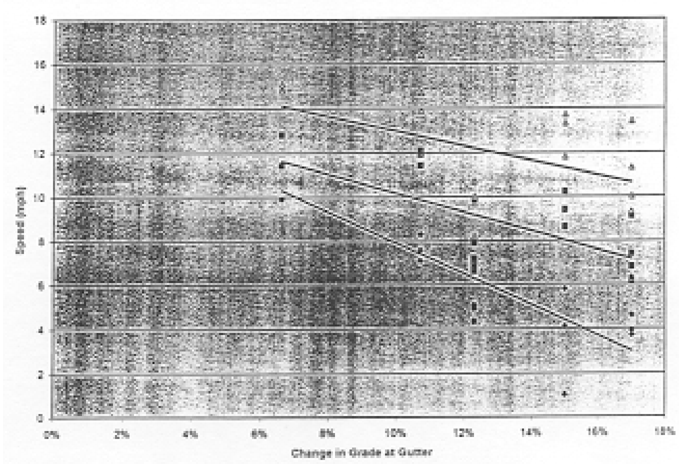
As indicated earlier, the maximum desirable algebraic difference in grade is 12-14%; the speeds are reduced by the vertical profile regardless of the horizontal geometries used.Pedestrian impacts could be reduced by using steep driveway slow too much in the street and are a hazard to other drivers. This significantly increases the potential for accidents on the street.Further, the speed difference of operations in the driveway does not change enough to help increase safety for pedestrians since speeds already are quite low.

Also, steep vertical profiles on driveways may also leave a steep cross-slope for the sidewalk section which poses a severe hazard for mobility aid users when the cross-section is greater than 2%.

Table 3. Average Speed with Respect to Profile Algebraic Difference

Site	Algebraic Difference In Grade	Average Speed (mph)	
		Right-Turn In	Left-Turn In
Dustpan	17.0%	7.4	6.8
Dustpan	12.3%	7.0	7.2
Dustpan	7.2%	7.2*	10.6
Dustpan	13.4%	9.4	8.8

*Significant difference at 95% confidence level.



Summary of Speeds versus Driveway Grades

Figure 3.

SIDEWALK LOCATIONS AT DRIVEWAY

The location of driveway directly adjacent to the curb places the conflicts close to the conflicts on the roadway. This compounds the operations and the sighting process for both drivers and pedestrians.

Where sidewalks are set back, a number of benefits to drivers and pedestrians are realized. A driver can pull completely out of the traffic stream before stopping to yield to a pedestrian if the planter strip is of an adequate width. Pedestrians are separated from major street traffic and better protected. The driveways can maintain a constant flat grade, without obstruction, thereby easily meeting ADA requirements.

ADDED RIGHT-TURN LANE AT DRIVEWAYS

One proposed improvement that can reduce speeds of vehicles turning into a driveway is an added right-turn lane. This allows the vehicle to decelerate in the lane and turn at a minimum radius curb.This results in a minimum turning speed and a narrow crossing for pedestrians.

The effectiveness of right-turn lanes at driveways in reducing speeds was investigated by comparing driveway pairs that had similar geometries except for the presence or absence of a right-turn lane on the main street. Two driveway pairs were investigated. The first pair both have a divided cross-section with two 7.6 m (25 ft) roadways with a 2.1 m (7 ft) median and a 6.1 m(20 ft) radius curb; the driveway profiles are both relatively flat at3.0% and 6.2% algebraic differences, respectively. The second pair both have a 10.9 m (36 ft) undivided cross-section with a dustpan design; the driveway profiles are both moderate at 7.2%and 9.8% algebraic differences, respectively. The comparison of the average speeds is given in Table 4.

Table 4. Travel Speeds for Comparable Driveway Pairs with/without Right-Turn Lanes

Driveway Pair	Average Observed Speed (mph)		Speed Difference (mph)	Standard Deviation (mph)	
	No Right Lane	Right Lane		No Right Lane	Right Lane
1	11.1	9.6	25*	1.89	1.72
2	10.5	7.2	33*	1.78	1.97

*Difference statistically significant at 95% level of confidence

This limited database indicates that an added right-turn lane can reduce speeds; however, the speed difference is not seen to be large.

MEDIANS

The impacts of the design and use of medians on pedestrians are numerous and very significant. The safety effects of raised medians on pedestrians are demonstrated by the pedestrian-vehicle crash rates given in Table 5. This table summarizes the results of a study by Bowman and Vecellio on vehicle/pedestrian crashes on arterial streets in Atlanta, Georgia; Phoenix, Arizona; Los Angeles and Pasadena, California. In general, the pedestrian accident rates are lower with raised medians than undivided highways or those with continuous two-way left-turn lanes (TWLTL). This is reinforced by the results from a study in Florida in 1993 by Long, Gan and Morfison, shown in Table 6. The rates at intersection and mid-block for undivided streets and TWLTLs are higher than raised median and also flush grass.

Table 5. Pedestrian-Vehicle Crash Rates

Area	Location	Median Type		
		Raised	TWLTL	Undivided
CBD	Midblock[1]	9.74	11.71	21.65
	Intersection[2]	3.28	1.31	4.02
Suburban	Midblock	3.86	6.66	6.69
	Intersection	0.97	2.49	2.32

[1]Crashes per 100-million vehicle miles
[2]Crashes per 100-million vehicle miles entering intersection
Source: Reference 3

Table 6. Crash Rates[1] Involving Pedestrians on Urban Arterials in Florida

Median Type	4 Lane		6 Lane	
	Total	Midblock	Total	Midblock
Undivided	18	11	NA	NA
TWLTL	10	6	11	7
Flush Paved	9	4	12	8
Flush Grass	3	2	5	4
Raised	4	2	8	4

[1]Crash rates per 100-million vehicle-miles.
Source: Reference 4

The presence of medians is very advantageous to pedestrians, if at least 1.2 m (4 ft) of width. In general, medians are beneficial to pedestrians, but attention must be given to design details. Medians with cut throughs and adequate storage space provide areas of safe refuge for pedestrians. On particularly wide streets, medians with pedestrian sensors can be used to assist with better signal timing where pedestrians take two signal cycles to cross the street. In this circumstance, adequate space must be provided for the pedestrians on the median.

SIGNALIZED INTERSECTION SPACING

The spacing of signalized intersection, on the surface, would not impact pedestrians dramatically. However, safety, travel time, convenience and access to activities can be impacted if pedestrian needs are not considered.

The recommended minimum spacing of signalized intersection is 1/2 mile. If no other crossings are provided, this can require significant out-of-direction walking to cross at the signal.The long walk may prompt pedestrians to cross at mid-block locations without protection, with major hazard to pedestrian. No data were collected in this study to confirm this hypothesis. However, the hazardousness of unprotected of rnid-block crossing by pedestrians is demonstrated in both Table 5 and Table 6. Bus stops and other transit facilities are most often located near signalized intersections.

Mid-block crossings with or without signals can readily eliminate the hazardous potential and reduce the travel distance and inconvenience. The design and control of these locations must be treated with care to assure safe operations.

BICYCLE IMPACTS

The study of bicycle impacts is still underway. Some of the impacts on bicyclists are the same as found for pedestrians.However, the operations and impacts can be more complex because the bicycle must operate as vehicle but has characteristics similar to the pedestrian.

DRIVEWAY SPACING

The frequency of driveways along major streets impacts bicyclists much as it does pedestrians. The more frequent the driveways are placed, the greater the number of conflicts and overlapping conflict areas. Therefore, the larger driveway spacing, or separation, reduces conflicts and hazards.

DRIVEWAY GEOMETRICS

The driveway geometries, in general, do not affect bicycle operations significantly due to these lower operating speeds and maneuverability. Operating problems and hazard of falling can result from use of a lip, or discontinuity, at the gutter line in a driveway. Bicyclists can be thrown if they hit this discontinuity obliquely.

ADDED RIGHT-TURN LANE AT DRIVEWAYS

An added right-turn at a driveway does not create significant operational or safety problems for bicyclists. Since the conflicts are separated, they are less severe. Further, the appropriate markings for bike lanes can reduce operational problems and hazards at these locations.

MEDIANS

No data were collected or found that shows the impacts of medians on bicycles. However, the effects of medians on vehicular traffic would be similar since medians control or eliminate left-turns. Various research efforts have found that 70% of the accidents at driveway locations are left-turn related.

The severity of conflicts are controlled at locations with continuous two-way left-turn lanes. The left turning maneuver is less complex because the vehicle can pull out of the traffic stream.They then have time to see and accept a safe gap between on-coming vehicles and oncoming bicycles. Obviously, if a raised median is used, the left-turning conflicts are eliminated.

BICYCLE-VEHICLE INTERACTION

Some data were collected in this study to determine the effect of a bicycle on a vehicle that is entering a driveway. The study determined the times that a vehicle would yield the right-of-way when they were 45 m (150 ft) upstream of the driveway. Table 7 shows the number of vehicles yielding relative to the bicycle location upstream of the driveway.

Table 7. Number of Turning Vehicles Which Yield to Bicycles

Bicycle Location	Turning Vehicle Yields to Bicycle	
	No	Yes
0-25 ft	0	1
26-50 ft	0	3
51-75 ft	0	2
87-100 ft	0	4
101-125 ft	1	3
126-150 ft	3	1
151 ft+	2	0

From this data it appears that vehicles will normally yield to bicycles if a bicycle is 38 m (125 ft) or closer to the driveway. This implies that the vehicle must essentially stop in the roadway, increasing the speed differential, and consequently the accident potential, to the vehicle and the bicyclist.

CONCLUSIONS

In conclusion, there are impacts to pedestrians and bicyclists due to access management. However, the detrimental impacts are not severe or are readily correctable. Further, some access management designs and operational strategies reduce pedestrian and bicyclist impacts.

In summary, the following conclusions can be drawn:

- With driveway spacing, pedestrian impacts are reduced due to the longer driveway spacing typically required by access management codes.

- Typical driveway horizontal geometries do not have a major impact on pedestrians since vehicle driveway entering speeds are typically between 15 to 25 km/h (9 to 14 mph).

- Driveway profiles significantly slow driveway entering speeds for algebraic difference in grades of 12-14% or more.

- An added right-turn lane can reduce the entering speed of vehicles at the driveway curb return even more. Plus, the conflicts are reduced and the walking distance can be decreased.

- Raised medians or other non-traversable medians, in general ,reduce the hazard to pedestrians.

- Signalized intersection spacing can increase accidents by encouraging pedestrians to cross mid-block. Mid-block crossings can reduce this hazard.

- Signalized intersection spacing can potentially increase walking distance and reduce convenience to pedestrians. Mid-block crossings can mitigate the inconvenience.

Improvements that have major potential to reduce pedestrian impacts include:

- Added right-turn lanes can reduce speeds at the driveway/sidewalk crossing and reduce conflicts and confusion.

- Medians, particularly raised medians, can reduce accident potential and severity, and provide an area of refuge.

- Mid-block pedestrian crossings, signalized or unsignalized, can reduce accidents, travel distance and inconvenience.

This paper provides some preliminary results on the study of pedestrian, bicyclist and transit impacts of access management.

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Relationship Between Access Management And The Design Of Bicycle And Pedestrian Facilities

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ABSTRACT

The intent of this paper is to provide a background on access management practices in the State of Oregon, a brief discussion on the current transportation planning elements that encourage the application of access management techniques and the relation of its applications on the design of bicycle and pedestrian facilities. It also contains a brief discussion of the Oregon Department of Transportation (ODOT) Access Management Policy and the Transportation Planning Rule (TPR), and how these elements are driving local communities toward implementing access management plans around the state.

INTRODUCTION

Today Oregonians are facing crossroads with respect to the state transportation systems. The interstate highway system has been completed. Transportation deregulation that begun in the 1970s has eliminated most of the economic regulation from rail, trucking, and aviation. The federal government no longer pays 100 percent of the costs associated with navigational projects. The 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) and now the Transportation Efficiency Act (TEA-21) are moving the country toward a multimodal transportation system.

Transportation is a part of the vision for Oregon articulated in the Land Conservation and Development Commission's (LCDC) Statewide Planning Goals and Guidelines and in the Oregon Benchmarks. The statewide planning goals reflect the concerns of hundreds of citizens who participated in updating them since then. The Oregon Progress Board developed the Oregon Benchmarks in 1990 after a series of public meetings, and the legislature adopted them as state objectives in 1991.

The statewide planning goals directly relating to transportation envision a safe, convenient, and economic transportation system that maintains and improves air and water quality, satisfies recreational needs, conserves energy, protects estuaries, protects natural and scenic resources, and provides adequate opportunities throughout the state for a variety of economic activities. The goals require planning and developing a timely, orderly, and efficient arrangement of public facilities and services as a framework for urban and rural development.

The LCDC Goal 12 Transportation Planning Rule calls for developing land uses and transportation facilities that are mutually supportive. In urban areas, it relies on increased use of transit, bicycling and walking.

Oregon's population will grow faster than the nation's for most of the next 40 years. According to ODOT forecasts, the state's population is projected to increase from 2.8 million in 1990 to 3.8 million in 2012 and to almost 4.0 million in 2030. Most of this growth will take place in the Willamette Valley, where population densities will approach those of more urban states. Much of the state's growth will take place in suburban areas.

Increased demands for transportation services will be most prevalent in the Willamette Valley, especially in the Portland metropolitan area, and in the Medford metropolitan area of the Rogue Valley. Congestion will become an increasing problem in all metropolitan regions but specially in the Portland metropolitan area. Links to rural areas must be maintained and enhanced in order to serve the economy of regions outside of metropolitan areas and the Willamette Valley.

LAND USE DEVELOPMENT PATTERNS

Land use policy will continue to be the primary tool used by Oregonians to guide development of the state while protecting its resources and livability and developing its economy.

Although urban growth boundaries have discouraged urban development in rural areas, metropolitan areas have developed at a level of density and in patterns that often discourage the use of public transit, bicycles and pedestrian walkways. Low density development has resulted in the kind of sprawl that creates congestion and air pollution. Often transportation facilities have not supported local land use plans and vice versa.

To create more livable communities and to encourage the use of transportation alternatives to the single occupant vehicle, land use policies are changing to support:

- Downtown cores that maintain healthy central hubs for commerce within an urban region.
- Increased density and infill development for efficient use of urban land balanced by open space areas and better residential site design for privacy and safety.
- Improved circulation systems for pedestrians, bicycles and transit that allow for their exclusive use in some areas and provide safety where they come into contact with autos.
- Mixed use developments where housing, daycare, schools, commercial areas, and employment can be close together to minimize travel.

In rural communities of the state, land use planning will become a tool to promote development through the logical planning and extension of public infrastructure and services necessary to support new industry and development. Scenic attractions will enhance the tourist industry.

THE ROLE OF ACCESS MANAGEMENT

The TPR requires ODOT to identify a system of transportation facilities and services adequate to meet identified state transportation needs and prepare a transportation system plan (TSP). It also requires that TSPs be based on transportation capacity analysis based on information which also critically impacts administrative elements of access management.

The TPR sets requirements for coordination among affected levels of government for preparation, adoption, refinement, implementation, and amendment of transportation system plans. It provides that major road improvements to state highways of regional or statewide significance have to reduce accesses to the minimum practicable and can not exceed that which would be consistent with the function and operation of the highway considering traffic at buildout of nearly rural lands.

It is the policy of ODOT to control access to state highway facilities to the degree necessary to maintain functional use, highway safety, and the preservation of public investment. Access control and management can play a critical role in achieving the Oregon Transportation Commission's goal of preserving and maintaining the functional use of the present highway system. Without effective access control and management the state is in effect committing itself to a policy of bypassing the bypasses that have become clogged through inappropriate land use planning and inadequate or insufficient access control policy and management.

Traditionally, the Oregon highway system has served two types of travel: high speed through travel and land access. Both traffic movement and land access are necessary but often conflicting functions of the road system. A variety of facilities are used to carry out these two functions. Arterials are primarily intended for the movement of through traffic. Local streets provide access to abutting land at the expense of through traffic movement. Collectors are intended to give relatively equal service to both functions.

While arterials are designed for long travel distances and for high speeds, they often become popular for short distance trips as well. This heavy use of arterials makes them desirable for business to locate. This in turn attracts additional development often resulting in strip development. With one or more accesses for each business or residence, the resulting turning movements onto and off an arterial can impede the flow of traffic. As the number of accesses and the intensity of roadside development increases, the accident rate also increases. Before long, an arterial may be performing very poorly in serving through traffic or providing safe, easy access to abutting properties.

Frequently, the orderly economic and land use development of cities and counties has been altered by the presence of a state highway. State highways are designed primarily for longer travel distance and for higher speeds. Because the public can normally expect to travel at higher speeds on the state highway system, highways become popular for travel other than intercity. Eventually, a state highway is the fastest route to cross, enter, or leave town.

Traffic increases rapidly when a highway through town is improved or new route built. Sometimes businesses expand and development pressures intensify hoping to take advantage of the state investment. Often there is an expectation that state funded improvements will ameliorate resulting congestion. Local zoning ordinances often do not discourage this practice, particularly in smaller cities, growth patterns orient toward the highway and strip development emerges.

In some cities there are several “downtowns” because the routing of a major highway has changed. The ultimate result is that highways become congested with local traffic and soon exceed their capacity.

In the past, such highways might have been widened, a bypass built, or some other improvements made. This has always been expensive due to the change in land use along the highway over time. What were once vacant properties at the time of initial construction are now business sites.

Frequently, structures are close to right-of-way lines forcing expensive condemnations and relocations. Often after the section is reconstructed travel resumes at a faster pace encouraging business development even further from the center of town creating more travel and congestion. This enables quick, low cost development which may relieve local tax burden and in case of annexation, absorption of this new development will increase the local tax base. Cities looking to ODOT for help will find that this agency simply may not have funds to correct local mistakes in land development.

Residential development poses some related problems. Both major residential developments and incremental development add to local highway congestion. Incremental development slowly erodes some controlled access facilities and turns other facilities into local land service roads.

ODOT gained approval of the Land Conservation and Development Commission for its State Agency Coordination Program. Achieving effective coordination between state and local planning bodies was one of the principal issues addressed by the 1973 Legislature in passing Oregon's land use planning act. The law requires agency coordination to be brought about in two ways: (1) through the preparation, acknowledgment and periodic review of comprehensive plans, and (2) by the preparation and certification of state agency coordination programs.

THE ODOT ACCESS MANAGEMENT POLICY

The citizens of the State of Oregon have an enormous investment in their state highway system. At one time highways could link the state's activity centers to each other and serve as "Main Streets" for communities, facilitating roadside development . This is no longer the case because highways are costing more to construct, and poor access management in the past has made it necessary to build new bypasses when old bypasses have become congested because of new development along the route. This presents a sizable challenge to protecting the system and maintaining reasonable levels of service for users.

Several factors, including the number, spacing, type and location of accesses, intersections, and traffic signals have a significant effect on the capacity, speed, safety, and general operational efficiency of the highway. These factors need to be effectively managed in order to operate the highway system safely, at reasonable levels of service and in a cost effective manner. Collectively these factors comprise access management.

The Oregon Transportation Commission recognizes the importance of an effective access policy in managing and protecting the system of state highways. Access management categories were developed to assist ODOT in achieving effective access management, and they are to be applied to all sections of the state highway system.

Standards were developed for each category to ensure that all state highways will continue to function safely and efficiently. These standards will be applied to ODOT's access management, operation, design, and local planning coordination actions in accordance with the following considerations from the ODOT Access Management Policy:

1. The existing connections, median openings and traffic signal spacing of a highway segment are not required to meet the spacing standards of the assigned category at the time of assignment. The assigned category provides a mechanism for improving a highway to its eventual functional purpose. The use of existing permitted connections, not conforming to the standards, will continue to be allowed unless a traffic problem develops.

2. The access management category standards represent minimums for each access. More stringent levels of access management will be retained where they already exist. For engineering design reasons, the minimum distances for spacing may have to be greater than those specified in the Access Management Classification System. Examples include the need for auxiliary lanes and additional storage.

3. In cooperation with the appropriate local governmental entity, ODOT may enact different standards to meet the requirements of the Level of Importance policy and this policy through the adoption of individual corridor access management plans. Local government agencies affected by these access management plans will be notified and their input requested.
4. Although this policy focuses on new and emerging areas, it is meant also to encourage "retrofitting" problem areas with better access management plans in cooperation with local governments.

5. Single ownership properties with frontage exceeding the minimum spacing standards shall not be permitted the total number of connections, median openings or traffic signals possible based on the

spacing standards. The total number of connections permitted shall be the minimum necessary to provide reasonable access based on operational, safety, and functional integrity considerations for the highway.

6. Connections permitted in accordance with this policy shall be designed and managed to be consistent with the function and purpose of the state highways as presented in this and other policies, and to operate safely, efficiently, and cost effectively.

7. In conjunction with major improvements to interstate, statewide, or regional highways in rural areas, access will be managed to be consistent with the requirements of Statewide Planning Goals 11 and 14 and administrative rules adopted by the Land Conservation and Development Commission to carry out those goals. Major improvements include major realignments, the addition of travel lanes and new interchanges and intersections.

Access management categories will be assigned to all sections of the state highway system. The following factors are also being considered when making assignments:

- Existing and proposed roadside development patterns
- Regional and local transportation system plans and comprehensive plans
- The potential for increasing the use of local roads to provide property access and local circulation
- Topography, drainage, or other land considerations
- Existing access agreements between ODOT and local jurisdictions
- Other operational aspects of access

PROBLEMS WITH UNCONTROLLED ACCESS

ODOT and local jurisdictions are confronted on a daily basis with applications for land use development adjacent to either the state highway system, arterials, collectors, and local streets. Typically, one element that these jurisdictions use to evaluate the impact onto their transportation system is a Transportation Impact Study that is submitted with the land use action application.

The specific elements of a Transportation Impact Study vary depending on the jurisdiction but in most cases the study would provide mitigating measures to resolve the anticipated impact. Access management could be an important element in mitigating the impact from a proposed land use development onto a transportation facility.

With unrestricted access to a transportation facility, the following are the anticipated problems:

- Conflicts between cars entering or exiting a road, and bicyclists and pedestrians riding or walking the road.

- Pedestrians crossing a road need gaps in traffic stream but with unlimited access vehicles entering the road fill available gaps.

To provide for a more efficient and safer design for an access and taking into consideration the interaction with bicyclists and pedestrians, the following elements should be taken into consideration in designing accesses:

- If an access is not designed properly, a vehicle may be forced to enter or exit without taking into consideration pedestrians or bicyclists near the access point. In cases where large turning radii are used, precaution should be taken to make certain that the driver would recognize the possibility of encountering a pedestrian or a bicyclist crossing the access. This can be done either by providing adequate striping or perhaps restricting the access to a right-in/right-out to eliminate an unanticipated turning movement from a vehicle entering or exiting the site. A right-in/right-out would benefit a pedestrian by allowing an area of refuge to the pedestrian to cross the full length of the access, as well as making the pedestrian more visible to the driver.

- Depending on the type of roadway, the designated posted speed, available sight distance, and whether the access requires the use of an exclusive right turn lane or deceleration or acceleration lanes, a bike lane should be striped to make it evident to the driver the presence of bicyclists on the road. This striping could be done in conjunction with appropriate signage.

- If a median must be installed to enforce the limitation of an access to a right-in/right-out, and if adequate space is provided on the roadway, a consideration should be given to build this median to allow for safe crossing of pedestrians or provide for an opening for bicycles to cross the median to access the site. Design of this median should comply with the requirements established by the American Association of State Highway and Transportation Officials (AASHTO).

BENEFITS OF ACCESS MANAGEMENT FOR BICYCLISTS AND PEDESTRIANS

Some of the anticipated benefits of access management in relation to the design of bicycle and pedestrian facilities are:

- By installing raised medians the number of conflict points is reduced because of the restriction of left turns and anticipated right-in/right-out turning movements. Vehicular turning movements are more predictable.

- Motor vehicles can be redirected to intersections with control devices. In cases where left turns would not be safe, by redirecting traffic to signalized intersections or areas where left turns bays would be provided, traffic on an arterial or collector would flow more efficiently and safely.

- Pedestrian crossing opportunities are enhanced with raised median and fewer conflicts with turning cars.

- By using access management concepts and techniques, driveways could be consolidated to benefit the disabled and achieving better compliance with the ADA requirements.

- Traffic volumes on arterials may decrease if local traffic uses other streets or frontage roads for local destinations.

- Improved traffic flow reduces the need for road widening, providing right-of-way that can be recaptured for the design of bicycle and pedestrian facilities.

CONCLUSIONS AND RECOMMENDATIONS

There are no predetermined answers to make the design of accesses compatible with the design of bicycle and pedestrian facilities. The general elements to consider in the design of these facilities can be found in AASHTO but specific engineering standards can be enforced only by the respective jurisdiction. Some value can be found in combining the benefits of a local Traffic Calming Program with access management standards and the design of bicycle and pedestrian facilities.

Following is a list of recommendations to consider in pursuing design of accesses that would provide for safer circulation of bicycles and pedestrians at determined access points:

1. In order to provide for consistency of application of access management standards is very important that local and state agencies work together in defining these standards. Also, because in Oregon the Transportation Planning Rule addresses the need for access management plans and to develop bicycle and pedestrian facilities, local jurisdictions will be producing TSPs that will be consistent with the regional and state TSPs. The Rule could be used as the mechanism to achieve this goal.

2. In the day-to-day review of Transportation Impact Studies, it is strongly suggested that jurisdictions develop guidelines that could be used by land use developers for submitting these studies as part of land use applications. These guidelines should include specific design criteria on the elements to consider to minimize potential conflicts between pedestrians and bicyclists, and vehicular traffic. The guidelines should also include access management standards and how these standards are related to the design of bicycle and pedestrian facilities.

3. Traffic calming programs can benefit from the implementation of access management techniques and standards to provide safer streets for bicyclists and pedestrians. A typical example would be a street closure or a traffic diverter installed with the purpose of not allowing local traffic to use a street as a cut through, or to keep collector or arterial traffic from using local streets as connectors for high speed traffic. Pedestrian and bicycle access should still be permitted.

4. Encourage communities to develop access management programs to protect their investment on transportation facilities in the future. This should include developing public forums where citizens would be encouraged to participate and understand the real issues behind access management and its importance in planning for better mobility.

References

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Development of a Comprehensive Multi-Modal Access Management Program

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ABSTRACT

The Delaware Department of Transportation (DelDOT) has recognized that it needs to establish a comprehensive access management program to protect the functional integrity of the arterial highway system and to provide improved due process for applicants. At the same time, DelDOT's Long Range Transportation Plan emphasizes the importance of developing a multi-modal transportation system and seeks to focus transportation investments and improvements in targeted growth areas of the state.

The State of Delaware has jurisdiction over 88% of all roadways in the state. As a result, an access management program for Delaware has to provide guidance over how access should be provided on local and collector streets as well as controlling the amount of access that should be afforded to properties fronting on arterials.

The program developed by Delaware establishes appropriate access management objectives for each highway functional class. In addition, the program identifies the role each functional class should serve in supporting non-automobile travel modes -- public transportation, walking and bicycling. A total of seven access level classifications have been proposed for use in managing access to the transportation system in Delaware. Three of the access levels established by DelDOT break new ground:

Access Level 3 consists of strategic arterial highways on which access to abutting property should be controlled in order to maintain the functional integrity of highways serving high speed, long distance motor vehicle travel.

Access Level 4 consists of regional arterial highways in centers, principal and minor arterials on which direct access to property should be managed to encourage pedestrian mobility and support public transportation operations.

Access Level 7 is being reserved to permit future regulation of access to property located along local and collector roads that have unique aesthetic characteristics and along which roadway improvements should be limited.

Procedurally, the Delaware access management policy builds upon the existing development review process that state and local governments have created in Delaware. The process provides for an incremental review process through four stages of development review. At each stage, DelDOT's review is explicitly coordinated with the review being conducted by the local government authority.

To support its access management policy, Delaware is preparing revised regulations governing the design of subdivision streets and entrance driveways that will be presented in an access management design manual.

What is Multi-Modal Access Management?

Multi-modal access management:

- Manages how access is provided to land development
- Establishes the number of entrances onto a road for all modes
- Regulates how entrances should be designed for all modes
- Protects the public interest in transportation transportation investments
- Assures adequate and appropriate motor vehicle, transit, bicycle and pedestrian access to land developments
- Encourages connections between land developments

Development of a Comprehensive Multi-Modal Access Management Program Slide 1 - 10/5/98

How Does Access Management Work?

Controls the location, design and operation of both driveway and street connections to public roadways.

Establishes standards for the spacing of driveways and street intersections.

Relies upon an access classification system based upon

- Roadway's transportation function
- Area in which the roadway segment is located

Development of a Comprehensive Multi-Modal Access Management Program Slide 2 - 10/5/98

How Does Multi-Modal Access Management Work?

The same as traditional access management

- Classify roadways for access management
- For each access classification, identify the physical requirements for all transportation modes
- Establish spacing standards for driveways and street intersections that respect all transportation modes
- Identify how access should be secured to property to assure that land development is accessible by all highway modes
- Create an implementation process that assures that all access needs are addressed in site reviews

Development of a Comprehensive Multi-Modal Access Management Program Slide 3 - 10/5/98

Why Is Access Management Good?

- Preserves the ability of roads to carry the volume of traffic they were designed for
- Reduces congestion on highways by eliminating the interference to traffic flow created by multiple driveway entrances
- Helps to preserve the function of highways and can reduce the need for expensive road widening or bypass projects

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Why is Multi-Modal Access Management Good?

- Assures that a variety of travel modes can be used to access properties, increasing mobility options
- Reduces the number of serious access related accidents
- Enhances the mobility of people and the accessibility of places

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Objectives of the Access Management Policy

- Encourage development to relate to streets and roads in a way that provides access for all modes of travel.
- Encourage safe and convenient access to all properties.
- Encourage the use of alternative access.
- Discourage direct access to development from high-speed, arterials.
- Discourage direct motor vehicle access from developments on pedestrian streets.

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Role of Delaware Dept of Transportation (DelDOT)

Has jurisdiction over all roads not located in municipalities

Has jurisdiction over most non-local roads in municipalities

88% of state roadways are under DelDOT jurisdiction

Jurisdiction of subdivision roads in counties limited to cartway

Development of a Comprehensive Multi-Modal Access Management Program — Slide 7 - 10/5/98

Delaware Land Use Regulatory System

Land Use Decisions Are Made by Local Government

- Counties
- Municipalities

State Agencies Provide Advice Regarding Infrastructure Issues

Memorandums of Understanding Structure Responsibilities

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Existing Access Management Program

Statutory Authorization

Regulatory Controls

- Standards and Regulations for Access to State Highways
- Rules and Regulations for Subdivision Streets

Development Review Process

Corridor Preservation Program

Mobility Friendly Design Standards

Development of a Comprehensive Multi-Modal Access Management Program — Slide 9 - 10/5/98

Development of Multi-Modal Access Management Program

Statutory Authorization

Development of Access Management Policy

- Advisory Committee to Formulate Draft Policy
- Circulation of Draft Policy Implement
- Adoption of Policy Implement
- Classification of Roadways by Access Level

Preparation of Access Management Design Manual

- Revised Regulations for Access to State Highways
- Revised Subdivision Regulations

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Statutory Authorization

Delaware Code, Title 17, Chapter 146 (a)

The Department is authorized to adopt standards and regulations for the location, design, construction, reconstruction, maintenance, use and control of vehicular and pedestrian access to and from any State Maintained Highway in order:

to protect public safety,
to maintain smooth traffic flow,
to maintain highway right-of-way drainage,
to regulate drainage from property leading into or carried by the highway drainage system

and any other public purpose, as determined by the Department.

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Access Classification

Transportation Investment Areas (TIAs)

- Multi-Modal TIA
- Management TIA
- Preservation

Centers

- Places that have different transportation characteristics
  - Need to be managed differently from a transportation perspective
  - Encourage use of other travel modes -- especially walking
  - Discourage high vehicle speeds

Development of a Comprehensive Multi-Modal Access Management Program — Slide 12 - 10/5/98

Access Classification

Seven Access Levels

- AL 1 - Freeways
- AL 2 - Expressways
- AL 3 - Other strategic arterials
- AL 4 - Main Streets
- AL 5 - Minor arterials and collectors
- AL 6 - Local streets
- AL 7 - Reserved for country roads

Development of a Comprehensive Multi-Modal Access Management Program — Slide 13 - 10/5/98

Access Level 1

Description

- Managed for high-speed, long distance motor vehicle travel
- Motor vehicle access only at grade-separated interchanges
- All direct access rights to property acquired by deed

Criteria for Selection

- All principal arterial highways that are functionally classified as freeways, including all Interstate Highways

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Access Level 1

Transit

- Regional transit stations
- Express bus service

Pedestrians

- Consider provision of independent trails
- Provide grade separated crossings where needed
- Accommodate pedestrians at interchanges and grade separations

Bicycles

- May be designated for bicycle use

Development of a Comprehensive Multi-Modal Access Management Program — Slide 15 - 10/5/98

Access Level 2

Description

- Managed for high-speed, long distance motor vehicle travel
- Motor vehicle access to property occurs only at intersecting streets or grade-separated interchanges
- All rights for direct access to property acquired by deed

Criteria for Selection

- All principal arterial highways functionally classified as expressways

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Access Level 2

Transit

- Regional transit stations
- Express bus service
- Transit stops and flag stops

Pedestrians

- Consider provision of independent trails
- Accommodate pedestrians at intersections
- Provide grade separated crossings where needed

Bicycles

- Shoulders useful for bicycle trips
- Manage merge and diverge locations at intersections

Development of a Comprehensive Multi-Modal Access Management Program — Slide 17 - 10/5/98

Access Level 3

Description

- Highways strategically important for the movement of people and goods over long distances but are not freeways or expressways
- Managed for high-speed, long distance motor vehicle travel
- Properties with sufficient frontage may have right-in, right-out motor vehicle entrances where access rights have not been acquired and where there is no reasonable alternative access
- Wide spacing is required for motor vehicle entrances and street intersections

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Access Level 3

Criteria for Selection

- Principal arterial highways included in the National Highway System (NHS)
- Not functionally classified as a freeway or expressway
- Strategically important for the efficient movement of people and goods

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Access Level 3

Transit

- Express bus service
- Transit stops and flag stops

Pedestrians

- Provide parallel pedestrian facilities in developed areas
- Accommodate pedestrians at intersections
- Provide grade separated crossings, mid-block crossings where needed

Bicycles

- Shoulders useful for bicycle trips
- Merge and diverge locations need to be managed

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Access Level 3

State roles:

- Limit direct access to right-in/right-out at widely separated locations
- Require use of alternative access when available
- Proactively seek and facilitate cross-access easements
- Close direct entrances when alternative access becomes available
- In multi-modal TIAs:
  - require facilities to serve bicyclists and pedestrians
  - require safe pedestrian access to transit stops

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Access Level 3

Local government roles:

- Discourage land development that fronts directly on these highways
- Require front doors and main entrances to be oriented to lower classified streets where available
- Use zoning to discourage intense development along these roadways unless also served by AL 4 streets

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Access Level 4

Description

- Important streets and highways on which pedestrian and transit activity shall be encouraged and promoted
- Managed to encourage and promote pedestrian mobility and to accommodate efficient and convenient transit operation
- Most local transit routes will operate along AL 4 streets and highways
- By reducing operating speeds, more frequent street intersections can be allowed

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Access Level 4

Criteria for Selection

- Functionally classified as a principal arterial or minor arterial
- Not included in the National Highway System (NHS). (Some NHS highways in centers may be classified AL4 at the recommendation of the classification team)
- Located in a center

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Access Level 4

Pedestrians

- Encourage pedestrian use
- Provide sidewalks on both sides of streets
- Provide pedestrian amenities
- Relate development entrances to the pedestrian environment
- Limit and control interruptions to the pedestrian system
- Time signals to promote pedestrian use
- Consider mid-block crossings with pedestrian refuges
- Employ appropriate traffic calming measures

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Access Level 4

Transit

- Facilitate transit operation, if present
- Location of most local transit routes
- Provide enhancements at transit stops

Bicycles

- Encourage bicycle use
- Assure pedestrians primacy over bicycles
- Consider provision of bicycle lanes or riding area
- Land development should assure good bicycle access and parking

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Access Level 4

State roles:

- Require motor vehicle entrances to be located on intersecting or parallel streets
- Encourage pedestrian entrances on AL 4 roads
- Provide facilities for buses if on transit line (shelters, pads, amenities)
- Provide crosswalks at both intersections and mid-block locations, consider provision of pedestrian refuges
- Permit more closely spaced traffic signals; interconnect signals at reduced speeds of progression -- 25 - 35 MPH

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Access Level 4

Local government roles:

- Utilize *Mobility Friendly Design Standards*
- Through zoning, encourage any intense development activity to front on these roads
- Adopt land use design standards that reduce setbacks and promote parking in the rear of a site
- Adopt zoning ordinances that establish cross-access corridors to promote shared or joint access
- Adopt zoning ordinances that promote transit-friendly land uses near transit stops

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Access Level 5

Description

- Managed to serve motor vehicle traffic movements efficiently while still accommodating other travel modes
- Serve moderate distance motor vehicle traffic which may operate at high or moderate speeds
- Motor vehicle entrances must meet moderate spacing standards on both divided and undivided roadways
- On divided roadways, motor vehicle entrances are limited unless spacing standards for median openings or traffic signals are met

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Access Level 5

Criteria for Selection

- Functionally classified as a principal or minor arterial or as a collector road
- Not included in the National Highway System (NHS)
- Not located in a center

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Access Level 5

Pedestrians

- Sidewalks
  - Provide sidewalks on both sides in centers and multi-modal areas
  - Provide sidewalks in developed portions of management TIAs
  - Sidewalks usually not required in preservation TIA
  - Where sidewalks are not provided, assure pedestrians a safe place to walk
- Land developments must accommodate pedestrian mobility and access
- Provide cross-walks at intersections
- Consider mid-block crossings with refuges where pedestrian crossings are likely
- Employ appropriate traffic calming measures where needed

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Access Level 5

Transit

- Location of most local transit routes outside of centers
  - Accommodate transit operation, if present
- Provide transit stops at subdivision entrances, development entrances
- Collector roads within major developments should provide direct travel paths to facilitate efficient transit access

Bicycles

- Location of most bicycle travel
- Consider designating bicycle lanes or routes
- Land development should assure good bicycle access and parking

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Access Level 5

State roles:

- Assure adequate spacing of driveways and require turn lanes and auxiliary lanes where warranted
- Require use of alternative access where available and appropriate
- Assure that properties are developed to accommodate bicycle and pedestrian access
- Design or improve roadways to accommodate bicycle and pedestrian traffic

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Access Level 5

Local government roles:

- Discourage intense development along these roadways. Most intense development should front on AL4 roadways
- Require properties in the Multimodal and Management TIAs to provide sidewalks
- Do not permit new residential lots to be created with direct frontage

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Access Level 6

Description

- Managed to provide convenient direct access to property
- Motor vehicle entrance spacing assumes low motor vehicle operating speeds and can be as small as 50'
- Through traffic and high operating speeds are discouraged through roadway design elements

Criteria

- Functionally classified as a minor collector or local road
- Includes most subdivision streets and service and frontage roads

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Access Level 6

Pedestrians

- Sidewalks normally required in centers and multi-modal areas
- Provide linkage trails if street layout restricts pedestrian mobility
- In management and protection areas, assure safe walking environment
- Can be used with linkage trails to create alternative bicycle routes

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Access Level 6

Transit

- Transit service usually occurs on higher order streets
  - Assure good and direct pedestrian connections to higher order roadways with transit service

Bicycles

- Low volume and speed generally assures bicycle accommodation

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Access Level 7

Access Level Reserved for Designated Country Roads

- Separate program to be managed by DelDOT
- Program will preserve the aesthetic, rural, scenic or environmental character of a designated roadway.

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Access Classification Process

Access Classification Teams

- DelDOT
- County planning department
- Municipal government
- Chamber of Commerce
- Citizen
- Consulting Engineers Council
- Other state agencies:
  - Delaware Transit Corporation
  - Dept of Natural Resources and Environmental Control
  - Dept of Agriculture
- MPO

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Implementing the Access Management Policy

- At Re-Zoning:
- At Subdivision/Site Plan
- At Permit Issuance:

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Conclusions

- Classification system accommodates all transportation
- Access requirements should reflect the area
- Speed not always the principal objective of highway design
- Access management should assure good access
  - For all travel modes
  - Appropriate facilities for the area and the roadway
- Inter-agency cooperation essential for an effective program

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Session 6

Safety Research

Moderator: Marc Butorac, Kittelson and Associates

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Two-Way Left-Turn Lane With A Raised Median: Atlanta's Memorial Drive

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ABSTRACT

In 1990 the Georgia DOT replaced a two-way left-turn lane (TWLTL) with a raised median separation along 4.34 miles of Memorial Drive in greater Atlanta. In the year after completion, the project prevented about 300 crashes and 150 injuries. There was a 37 percent reduction in total accident rate and a 48 percent drop in the injury rate. Left-turn accidents between intersections were virtually eliminated.

However, after the project, traffic volumes dropped 12 percent within the project and only 5.5 outside it (1991 was a recession locally and nationwide). Articles appeared in the local newspapers quoting merchants as saying that the median project had hurt business by eliminating left-turns into and out from their establishments. The project did not include any measures to improve inter-parcel access by providing frontage roads or rear alleyways or joint parking lots. The authors concluded that the project probably did have a negative effect on stores at mid-block locations and those that must do a large-volume business because of a small profit on each sale.

These results were presented and published at the First National Access Management Conference, in 1993. It was reported there that, as of May of 1993, after over 2.5 years of the median, not a single fatality had occurred, whereas in the 11.6 years preceding the project there were 15 fatalities, including six pedestrian deaths.

The present paper updates the Memorial Drive experience, reporting the longer-term impacts on both safety and abutting-business activity after eight years of the raised median. As of the date of this presentation in early October,1998, there still has not occurred the first fatality, either motorist or pedestrian. However, the enormous percentage reductions in crashes experienced during the first year have not been found to hold up over time, at least on a project-wide basis. The annual number of crashes has been increasing since 1992, despite the fact that traffic volumes are gradually decreasing. However, the paper suggests that this increase is not significantly different from the county-wide increase during the same period and therefore is not attributable to the median. Interviews with the traffic police in the area revealed strong opinions that driver inattention is to blame for the upward trend in crash frequency. There is a perception that in earlier times, before the invention of the cell phone, drivers were much less distracted from the task at hand and more likely to take their driving seriously.

Memorial Drive, once prosperous with leading retail stores and automobile dealers, now has retail-vacancy rates of 15 percent, twice the Atlanta average. Newspaper accounts of the decline cite the raised median as one factor of several, but the paper shows that, in fact, the demographics of the corridor were weakening years before the median was built, due to socioeconomic influences such as court-ordered desegregation and the construction of a rapid-rail system.

INTRODUCTION

Memorial Drive is a 16-mile arterial that stretches from downtown Atlanta to Stone Mountain, in the suburbs. It passes through two counties and four municipalities. For much of its length it has a center median in the form of a two-way left-turn lane (TWLTL). In the early 1980's the Georgia DOT became concerned over the lack of safety on a 4.34-mile, seven-lane section that is densely commercial, and decided to replace the TWLTL with a raised median. The GDOT was concerned specifically with (1) a high number of crashes, especially mid-block ones, and a high accident rate; (2) a high number of pedestrian fatalities; and (3) an increasing traffic volume. There was stiff opposition to the plan from the owners of abutting businesses, but safety concerns prevailed and the raised median was installed in 1990. In the first year after completion there were 300 fewer crashes and 150 fewer injuries. There was a 37 percent reduction in total crash rate and a 48 percent drop in the injury rate. Left-turn accidents between intersections were virtually eliminated.

The raised median caused reductions in crashes on Memorial Drive for the following reasons:

- Conflict points were reduced in number.
- Conflict areas were reduced in size.
- Pedestrians found refuge while crossing.
- Mid-block crashes dropped because of the elimination of left turns in and left turns out.
- Left turns were eliminated into and out of seven public roads and many driveways, as they were not given median crossovers (breaks in the raised median).
- All 14 median crossovers (at 10 major public-road intersections and four significant private driveways) were signalized. These are full openings, not channelized to allow only left turns or U turns.
- Intersection crashes dropped because of excellent design of geometrics, with double left-turn lanes and U-turn capabilities, and because seven intersections became right in to and right out from the cross streets.

However, after the project, traffic volumes dropped 12 percent within the project and only 5.5 outside it (1991 was a recession locally and nationwide). Articles appeared in the local newspapers quoting merchants as saying that the median project had hurt business by eliminating left-turns into and out from their establishments. The project did not include any measures to improve inter-parcel access by providing frontage roads or rear alleyways or joint parking lots. The authors concluded that the project probably did have a negative effect on stores at mid-block locations and those that must do a large-volume business because of a small profit on each sale.

These results were presented and published at the First National Access Management Conference, in 1993 (1). It was reported there that, as of May of 1993, after over 2.5 years of the median, not a single fatality had occurred, whereas in the 11.6 years preceding the project there were 15 fatalities, including 6 pedestrian deaths. The present paper updates the Memorial Drive experience, reporting the longer-term impacts on both safety and abutting-business activity after eight years of the raised median.

LONGER-TERM IMPACT ON SAFETY

To date there has still not occurred the first fatality, either motorist or pedestrian, since the installation of the raised median. However, the enormous percentage reductions in crashes experienced during the first year have not been found to hold up over time, at least on a project-wide basis. Table 1 shows the updated crash experience, where the rates are per 100 million vehicle miles.

As of early October,1998 there have been no fatalities in the 7 years since project completion. Table 1 shows that the first-year reduction of 37 percent in total crash rate and the 48 percent reduction in the injury rate did not continue into the ensuing years. By 1995 the crash rate reduction was only 17 percent and the injury-rate reduction was only 10 percent. This means that, after the initial drop, the number of crashes and injuries increased over time. Did this mean that the raised median was losing its effectiveness over time, or was there another explanation? Perhaps crashes were increasing county-wide, and Memorial Drive was simply part of an overall trend. To answer this question, crash frequency in DeKalb County was compared with crash rate on Memorial Drive from 1988 to 1997, with the results shown in Table 2. The County data are total number of crashes, unadjusted for VMT (unknown to the authors). The crash rates on Memorial Drive are the numbers of crashes per 100 million vehicle miles of travel. The calculation of rate on Memorial Drive was especially important due to the gradual decreases in traffic volume over the time period.

Table 2 normalizes the data by establishing Crash Indices using a base of 1.00 for the county-wide data in 1988 and also 1.0 for the Memorial Drive data for 1988-89. These indices are plotted in Figure 1, which shows that both curves begin with an index of 1.0 in 1988 and that there is a gap in the Memorial Drive data until 1991, due to construction. Figure 1 shows clearly that, while the crash rate did increase on Memorial Drive from 1992 to 1997, the increases were not significantly different from the increases in number of crashes experienced by DeKalb County as a whole.

POLICE VIEWS ON INCREASING CRASH FREQUENCY

The DeKalb County Police Department is located on Memorial Drive, at one end of this project. Therefore there is a strong police presence in this area. Interviews were conducted with a traffic officer at Sergeant level who is especially familiar with this stretch of road. The question put to him was as follows: "If traffic volumes are stable on Memorial Drive, then why are crashes in creasing?" The officer was emphatic in coming down hard on drivers. His comments included the following:

> "Inattentiveness--that is the number one problem."
> "People don't take driving as seriously as they used to."
> "I see drivers shaving or putting on makeup."
> "I see drivers using cell phones for pleasure--just chit-chat--not for business."
> "There is an abundance of hit-and-run crashes."
> "Reason: Driver. End of story."

These quotations, while hardly a scientific sample, are frequently echoed in newspaper articles about Atlanta traffic. They point up the fact that long-term studies of the safety aspects of access-management tools can easily be confounded by other trends.

TABLE 1. Before/After Tabulation of Crashes, Injuries and Fatalities

		Crashes		Injuries		Fatalities	
Year	Average. ADT	No.	Rate	No.	Rate	No.	Rate
BEFORE							
Year Just Before Project							
7/88 - 7/89	50,400	947	1186	388	486	1	1.25
In the 11.6 years prior to this project, there were 15 fatalities, including 6 pedestrians							
AFTER							
Year Just After Project	43,000	511	750	174	255	0	0
10/90 - 10/91							
First-Year Change in Rates			**-37%**		**-48%**		
1992	40,849	484	748	183	283	0	0
1993	42,084	574	861	188	282	0	0
Avg. After, 1991-93	42,000	523	787	182	274	0	0
Change in Rates, 1991-93			**-34%**		**-44%**		**-100%**
1994	41,679	675	1023	299	453	0	0
1995	40,727	708	1097	341	529	0	0
Avg. After, 1991-93	41,668	590	894	237	359	0	0
Change in Rates, 1991-1995			**-25%**		**-26%**		**-100%**
1996	40,676	736	1142	339	526	0	0
1997	38,430	635	1043	329	540	0	0
Averages Over 7 Years	40,740	635	984	280	435	0	0
Change in Rates, 1991-1997			**-17%**		**-10%**		**-100%**

TABLE 2. Comparison of Crash Frequency in DeKalb County and on Memorial Drive

Year	Total Crashes in DeKalb County	County Crash Index	Crash Rate on Memorial Dr.	Memorial Dr. Crash Index
1988	26,880	1.00 = base		
7/88 to 7/99			1186	1.00 = base
1989	26,992	1.00	Under Construction	
1990	25,630	0.95	Under Construction	
10/90 to 10/91			750	0.63
1991	24,843	0.92		
1992	26,913	1.00	748	0.63
1993	28,240	1.05	861	0.73
1994	31,443	1.17	1023	0.86
1995	32,891	1.22	1097	0.92
1996	33,929	1.26	1142	0.96
1997	35,159	1.31	1043	0.88

ECONOMIC IMPACTS OF THE MEMORIAL DRIVE PROJECT

As explained earlier, it appears that the project probably did have a negative effect on stores at mid-block locations and those that must do a large-volume business because of a small profit on each sale. However, there have been socioeconomic changes occurring on Memorial Drive, beginning well before this project, that have contributed to loss of business. These have been reported by the local newspaper (2) and are described next.

This section of DeKalb County was the picture of suburban affluence from the 1950's to the early 1970's. However, in 1969 the DeKalb County public schools were desegregated by court order. "Thousands of whites began moving to next-door Gwinnett County, soon to become the next boom county "(2). In the mid-1970's the MARTA rapid-rail lines were constructed, giving quick and easy movement from Atlanta's inner city to the eastern edge of the metropolitan area, where this section of Memorial Drive is located. The racial composition of the Census Tract there changed radically from 1980 to 1990, before the raised median was even built. During that same decade, the average income in that Census Tract dropped from $20,337 to $17,695. The growth focused on Gwinnett County, farther to the east and beyond the reaches of the MARTA subway lines. Memorial Drive was left behind as urban sprawl passed through the area and moved onward. Confounding an analysis of the impact of the median is that fact that the entire United States was in a business recession at the time the median was built and opened to traffic.

Currently, Memorial Drive is “in far-from-desperate shape” according to Neil Carn, a professor of real estate at Georgia State University who lives in a subdivision off Memorial Drive. “When we moved in, we were in the country. We’ve seen Memorial Drive come and go. It’s hard for me to be able to understand everything that has occurred there” (2). There are sad facts. The very first store in the Home Depot chain, Atlanta-based, has closed and the site turned into a flea market. Memorial Drive has become “a confusing array of traffic, pawn shops, boarded-up houses and fast-food joints” (2). A group has been formed to revitalize the area, possibly by enticing medical clinics and assisted-care homes to take over the empty retail sites. Its director, Gary Peet stated “The culprit was not so much the DOT or the median, but too much growth” (2). Some of the businesses that flourished in earlier decades were left without their customer base when Atlanta’s “frontier” moved farther out. Should the revitalization include removal of the median? “I think that’s futile”, said Peet. “We’ve got to have a plan.”

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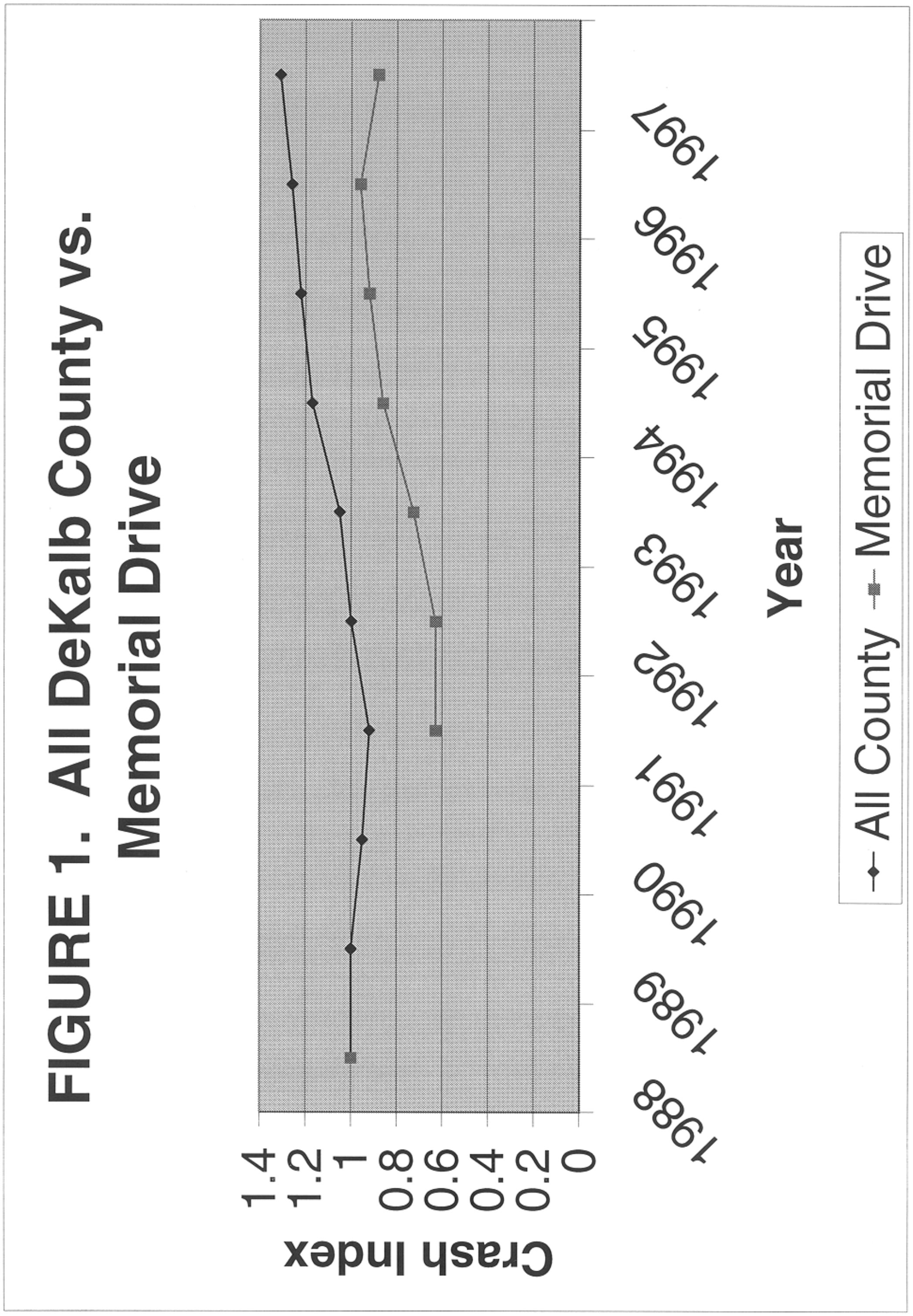

FIGURE 1. All DeKalb County vs. Memorial Drive

Effects of Reducing Conflict Points on Reducing Accidents

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Abstract

Current and past access management and traffic safety literature frequently states that decreasing the number of conflict points by implementing access management techniques leads to safer roads. However, after a review of literature related to access management and accident reduction factors, no clear relationship has been defined between the reduction of conflict points on a length of roadway and the expected reduction in accident rates. Although the value of good access management is somewhat intuitive, a better understanding of the relationship between conflict points and safely provides an additional tool for predicting the safety benefits of various access management techniques. This research used before and after data from case study locations to investigate the relationship between reduction in conflict points along a lengthy roadway and the expected reduction in accident rates. Although there is not a simple relationship between reducing conflict points and reducing accident rates, a methodology was developed for using weighted conflict points and traffic volumes to predict a subsequent reduction in accident rates.

No Presentation Material Available for Print

Estimating the Safety of Unsignalized Intersections Using Traffic Conflicts

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Abstract

The deficiencies of motor vehicle accident records have long been recognized as an obstacle to a complete understanding of traffic safety problems at intersections. The Traffic Conflict Technique was developed to provide additional information that could help make up for the deficiencies of accident records. This paper describes the application of the traffic conflict technique to the estimation of safety at unsignalized intersections. A computer simulation model, TSC-Sim, is used to study traffic conflicts with time-to-collision as the critical traffic event in stimulating driver behavior. Some aspects of the gap-acceptance criteria, in addition to the differential effects of several driver characteristics (e.g., age, sex, and waiting time tolerance), are examined. The effects of traffic flow characteristics, such as speed and volume, on the number and severity of conflicts are also discussed. Using the data collected from 30 conflict surveys, traffic conflict frequency and severity standards for unsignalized intersections have been established. These standards allow the relative comparison of the conflict risk at various intersections. An Intersection Conflict Index measure was established to summarize the intersection conflict characteristics.

INTRODUCTION

Traffic accidents at intersections are pervasive road system failures, yet our understanding of the failure mechanism is poor, which reduces the accuracy of road safety diagnosis and the estimation of countermeasure effectiveness. Accident records have well-recognized measurement and statistical problems; observation of traffic conflicts as a road-user behavioral factor has been advocated as a procedure to study the vehicle accident failure mechanism from a broader perspective than accident statistics alone [1, 2]. The Traffic Conflict Technique entails observing, recording, and evaluating the frequency and severity of traffic conflicts at an intersection by a team of trained observers. The technique, therefore, allows the analyst to make on-the-spot observations and evaluations of unsafe driving maneuvers at an intersection and to investigate the relationship between such maneuvers and the road characteristics. This paper describes the application of the Traffic Conflict Technique to the estimation of safety at unsignalized intersections. It includes an overview of the establishment of traffic conflict standards and a description of a traffic conflict computer simulation model using time proximity measures as a driver-perceived measure of safety.

THE TRAFFIC CONFLICT TECHNIQUE

The concept of traffic conflicts was first proposed by Perkins and Harris [3] as an alternative to accident data, which in many cases are scarce, unreliable, or unsatisfactory. Their objective was to define traffic events or incidents that occur frequently, can be clearly observed, and are related to accidents. They defined a traffic conflict as any potential accident situation leading to the occurrence of evasive actions such as braking or swerving. This simple definition has since been refined to incorporate categories of vehicle maneuvers and measures of time and space between vehicles at the time of conflicts. An internationally accepted definition of a traffic conflict is: "A conflict is an observable situation in which two or more road users approach each other in space and time for such an extent that there is a risk of collision if their movements remain unchanged." [4]

A variety of observation methods have been developed to measure traffic conflicts. These methods can be classified into subjective and objective methods. Subjective methods include considerable judgment by the conflict observer and are criticized by several researchers [5, 6] because the grading of severity of the evasive action can vary greatly from one observer to another. Objective methods include a cardinal or ordinal time-proximity dimension in the severity scale. Hayward [7] used the time to collision (TTC) defined as "the time until two vehicles collide if they continue at their present speed and on the same path." The value of the TTC is infinite if the vehicles are not on a collision course. If the vehicles are on a collision course, the value of the TTC is finite and decreases with time. The minimum TTC reached as the vehicles approach on the collision course is taken as the critical conflict severity.

Traffic Conflict Surveys in British Columbia

In 1986, the University of British Columbia prepared its *Traffic Conflict Procedures Manual* for the Insurance Corporation of British Columbia (ICBC) [8]. The manual summarized the body of knowledge related to traffic conflicts at the time and presented a procedure to systematically observe and record conflicts at intersections with perceived safety problems. The manual also presented guidelines for conflict-observer training requirements.

Since 1989, ICBC has provided funding for studies analyzing conditions at intersections where traffic safety is a concern. The purpose of the studies is to identify both the factors contributing to unsafe conditions and potential mitigating measures. The studies include a review of intersection geometry, capacity, accident history, and conflict characteristics based on conflict surveys conducted according to the procedures of the 1986 Manual. These studies have been conducted as part of ICBC's Road Improvement Program in partnership with the Ministry of Transportation and Highways and with municipalities throughout British Columbia. In 1993, ICBC began funding the actual implementation of improvements recommended in the studies. By the end of 1995, conflict surveys had been completed at approximately 100 intersections (of which 30 are unsignalized) throughout British Columbia. This allowed for the establishment of traffic conflict standards, which can be used to evaluate the relative frequency and severity of conflicts at various locations. The following is a summary of some of the important aspects of the traffic conflict procedure, including measures of conflict frequency and severity.

Traffic Conflicts Observation and Measurements

At each study intersection, traffic conflicts are observed for 2 days, with 8 hours of observation per day. Typically, 2 trained observers are stationed at strategic observation locations for the 16 hours of observation. The observation periods were 7-10 a.m., 11 a.m.-1 p.m., and 3-6 p.m.. The severity of traffic conflicts is determined by the sum of two scores: the TTC score and the risk of collision or ROC score (Table 1). The ROC is a subjective measure of the seriousness of the observed conflict and depends on the driver's perceived control over the conflict situation, the severity of the evasive maneuver, and the presence of other road users or constricting factors that limit the driver's response options. The ROC score is independent of the TTC score; however, conflicts with a high TTC score will typically, but not necessarily, have a high ROC score.

Table 1. TTC and ROC Scores

TTC and ROC Scores	Time to Collision (TTC)	Risk of Collision (ROC)
1	1.6-2.0 seconds	Low risk
2	1.0-1.5 seconds	Moderate risk
3	0.0-0.9 seconds	High risk

The sum of the TTC and ROC scores gives the overall severity score, which ranges from 2 to 6, with the higher values denoting high-risk conflict situations. The midpoint of the composite scale registers the critical event, corresponding to a TTC of 1.5 seconds or less with a moderate ROC. Reliability tests of the observation method gave 77% accuracy with 95% confidence, with an 85% accuracy for assessing the correct TTC. In addition, 13 intersections were studied to test the validity of a TTC of 1.5 seconds or less as a measure of safety (as defined by the number of accidents); it was found that at 8 of 11 intersection conflicts are significantly correlated with accidents at 95% confidence with $R^2 \geq 0.64$, with three intersections having $R^2 \geq 0.81$ [2].

Traffic Conflict Standards at Unsignalized Intersections

Traffic conflict standards were developed for both conflict frequency and conflict severity using the results of the 100 conflict surveys. Cumulative distributions for various measures were developed. Examples for these measures include: the average hourly conflict (AHC) rate, defined as the total number of observed conflicts at an intersection divided by the number of observation hours; the AHC rate per 1,000 entering vehicles (AHC/TEV); and the average conflict severity (ACS), defined as the total conflict severity scores divided by the total number of conflicts. Examples of AHC rate distribution, AHC/TEV distribution, and ACS distribution for unsignalized intersections are shown in Figures 1, 2, and 3, respectively. Using these standards, the conflict risk at unsignalized intersections can be compared with other intersections where surveys have been conducted. Separate cumulative distributions were also developed for subgroups of intersections (e.g., signalized intersections) and adjacent land use (e.g., commercial and residential).

Using the AHC/TEV and the ACS characteristics at each surveyed intersection, an Intersection Conflict Index (ICI) was established using a scatter plot diagram, as shown in Figure 4. Like the level-of-service measure for capacity, the ICI is intended to summarize the conflict risk at an intersection and ranges from A (low frequency and low severity) to E (high frequency and high severity). The ICI regions were determined using one standard deviation of the calculated mean of the overall ACS and the AHC/TEV. The ICI therefore indicates the relative risk of being involved in a conflict at an intersection.

TRAFFIC CONFLICT SIMULATION

Computer simulation of traffic conflicts would reduce the need for trained observers and on-site observation time. In 1994, research conducted at the University of British Columbia [1] resulted in the development of a conflict simulation model for unsignalized (stop and yield) intersections. The Traffic Systems Conflict Simulation (TSC-Sim) model was validated using actual conflict survey data collected for the ICBC Road Improvement Program. TSC-Sim uses time proximity to hazard as the driver-perceived measure of safety to simulate conflicts. The model determines behavioral responses based on the driver's reactions to hazards perceived through TTC measures. A traffic conflict is viewed as a unique, independent critical event in the traffic process that signals a hazard and represents a discrete risk at a certain severity level. The concept of the traffic conflict, showing the relationship between the TTC and the critical event occurrence, is shown in Figure 5. Point A in the figure indicates TTC when the evasive action (braking) is started, representing the available maneuvering space at the time of braking. Point B gives the TTC_{min}, reached during the approach.

The model is unique in using a technique of importance sampling; that is, during simulation, the model saves characteristic information for only those conflicts predefined as "significant," and stores these events for later study. Graphic animation displays are used to show how the conflicts occurred and the value of critical variables at the time. The model was calibrated using empirical data, and simulation results correlated reasonably well with actual observations.

The model is microscopic because it deals with individual vehicles as they approach, go through, and depart the intersection. Actions for vehicles in the model include vehicle generation, approach to the intersection, choosing a gap (lag), and proceeding to depart. The input parameters to the model include:

- Traffic volumes of all traffic streams
- Percentage of heavy vehicle traffic relative to the total traffic volume
- Type of intersection control
- Speed limit on the major road
- Percentage of each driver type in the driver population
- Number of lanes for both major and minor roads
- Total default simulation time

Several other parameters such as move-up time, minimum allowable headway, turning speed of vehicles, and maximum queue lengths are given as constants to the model. It is possible to change the value of these parameters between simulation runs.

The Gap Acceptance Process

This process takes place when a vehicle has to cross or merge with other traffic streams having different priority levels according to the rules of the road. Each vehicle is assigned a primary critical gap value by testing the gap-acceptance function according to the driver type and the intersection type of control (Table 2).

Table 2. Mean and Standard Deviation of the Gap Acceptance

	Yield Control		Stop Control	
Group	Mean (Seconds)	Std. Dev. (Seconds)	Mean Std. (Seconds)	Dev. (Seconds)
Young males	4.0	0.75	5.0	0.75
Old males	4.5	0.85	5.5	0.85
Young females	5.5	1.00	6.5	1.00
Old females	6.0	1.25	7.0	1.25

The primary critical gap value is modified according to the vehicle type and the number of lanes to be crossed. Vehicles trying to cross or merge wait for a gap in the conflicting traffic stream(s) greater than or equal to their critical gap. The critical gap value is obtained by multiplying the primary critical gap with a delay modification factor. The delay modification factor is calculated from the following function:

$$\theta_D = \frac{DL}{Q_D + DL} + C \qquad (1)$$

where

θ_D = delay modification factor

DL = the delay value after which driver behavior begins to change (seconds)

Q_D = the stopped delay value (seconds)

C = constant value (seconds)

The values of DL and C were selected as 27 and 0.5 seconds based on the data provided by Adebisi and Sama [9].

The delay modification factor has an initial value of 1.5 when the vehicle faces no delay; this value decreases as the vehicle's stopped delay increases with a minimum theoretical value of 0.5 when the vehicle faces infinite delay. The model assumes that no driver will accept a gap that he or she thinks will certainly lead to a collision. Therefore, a minimum acceptable gap is used, with a value of 2.0 seconds as a minimum allowable critical gap, based on data provided by Wennel [10]. Drivers who decide to enter the intersection are assigned a single lane maneuver time. This time is sampled from a truncated normal distribution function. The mean and standard deviation of the function depend on the driver type [11]. The sampled maneuver time is then corrected according to the number of lanes to be crossed and the vehicle type. A traffic conflict occurs when a driver decides to execute a maneuver that puts him or her at risk of collision with another vehicle.

Some Model Results

The goal of the model is to study traffic conflicts as critical event traffic situations and the effect of driver and traffic parameters on the occurrence of conflicts. The analysis extends conventional gap-acceptance criteria to describe driver behavior at unsignalized intersections by adding such parameters as driver age, gender, and waiting time. The model also tests the impact of traffic characteristics such as volume and speed on traffic conflict frequency and severity.

For example, Figure 6 shows the model-established relationship between traffic volumes and conflicts at four-leg intersections. The figure indicates that over a wide range of traffic volumes, including congested conditions, an exponential function seems to give a good fit to the relation between traffic volume and conflicts. However, if only low traffic volumes are considered (volumes less than the warrants for a traffic signal), conflicts may appear to be proportional to the square root of the conflicting volumes as suggested by [12]. The curves representing the conflicts for yield- and stop-controlled intersections were very close at low traffic volumes; the difference between them increases rapidly as traffic volume increases. This outcome tends to confirm the engineering practice of setting a volume warrant that limits the volume above which yield signs should not be used to control unsignalized intersections.

The relationship between speed and conflicts at T-intersections is shown in Figure 7. The figure indicates an increase in the number of conflicts as the mean approach speed increases for a fixed volume. A slight increase was obtained at low traffic volume and a significant increase at high traffic volumes.

The TSC-Sim model provides a useful tool to reduce the human resources required for traffic conflict observation. It also allows for the technical analysis of driver- or road-related causes of the simulated traffic conflicts. The model will be further calibrated using the latest available empirical data and will then be expanded to allow the simulation of signalized intersections.

Currently, a visual information selective acquisition (VISA) model is being developed. This model facilitates realistic visual constraints and gathers information based on a selective process that allows for events such as distractions. It is to be incorporated into TSC-Sim to enhance its visual information selection abilities by using a broader range of variables pertaining to the driver's visual system. Overall, the goal is to develop a simulation model that is comprehensive enough to be used in a wide range of studies requiring visual sensitivity, such as Intelligent Transportation Systems (ITS) applications (in-vehicle navigation systems research, etc.) and detailed enough to model a variety of visual conditions (age-related, intoxicated) within varying driving environments.

CONCLUSION

The observation, recording, simulation, and analysis of traffic conflict characteristics represent important new tools to assist in the understanding of traffic operations at intersections with potential safety deficiencies. This paper has summarized the latest research being conducted in the field of traffic conflicts. Using data collected from 30 conflict surveys, traffic-conflict frequency and severity standards have been established for unsignalized intersections. These standards allow the comparison of conflict risk at various intersections. An ICI measure was also established to summarize the intersection conflict characteristics.

The simulation of traffic conflicts can reduce the human resources required to collect data. A computer model, TSC-Sim, has been developed to simulate conflicts at unsignalized four-leg and T-intersections. The model utilizes time proximity to hazard as the driver-perceived measure of safety to simulate conflicts. The model determines behavioral responses based on driver reaction to hazards perceived through TTC measures, and allows for the analysis of conflicts as a function of driver and traffic characteristics. The model is therefore useful as both a predictive and analytical tool. The advancements described in this paper are expected to further enhance the usefulness of the Traffic Conflict Technique as a tool to evaluate the safety of traffic operations at hazardous intersections and to help in determining effective mitigating measures.

ACKNOWLEDGEMENT

The author would like to thank Hamilton Associates for kindly providing the traffic conflicts data. Much of the early research on traffic conflicts in British Columbia was done by G.R. Brown. The author benefited greatly from working with him.

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Figure 1. Average Hourly Conflict (AHC) Rate Distribution

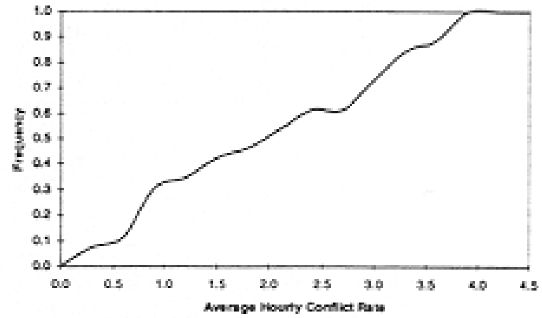


Figure 2. Distribution of Average Hourly Conflict Rate Per Thousand Entering Vehicles (AHC/TEV)

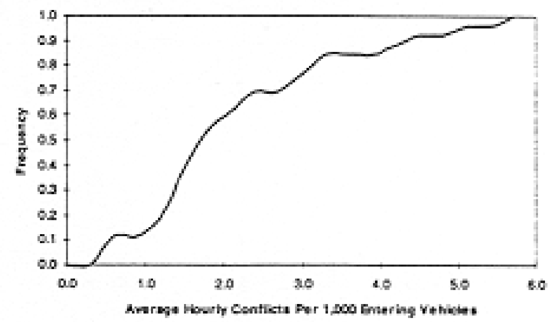


Figure 3. Average Conflict Severity (ACS) Distribution

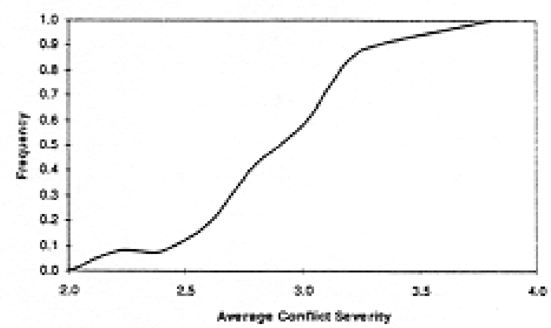


Figure 4. Unsignalized Intersections Conflict Index (ICI)

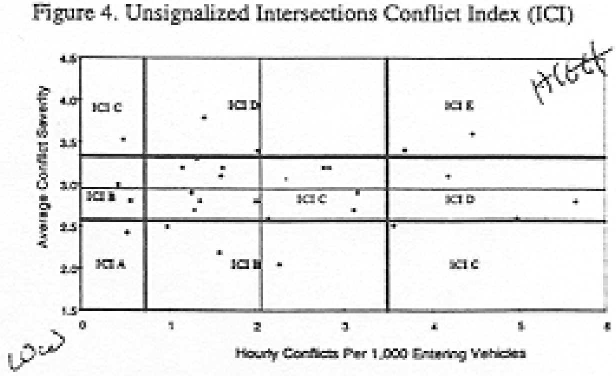


Figure 5. Traffic Conflict Relationship with Time To Collision (TTC)

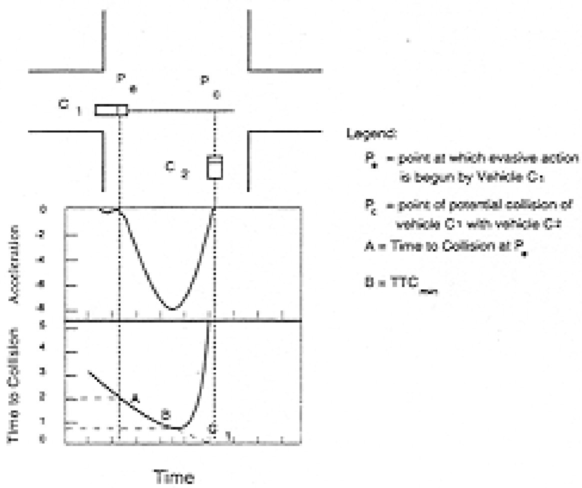


Figure 7. Relationship Between Speed and Conflicts at Unsignalized T-Intersections

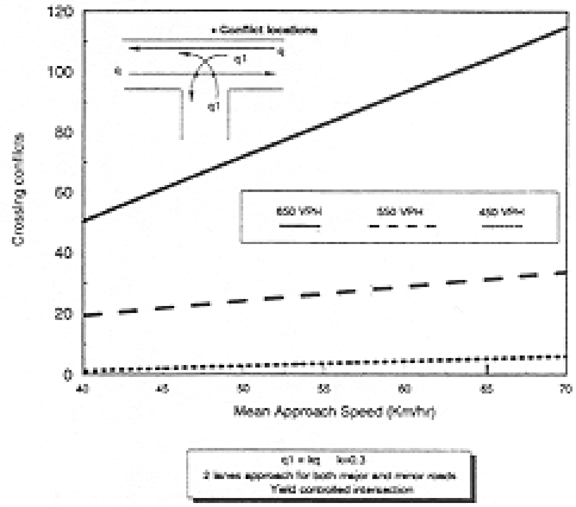
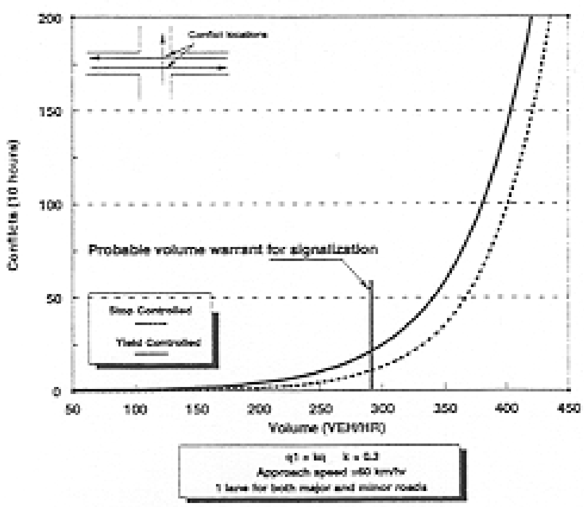


Figure 6. Relationship Between Traffic Volume and Conflicts at Unsignalized Four-leg Intersections



Session 7

Managing Corridor Development Workshop

Moderator: Kristine Williams, Center for Urban Transportation Research

Session 8

Local Government and MPO Forum

Moderator: Edward J. Kant, Collier County Florida Transportation Services Department

Participants: Sarah Ward, Pinellas County MPO
Steven A. Tindale, Tindale-Oliver and Associates, Inc.
Gary Davies, Garmen Associates
David Plazak, Iowa State University

Pinellas County MPO Access Management Study

Steve Tindale, Tindale-Oliver and Associates
Sarah Ward, Pinellas County MPO

Abstract

The Pinellas County MPO Access Management Study was developed in three phases. The first phase involved reviewing other Access Management Systems and studies that were undertaken throughout the state of Florida. In addition to this review, interviews were conducted with agencies within the County (including the Florida DOT) which were involved in access management and driveway/median design and control. From these interviews, a report was developed which discussed issues and concerns. The subjects discussed were:

- *Classification standards*
- *Data variables required to do an access management classification*
- *Development review process*
- *Design of new* roads
- *Land development regulations*
- *Benefits of the plan*
- *Concern of the amount of effort needed to implement an Access Management process for the County*
- *Use of Florida DOT classifications*

Phase two involved initial data sampling and the initial classification of these sampling and the initial classification of these sample roads. During this phase, a sample of the County roads was chosen and data was collected from this sample. An analysis was done and a preliminary assignment of access classification was made based on existing conditions.

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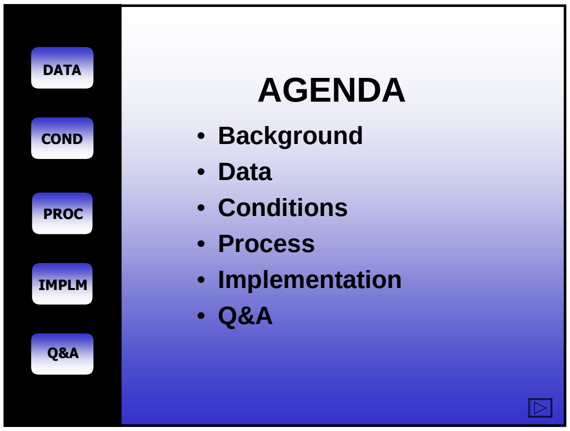
Phase three was completed in three steps:

- *Data collection for the complete County road system*
- *Analysis - This included analyzing driveway and median spacing, the average lot size, land use, posted speeds and lane configurations. From this analysis, a determination of the correlation between these variables was completed.*
- *Process classification - Development of classification procedures, implementation of procedures for classifying roads, and the initial access classification and process.*
- *Process classification - Development of classification procedures, implementation of the procedures for classifying roads, and the initial access classification for all County roads.*

Legal counsel (County Attorney) was involved throughout the development of the classification process. Care was taken to ensure the legal defensability of both the classification and process.

After completion of Phases 1, 2, and 3, the County has utilized this classification as guidance in the development review, permitting and access control processes utilized by the County.

This project can serve as a role model for communities to use in implementing access management at the local level.


DATA
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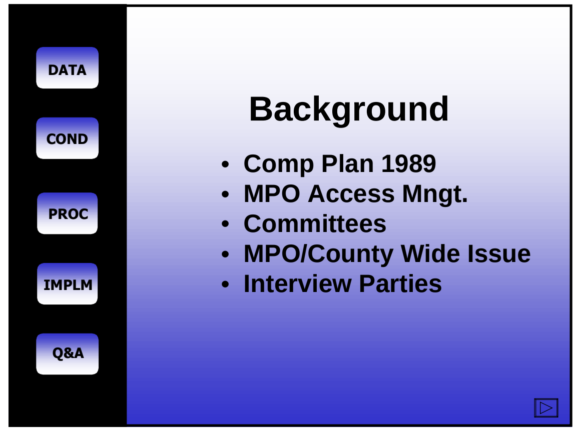
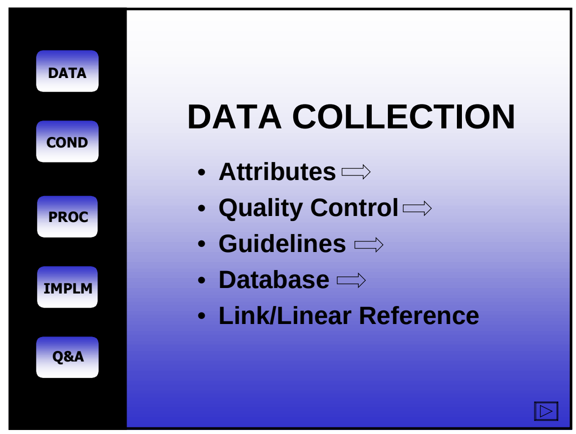
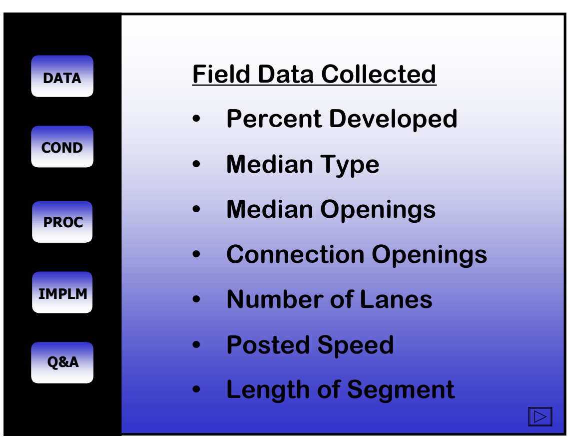
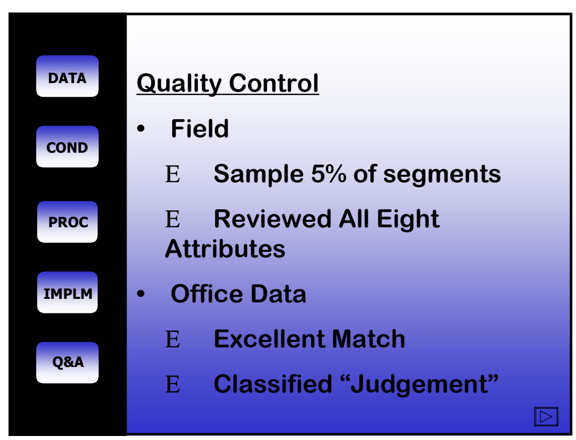
PROC
IMPLM
Q&A
AGENDA
• Background
• Data
• Conditions
• Process
• Implementation
• Q&A

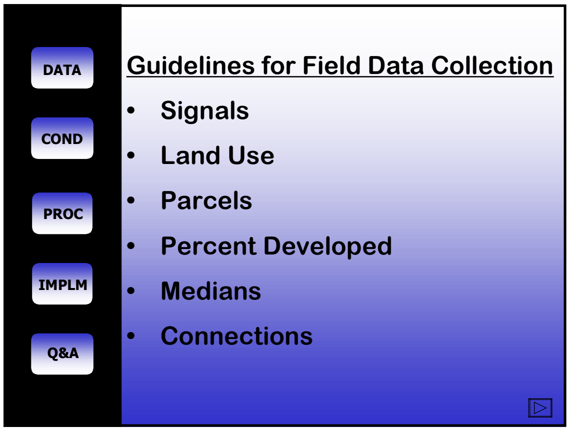

DATA
COND
PROC
IMPLM
Q&A
Background
• Comp Plan 1989
• MPO Access Mngt.
• Committees
• MPO/County Wide Issue
• Interview Parties


DATA
COND
PROC
IMPLM
Q&A
Study Goals
• Develop Standards
• All County Roads
• Define New Process
• Adopt Ordinance
• Implement Process


DATA
COND
PROC
IMPLM
Q&A
DATA COLLECTION
• Attributes ⇨
• Quality Control ⇨
• Guidelines ⇨
• Database ⇨
• Link/Linear Reference


DATA
COND
PROC
IMPLM
Q&A
Field Data Collected
• Percent Developed
• Median Type
• Median Openings
• Connection Openings
• Number of Lanes
• Posted Speed
• Length of Segment


DATA
COND
PROC
IMPLM
Q&A
Quality Control
• Field
E Sample 5% of segments
E Reviewed All Eight Attributes
• Office Data
E Excellent Match
E Classified "Judgement"


DATA
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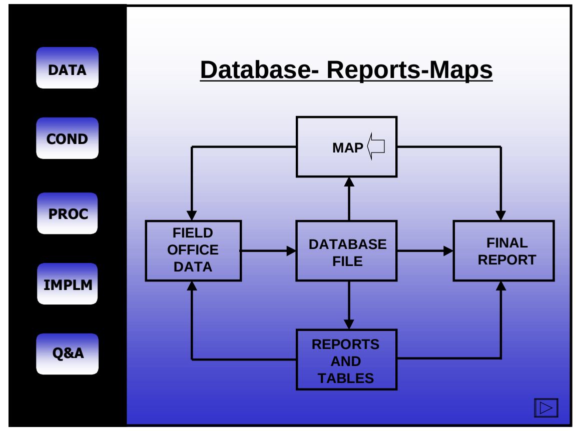
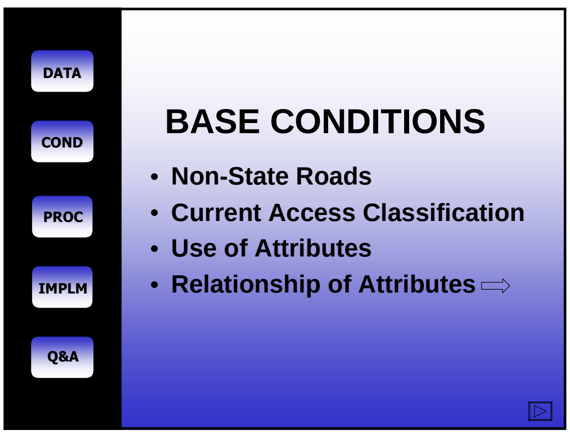
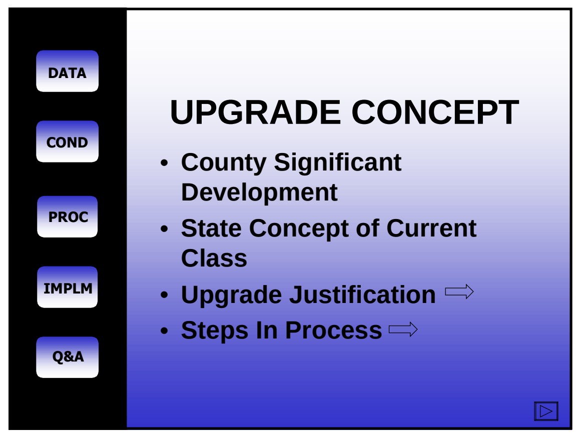
PROC
IMPLM
Q&A
Guidelines for Field Data Collection
• Signals
• Land Use
• Parcels
• Percent Developed
• Medians
• Connections


DATA
COND
PROC
IMPLM
Q&A
Database- Reports-Maps
MAP
FIELD OFFICE DATA
DATABASE FILE
FINAL REPORT
REPORTS AND TABLES


DATA
COND
PROC
IMPLM
Q&A
BASE CONDITIONS
• Non-State Roads
• Current Access Classification
• Use of Attributes
• Relationship of Attributes


DATA
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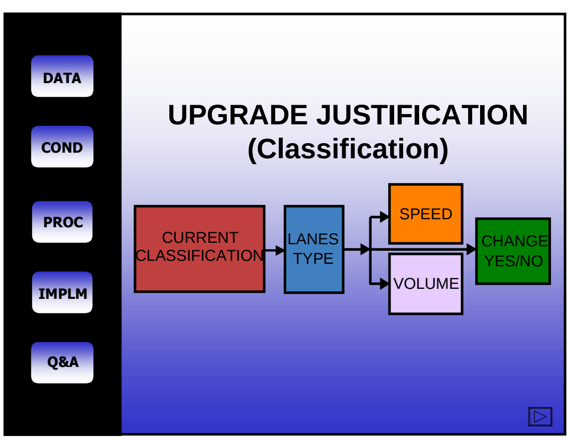
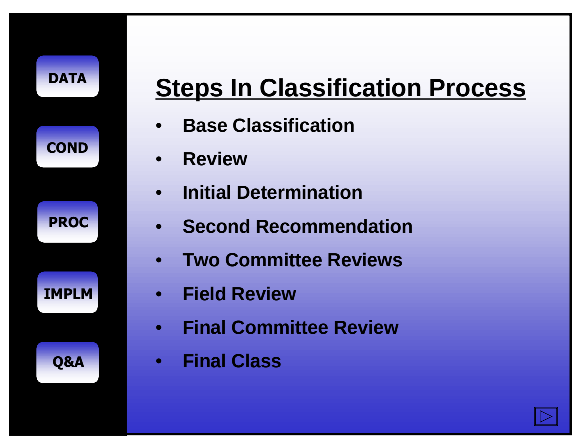
PROC
IMPLM
Q&A
UPGRADE CONCEPT
• County Significant Development
• State Concept of Current Class
• Upgrade Justification
• Steps In Process


DATA
COND
PROC
IMPLM
Q&A
UPGRADE JUSTIFICATION (Classification)
CURRENT CLASSIFICATION
LANES TYPE
SPEED
VOLUME
CHANGE YES/NO


DATA
COND
PROC
IMPLM
Q&A
Steps In Classification Process
• Base Classification
• Review
• Initial Determination
• Second Recommendation
• Two Committee Reviews
• Field Review
• Final Committee Review
• Final Class

DATA
COND
PROC
IMPLM
Q&A

MPO ROLE

- Implementation
  - Modified Study
  - Adopted Standards
  - Field Verification
  - Adopted Class by Segment
  - MPO/Adopted
  - County Commissioners

DATA
COND
PROC
IMPLM
Q&A

COMPREHENSIVE PLAN

- Policy ⇨
- Ordinance ⇨
- Maps Adopted
- Concurrency

DATA
COND
PROC
IMPLM
Q&A

Safety, Efficiency, and Goods Movement

1.9 Policy

Pinellas County shall implement access management standards in accordance with the median opening and driveway connection spacing maps contained in the Transportation Element as Figures 7-2 and 7-3. These standards shall be implemented through the site plan review process and the application of the Access Management and Concurrency Management Sections of the Land Development Code for properties adjacent to County roads.

DATA
COND
PROC
IMPLM
Q&A

Ordinance 97-51
Access Management

An Ordinance Amending the Pinellas County Access Management Ordinance 90-13, as amended:

Providing a new title; providing for additional design standards, providing for insurance guidelines; providing for traffic control standards; providing for severability; and providing for an effective date.

DATA
COND
PROC
IMPLM
Q&A

ORGANIZATION CHANGE

- More Efficient
- More Consistent
- Use During Review Process
- Use for Design
- Subdivision review

DATA
COND
PROC
IMPLM
Q&A

Question & Answer

Highland	Criteria	Functional Classification
Trinity	Upgrade	Spacing of Driveways
East Lake	Steps	Distribution of % Developed
Keene	Distribution of Land Use	Distribution of Widths of Parcels
% Miles at Posted Speed	Driveway	Median

Local Government Access Management Issues In New Jersey

Gary Davies, Garmen Associates

This presentation will cover the successful work done by New Jersey DOT, Monmouth County and Colts Neck Township to create a joint access management plan affecting a critical suburban corridor.

No Presentation Material Available for Print

Bridging The Gap Between Access Management and Local Land Use Policies

David Plazak, Iowa State University

ABSTRACT

Access management has become an increasingly important and controversial issue in many cities in Iowa and across the nation. In Iowa and elsewhere, one of the major obstacles to the successful implementation of access management principles is the seeming disconnect between the activities of agencies responsible for administering roadways and the activities of agencies responsible for local land use planning and regulation.

Bridging the gap between transportation system management and land use planning and regulation is clearly a key to better functioning and safer roadways. However, a recent survey of Iowa's cities and counties conducted by the Center for Transportation Research and Education found that there is a significant disconnect in Iowa between roadway administration (e.g. driveway permit issuance and control of access rights) and land use planning and regulation (e.g. master planning and zoning).

In most cases in Iowa, larger city and county governments have ordinances pertaining to access management; however, these ordinances have little direct relationship to an overall transportation plan. Most local ordinances in Iowa do not fully utilize the powers granted by the Code of Iowa governments to control access to roadways. There is also no consistent process used by roadway jurisdictions, including the Iowa Department of Transportation, to review local access related changes to roadways except at the point when driveway permits are being sought by landowners. At the same time, the survey concluded that city and county officials in Iowa see access management as an increasingly important issue and as a high priority for action.

This disconnect between what officials think and what they actually practice presents an obvious problem. There are several potential solutions to this problem, all of which involve improving communications between road jurisdictions and land use planning agencies. A first logical step in improving communications is to identify current "best practices" across the state and across the nation and use them as models for localities in Iowa to use. Many potential best practices have already been identified in the access management literature. The next step in a program designed to remove the disconnect between transportation planning and land use planning would involve modifying these practices to fit specific Iowa circumstances.

This paper will identify specific ways that land development planning and regulations in Iowa could be strengthened to incorporate specific design principles for improving the functioning of transportation corridors. At the same time, it will identify a specific set of programs designed to demonstrate the benefits of coordinated access management to local land use planners and transportation engineers and planners. Finally, it will propose a process for identifying where future transportation and land access conflicts are most likely to arise statewide, such that a state DOT could designate them as high priority areas for increased interaction and coordinated planning.

Access Management And Business Vitality

An Impact Assessment
Based On Iowa Case Studies

The Problem

- Businesspersons think access changes could negatively impact their sales or customer base
- Retail business failure rates are generally high
- Businesspersons often have considerable influence with local decision-makers
- If access management projects are to succeed, understanding of and support from businesspersons is necessary

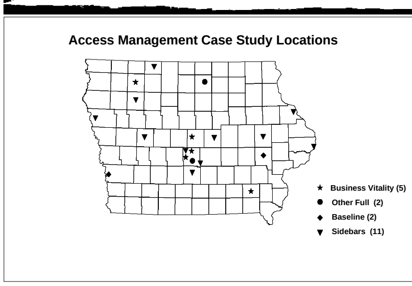
Presentation Outline

- Recap previous business vitality research
- Provide background on the Iowa Access Management Research and Awareness Project
- Summarize research methods used
- Summarize key research results
- Discuss conclusions and recommendations

Previous Research Findings

- The majority of businesses do not experience sales losses as a result of access changes
- Any losses that do occur are temporary and are recovered from within one to two years
- Highway-oriented businesses are the most vulnerable to changes in access
- Most motorists support access management projects, and they are business customers

Access Management Research And Awareness Project



Case Study Selection

- 50 possible case studies were nominated by transportation engineers and planners throughout Iowa
- Criteria for selection included geographic coverage of Iowa and coverage of different types of access management issues and project types
- Five business vitality case studies were selected by the Task Force to reflect a variety of communities and project types

Research Methods And Data Sources

- Retail sales tax data from the Iowa Department of Revenue and Finance, R.L. Polk city directories
- Opinion surveys of business owners and managers, motorists/business customers, and public officials conducted by the School of Business at the University of Northern Iowa
- Sampling rates for business owners/managers were higher than those for other groups

Case Study Communities

Community	Highway Route	Street Name	Community Population
Ames	US 69	S. Duff Ave.	47,198
Ankeny	US 69	N. Ankeny Blvd.	21,485
Clive	Not applicable	NW 86th St.	9,073
Fairfield	US 34	W. Burlington Ave.	9,768
Spencer	US 71	S. Grand Ave.	11,066

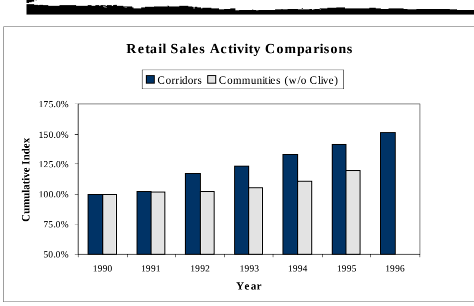
Project Characteristics

Community	Project Type	Length (Miles)	Year Completed	Traffic Before Project (AADT)	Traffic After Project (AADT)
Ames	Two-way left turn lane	0.5	1994	20,500	21,800
Ankeny	Raised median	1.0	1993	12,000	16,300
Clive	Raised median	0.6	1991	26,000	28,000
Fairfield	Driveway consolidation	0.6	1992	16,800	15,800
Spencer	Two-way left turn lane	0.6	1992	14,800	17,600

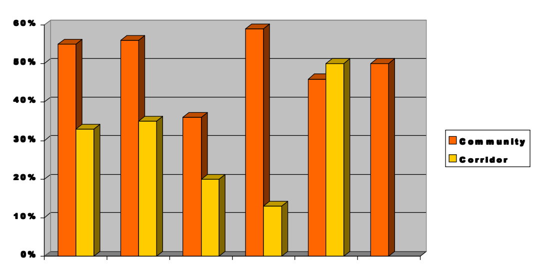
Community Retailing Characteristics

Case Study	Five Year Sales Growth	Five Year Change In Retail Firms	1996 Retail Trade "Pull Factor"
Ames	+8.8%	+2.1%	1.14
Ankeny	+57.2%	+22.7%	1.06
Clive	+346.2%	+171.0%	1.71
Fairfield	+7.0%	+10.4%	1.16
Spencer	+5.5%	+3.4%	1.57

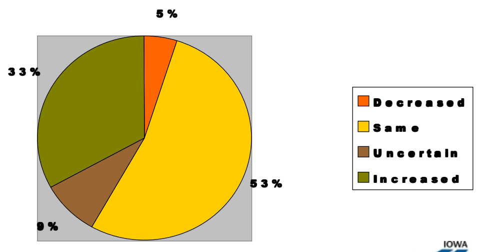
Case Study Corridor Sales Outpaced Their Communities



Five Year Business Loss Rates Were Usually Lower in Corridors Than In Their Communities



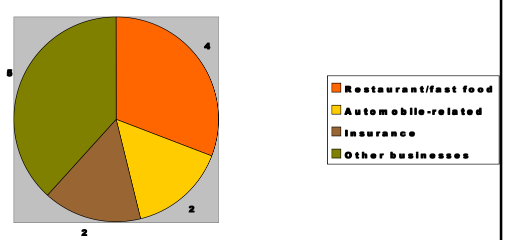
Businesses' Sales Were Usually The Same Or Higher After Project Completion



Businesses Reporting A Loss Of Sales After Project Completion

- Three of 63 businesses surveyed (5%) reported sales losses; they were:
  - A real estate office (Ankeny)
  - A supermarket (Ankeny)
  - A tanning salon (Clive)
- Only one of these, the supermarket, is an "impulse purchase" or automobile-oriented business
- The supermarket was faced with the introduction of a new, larger competitor at the same time as the access change

Businesses Reporting Customer Access Complaints, By Type



A total of 13 of 63 businesses surveyed (21%) reported complaints.

Support For Access Management Projects Is Impressive

Percentage Expressing A Favorable Opinion Overall

Group Surveyed	Ames (CLTL)	Ankeny (Median)	Clive (Median)	Fairfield (Drives)	Spencer (CLTL)	Average, All Projects
Customers and Motorists	96%	100%	92%	100%	100%	98%
Business Owners and Managers	91%	100%	70%	88%	100%	90%

Key Conclusions: Pluses

- Business failure rates in study corridors were generally below the statewide average
- Project corridors outpaced their surrounding communities in terms of sales growth by 15-20%
- Over 85 percent of businesses reported no sales losses
- Over 80 percent reported no customer complaints about access to their business after project completion
- Access management projects are supported by a great majority of motorists, who are also business customers
- There is some anecdotal evidence in Iowa that improved roadways can lead to urban redevelopment

Key Conclusions: Minuses

- Some individual businesses did report sales declines and customer complaints about access
- On average, about 5% of businesses may experience sales declines following project completion
- More may experience temporary declines during construction, but bounce back
- Business support (or opposition) can vary greatly by project

The Solution

- Involve businesses as early as possible in access management project planning and development
- Share real business experiences with them
- Let businesses know that they may experience temporary sales disruptions
- Be innovative in finding alternative access solutions
- Institute measures to help direct motorists to businesses where access is changed during and after the project

Session 9

Site Impact Analysis Techniques

Moderator: Art Eisdorfer, New Jersey Department of Transportation

Participants: John Taber, Tabermatics, Inc.
Steven A. Tindale and Doug Coxen, Tindale-Oliver and Associates, Inc.
Sandra Goslin and Art Eisdorfer, New Jersey Department of Transportation

Utah's Site Impact Simulation Model

John Taber, Tabermatics, Inc.

This will be a presentation on the recently completed tool to assist in site impact analysis. This, developed for Utah DOT, is a Windows based program allowing the investigator to supply some of the basic site data(development size, land use, etc.). The program assists in guiding the user to the safest and most appropriate access features.

No Presentation Material Available for Print

Simulation Models for Site Access Analysis

Steven A. Tindale, Tindale-Oliver and Associates, Inc.
Doug Coxen, Tindale-Oliver and Associates, Inc.

Abstract

This paper presents the procedures that were used to develop an access management plan for large development on a major State road. The process centers on the use of a simulation modal to assist in evaluating various options for access to this site and to the State road system.

Issues that were evaluated are:

- *The number and types of access points to the State road*
- *The relocation and specific optimization of location of access from the site to the State road*
- *The evaluation of site access for a major development that is using a State road*

In addition to the access management issues related to directly connecting the site to the State road system, internal circulation and access controls were evaluated for the site itself, including:

- *The location of driveways in relation to the road system connecting to the State roads*
- *The spacing and issues relating to queuing with the site*
- *The impact on site circulation of the modification of site access to the State road*

This presentation will show the various modeling tools that are available, the set-up of these tools, application of site access control measures, and site design as it related to access control on State road.

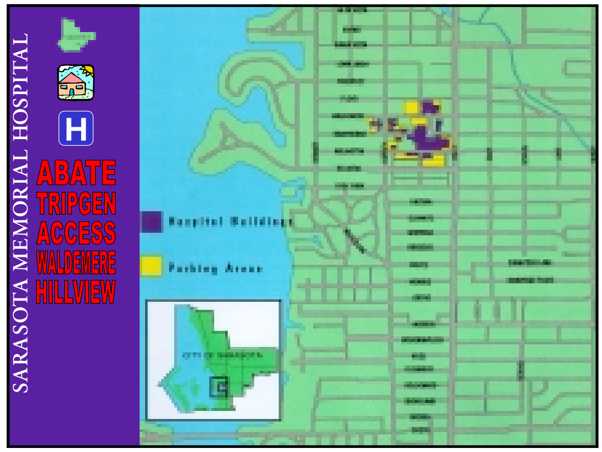
The specific model used is CORSIM. This model was used not only to assist in making a determination of access controls to protect the State road but to assist the developer in understanding the issues related to queuing, access, and circulation within the site.

Through use of this tool's visual presentation, the developer, neighborhood citizens, and everyone involved could clearly see the issues surrounding access management and its impact both on the State road and the site itself.

This project can serve as a role model for public agencies, site developers, and individuals concerned with access management at the local level.

We propose to show a "real-world" issue concerning site access controls, site circulation, and site access management. This demonstration will be through pictures, videotape, and most importantly, the use of state-of-the-art simulation/animation tools.


The Third National Conference
on
Access Management
Improving Transportation
Safety and Quality
October 4-7, 1998
Fort Lauderdale, Florida
SIMULATION MODELS FOR
SITE ANALYSIS
Presented by:
Steve Tindale
and
Doug Coxon
TINDALE OLIVER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Hospital Buildings
Parking Areas


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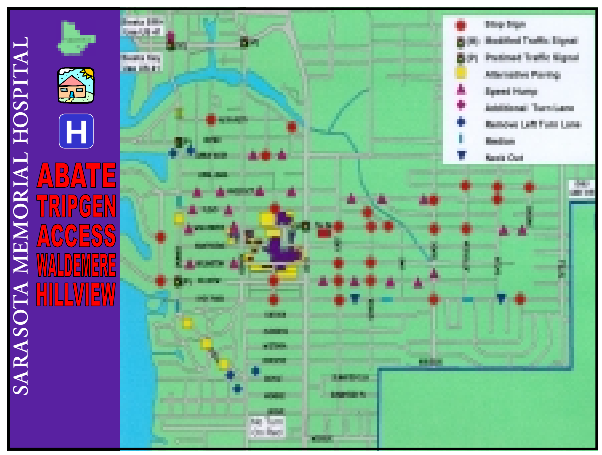
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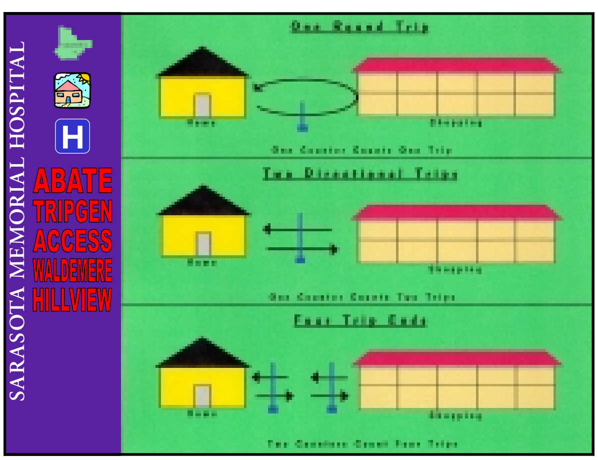
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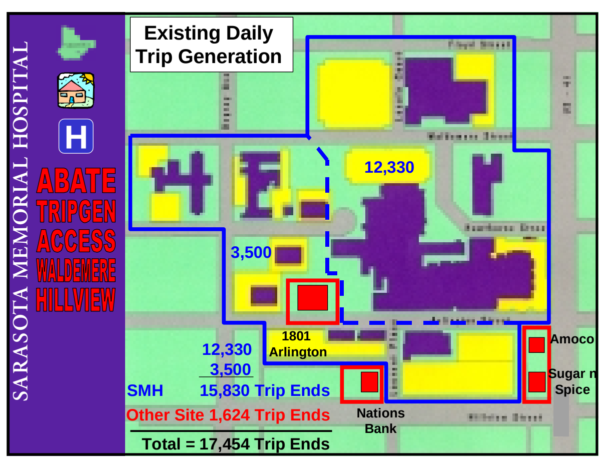
One Round Trip
Two Directional Trips
Four Trip Ends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Existing Daily
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12,330
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1801
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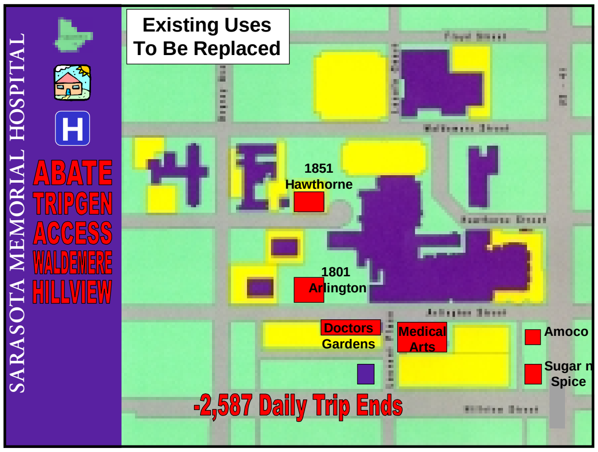
SMH 15,830 Trip Ends
Other Site 1,624 Trip Ends
Nations
Bank
Total = 17,454 Trip Ends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To Be Replaced
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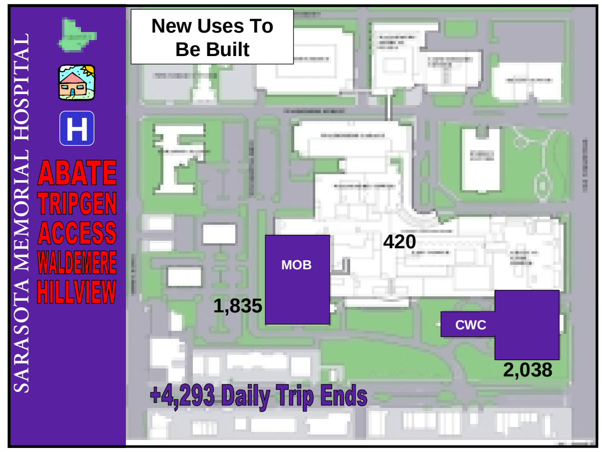
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New Uses To
Be Built
420
MOB
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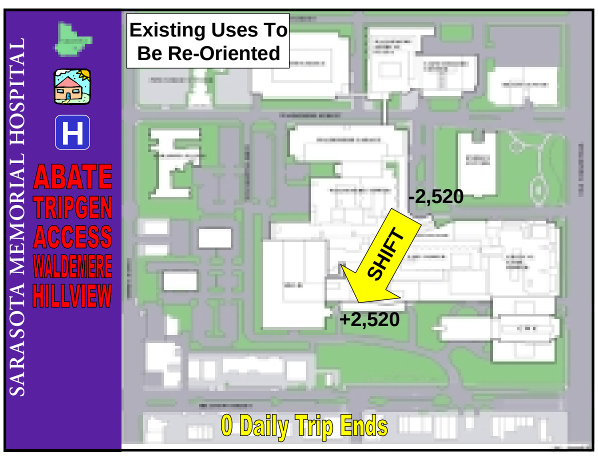
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HILLVIEW
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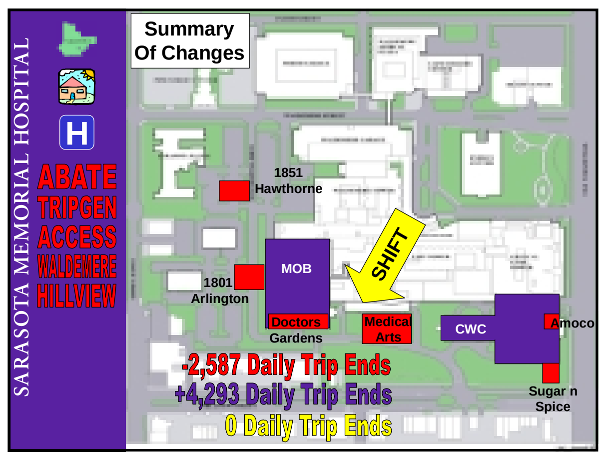
Be Re-Oriented
-2,520
SHIFT
+2,520
0 Daily Trip Ends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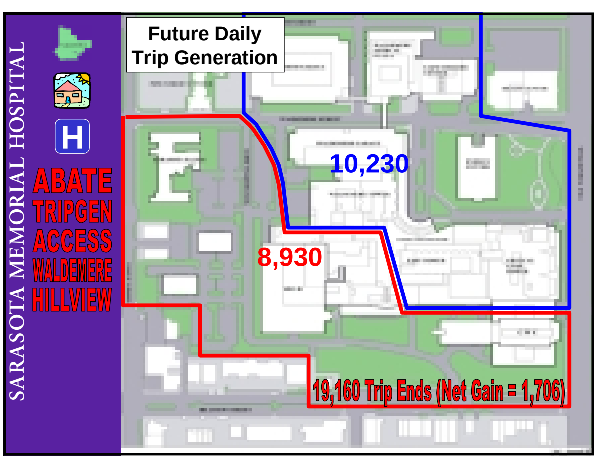
Summary
Of Changes
1851
Hawthorne
MOB
SHIFT
1801
Arlington
Doctors
Gardens
Medical
Arts
CWC
Amoco
Sugar n
Spice
-2,587 Daily Trip Ends
+4,293 Daily Trip Ends
0 Daily Trip Ends


SARASOTA MEMORIAL HOSPITAL
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TRIPGEN
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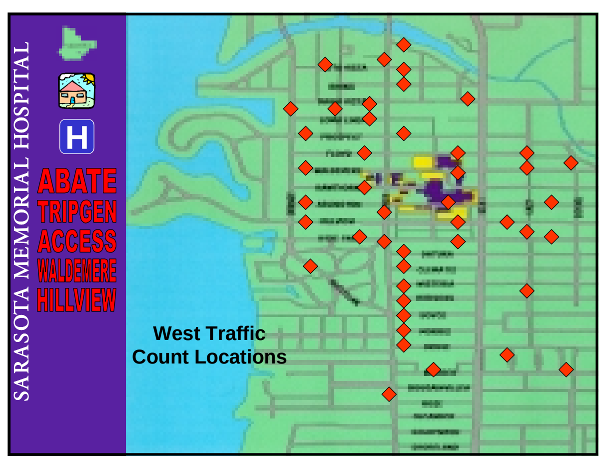
HILLVIEW
Future Daily
Trip Generation
10,230
8,930
19,160 Trip Ends (Net Gain = 1,706)


SARASOTA MEMORIAL HOSPITAL
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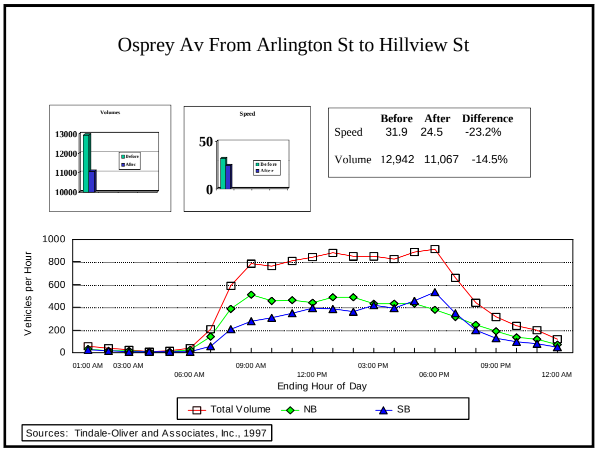
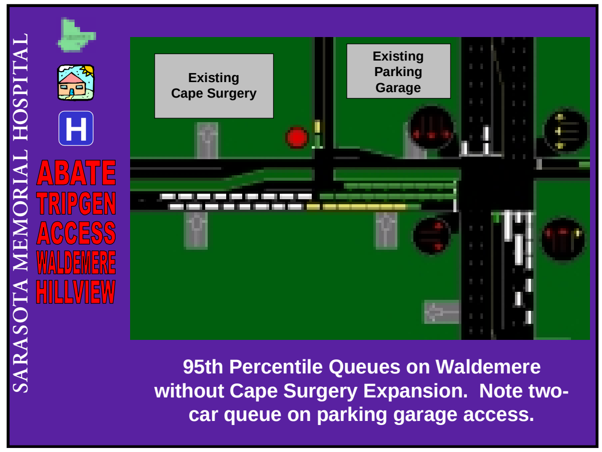
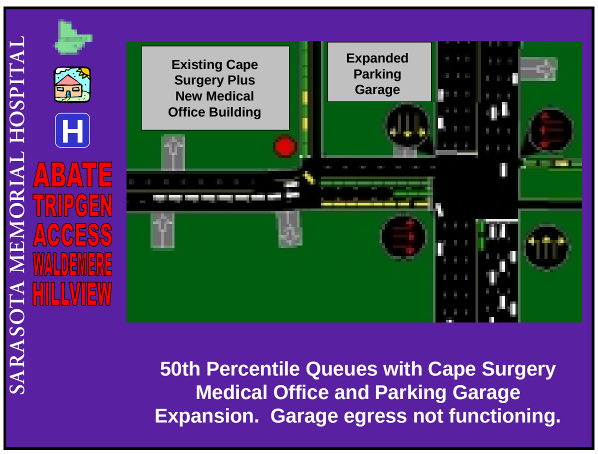
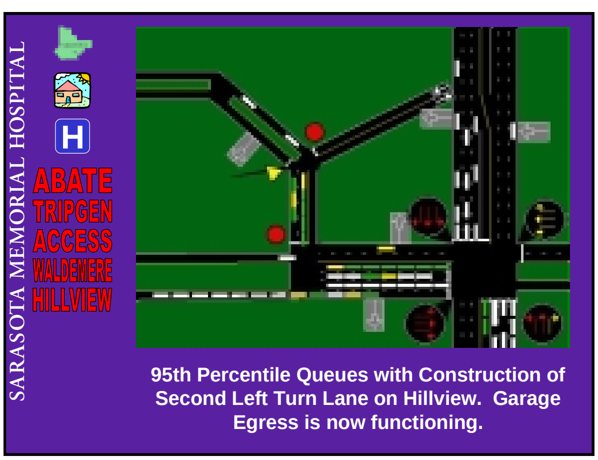
TRIPGEN
ACCESS
WALDEMERE
HILLVIEW
West Traffic
Count Locations

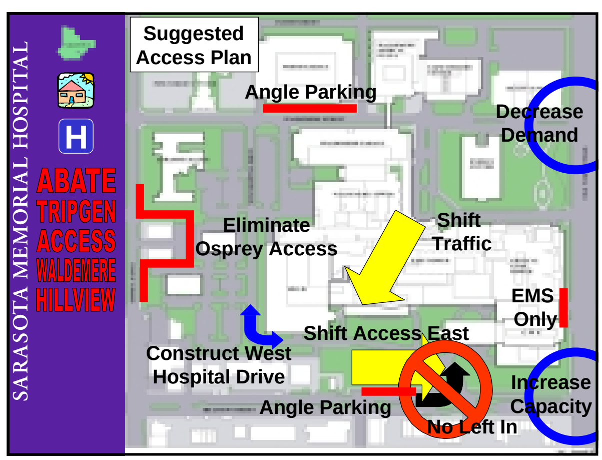

Osprey Av From Arlington St to Hillview St
Volumes
13000
12000
11000
10000
Before
After
Speed
50
0
Before
After
Before After Difference
Speed 31.9 24.5 -23.2%
Volume 12,942 11,067 -14.5%
1000
800
600
400
200
0
Vehicles per Hour
01:00 AM 03:00 AM 06:00 AM 09:00 AM 12:00 PM 03:00 PM 06:00 PM 09:00 PM 12:00 AM
Ending Hour of Day
Total Volume NB SB
Sources: Tindale-Oliver and Associates, Inc., 1997


SARASOTA MEMORIAL HOSPITAL
ABATE
TRIPGEN
ACCESS
WALDEMERE
HILLVIEW
Existing Cape Surgery
Existing Parking Garage
95th Percentile Queues on Waldemere without Cape Surgery Expansion. Note two-car queue on parking garage access.


SARASOTA MEMORIAL HOSPITAL
ABATE
TRIPGEN
ACCESS
WALDEMERE
HILLVIEW
Existing Cape Surgery Plus New Medical Office Building
Expanded Parking Garage
50th Percentile Queues with Cape Surgery Medical Office and Parking Garage Expansion. Garage egress not functioning.


SARASOTA MEMORIAL HOSPITAL
ABATE
TRIPGEN
ACCESS
WALDEMERE
HILLVIEW
95th Percentile Queues without Second Left Turn Lane on Hillview. Note long queue on CWC parking garage access.


SARASOTA MEMORIAL HOSPITAL
ABATE
TRIPGEN
ACCESS
WALDEMERE
HILLVIEW
95th Percentile Queues with Construction of Second Left Turn Lane on Hillview. Garage Egress is now functioning.


SARASOTA MEMORIAL HOSPITAL
ABATE
TRIPGEN
ACCESS
WALDEMERE
HILLVIEW
Suggested Access Plan
Angle Parking
Decrease Demand
Eliminate Osprey Access
Shift Traffic
EMS Only
Shift Access East
Construct West Hospital Drive
Increase Capacity
Angle Parking
No Left In

EQUITABLE TRAFFIC IMPACT ASSESSMENTS

Arthur Eisdorfer, New Jersey Department of Transportation
Sandra Goslin, New Jersey Department of Transportation

ABSTRACT

Introduction *In 1989, the State of New Jersey enacted the "State Highway Access Management Act . The Act required that the Department of Transportation (NJDOT) adopt comprehensive access management regulations. The regulations, the "State Highway Access Management Code", require that owners of large, proposed traffic generators pay their fair share of the cost of highway improvements that are needed to accommodate the added traffic from their developments. This fair share is determined through a traffic impact study, which is part of a State highway access permit application. These studies include analyses of locations where an applicant's traffic will have a significant impact on the State highway network, and subsequently indicate where traffic mitigation may be needed.*

NJDOT recognized that substantial engineering was associated with determining the fair share for a large development. However, NJDOT found the complex calculations to be necessary to comply with the law. The Act establishes that NJDOT has a public trust responsibility to effectively manage and maintain each highway within the State highway system to preserve its functional integrity and public purpose for present and future generations. It also states that land development activities and unrestricted access to State highways can impair the purpose of the State highway system and damage the public investment in that system. It further indicates that, in implementing access management, NJDOT should avoid undue burdens on property owners. NJDOT concluded that the work to determine the fair share was necessary to protect the public, even though it imposed some burden on applicants.

This paper will explore how fair share responsibility is determined, using methods that comply with New Jersey's Access Act and Code. It will cover the necessary information to include in a traffic impact study to be able to reach a fair share determination. The steps required to produce the information include preparing a scope of study, analyzing traffic, proposing traffic mitigation, and calculating the fair share.

Traffic Impact Study *A traffic impact study is a report that analyzes anticipated roadway conditions with and without a proposed development. Those required by NJDOT contain several major sections: a scope of study, which identifies the locations to be studied, the analyses of traffic conditions at these locations, and, if necessary, proposed mitigation measures and calculations of the applicant's fair share of the cost of these measures.*

Scope of Study *The selection of locations to analyze for possible traffic impacts can be a source of disagreement between professionals representing a transportation agency and a developer. New Jersey has created a method that objectively identifies such locations. It is called a scope of study and it establishes the locations where traffic attributable to an applicant's development will have a significant effect on the State highway network. Traffic at these locations is then analyzed in a traffic impact study. A scope of study includes trip generation for a site, as well as the trip distribution and site traffic assignment.*

Traffic Analysis / Mitigation *The access permit process in New Jersey requires that traffic mitigation be considered twice. The first occurrence is in a theoretical determination of the improvements that would provide sufficient capacity to accommodate traffic to be added to the State highway system. These improvements are tested through levels of service analyses, to ensure that standards for degradation of*

traffic flow are not exceeded. The costs of the improvements needed to mitigate violations of the level of service standards are determined next.

Traffic mitigation is considered again, after an applicant's fair share cost has been computed. The mitigation that the applicant will actually be required to build must then be established. From the previously identified improvements, those that will be equal to the fair share cost must be agreed upon between NJDOT and the applicant.

Fair Share Cost Determination *Highway improvements generally provide large, incremental increases in capacity. However, a small increase in capacity may be all that is needed to accommodate the additional traffic attributable to a new development or the expansion of an existing development. Under these circumstances, there is a need to establish the proportion of the capacity that the applicant should be responsible for.*

New Jersey established a method of calculating fair share responsibility in 1992. The method meets the subsequent tests of "individualized determination", "related in both nature and extent to the proposed development=s impacts" and "rough proportionality", which the United States Supreme Court established in the landmark Dolan vs. City of Tigard case in 1994. This paper will explain how such fair share determinations are made.

Conclusion *The improvements that a transportation agency may impose on an applicant must be equitable and must be determined through a process that will withstand public and legal scrutiny. In its access regulations, New Jersey has included a step-by-step process that minimizes subjectivity. This provides predictable and consistent treatment for those seeking to develop property along State highways. The method used in New Jersey can also be adapted for use by other transportation agencies.*

INTRODUCTION

In 1989, the State of New Jersey enacted the "State Highway Access Management Act". The Act required that the Department of Transportation (NJDOT) adopt comprehensive access management regulations. The regulations, the "State Highway Access Management Code", require that owners of large, proposed traffic generators pay their fair share of the cost of highway improvements that are needed to accommodate the added traffic from their developments. This fair share is determined through a traffic impact study, which is part of a State highway access permit application. These studies include analyses of locations where an applicant's traffic will have a significant impact on the State highway network, and indicate where traffic mitigation may be needed.

NJDOT recognized that substantial engineering was associated with determining the fair share for a large development. However, NJDOT found the complex calculations to be necessary to comply with the law. The Act establishes that NJDOT has a public trust responsibility to effectively manage and maintain each highway within the State highway system to preserve its functional integrity and public purpose for present and future generations. It also states that land development activities and unrestricted access to State highways can impair the purpose of the State highway system and damage the public investment in that system. It further indicates that, in implementing access management, NJDOT should avoid undue burdens on property owners. NJDOT concluded that the work to determine the fair share, described below, was necessary to protect the public, even though it imposed some burden on applicants.

This paper explores how fair share responsibility is determined, using methods that comply with New Jersey's Access Act and Code. It will cover the necessary information to include in a traffic impact study in order to reach a fair share determination. The steps required to reach the conclusion include preparing a scope of study, analyzing traffic, proposing traffic mitigation, and calculating the fair share.

TRAFFIC IMPACT STUDY

A traffic impact study is a report that analyzes anticipated roadway conditions with and without a proposed development. The traffic impact studies required by NJDOT contain several major sections: a scope of study, which identifies the locations to be studied, the analyses of these locations, and, if necessary, proposed mitigation measures and calculations of the applicant's fair share of the cost of these measures.

There is a substantial body of literature available on the subject of traffic impact studies. Some noteworthy guides include:

- “Traffic Access and Impact Studies for Site Development”, a Proposed Recommended Practice, prepared by the Transportation Planners Council for the Institute of Transportation Engineers, 1988.
- “Evaluating Traffic Impact Studies”, prepared by the Michigan DOT, Tri-County Regional Planning Commission, and the Southeast Michigan Council of Governments, 1994.
- “Site Impact Analysis Requirements Manual”, prepared by the British Columbia Ministry of Transportation and Highways, January, 1997.
- NCHRP Report 348, “Access Management Guidelines for Activity Centers”, 1992.
- New Jersey State Highway Access Management Code, N.J.A.C. 16:47-4.30.

Some common deficiencies of traffic impact studies were identified in the Michigan report. They include:

- Lack of uniform standards.
- Communities do not adequately address traffic implications of land use plans.
- Contents of studies vary. A standard practice is needed.
- Community leaders lack a guide for reviewing traffic studies.
- Traffic impacts are often inappropriately used as a reason for denial.
- Some communities require traffic studies for very small projects which have negligible impacts.
- Some communities allow very large-scale projects, which seriously compromise the integrity of the roadway system, without evaluating likely traffic impacts and necessary mitigation.

These deficiencies highlight the importance of consistency. However, consistency is difficult to achieve through the use of guidelines. Such an approach fosters individual application of the guidance and leads to a reliance on the personal preferences of the agency representatives. This results in inconsistencies and inequities. More consistent and equitable outcomes are achieved through mandatory procedures and requirements, coupled with the judicious granting of variances. This approach also provides the flexibility that is generally desirable to address truly unique conditions.

In 1992, the Access Code adopted by NJDOT contained comprehensive requirements for traffic impact studies. Simple studies cost several hundred to several thousand dollars to prepare, while complex studies cost many thousands of dollars to prepare. NJDOT staff review of the early traffic impact studies frequently found flaws in basic assumptions. Many of the costly analyses based on these assumptions then had to be rerun. In 1997, with the readoption of the Access Code, NJDOT reduced the risks and costs to applicants by allowing the scopes of study to be reviewed in advance of the submission of an application containing a traffic impact study. Scopes of study are addressed in more detail later in this paper.

The initial issue with regard to a traffic impact study is determining when one is necessary. The sources listed above contain information that indicates that common thresholds range between 50 and 200 peak hour trips. For the sake of consistency and predictability, an agency should specify a threshold. NJDOT requires a traffic impact study for any application for a development with an expected peak hour volume of 200 or more vehicle trips directly accessing a State highway.

NJDOT requires that traffic impact studies address existing conditions, the no build conditions anticipated at the time a development is predicted to open, and the build conditions expected at the time a development is proposed to open. NJDOT does not require analyses of other horizon years, such as 5, 10, or 20 years after the opening of a development. This is not necessary, because NJDOT regulates all connections to State highways and requires mitigation of most impacts from most large developments. NJDOT accepts responsibility for the cumulative impact of small developments and for some impacts of large developments. However, other transportation agencies require analyses of future horizon years. These are usually agencies that only regulate connections to roadways and do not require analyses of locations other than direct access to the site in question. Such agencies may need to require an applicant to be responsible for future conditions at the direct access, unless the agency is willing to assume the responsibility and use public funds to address future conditions.

The following sections describe the major components of a traffic impact study.

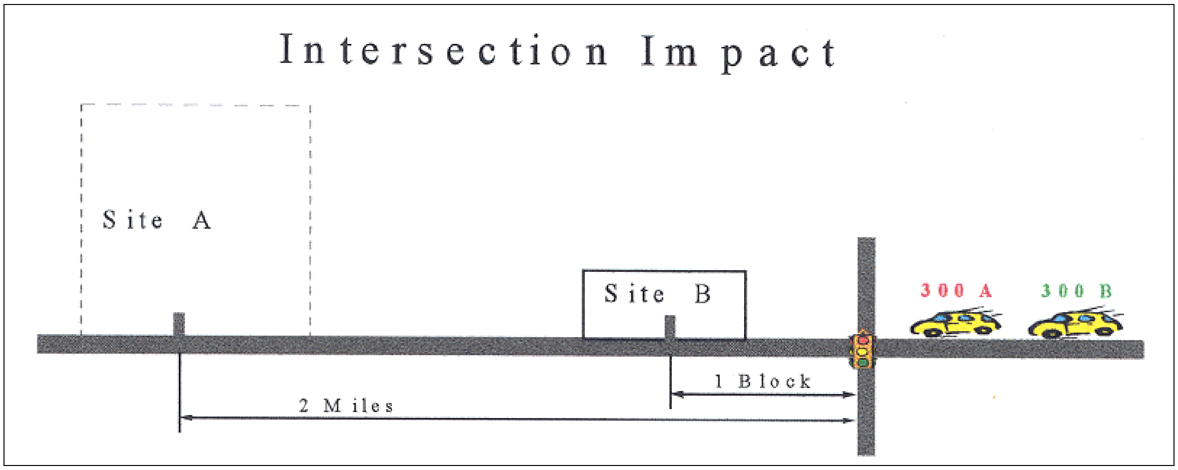
A. Scope of Study

The selection of locations to analyze for possible traffic impacts can be a source of disagreement between professionals representing a transportation agency and a developer. New Jersey has created a method that objectively identifies such locations. It is called a scope of study and it establishes the locations where traffic attributable to a proposed development will have a significant effect on the State highway network. Traffic at these locations is then analyzed in the traffic impact study. A scope of study includes the trip generation for a site, as well as the trip distribution and site traffic assignment.

Many jurisdictions have not established a means of objectively identifying locations that should be analyzed. Still other jurisdictions have set distance limits, such as the nearest intersection on either side of a proposed development, or 2 kilometers along the highway from the side property lines of a proposed development. Both the lack of specified criteria for defining locations to be analyzed and a distance threshold fail to adequately protect motorists from potential traffic congestion.

To illustrate this point, consider the perspective of one motorist. All other motorists have the potential to create traffic impacts. For the subject motorist, there is little relevance to the origin or intended destination of the other motorists on the road. Therefore, the subject motorist is not concerned whether a competing motorist has a destination one block away, one mile away, or 10 kilometers away. The subject motorist does not want to be impeded. This perspective provides support for the conclusion that impacts should be determined based on the number of site vehicles that impact a location, rather than the distance between the location and a proposed development.

This same point can be illustrated by viewing an intersection in isolation, as shown below. Site A is two miles from the subject intersection and it will add 300 peak hour trips to that intersection. Site B is one block from the subject intersection and it will add 300 peak hour trips to that intersection. In this example, both developments should be assessed identically for their impacts at the subject intersection.



Step 1 - Trip Generation

The first step toward completing a scope of study is to develop the trip generation for the proposed land use. New Jersey=s Access Code requires applicants to use the current edition of the Institute of Transportation Engineers publication entitled ATrip Generation@, or superseding trip generation rates that have been adopted by NJDOT. The trip generation establishes the number of trips associated with a site for the weekday AM and PM and weekend peak hours, as well as 24 hour counts for a weekday and a weekend day. The trip generation in each peak hour must be established so that the appropriate analyses can be performed in Step 6.

Step 2 - Trip Distribution

Once the trip generation is established, the next step is to develop a trip distribution for site traffic. The trip distribution indicates the percentage of site traffic coming from each direction, such as north, south, east, and west. The most common methods of developing trip distribution include the gravity model, which uses population densities and distance from the site as part of a mathematical equation, and marketing studies. Other factors should also be taken into account, such as a competing land use, which would draw traffic away from the site, or natural barriers, which would impede a customer from reaching a site, such as a river without a nearby bridge.

Step 3 - Site Traffic Assignment

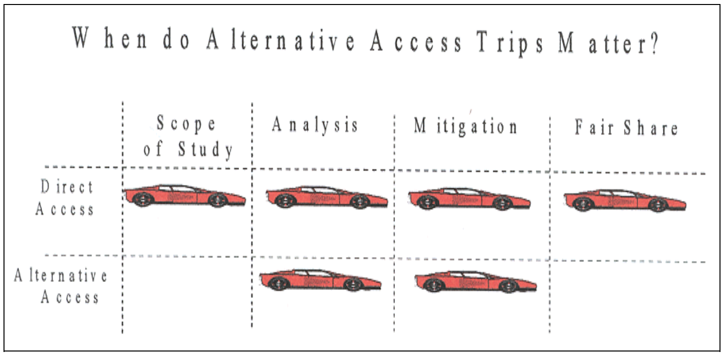
The next step is to develop a traffic assignment for the site trips. The anticipated trips are assigned to the existing roadway network using the trip distribution, as well as any knowledge of the area that would influence a potential Acustomer@ to chose one road over another. A figure should then be developed illustrating the site traffic using each segment of the roadway network.

Step 4 - Trips not Considered

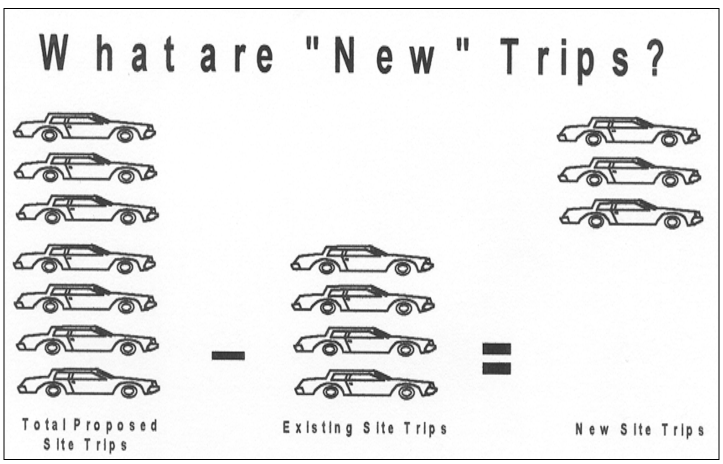
There are several different types of trips to identify and remove from consideration when preparing a scope of study, even though these trips are pertinent to a traffic impact study. These include pass-by trips, alternative access trips, and existing site trips. The pass-by trips are trips that pass the site, on their way to another destination, before the proposed site is developed. These trips may be planned or unplanned. For instance, every night on the way home from work you pass directly by your bank, but you only stop in on payday. That is a planned trip. However, one night on your way home, you realize you are going to need extra cash for dinner and so you stop by the ATM machine at the bank. That is an unplanned trip. These are pass-by trips, since neither trip is a new trip to the roadway network, because you travel the road every day. Pass-by trips are removed from a scope of study because these trips do not create impacts as a result of a proposed development.

Alternative access trips are also not reflected in a scope of study. These are trips that access the site from access points not located on the State highway frontage of the site. The percentage of site trips using alternative access should be justified by some form of supporting documentation, such as a gravity model or license plate survey.

The cars in the following figure indicate when alternative access trips are considered in a traffic impact study:



The final type of trips that are not included in a scope of study are existing site trips. When an existing land use is expanded or changed, the existing site trips are already sanctioned. Only the Anew@ trips, the difference between the existing trips and the proposed trips, need to be included in a scope of study. The following figure illustrates this point:



Step 5 - Half trips

If an agency held every developer responsible for the full length of every trip to and from each development, the agency could assess each developer for twice the total traffic impacts from their development. Consequently, an applicant should not be held responsible for impacts along the full length of a trip from its origin to the site or from the site back to the origin. NJDOT established the half-trip rule to avoid double counting.

Once pass-by trips, alternative access trips, and existing trips are eliminated from the total trip generation for a development, the halfway point for each remaining trip should be identified. The halfway point would be the midpoint between the origin and destination for each trip. The half of each trip furthest from the site should be eliminated from the scope of study. The remaining trips should be illustrated on a site traffic assignment figure.

Step 6 – Analysis Locations

The next step is to identify the locations that must be analyzed. These locations are usually signalized or unsignalized intersections. However, they may also be at other locations that can be analyzed based on the techniques in the A1994 Highway Capacity Manual@ (HCM), Special Report 209, such as merge and diverge points for ramps and jughandles, and weaves in the vicinity of ramps.

There are two tests that NJDOT uses to determine if a potential analysis location needs to be analyzed. They are based on the half trips, as screened above:

- 100 peak hour site trips. See Figure 1.
- 10 percent of the anticipated daily site traffic. See Figure 2.

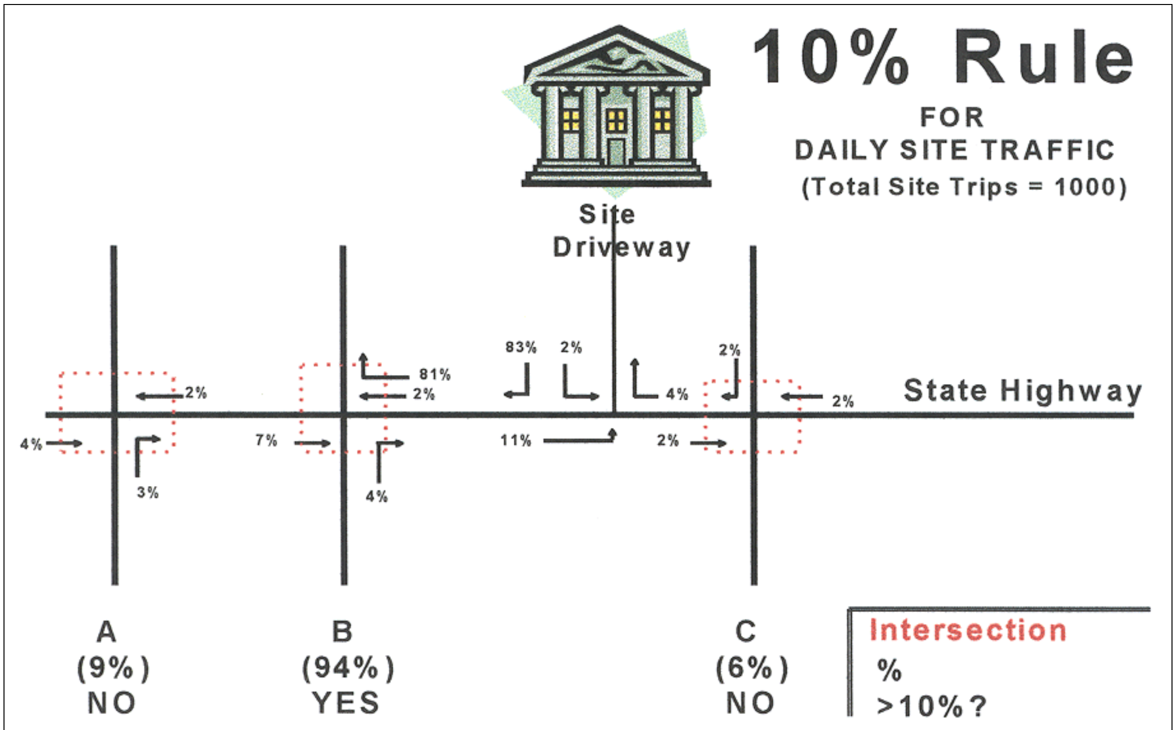


Figure 1

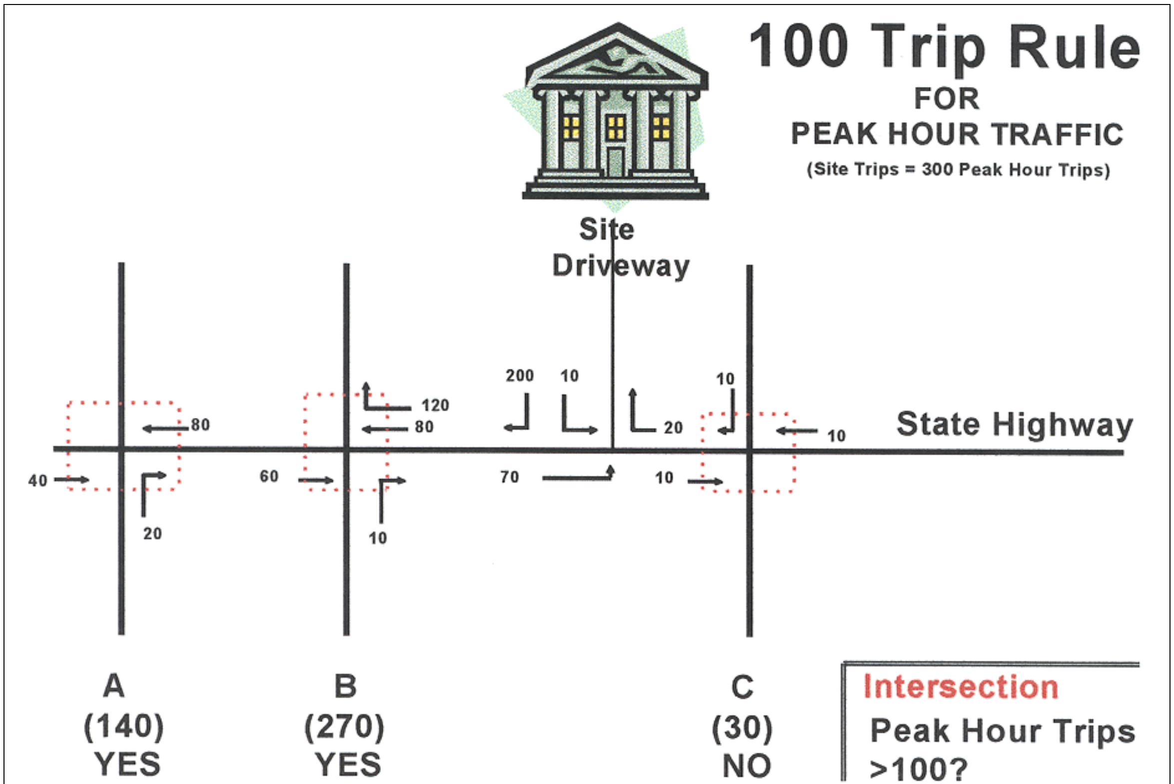


Figure 2

Any location where there are at least 100 peak hour site trips and at least 10 percent of the anticipated daily traffic is a location that must be analyzed. In the example above, Location B would need to be analyzed, because both of these tests are met. Whereas Locations A and C would not need to be analyzed, because both of the tests are not met.

Once all of the six steps have been completed, the scope of a traffic impact study will have been defined.

B. Traffic Analysis / Mitigation

After a scope of study has been prepared, there is additional information that is needed before the actual traffic analyses can be done. This information is frequently presented graphically and includes the following figures:

1. Background traffic. This is developed from traffic counts that are taken in the vicinity of the locations to be analyzed.

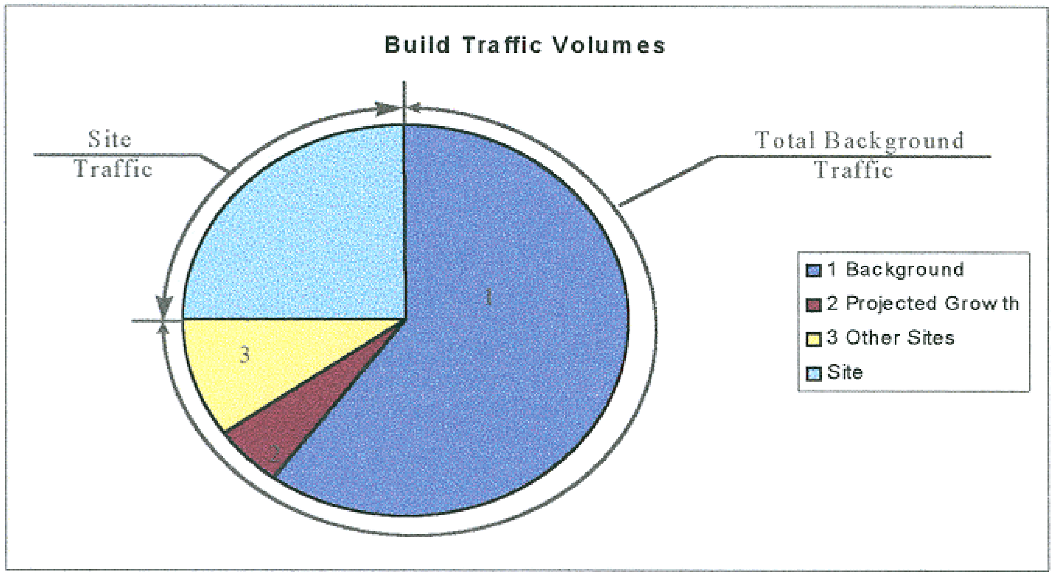
2. Projected growth traffic. This figure is necessary when the build year for the site is later than the year in which the traffic counts are taken. These projected counts are developed by using growth rates. NJDOT generates growth rates on a semiannual basis.

3. Traffic from other sites. These figures show potential traffic from developed sites that were not reflected in the traffic counts because the sites were unoccupied or not yet open for business.

4. Total background traffic or Ano-build@ traffic. The traffic volumes shown on the three previous figures are added together to create this figure.

5. Total traffic or Abuild" traffic. This last figure is generated by adding the total site traffic to the traffic shown on the no-build figure.

The following figure illustrates build traffic volumes.



As part of a traffic impact study, an applicant should analyze the effect the proposed site traffic has on the highway system, for those locations identified in the scope of study. This is done by performing analyses in accordance with the Highway Capacity Manual and comparing the before and after levels of service. This should be done for each peak hour. When a land use has a peak hour where its trip generation is higher than the trips it generates during the peak hour of the highway, the peak hour that is analyzed should be the hour that has the highest combination of site traffic and highway traffic. This insures that the applicant analyzes the site traffic when it has the greatest impact on the highway network and, therefore, on the motoring public.

The NJDOT has adopted level of service standards for each type of analysis, such as signalized or unsignalized intersection. These standards allow some deterioration in level of service from the no-build condition to the build condition. A violation occurs when the allowable deterioration is exceeded.

If a violation of the level of service standards occurs, then traffic mitigation must be proposed to reduce the deterioration to within the tolerance set forth in the standards. Some examples of traffic mitigation of a level of service violation are a change in signal timing, a lane addition, the addition of traffic signal to an intersection, or even the installation of an interchange.

The access permit process in New Jersey requires that traffic mitigation be considered twice in a traffic impact study. The first occurrence is in a theoretical determination of the improvements that would provide sufficient capacity to eliminate any level of service violations. Traffic mitigation is considered again, after an applicant's fair share cost has been computed.

C. FAIR SHARE COST DETERMINATION

Highway improvements generally provide large incremental increases in capacity. For example, the addition of one lane on a freeway may increase the capacity of that freeway by over 2,000 vehicles per hour. However, a new shopping center may only add 400 peak hour trips to a nearby freeway. The addition of left turn slots at a signalized intersection may increase the capacity of that intersection by over 500 vehicles per hour. However, an expansion at an office park may only add 120 peak hour trips to a nearby signalized intersection. In each of these cases, the smallest possible increase in capacity is larger than the capacity increase needed to accommodate the added traffic from the development. Consequently, there is a need for an equitable means of charging proposed development for the additional capacity it will require. It is that proportion of additional capacity of a proposed highway improvement that the applicant should be responsible for.

New Jersey established a method of assigning fair share responsibility in 1992. In the three prior years, several other methods were considered, but all were found unsuitable. An example of a method that was rejected follows next.

The Popular Method
One of the rejected methods had numerous supporters. It was based on the following factors:

$ Number of existing vehicles in the peak hour at a location = **# Before**
$ Number of vehicles added in the peak hour from the development = **Applicant traffic**
$ Cost of added capacity = **Total $**

This popular, but rejected method, computed the applicant=s fair share responsibility based on the following equation:

$$\textbf{Applicants \$} = \frac{\textbf{Total \$ * Applicant traffic}}{\textbf{(Applicant traffic + \# Before)}}$$

Using this method, an applicant adding 200 peak hour trips to a roadway carrying 3,800 peak hour trips, where the roadway required a $500,000 improvement to increase the capacity by 1,000 peak hour trips would have a fair share of $25,000.

Even though this method is used by some municipalities in New Jersey, NJDOT found it to be unworkable and inequitable. This is because the method, in effect, assesses existing traffic for a share of the improvement of the highway. Yet the existing traffic already fits on the existing highway and the existing traffic does not cause the need for the improvement.

The inequity of this method is compounded when multiple improvements are needed over time. The following chronicle illustrates this point:

1990 Motorist A moves into a new housing development and pays $100 towards a 2-lane road through the development.

1995 Motorist B moves into a new development across town and wants to ride on the 2-lane road, but the road is at capacity. The government widens the two lane road to 4 lanes. Motorist A and Motorist B each pay $50 in taxes for the widening.

2000 Motorist C moves into a different part of the community and wants to ride on the 4 lane road, but the road is at capacity. The government widens the 4 lane road to 6 lanes. Motorists A, B, and C each pay $33 towards the widening.

Motorist	A	B	C
Total $	$183	$83	$33

This example leads to the following conclusions:
1. Motorist A, who was comfortable on the road, had to continually pay to maintain that comfort.
2. Motorist A paid a disproportionate share of the cost of the road.
3. Each motorist paid a different amount to be able to use the same road in the future.

This method leads to an inequitable outcome.

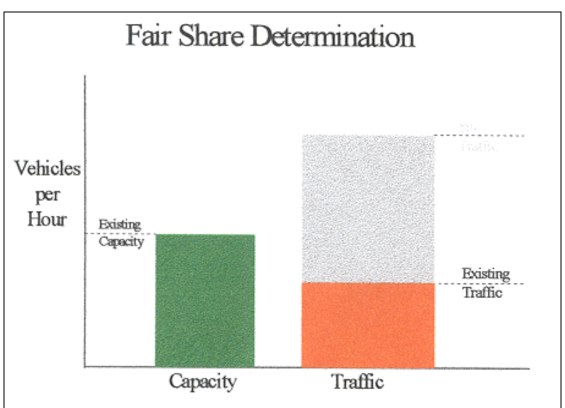
The NJDOT Method

The method of determining fair share proposed by NJDOT, and subsequently adopted for use on State highways, involves the following six steps. These steps are summarized on the flow chart at the end of this section.

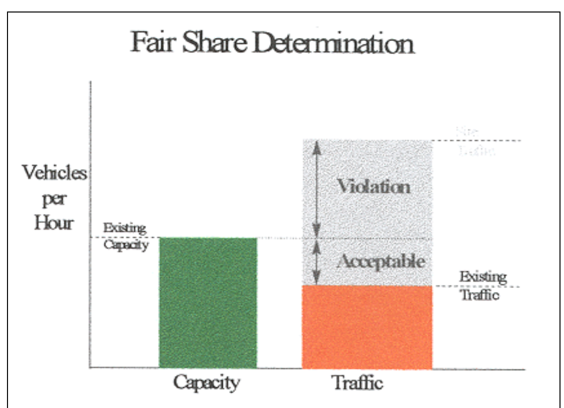
Step 1 - Site traffic

All traffic entering or leaving site driveways that connect to a State highway has the potential to be included in the assessment of fair share responsibility, except for pass-by trips and existing site trips. The remaining traffic is analyzed as previously described in this paper. An applicant is responsible for the fair share of the cost of mitigation at each analysis location where a level of service violation occurs. At a particular location, there may be existing capacity available to accommodate some or even all of the applicant s traffic. See Graph 1. Therefore, it is necessary to split the site traffic into two components. The first is comprised of site traffic that can be accommodated by the available capacity. This is called the acceptable component. The second is comprised of the site traffic that cannot be accommodated by the available capacity. This is called the level of service violation component. See Graph 2. Therefore, if there is no level of service violation at a location, then there is no level of service violation component and there is no fair share assessed for that location.

Site Traffic = Acceptable Component + LOS Violation Component



Graph 1



Graph 2

Step 2 - Capacity Increase

The traffic mitigation proposed at each location must add sufficient capacity to accommodate the anticipated increase in traffic from the proposed development at the time the proposed development opens. For fair share purposes, "capacity" means the maximum traffic volume possible at level of service E. In addition, the proposed traffic mitigation needs to be compatible with future plans for the highway at each location.

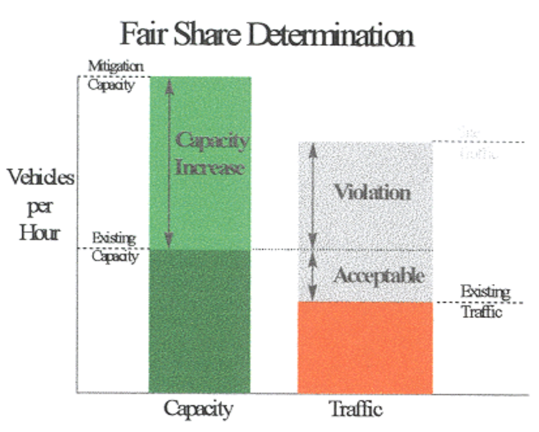
The capacity increase is the difference between the capacity after mitigation and the capacity before mitigation. See Graph 3.

Capacity Increase = Capacity After Mitigation - Existing Capacity

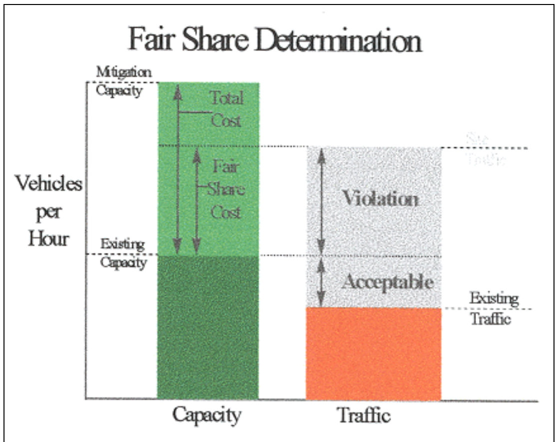
Step 3 - Fair Share Proportion

The fair share proportion establishes how much of the capacity increase will be used by site traffic at each location. It is important to note that the applicant is only responsible for capacity that could be constructed by the applicant and would be consumed by site traffic. The fair share proportion is equal to the level of service violation component divided by the capacity increase, as reflected in the following formula. On Graph 4, it is the magnitude of the violation component that is used to establish the proportion of the total cost that is the fair share cost.

Fair Share Proportion = LOS Violation Component/Capacity Increase



Graph 3



Graph 4

Step 4 - Traffic Mitigation Cost

The cost of traffic mitigation at each location is based on the costs that NJDOT would incur if it provided the mitigation. Even though some applicants may be able to provide improvements at a lower cost than NJDOT, the value of the improvements must be established on a uniform basis. This is particularly important if NJDOT accepts funds from an applicant, in place of the applicant constructing the mitigation, and NJDOT then uses the funds to make the improvements.

The cost of traffic mitigation at a location is the sum of the mitigation elements shown below. Utility relocation costs are not included. In New Jersey, utility relocation costs can be the responsibility of the applicant, NJDOT, or the utility company. The determination is based on who will implement the highway improvements and whether the highway improvements are for a public or private purpose. Because the determination is not straightforward, utility relocation costs are not included in fair share cost determinations.

1. Design of the mitigation
2. Right of way appraisal and acquisition
3. Construction of the mitigation
4. Management of the construction

5. Environmental cleanup, environmental mitigation, and permits

Mitigation Cost = Sum of the mitigation elements

Step 5 - Fair Share
The fair share is determined for each location where there is a level of service violation component. The fair share is derived separately at each location from the fair share proportion, established in Step 3, and the cost of the mitigation established in Step 4, as also reflected in the following formula:

Fair Share = Fair Share Proportion x Mitigation Cost

Step 6 - Total Fair Share
Frequently, traffic from a site will have impacts at multiple State highway locations. When this happens, the total fair share is determined by adding together the applicant's fair shares at each of the locations where level of service violations occur.

Total Fair Share = Sum of the fair shares at each study location

Applying the NJDOT method to the previous fair share example, an applicant adding 200 peak hour trips to a roadway carrying 3,800 peak hour trips where the roadway required a $500,000 improvement to increase the capacity by 1,000 peak hour trips would have a fair share of $100,000. This is substantially higher than the $25,000 result in the rejected fair share method. However, the NJDOT method more appropriately assigns the costs for highway improvements to those who create the need for the improvements.

NJDOT Fair Share Method Meets the Highest Standards
In 1994, the United States Supreme Court decided the landmark case, *Dolan vs. City of Tigard, Oregon*. Mrs. Dolan filed suit against the city because she believed that the city had unfairly assessed her for flood control and transportation impacts associated with the proposed expansion of her appliance store. In deciding the case in favor of Mrs. Dolan, the court found the assessment by the city to be lacking an "individualized determination", "related in both nature and extent to the proposed development s impacts" and not possessing a "rough proportionality" to the impact.

The NJDOT method for determining fair share meets each of the tests prescribed by the United States Supreme Court. The method results in a determination that is unique to the application. Therefore, it is an individualized determination. The method requires a capacity cure for a capacity impact and the larger the impact, the larger the cure. Therefore, it is related in both nature and extent. The larger impact resulting in a larger cure also meets the rough proportionality test.

Rules for Fair Share Determinations
Rule 1 - NJDOT can only require fair share contributions towards the cost of constructing capacity improvements to the State highway system.

Rule 2 - The site traffic to be considered must directly ingress or egress the State highway from the applicant s property. Traffic going to or from a State highway via someone else s lot or via a side street is not considered in a fair share determination.

Rule 3 - The highway improvements may include, but are not limited to, roadway and structure widenings, frontage roads, intersection improvements, structures, reverse frontage roads, and alternative access.

Rule 4 - Improvements that benefit only the applicant are entirely the applicant's responsibility and are not considered in the fair share determination. Examples of this are acceleration and deceleration lanes for a site driveway, and left turn slots which only provide access to a site.

Rule 5 - NJDOT may either have the applicant pay money, in an amount equal to the fair share to NJDOT, or NJDOT may permit the applicant to construct the improvement at the applicant's expense and under NJDOT supervision.

Rule 6 - If the NJDOT elects that the applicant pay fair share money, but NJDOT does not anticipate that the mitigation identified for a location will be implemented within 15 years of the date of the permit, then the applicant has no fair share responsibility at that location.

Rule 7 - If NJDOT permits the applicant to construct mitigation, then these improvements are to be at one or all of the locations where level of service violations would occur. NJDOT considers the needs of the applicant and the public, when determining the highway improvements to be constructed.

Rule 8 - NJDOT must hold all fair share money it receives in a designated account and identify the fair share amount for each location.

Rule 9 - Fair share money held by NJDOT may be expended on any of the mitigation elements listed in Step 4 above and at any of the locations for which the funds were collected.

Rule 10 - NJDOT must refund any fair share money and accrued interest applicable to the mitigation at a location, if the improvement is not implemented within 15 years. The refund will be made to the owner of the lot at the end of the 15 years.

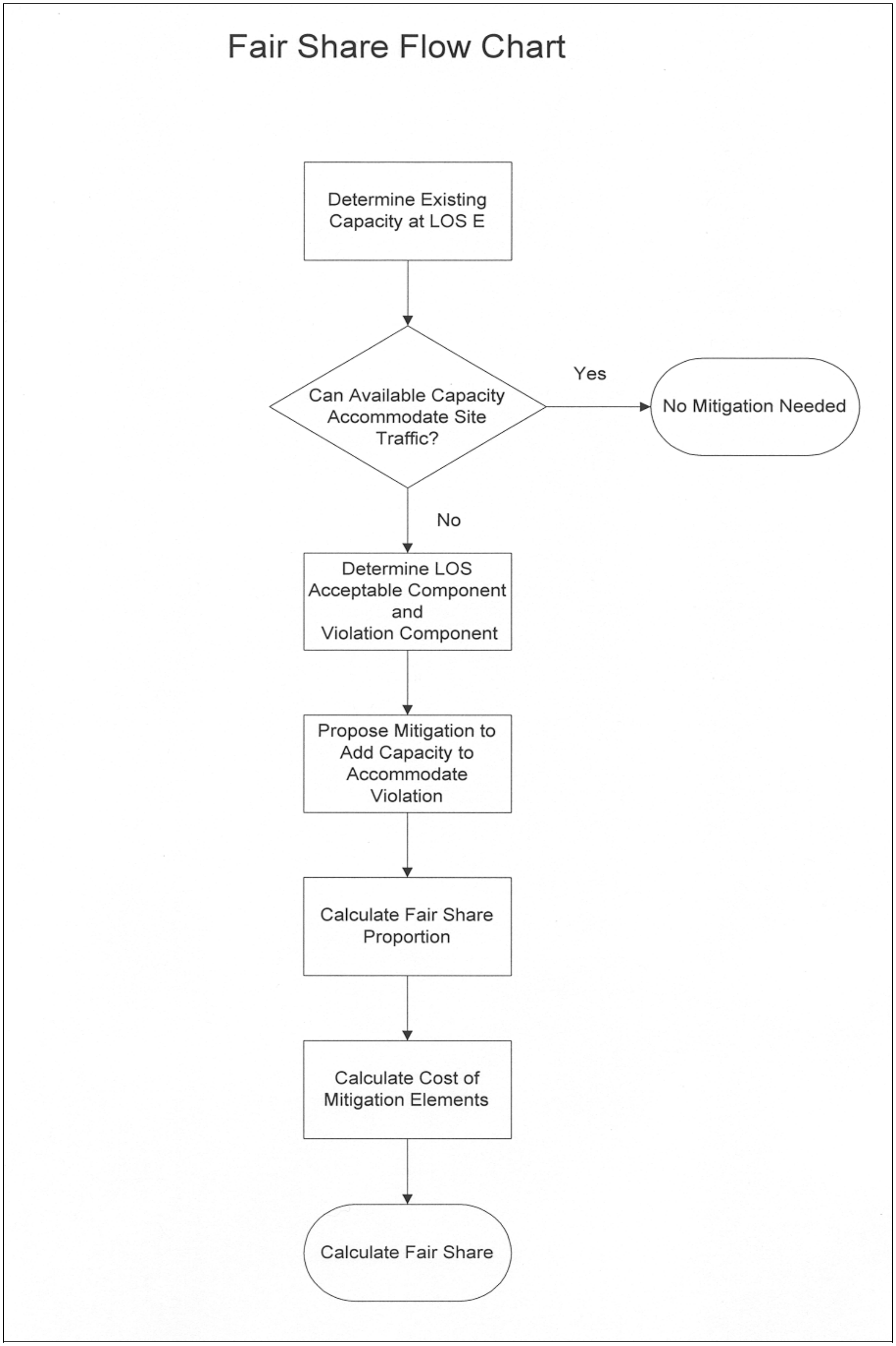
Rule 11 - If NJDOT accepts a right-of-way dedication, the value of the dedicated land is a credit against the applicant s fair share.

Rule 12 - NJDOT may release fair share money and accrued interest, or any portion thereof, to any federal, state, regional, or local entity, or to any person or private entity for implementing highway improvements at the identified locations.

CONCLUSION

The improvements that a transportation agency may impose on an applicant must be equitable and must be determined through a process that will withstand public and legal scrutiny. In its access regulations, New Jersey has included a step-by-step process that minimizes subjectivity. It also requires the applicant to perform calculations and submit the documentation in a traffic impact study as part of a State highway access permit application. This provides predictable and consistent treatment for those seeking to develop or redevelop property along State highways. It also provides equitable treatment for those motorists already traveling on State highways.

The method of determining fair share contributions used in New Jersey can also be adapted for use by other transportation agencies. In addition, this method can serve as a model for non-transportation agencies to determine other types of infrastructure impacts and responsibilities.


Fair Share Flow Chart
Determine Existing Capacity at LOS E
Can Available Capacity Accommodate Site Traffic?
Yes
No Mitigation Needed
No
Determine LOS Acceptable Component and Violation Component
Propose Mitigation to Add Capacity to Accommodate Violation
Calculate Fair Share Proportion
Calculate Cost of Mitigation Elements
Calculate Fair Share

Session 10

Working With the Media Workshop

Moderator: Steven Hurvitz, Minnesota Department of Transportation

Working with the Media Workshop

Steven Hurvitz, Minnesota Department of Transportation

This workshop will provide the transportation professional with insight into techniques and strategies that can be used when dealing with the media. This workshop will also provide advice and insight about the journalist's strategies and techniques when dealing with reports/articles.

No Presentation Material Available for Print

Session 11

States, In a State of Change, Panel Discussion

Moderator: Philip Demosthenes, Colorado Department of Transportation

Participants: Art Eisdorfer, New Jersey Department of Transportation
Del Huntington, Oregon Department of Transportation
Robert Krzeminiski, Florida Department of Transportation
Cecil Selness, Minnesota Department of Transportation

New Jersey
State of Access Management Changes

Arthur Eisdorfer, New Jersey Department of Transportation

New Jersey

State of
Access Management
Changes

NO Deep Changes in:

- Statute
- Administrative Rules
- Practices

Adopted Housekeeping Changes

- Added definitions
- Clarified
- Corrected
- Changed grammar
- Changed office designations
- Reclassified some highway segments

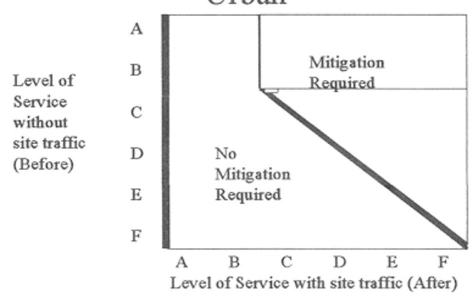
Adopted Substantive Changes

- Added tolerances for access point dimensions
- Allowed some access along turn lanes
- Added emergency access and firehouse driveways
- Changed LOS standards
- Addressed gated access points
- Deleted travel demand management plans
- Required application with 1 year of preapplication
- Expired old permit when construction begins on new permit

1992 Level of Service Standards Urban

No-Build	Build with Improvements
LOS A or B>>>>>>>>>>>>	LOS C Midpoint
LOS C or D>>>>>>>>>>>>	1/2 of LOS D, but not into LOS E
LOS E or F>>>>>>>>>>>>	No Deterioration

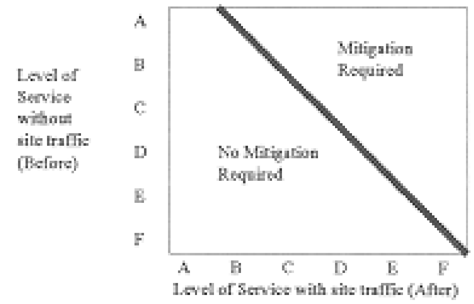
1992 Level of Service Standards Urban



1995 Level of Service Standards Urban

No-Build	Build with Improvements
LOS A, B, C, D, or E>>>>>	25% of difference between Existing LOS and bottom of LOS E
LOS F>>>>>>>>>>>>>>>>>	No Deterioration

1995 Level of Service Standards Urban



Changes to propose for permits

- Add application category called "Volunteer"
- Clarify that corner clearance includes intersection radii
- Add appeal process for permit expiration
- Require existing denial of access lines to be shown on applications

Changes to propose for projects

- Establish date for reasonable alternative access
- Define:
  - Convenient
  - Direct
  - State highway ingress and egress
- Standardize sign placement and letter size for revocation signing

Minnesota's Access Management Initiative

Cecil Selness, Minnesota Department of Transportation

Minnesota's Access Management Initiative

National Conference on Access Management
October 6, 1998

Background

- Office Established March, 1997
  - Growing concern about access management.
  - National trend.
  - Minnesota commitment came from workshop held August of 96:
    - Guest speaker - Del Huntington - Oregon
  - Priority initiative in Mn/DOT Strategic Plan:
    - Gary Sokolow - Florida

Background

- Minnesota Legislation
  - Study access management.
  - Consult broadly.
  - Develop comprehensive statewide policy.
  - Report to Legislature January 1999.

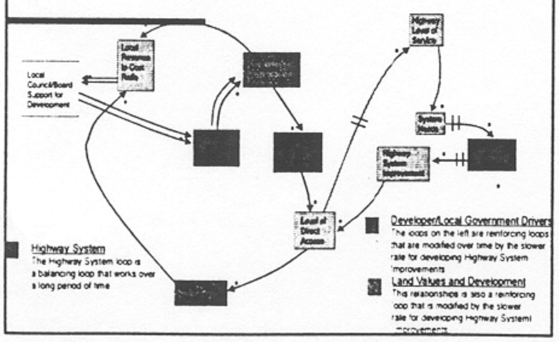
Work Plan

- Best Practices
  - Minnesota
  - Nationwide
    - Vergil Stover, Bud Koepke
- Studies
  - Systems thinking
  - Market research
  - Safety
- Consult Broadly
  - Steering Committee
  - Engineering Committee
  - Land Use Committee
- Workshops

Systems Thinking
Access Management

Systems thinking

4/1/98



Many Players, Different Perspectives

- Landowners - property values
- Developers - profitable ventures
- Neighborhood - privacy
- Local community - growth, tax base
- County - tax base and infrastructure
- Mn/DOT- safety, statewide mobility
- Driving public - all of the above + convenience

Individual Rationality

- Everyone seeks to minimize their own immediate and visible costs.
- The name of the game is to externalize your costs.

Diffused Management

- Decisions about development and land use are made at the local level.
- Decisions about the major highways are mostly made at the state level.

Decision-Making Time Lags

- The land use and economic development process is fast:
  - 6 months - 2 years
- The ability of the highway authority to respond is much slower:
  - 5+ Years

Problem Time Lags

- Large problems arise from many small, uncoordinated decisions made over time.
- By the time the problem is apparent, the best solutions are no longer available.

Market Research

- Methodology
- Qualitative
- 4 sites
- 3 customer groups
  - live on road
  - shop on road
  - travel through

Market Research Questions

- Purpose of trunk highways.
- Problems they perceive.
- Changes in land use.
- Relationship of land use and roadway.
- Safety risks.
- Suggestions for improvements in roadway.

Market Research Conclusions

- Primary purpose of trunk highways should be mobility.
- Drivers want well-organized, understandable and convenient access and are willing to drive a little further to reduce danger and frustration.
- Drivers are very sensitive to how well the roadway operates.

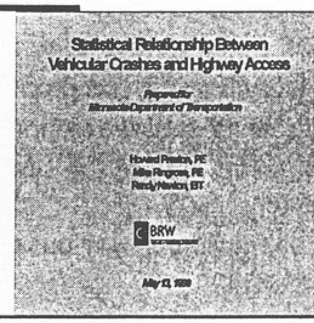
Market Research Conclusions

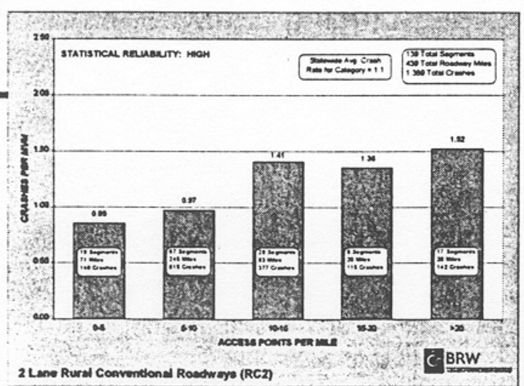
- Drivers are supportive of good roadway design:
  - They responded positively to the FHWA video.
- Drivers were aware and cautious of areas with many uncontrolled accesses.
- Drivers were conscious of the needs and rights of existing business.

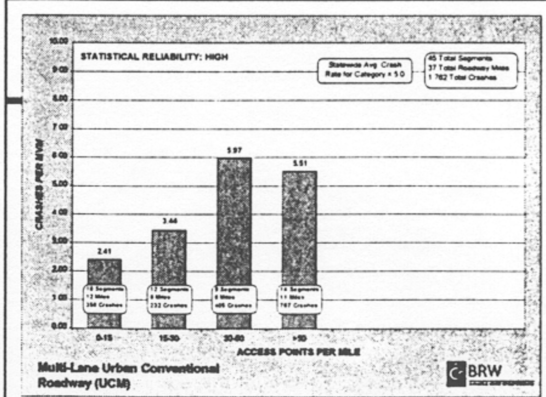
Market Research Conclusions

- Drivers were not aware of the jurisdictional issues but expected public agencies to take the action needed to address access management issues.
- There was a high degree of commonality of opinion among the different groups regardless of location and relationship to the roadway.

Safety Study







Safety Study Conclusions

- More accesses = more crashes.
  - Crash rates vary by road type and land use.
- Highest crash roads.
  - Urban undivided with high access.
  - Priorities = cost benefit.
- Relationship is causal.
  - Confirms national study.
- Case studies confirm benefits of access techniques.
  - Thanks Iowa!

Workshops

- Each district and metro area.
- Cosponsored by county, city and township associations.
- Present findings and options.
- Breakout sessions to get feedback.
- Report back to participants.

Why Do We Need to Take Action?

- Major roads are getting clogged.
- Safety is being compromised.
- It's costing a lot of money.
- Need to manage the system better.
- Can't build our way out of congestion.

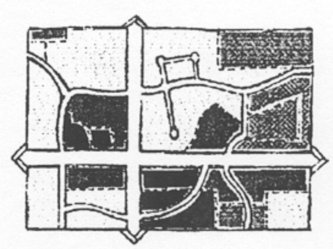
What are the approaches?

- Engineering best practices:
  Dave Engstrom
- Community development best practices:
  Peggy Reichert

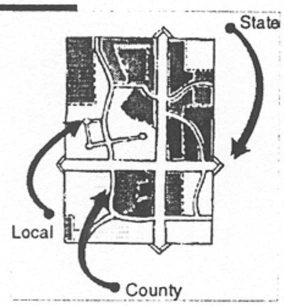
Engineering Practices

- Safety study
- Classification system
- Design guidelines
- Permitting process
- Warrants for purchase of access

Linking Land Use and Transportation



Partnerships Required



Legal Considerations

- Mn/DOT can't just say NO.
- Access is a property right.
- "Reasonably suitable and convenient access."

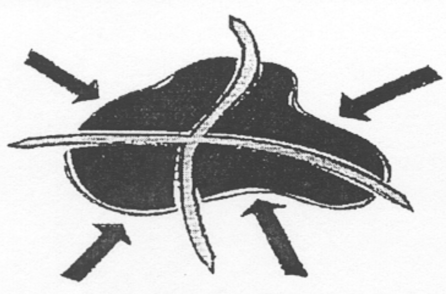
Local Land Use Decisions Affect Access

- Subdivision - new lots
- Rezoning
- Conditional use permits
- Site plan approvals
- Comp plan amendments

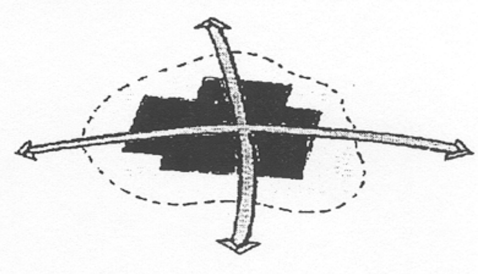
Why Partner? Community Benefits

- Support desired development.
- Prevent disruptive retrofits, relocations.
- Protect neighborhoods.
- Expand market area.
- Sustain land values, economic base.
- Enhance community appearance.

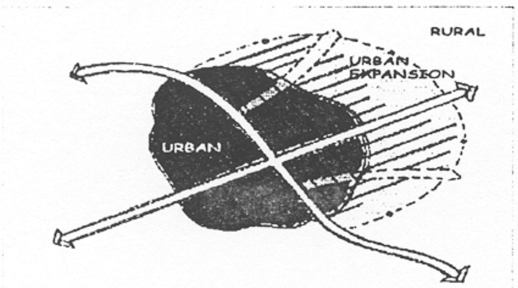
Best Practices: Community Development



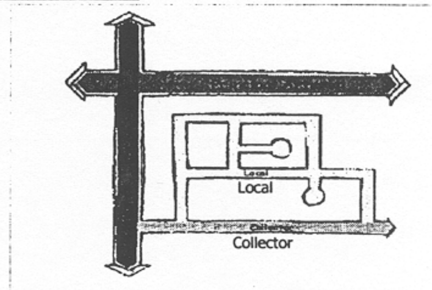
Consider Land Use and Transportation Together



Plan for Growth Areas



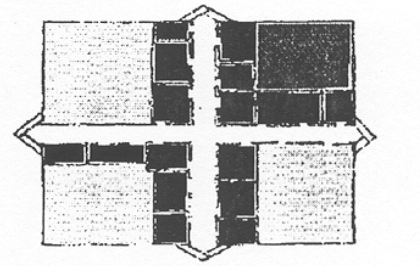
Develop an Adequate Local Road Network



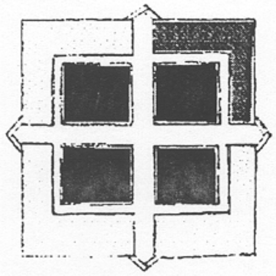
Access Spacing Guidelines

	Functional Classification of Highway				
	Principal Arterial	Minor Arterial		Collector	Local
Type of Access		>7,500 ADT	<7,500 ADT		
A. Private Residential Driveways	No Direct Access	No Direct Access	(2)	(2)	(2)
B. Commercial Driveways or Non-Continuous Commercial Streets	No Direct Access	No Direct Access	1/8 Mile	1/8 Mile	(2)
C. Non-Continuous Residential Streets	No Direct Access	1/8 Mile with No Median Opening	1/8 Mile	1/8 Mile	(2)
D. Continuous Local Streets and Collector Streets	½ Mile	¼ Mile	¼ Mile	1/8 Mile	1/8 Mile
E. Minor Arterials	½ Mile	½ Mile	½ Mile	½ Mile	½ Mile

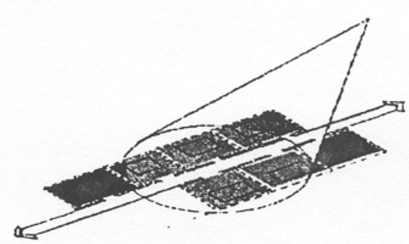
Avoid Commercial Strips



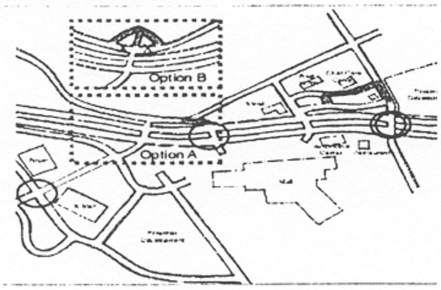
Support Commercial Clusters



Identify Corridors for Special Attention



Retrofit Plans



Update Regulations

- Incorporate access management provisions in:
  - Subdivision regulations
  - Zoning ordinances
  - Site plan reviews

Consult and Coordinate

- Mn/DOT
- Counties
- Adjacent communities
- Regional agencies

OPTIONS for Implementation

- 1. Education and standards for better cooperation.
- 2. Incentives for stronger partnerships.
- 3. Mandates for essential coordination.

Information for Better Cooperation

- Establish access management classification standards.
- Provide access management training.
- Expand technical assistance capability.
- Expand research.

Incentives for Stronger Partnerships

- Pilot projects.
- Expand land use and transportation planning.
- Access management planning grants.
- Expand capital funding eligibility.
- Link transportation investment to local access management efforts.

Mandates for Essential Coordination

- Legislate classification system and standards.
- Legislate "reasonably suitable and convenient access" to be consistent with access management standards.
- Legislate MN/DOT and county land use approval on proposals next to their roads.
- Require all communities to do access management plans and regulations.

Session 12

State "Start-ups" Programs
Part I

Moderator: Robert Jurasin, Wilbur Smith and Associates

Participants: Brad Oswald, New York Department of Transportation
Donald Bowman, Virginia Department of Transportation
Herman Joubert, GIBB Africa (PTY) Ltd.

The New York DOT Start-Up Experience

Brad Oswald, New York State Department of Transportation

NYSDOT has launched a broad, collaborative approach to access management which includes corridor preservation, land use, and finance elements. The emphasis is to include standards and guidelines in local ordinances while working with localities on a strategy and plan for key developing commercial corridors with an uncontrolled state arterial. The objective is to make it part of the vocabulary, considerations and the tools for addressing traffic congestion, not a separate program. Many of the tools recommended for corridor traffic management are familiar as local growth management activities. Each corridor application needs a custom set of tools to address the unique development/access problems and political realities.

Steps:
We are in the third year, outreach step of the start-up phase of the program:
- *Formulate approach 1994-5*
- *Prepare educational-training materials 1995-6*
- *Outreach presentations and workshops 1996-7*
- *Applications in planning, mitigation & design 1997-8*
- *Fully integrated corridor approach 1998-?*

Experience/Lessons Learned:
- *Localities & MPOs have responded well to the introductory outreach*
- *Case study successes & field experience are invaluable "selling tools"*
- *Program has to be actively "sold" for collaborations and applications*
- *Flexibility is important externally, while "cookbook" seems attractive internally....training materials need to be adjusted accordingly*
- *Program fits state "business friendly/economic development" objectives*

Conclusion:
Three dedicated staff in the Central Office, Albany, have made steady progress to implement the new statewide Program. A flexible, collaborative approach has been successful in the outreach to localities and MPOs; but more new internal training activity is needed in order to reach steps 4 and 5 – widespread applications and the objective of a fully integrated corridor approach. In sum, it has been an interesting creative and rewarding start-up process that promises future applications at state and local levels in NYS.

Presentation

No presentation material available for print.

A Case Study for Adopting A Comprehensive State-Wide Access Management Program

Donald Bowman, P.E., J.D., Virginia Transportation Research Council

ABSTRACT

This report analyzes comprehensive highway access management programs and looks at the potential benefits and legal limits to Virginia adopting such a program to replace Virginia's rather limited site specific permitting process. In 1942, Virginia passed legislation defining the right of private homeowners and commercial establishments to make connections to state highways. Va. Code §33.1-197 (private entrances) and §33.1-198 (commercial entrances). The statutes established a permit process for commercial and private entrances to state highways, administered by the Virginia Department of Transportation (VDOT) in accordance with the *Minimum Standards of Entrances to State Highways*. However, the *Minimum Standards* do not establish a comprehensive access management plan for Virginia's highway systems and have been criticized for being too permissive.

In 1980, Colorado became the first state to enact a comprehensive highway access management code, with strict safety and traffic criteria for private accesses to public highways. Since that time, Florida and New Jersey have also adopted comprehensive programs. However, Virginia's access management process continues to be a case-by-case permit review process.

This report considers the relative benefits of access management, analyzes the legal obstacles in Virginia for a comprehensive program and discusses options Virginia might consider. The report also includes an analysis of Virginia's legal and regulatory framework within which an access management program would operate.

The Appendix contains two alternative models for access management regulation to assist policymakers in their decisions.

A Case Study for Adopting a Comprehensive State-Wide Access Management Program

Virginia Transportation Research Council

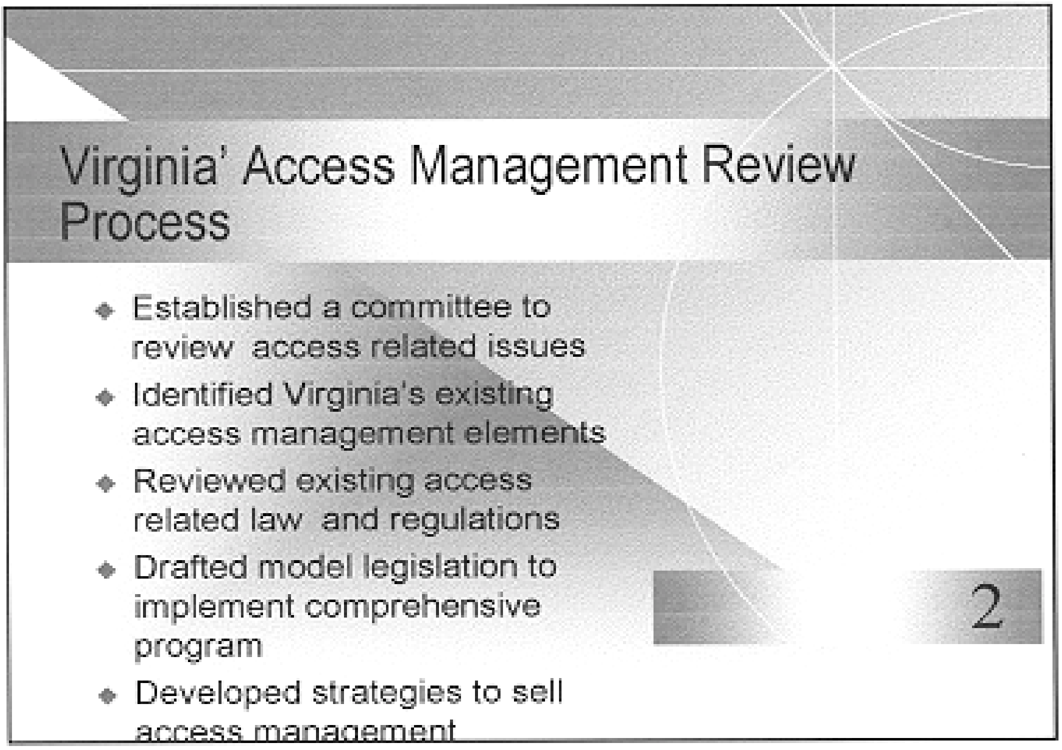
Virginia Department of Transportation

Donald Bowman, P.E., J.D.

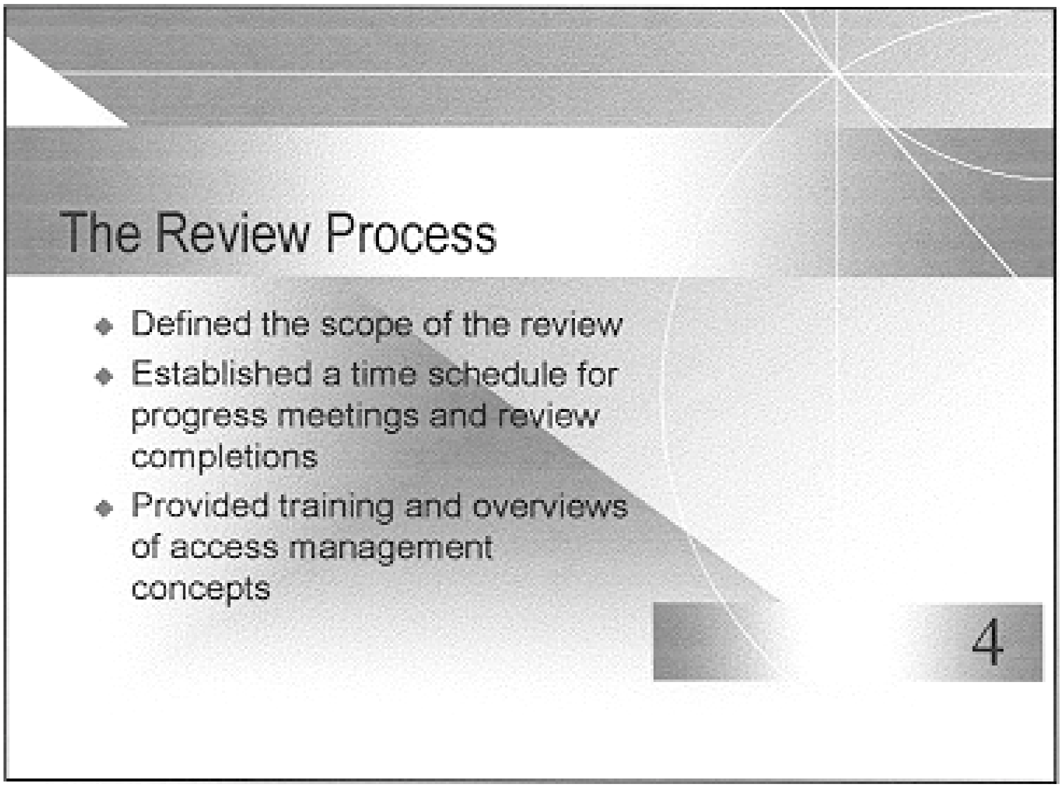
Introduction

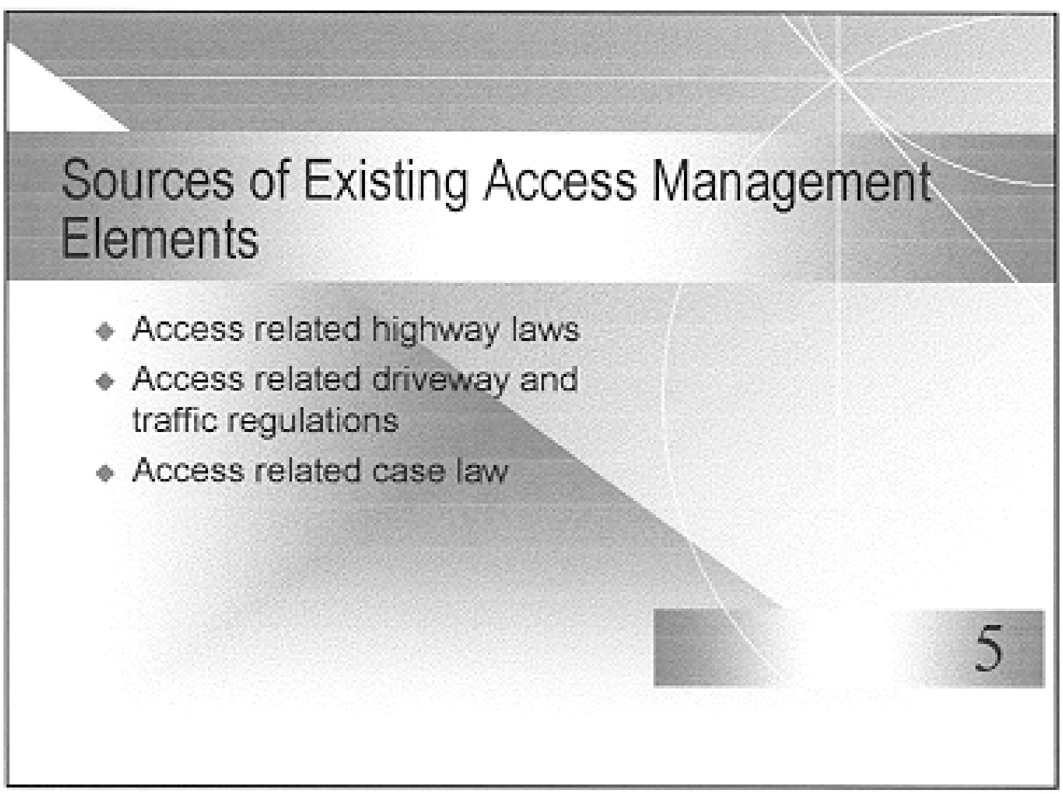
This presentation presents an overview of Virginia's on-going access management review process and implementation strategies for a comprehensive state-wide access management program.

1


Virginia' Access Management Review Process
Established a committee to review access related issues
Identified Virginia's existing access management elements
Reviewed existing access related law and regulations
Drafted model legislation to implement comprehensive program
Developed strategies to sell access management
2


Established a Review Team
Multi-disciplined review team
Traffic engineers
Highway planners
Location and design engineers
Traffic safety engineers
Location and design planners
3


The Review Process
Defined the scope of the review
Established a time schedule for progress meetings and review completions
Provided training and overviews of access management concepts
4


Sources of Existing Access Management Elements
Access related highway laws
Access related driveway and traffic regulations
Access related case law
5

Virginia's Existing Access Management Elements

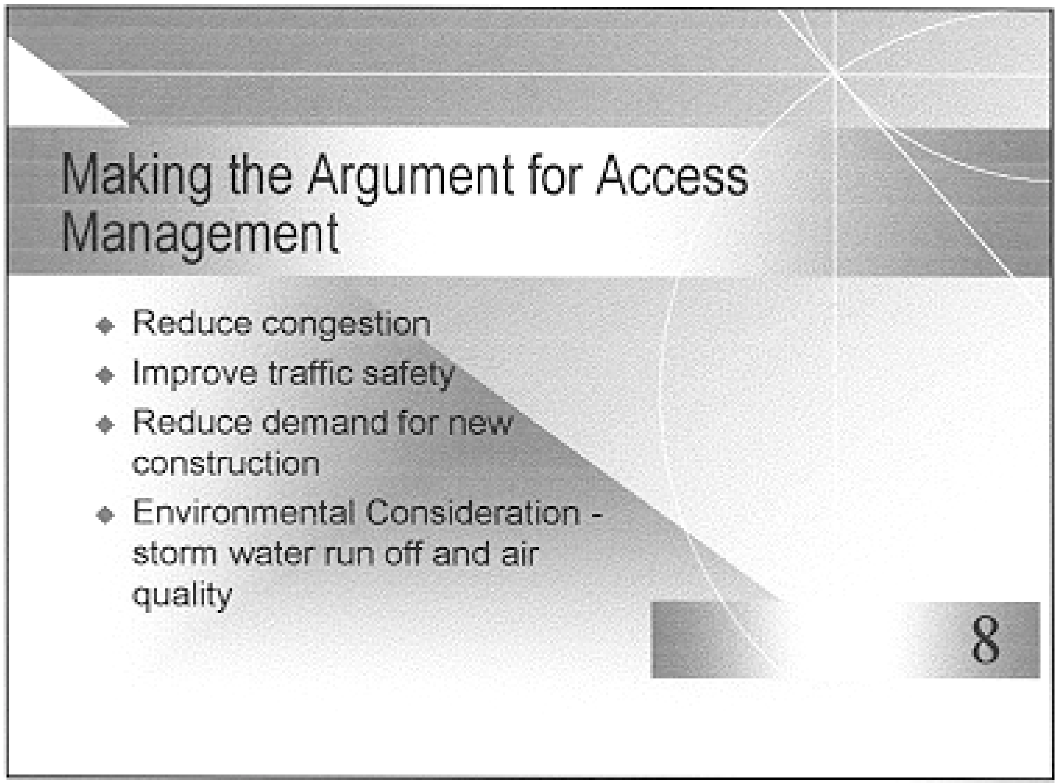
- Inherent state police power authority for health, safety, and general welfare
- Legislation granting direct access to public highways
- Driveway permitting requirements
- Highway entrance Minimum Standards
- Land use development manual

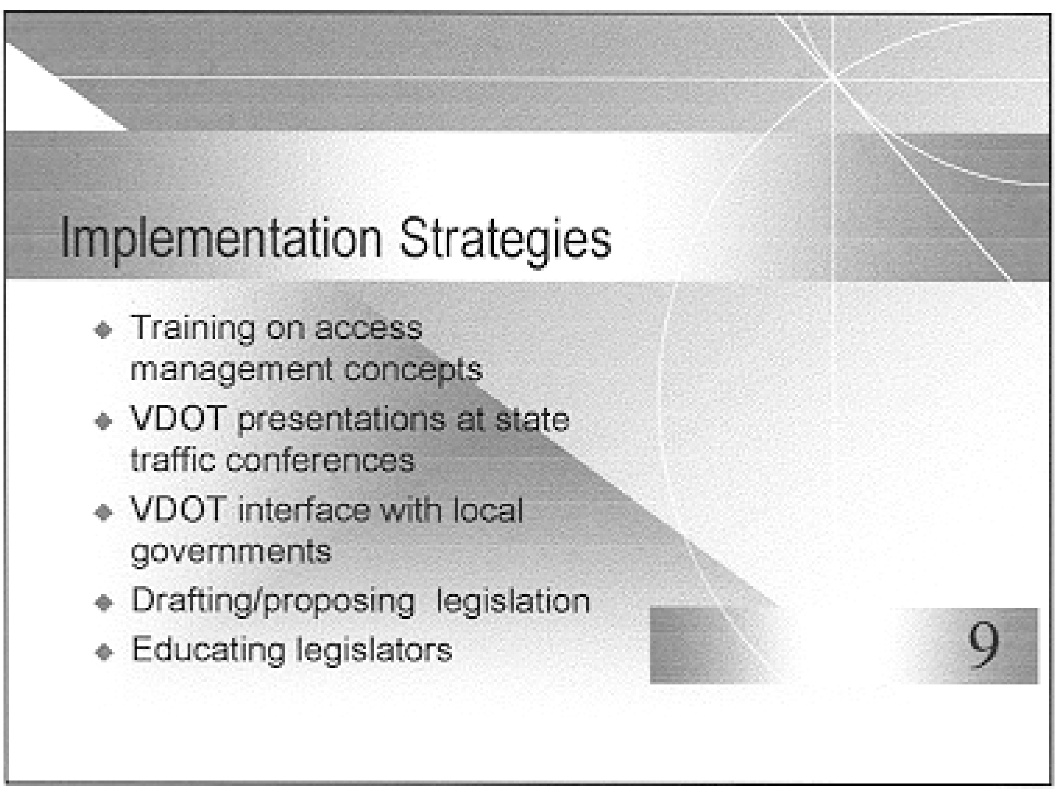
6

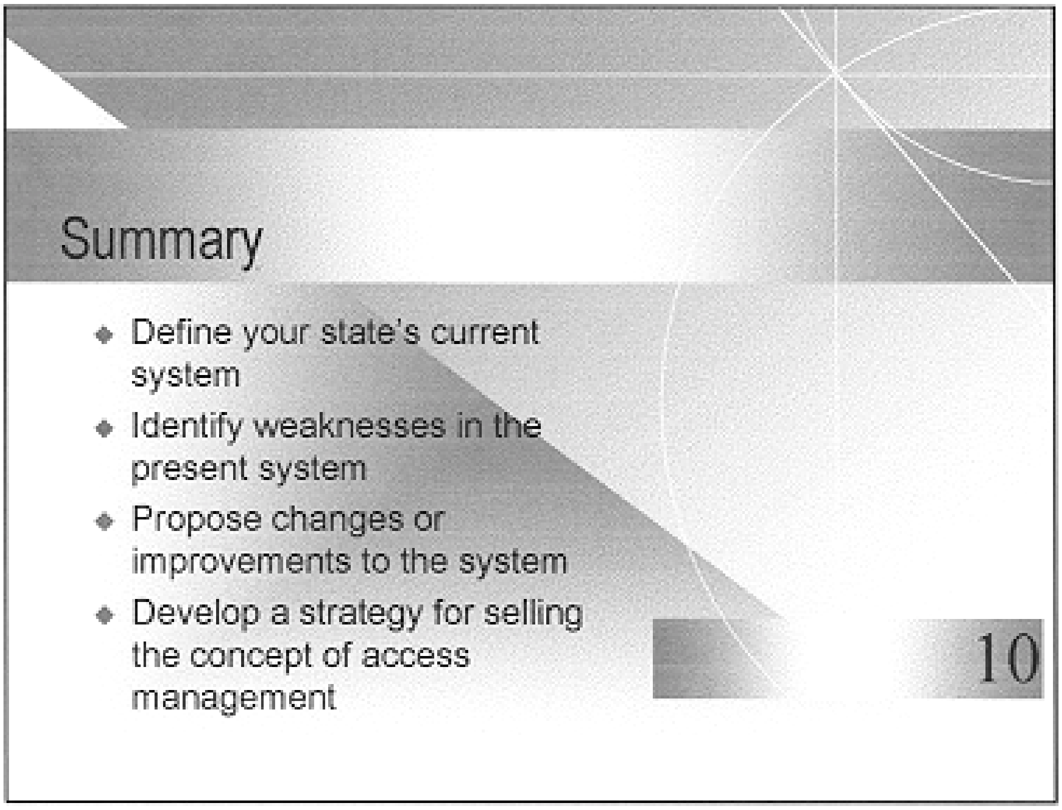
Examples of Virginia's Existing Case Law

- Control of driveway locations
- Regulation of medians
- Restriction of traffic turning movements
- Restricting direct access

7


Making the Argument for Access Management
Reduce congestion
Improve traffic safety
Reduce demand for new construction
Environmental Consideration - storm water run off and air quality
8


Implementation Strategies
Training on access management concepts
VDOT presentations at state traffic conferences
VDOT interface with local governments
Drafting/proposing legislation
Educating legislators
9


Summary
Define your state's current system
Identify weaknesses in the present system
Propose changes or improvements to the system
Develop a strategy for selling the concept of access management
10

Session 13

Highway Capacity Manual and Median Analysis Techniques Workshop

Moderators: Dane Ismart, Louis Berger and Associates
Gary Sokolow, Florida Department of Transportation

Implications of Changes in the Unsignalized Intersection Procedure on Access Management

Dane Ismart, Louis Berger and Associates

The goal of access management is to reduce the accident rate and improve the flow and speed of traffic on a highway system. Numerous research studies have consistently shown that the more access points per mile, the higher the accident rate. Access management techniques reduce the number of conflict points. Therefore, it is logical for accident rates to be lowered as the average distance between access points increases. This relationship is shown in Figures I and 2.

Figure 1. Relationship Between Accidents Per Mile and Average Access Spacing

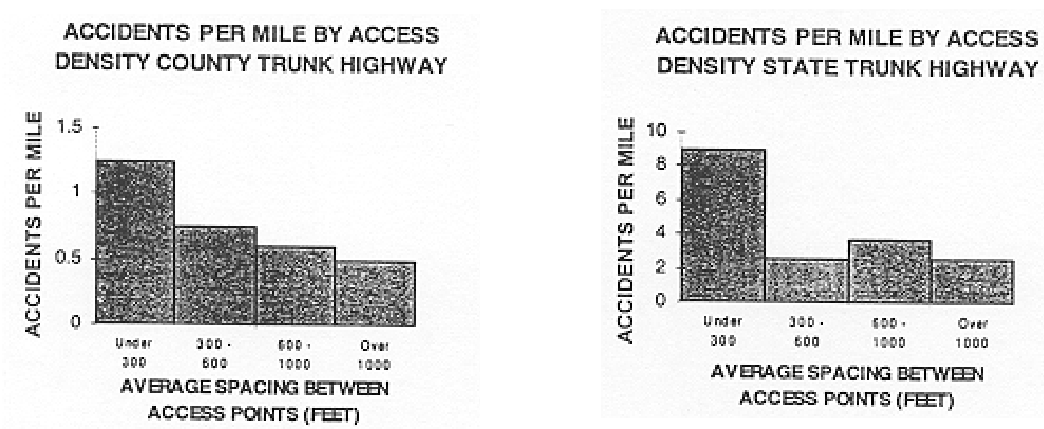
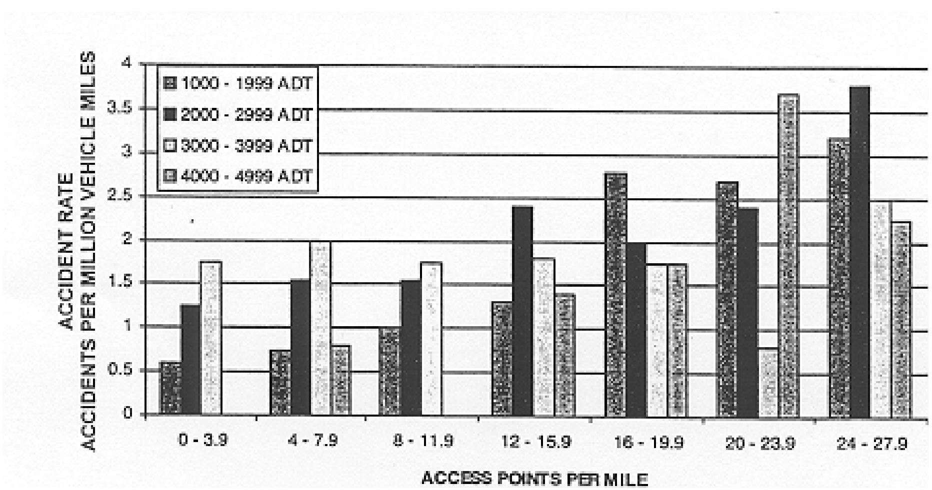


Figure 2. Accident Rates for Road Sections with Different Traffic Volumes and Access Point Frequencies



Access management also maintains traffic flow by reducing the number of access points and maintaining significant distances between signals. The current Highway Capacity Manual [1] states that for every right turn access point the free flow speed of a multi-lane highway drops .25 mph. To achieve efficient traffic progression and operate at consistently high speeds, the optimum distance, as shown in Table 1, must be maintained.

Table 1. Optimum Signalized Intersection Spacing for Efficient Traffic Progression

Cycle Length (sec)	Speed (mph) 25	30	35	40	45	50	55
	Distance in Feet						
60	1,100	1,230	1,540	1,760	1,980	2,200	2,430
70	1,280	1,540	1,800	2,050	2,310	2,500	2,820
80	1,470	1,760	2,050	2,350	2,640	2,930	3,220
90	1,630	1,980	2,310	2,640	2,970	3,300	3,630
120	2,200	1,640	3,080	3,520	3,960	4,400	4,840
150	2,750	3,300	3,850	4,400	4,950	5,500	6,050

The access management treatments that reduce accident rates and improve flow can be categorized in the following manner.

A. Limit number of conflict points
B. Separate conflict points
C. Limit deceleration
D. Remove turning vehicles from through lanes
These treatments translate into actions such as consolidation of and joint use of driveways. States and local communities tend to require minimum distance of highway frontage between center lines of access driveways. A typical spacing standard for access driveways is shown in Table 2.

Table 2. Waushara County Spacing Standards for Access Driveways

Class of Highway	Minimum Distance of Highway Frontage Between Centerline Access Driveways	Minimum Distance Access Driveways May Be Located to Centerline of an Intersecting Highway
Class A Highways		
Principal Arterials	1,000 feet	1,000 feet
Minor Arterials	600 feet	600 feet
Collectors	300 feet	300 feet
Class B Highways		
Collectors	300 feet	300 feet
Local	75 feet	150 feet
Class C Highways	75 feet	150 feet

The implementation of techniques to consolidate driveways and concentrate traffic presents an interesting dilemma. By consolidating driveways the number of conflicts are reduced, accidents are lowered and speeds are maintained. However, by consolidating traffic on side streets or on a joint use drive-way, the traffic may be increased to the point where it may become necessary to convert an unsignalized intersection into a signalized intersection. The signalization of an intersection, especially close to other existing signals, may result in a general decrease in roadway speeds. Signalizing an intersection may even result in a higher accident rate than existed with the unsignalized intersection.

The decision to signalize an intersection depends on many factors, including delay experience and accident history. Typically, an intersection will be evaluated on the basis of the MUTCD warrants to determine if threshold values have been reached and to determine if critical volume, delay, or accident values have been reached. Also, an analysis using Chapter 10 of the HCM will be conducted to determine the delay or the operating level of service of the intersection.

Any changes in the unsignalized capacity analysis procedure would have an impact on access management efforts to consolidate driveway spacings. Capacity changes that result in a higher capacity at a given level of service would permit greater driveway consolidation that would not result in signalization. Less capacity would make driveway consolidation more difficult.

Current proposals for changing the unsignalized capacity analysis procedures include, but are not limited to:

A. Modifying the conflicting volume formulas

B. Modifying base critical gaps, move-up times

C. Using adjustment procedures, including a new procedure for estimating capacity with a raised or striped median or two-way left-turn lane on the major street

D. Adding a flared approach analysis

E. Expanding progression signalization analysis

Each of these changes will affect the consolidation of drive-ways and side street traffic. An analysis of these changes and their effect on access management follows.

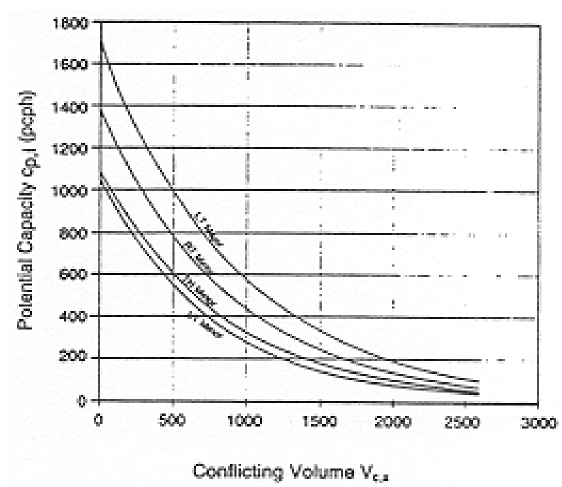
First, we will examine the changes in determining the conflicting volumes to the minor street through movements and the minor street left turns. The new procedure doubles the conflicting major street left-turn volume as part the new method for estimating conflicting volume. The new formulae are:

CONFLICTING VOLUME

Minor St. Through =
2VI + V2 +.5V3 + 2V4 + V5 + V6 + V15 + V16
Movement Crit. Vol.
where:
VI = major street left turn volume

V4 = opposite direction major street left turn volume
V2 = major street through volume
VS = opposite direction ma or street through volume
V3 = major street right mm volume
V6 = opposite direction major street right turn volume
V 1 5 and V 1 6 = conflicting pedestrians

Figure 3. Potential Capacity-Four-Lane Highway



By doubling the major street left-turn volumes for determining the conflicting volume of minor-street through and left-turn movements, the capacity of these movements will be reduced. The relationship between conflicting volume and potential capacity can be seen in Figure 3. Holding all other parameters constant, the doubling of the conflicting left turns will decrease the capacity of through and minor-street left turns by an amount dependent on the size of the conflicting left turn. For example, if the VI volume was I00 left-turning vehicles, then movement 8's capacity would be reduced by an amount correspondent to the total amount of conflicting volume. At a low conflicting volume, the reduction in capacity would be 100 vehicles per hour. At a higher conflicting volume the capacity reduction would be significantly less.

What are the implications of the conflicting volume changes for access management? If this were the only change, the proposed unsignalized procedure change would result in a worse level-of-service when driveways were consolidated.

The second change was in the base critical gap and follow-uptime and their adjustments. As proposed, the critical gaps and follow-up time are shown in Table 4.

As can be seen in Table 4, critical gap times are reduced for left turns for major streets but are increased for minor-street right and left turns and minor-street through movements.

Table 4. Critical Gap (CG) and Follow-Up Time

	Two-Lane		Four-Lane		Follow-Up Time	
	199~~4~~7 CG	199~~7~~4 CG	199~~4~~7 CG	199~~7~~4 CG	199~~4~~7 ~~CG~~	199~~7~~4 ~~CG~~
Left-Turn Major Street	4.1	5.0	4.1	5.5	2.2	2.1
Right-Turn Major Street	6.2	5.5	6.9	5.5	3.3	2.6
Through Movement						
Minor Street	6.5	6.0	6.5	6.5	4.0	3.3
Left-Turn Minor Street	7.1	6.5	7.5	7.0	3.5	3.4

With an increase in critical gap time, capacity will be reduced. An analysis should show that the new procedure will forecast a smaller capacity for all minor street movements and an increase in capacity for the major left-turn movement. To demonstrate this change, the following example will be run under both the old procedure and the proposed method.

Sample Problem for Major Street East-West

	Lefts	Throughs	Rights
East Bound	50	300	50
West Bound	50	300	50
North Bound	30	70	30
South Bound	30	70	30

The sample problem is run using the 1994 HCM procedure and the proposed 1997 method with the only differences being the doubling of the critical volume for left turns and the changes in critical gap and follow-up time. Heavy vehicles, grade, and pedestrians are set at zero to keep all other parameters equal.

The results of the runs are not encouraging since a comparison of the old analysis versus the new procedure shows a drop in capacity for all minor-street movements and an increase only in the major-street left turn. Although the rninor-street left turn and through movement capacity reductions are small, it will make consolidation of driveways more difficult without installing signals. In fact, in this example, the southbound minor-street movement goes from a level-of-service C to D.

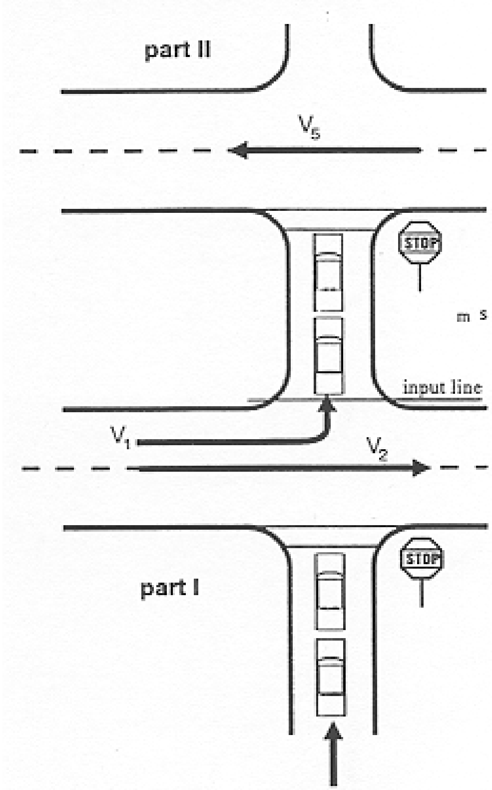
Table 5 is a summary of the results for the sample problem for both the old and new method.

Table 5. Results of Sample Problem Analysis

	1994 HCM			1997 Proposed		
	Delay	Capacity	LOS	Delay	Capacity	LOS
Left-Turn Major Street	3.4	1,112	A	3.3	1,222	A
Right-Turn Major Street	3.3	1,129	A	4.4	845	A
Through Movement Minor Street	14.1	342	C	22.7	244	D
Left-Turn Minor Street	16.9	249	C	30.0	156	D

At this point, the proposed changes in times and critical volume calculations will lower the capacity for comparable intersections. The third major modification, two-stage gap analysis, should increase the capacity of unsignalized intersections. This change involves the impact that a median or a two-way left-turn lane will have. If the major road has a median or TWLTL wide enough to serve as a storage area (as shown in Figure 4), then minor street through and left turns will enter the intersection in a two-stage process.

Figure 4. Intersection With Two-Stage Gap Acceptance



The capacity of an unsignalized intersection with a median storage area should be significantly higher than for an intersection crossing an undivided highway. The conflicting volume will be significantly less for each stage of a vehicle crossing a divided highway versus an undivided highway. To determine the increased capacity potential a median has, we will run the sample problem again as a divided and undivided high-way. The critical gap and follow-up time will be made the same so that the only difference will be the introduction of a median. Median storage space will consist of two vehicles.

Median Capacity Analysis

A median capacity analysis was done based on the configuration shown in Figure 4.

Given: V1 = 100 yph

V2 = 600 yph
VS = 400 yph

The minor street through capacity, undivided, was 144 vph and the minor street through capacity with a median was 342vph.

As shown in the sample problem, the capacity of the minor street through movement for the unsignalized intersection is144 vph versus 342 vph for an unsignalized intersection with median storage for two vehicles. The results are consistent with the empirical data discussed in NCHRP Project 3-46.

As part of Project 3-46, capacities calculated from standard HCM models were compared to field capacity measurements of unsignalized intersections with raised medians or two-way left-turn lanes on the major road. The results of Project 3-46 indicated that raised median storage space increases capacity by a ratio of 2.1 and the TWLTL causes an increase of 2.8 versus an intersection without a median. Using these ratios, the sample problem capacity for the two-stage analysis should range from 302 (144 x 2.1) to 403 (144 x 2.8), depending on the type of median treatment. The sample problem's capacity with a median treatment is 342 vph, well within the estimates developed in NCHRP Project 3-46.

The increased capacity resulting from median treatment has major implications for access management. The doubling of capacity indicated by the two-stage analysis easily compensates for reduced capacity resulting from critical gap and critical volume changes. Flared approaches and a properly designed progression system can also increase the capacity of unsignalized intersections.

SUMMARY

What do all of these changes mean in applying access management techniques to arterials? Access management techniques that consolidate driveways reduce major street delay but result in greater delays to the side street traffic entering the arterial. The 1997 proposed unsignalized intersection capacity procedure will calculate a lower capacity and higher delay versus the 1994 HCM procedure if design or signalization improvements are not made. By modifying the design of the unsignalized intersection to include median storage areas, flared approaches, or a progressive signal system to maximize the gaps at the unsignalized intersections, the capacity will be greatly increased and driveways could be consolidated with less tendency for signalizing the intersections.

Changes in the 1994 HCM unsignalized intersection procedure mean that it is critical for highway engineers and planners to consider roadway and signal design when implementing access management treatments. Without coordination of design and access treatment, the improvements in safety and the reductions in delay may be lost to increased signalization. A closer tie must exist between access management and highway capacity to maximize the benefits of access management treatments.

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Session 14

State “Start-up” and New Concepts Part II

Moderator: Jim Gattis, University of Arkansas

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Access Management in Maryland

Dan Scheib, Maryland Department of Transportation

Presentation

This report focuses on how access management has evolved and is being applied to the Maryland's Primary System since our last presentation to the conference in 1993. Maryland has become extremely successful in controlling access to our Primary System in its rural travel corridors.

One of the first things that Maryland did with, respect to access management, was to establish an Access Management Program for the State of Maryland's Primary Highway System.

Access Management Program

The Access Management Program was established to maintain and improve safety on the State Primary System.

Access Management Team

The program is overseen by the Access Management Team. The Team is cross functional and was formed to review access issues in selected corridors. Team members include:

Office of Real Estate (ORE) - responsible for purchase of properties and frontage.

Engineering Access Permits Division (EAPD) - submits access permits, site plans and building permits to the team for review and comment. They are also the liaison with the local jurisdictions.

Office of Counsel (OOC) - provides advice on legal issues.

Office of Traffic and Safety (OOT&S) - provides advice on traffic on traffic related issues.

Office of Planning and Preliminary Engineering (OPPE) - coordinates the team effort and monitors expenditures to purchase frontage/properties.

The Team review each development plan, site plan and entrance permit that comes before them. These plans are submitted through local planning offices. The team will develop and/or evaluate options regarding access for each plan and formulate recommendations for access. These recommendations are forwarded to the local jurisdictions for acceptance and in most instances implementation.

Review and Coordination

The Team review the request to determine:

- Does the property have alternate access to the highway?
- If not, can alternate access be provided?

If they determine that the property has access an alternate means of access, I.E. another public road, the team will try to obtain access controls along the part of the property that fronts on the highway and make a recommendation to the local jurisdiction that the site use the alternate means of access.

If alternate access will be via a future service road the team will try to obtain access controls along the part of the property that fronts the highway and also issue a “TEMPORARY” access permit until such time as a service road can be constructed and at that time the direct access will be closed and all access to and from that property will be via a service road.

If a property were to be landlocked by the SHA’s proposed improvement the Team may recommend the purchase of this property.

I do not wish to make our review process sound overly simplistic. There are many research steps in the process once the property is introduced to the Access Management Team. For example:

> If it is a “For Sale” property, right-of-way appraisals have to be made too determine the value of the offer.
>
> If an entrance permit, site plan, building permit, or subdivision plat is requested to be reviewed we have to determine if there is a change in land use that will increase trip generation from the property.
>
> The Team must determine if the property can be serviced either now or in the future. If the property can not be serviced the team will prepare a recommendation package to pursue the purchase of the property.
>
> The results of the review are coordinated with the local planning office. This process has fostered an Access Management dialogue with the local jurisdictions, promoting Access Management on local roadways as well.
>
> The Team has refined access management process of the Primary System over the years.

OPPE has developed access management concepts for most of the corridors under their purview. These concepts are developed in coordination with the local jurisdictions and are used to guide development and redevelopment. They are also used to monitor purchases and access management decisions such as the location of public road access points and where temporary access permits are issued. These plans are flexible and intended to be implemented through the local jurisdications development process.

The Team is responsible for:

- Obtaining access controls through the local development process.
- Purchase of access controls.
- Development of long range corridor access plans.

The three major travel corridors used to refine the techniques of managing the program are:

  - MD 2/4 - in Calvert County
  - US 50 - from US 301 to Salisbury
  - US 301 - from Virginia to US 50

Obtain controls through the Local Development Process

The Team works through the local development process at the time of site plan review by recommending the limiting the number of access points to a site or redirecting the access to the lesser traveled roadway. The

Team may also request donation of access controls at the time of review.

If the county agrees with the recommendation they would put a notation on the site plan indicating access denial except where approved by SHA. The Team considers this technique as restricting access via the local development process. The property owner normally accepts the conditions of the site plan approval. The frontage is considered restricted because the controls are not deeded to the SHA.

- The Team is also developing a prototype deed that can be used to obtain the access controls in the name of State Highway Administration (SHA).

A corridor that exemplifies access management through the development process is the MD 2/4 corridor in Calvert County MD. It has 188,900' (35 miles) of frontage. The SHA has secured 940' of controls via the access permit process while the county has restricted access to 22,000' of frontage on MD 2/4 for a total of 13% (23,000' - 4.3 miles) of frontage restricted.

Purchase of access controls

In 1990 the Team realized that working through the local development process was a tool to have access restricted via site plan notation. The Team felt a higher level of access control was necessary and they requested SHA Senior Management to set up funding for the purchase of access controls. This money was to be targeted for the purchase of agricultural controls in the US 50 corridor.

US 50 services the Maryland/Delaware Peninsula and ocean resort area. The travel corridor is over 90 miles in length and serves regional summer beach traffic from Washington, DC and Baltimore, MD as well as local and commuter traffic. During the summer peak periods traffic flow on US 50 increases as much as 150%. This increase in traffic flow has historically created problems throughout the corridor. There were approximately 60 miles of US 50 where SHA did not control access....when the access program was initiated.

Since 1990, SHA has purchased 57 percent of the agricultural frontage (approximately 30 miles) for $3.5 million on US 50. There is approximately 52 miles of agricultural frontage on US 50.

The establishment of a funding source for access management is key to the program and more importantly shows commitment from the State of Maryland in supporting access management.

This technique is applied to rural areas where agricultural frontage is fairly inexpensive, compared to the commercial and residential frontage costs in urban areas. Maryland also leaves break in the frontage for future development of the parcels, these breaks are for public roads.

Long Range Access Management Plans

Long range access management plans are being developed for 18 miles of the US 301 corridor. These plans will be used to guide development and redevelopment of property to where their future access can be located. These plans are being developed while the SHA completes the NEPA process and begins formal Project Planning studies for the US 301 corridor in Maryland from US 50 to the Nice bridge over the Potomac river, approximately 40 miles. These access management plans are being developed in partnership with the local governments impacted by the corridor. (These types of access management plans have been developed for the US 50 and MD 2/4 corridors.)

Access Management has also influenced/or prompted

- Development of costs to purchase access controls by linear foot.

- Development of a costs to close access points.

- Review of spacing of public road intersections desired goals to provide 1/4 mile spacing (1,320 feet) of public road intersections in rural areas.

- Minimization of Crossovers.

- Corner parcels new access to be located via the lower functioning road, unless denial of that access creates a compelling safety problem.

- The joint development access management concepts with local jurisdictions that will allow for economic growth and development while maintaining or improving mobility/safety, circulation and capacity of the existing roadway.

- The developing a deed that could be used at time of site plan approval for the owner to transfer access controls across the front of the parcel to the SHA.

Legislation

The 1997 General Assembly passed legislation that allows SHA to deny NEW access to our highway system when alternate access is available or when safety is a concern. Annotated Code of Maryland under Transportation sections 8-620 and 8-625

- SHA policy is to apply this authority along the primary system.

- Major change in access policy - in past SHA was obligated to approve access to parcels that front on state highways or purchase controls even if other reasonable access was available, i.e. corner parcels.

- The legislation would only be applied if the counties development approval process failed to obtain denial to the State system.

- SHA's policy is to apply this authority along the Primary System, but it may be applied to the State Secondary system as well where safety is a predominant factor. We will apply this policy outside priority funding areas designated by the counties under Smart Growth. We have met with all the county planning directors to explain our application of the law in detail. We will work through the county development process to manage access to the State Highway System.

SMART GROWTH

In 1996 the Maryland General Assembly enacted the Smart Growth Bill which will guide growth to suitable areas. In rural areas growth will be directed to existing population centers by focusing spending in those areas, including parts of locally designated growth areas that constitute the most effective and efficient use of taxpayer dollars to best preserve existing neighborhoods. This bill limits state funding of projects to Smart Growth areas. Its impact on Transportation Projects by providing funding for projects that maintain existing systems, provided that the project does not increase highway capacity. Projects that serve to connect state priority funding areas as long as they are access controlled to prevent development that is inconsistent with Smart Growth Legislation and/or constrains development that will detract from main street business areas.

Access Management as Strategy in a Statewide Safety Goal

Michele Gallant, Carter-Burgess, Inc.

Abstract

The Florida Department of Transportation (FDOT) is beginning to update the Florida Transportation Plan (FTP), a statewide 2020 Long Range Transportation Plan which sets forth the policy under which FDOT conducts its planning, design and construction activities. This Plan identifies four goals, the first of which relates to safety. This goal strives to provide "Safe transportation for residents, visitors and commerce." To help achieve this goal, FDOT has developed several objectives and strategies, all of which could be impacted by the State's access management policy.

Florida has developed access management standards which are present in the Rule Chapter 14-97, Florida Administrative Code. These standards are implemented, to varying degrees, based on the functional classification of each roadway. For example, the Florida Intrastate Highway System (FIHS) maintains the highest level access management standards due to the purpose of providing for intrastate commerce and travel.

To use access management as a strategy for implementing the safety goal, the status of access management implementation must be assessed. Additionally, a relationship must be formed between access management, crash rates and safety indicators (i.e., highway fatality rates). Once this relationship is formed, the study effort will determine how access management relates to the safety goal of the FTP. For instance, one of the FTP Short Range Component objectives tries to reduce the percentage of crashes where road-related conditions are listed as a contributing factor. Do road-related conditions include issues with access management? If not, should they?

In conclusion, the presentation will discuss how access management policies will help FDOT implement the FTP safety goal by identifying safety improvements and enforcement needs. Through a coordinated effort, in all phases of project development, access management could be used as a tool to implement FDOT's safety goal.

This abstract represents the approach to a presentation only. Much of the research related to this subject is being conducted by the FDOT Safety and Statistics Offices and will need to be reviewed, but no additional research is anticipated for this presentation. It is not anticipated that any detailed research on access management will be conducted during the FTP update process, however, if the findings of this research review demonstrate the need for detailed issue analysis, it will be conducted.

Presentation

No presentation material available for print.

Access Management in Montana

David Rose, Dye Management Group

Abstract

This paper will present the results of the study of access management in Montana. It is being performed to review the current access management process of the Montana Department of Transportation (MDT) and identify areas of potential improvement. The objective of this project is to evaluate MDT's existing access control policies as they pertain to approach control, site development, and the state/local review process in addressing access along state highway facilities. This evaluation is being done to assist in the development of a systematic overall approach to access management. As urban and suburban land use densities increase and as traffic volumes and trip generation increase, the influence of the frequency, location and design of driveways and intersections has become a critical factor in the performance and safety of the arterial system. Access movements have been clearly identified as a significant element in accident rates and causes of congestion.

The conflict between movement and land access will increase as development occurs in both urban and rural areas. The challenge is how best to coordinate access with land development in a way that encourages economic activity while simultaneously preserving mobility. A systematic approach to access management is needed - one that provides a sound legal basis for access control decisions. This approach must be tailored to Montana's particular needs - its broad range of road types, development patterns, geography, and political jurisdictions. This need underlies this study.

Presentation

No material available for print.

Access Management in Practice: The Pretoria Experience

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Abstract

Due to the rapid development of previously vacant land as well as changes in land use along important traffic corridors, the city of Pretoria is under increasing pressure to provide access to and from the street network, especially along major arterials. To preserve mobility and protect the intended functions of streets, a policy was developed for the City Council of Pretoria that would clearly set the requirements for accesses on different street classes. The policy emphasizes integrated land use and network planning, with street access forming the interface between the two systems. The policy consists of two principal components. The first component is a classification of the street network to establish an appropriate Level of Access (LOA) for each street. These levels vary from LOA O (most restrictive) to LOA9 (least restrictive). The second component consists of the design standards appropriate to each of the access categories. These standards include criteria for both signalized and unsignalized intersections and accesses. Successful implementation of the policy and the approval of Access Management Plans depend on the cooperation of all stakeholders, including property owners, developers, and relevant City Council departments.

INTRODUCTION

A policy for the management and control of access to the street network was developed for the City Council of Pretoria [I].The policy was needed to protect the street system, particularly the arterial street network, from functional obsolescence resulting from excessive densities or in appropriate spacing of accesses. The goal of the policy is to prevent future capital expenditure for replacing obsolete streets and roads while still encouraging development.

Some arterial streets in Pretoria are currently deteriorating in their ability to accommodate traffic because of the conflicting requirements of mobility and accessibility. Because of the economic benefit of passing trade, transportation officials feel increasing pressure to allow direct access to commercial developments from major roads that carry high volumes of traffic. To balance the needs for access versus mobility, it was important to institute access control on streets in accordance with the intended function of a street.

The policy is similar to access management and control practices in some states in the U.S.A., but it takes into account local conditions and behavior. In principle, the policy consists of the following two components:

1. Access categories. Streets are classified according to ten Level of access (LOA) categories, ranging from LOA0 (most restrictive) to LOA 9 (least restrictive). The classification scheme is based on the functional classification of streets as well as adjoining land use.

2. Design standards. Each LOA is associated with appropriate design standards. These standards specify criteria such as type of access allowed, access spacing, and de-sign requirements.

For the purposes of the policy, an "access" was defined as a private access to or from a public street, in contrast to an "intersection," which is defined as the intersection between two public streets. However, it is important to realize that accesses to large developments, such as shopping malls and office parks, may generate traffic volumes significantly higher than residential collector streets. From a functional point of view, there-fore, there is no distinction between a private access and a public intersection, so a single standard is provided for both.

ACCESS CATEGORIES

The access management system is based on a classification of the street network into various LOA categories. Ten LOA (LOA 0 through LOA 9) were identified, and each street is assigned one of these levels. This system is a convenient means of classifying streets because it uses numerical symbols, which are simpler and more flexible than word descriptions. The access category approach also has been used in a number of states in the U.S.A., for example, New Jersey [2], Colorado[3]. and Florida [4].

The assignment of an LOA to a specific street depends on the relative importance of movement along compared with ac-cess to the street, and the level of development of adjacent land. The classification system is based on the current hierarchical street classification system used in many cities, but is extended to take adjacent land use and the operating environment into account. The hierarchical classification system places streets that are mainly intended to serve through traffic at the top of the hierarchy, while streets that are intended to provide access to properties are placed at the bottom of the hierarchy. An extensive and detailed roadway classification system has been used in Pretoria. This system forms the basis of the computerized road network that is integrated with a geographic information system (GIS) and a transportation demand model. The LOA classification used in Pretoria is primarily based on this roadway classification system.

The LOA classification system developed for Pretoria is as follows:

LOA Functional Classification System

0 Freeways
The most restrictive category is assigned to freeways, where full access control is applied and provision is made only for grade-separated intersections.

1. Strategic major arterial streets in rural areas or streets with a rural character
This classification is for streets on which traffic operates at high speeds. Providing traffic mobility is more important than providing access to abutting land. Development plans for the adjacent land generally exclude any commercial or business rights. Traffic signals are not commonly found on these roads and are not generally desired.

2. Strategic major arterial streets in urban (developed) areas
These streets provide for high volumes of traffic traveling at relatively high speed. Mobility is more important than accessibility. Access is limited to efficiently spaced signalized intersections, which can provide for high-progression speeds in both directions of operation. An exception is made for peak traffic periods, when progression speeds are allowed to decrease to a minimum of 50 kph.

3. Major arterial streets in urban (developed) areas with limited direct access
This classification is similar to LOA 2, except that some limited accesses to major development along the street can be provided.

4 Minor arterial urban streets (two-way streets with two or four lanes and limited access)
These streets are provided to carry medium to high traffic volumes at medium to high speed. Traffic mobility is still more important than providing access, but a limited degree of access can be provided.

5 Major or minor one-way arterial urban streets (commercial streets with a mobility function)
These streets either have a present proliferation of commercial accesses or are considered commercial streets in terms of town planning objectives, but still have a mobility function as a minor arterial street.

6 Minor one-way arterial urban streets
This special classification is assigned to one-way arterial streets. The types of traffic conflicts on these streets are different than those on two-way streets, resulting in the need for a different approach to access management and control.

7 Major collector streets
A reasonable balance between direct access and mobility needs is provided on these streets. Signal spacing should allow for an acceptable progression efficiency.

8 Minor collector streets
Access and mobility are considered to be of equal importance on these streets. Traffic volumes typically do not warrant signals along these streets, and therefore progression efficiency is normally not an issue.

9 Local streets
This category includes most street segments in a road network and provides for direct access to abutting properties.

DESIGN STANDARDS

Design standards are provided for each LOA category in accordance with the intended function of the streets within the category. The most important standards are those for accesses and intersections, but standards are also given for such factors as:

- Signal progression and green band width
- Medial access, i.e., median openings to allow turning maneuvers
- Marginal access, e.g., right-in, right-out movement only (South African left)
- Auxiliary lanes (specifically deceleration lanes)
- Design and location of accesses and intersections

Details of the design standards are available in the policy document [1]. In establishing the standards, the following basic principles were adhered to:

- No access or intersection should be located within the functional boundary of another access or intersection. This boundary includes the extent of auxiliary lanes needed for speed changes (deceleration and acceleration) plus the required storage length.
- Signals should be spaced to provide efficient progression during both peak and off-peak hours. Any deviation from the desired spacing will lead to a reduction in green bandwidth, resulting in a reduced level of service. Different minimum bandwidth criteria, however, maybe allowed for the different LOA categories because poorer efficiencies can be tolerated on the lower order streets.

- Excessive access density has a significant negative im-pact on level of service and safety because of increased friction and conflict.

- Medians may be used to either allow or prohibit certain turning maneuvers. Medians can be very effective in blocking turning movements to and from developments along a road. Medians, however, also can be designed to provide protected space for such turning movements.

- Accesses should, at a minimum, be spaced according to desirable stopping sight distances.

- The design speed selected for a street must correspond with prevailing speed limits, except where actual 85^{th} percentile speeds are certified to be higher (based on speed surveys).

ACCESS CONTROL ON EXISTING STREETS

The formulation of an access management and control policy is less complex in the ideal situation, where a new street net-work is developed or where little or no development exists along current streets. On most existing streets, however, retrofit techniques are needed to improve the situation. In many cases, traffic operations can be significantly improved by the introduction of such techniques. Where this is possible, the LOA classification of the street can be modified.

It is, however, not always possible to retrofit streets to reflect the desired standards for the specific LOA assigned to the streets. In such cases in Pretoria, the fact that an existing access does not conform to the policy does not constitute a basis for the approval of new accesses; new accesses must meet the requirement of the relevant LOA assigned to a street.

EXPERIENCE WITH THE POLICY

A major problem in South Africa is the lack of understanding and cooperation from developers regarding the need for access control on streets. Developers often consider such control a burden and an unnecessary constraint on development ,rather than an aid to efficiency. Both effort and commitment by city officials will be required to convince developers of the need for, and importance of, such control.

The access management and control policy of Pretoria pro-,vides for Access Management Plans (AMPS) to regulate access to specific roads. Approval of rezoning applications and site development plans requires input from various disciplines, including town planning and urban design, transportation engineering, and traffic control. AMPs will assist in providing an unambiguous guide for determining the types and locations of accesses that can be allowed.

In Pretoria, AMPs have already been implemented for a number of corridors where applications for development have been received. These corridors typically carry high volumes of traffic and have a high commercial potential, resulting in the pressure for development.

CONCLUSIONS

The City Council of Pretoria has introduced a policy to control and manage access to its road network. The policy establishes LOAs and associated design standards for the various streets in the network, thereby specifying the type of access, access location, and access design that are allowed on each street. The policy coordinates land use and transportation is-sues and involves various disciplines. A number of pilot projects are under way to develop AMPs for specific streets.

REFERENCES

1. African Consulting Engineers, Inc. Management and Control of Access to the Pretoria Street System. City Council of Pretoria. 1996.

2. New Jersey Department of Transportation. Access and Spacing Standards for State Highways. 1990.

3. Highway Commission, State of Colorado. The State Highway Access Code. 1985.

4. Florida Department of Transportation. State Highway System Access Management Classification Systems and Standards. 1990

Session 15

Restrictive Medians and Two-Way Left-Turn Lanes Panel Discussion

Moderator: Gary Sokolow, Florida Department of Transportation

Participants: Herbert Levinson, Consultant
Peter S. Parsonson, Georgia Institute of Technoloy
Paul C. Box, Box and Associates Engineering
Ali Eghtedari, Multnomah County Transportation Division
Wayne Kittelson, Kittelson Associates

Restrictive Medians and Two-Way Left Turn Lanes Some Observations

Herbert S. Levinson, Transportation Consultant

Presentation

I would like to address the choice of median alternatives from the broader perspective of the left turn problem. For if there were no left turns, the choice is quite straightforward.

Left turns pose many problems at driveways and street intersections. They increase conflicts, delays, and accidents, and they often complicate traffic signal timing.

- More than two-thirds of all driveway-related accidents involve left-turning vehicles.

- Where there are more than six left-turns per traffic signal cycle, virtually all through vehicles in the shared lane may be blocked by the left-turning vehicles.

- Where left-turn lanes are provided along multi-lane highways, each left-turning vehicle reduces the through vehicle capacity by the number of through lanes it crosses (e.g., 100 left turns/hour across three traffic lanes reduces the through vehicle capacity by 300 vehicles/hour).

Thus, the treatment of left-turns is a major access management concern. Left-turns at driveways and intersections may be accommodated, prohibited, diverted or separated, depending upon specific circumstances.

The most common approach is to provide protected left-turn lanes. A synthesis of the safety research conducted during the last 30 years indicates that removing left-turns from through travel lanes reduced accident rates about 50% (the range was 18% to 77% based on 9 studies of which 6 involved before-and-after comparisons). Since the capacity of a shared lane may be 30% to 60% of that for a through lane under typical suburban conditions, providing left-turn lanes along a four-lane arterial would result in about a 33% gain in capacity each way.

The basic choices for designing the roadway median along many highways is whether to install a continuous two-way left-turn lane or a non-traversable median on an undivided roadway, or to replace a two-way left-turn lane with a non-traversable median. These treatments improve traffic safety and operations by removing left-turns from through travel lanes. Two-way left-turn lanes provide more ubiquitous access and maximize operational flexibility. Medians physically separate opposing traffic, limit access, clearly define conflicts and provide better pedestrian refuge; but adequate provision for left and "U" turns is essential to avoid concentrating movements at signalized intersections.

Let me share with you some safety benefits of these treatments as reported in NCHRP Report 3-52 for studies conducted since 1970:

- Highway facilities with two-way left-turn lanes had accident rates that were about 38% less than experienced on undivided facilities (13 studies, of which 9 involved before-and-after comparisons).

- Highway facilities with non-traversable medians had an overall accident rate of 3.3 per million vehicle miles (VMT) compared to about 5.6 per million VMT on undivided facilities (10 studies, of which 2 involved before-and-after comparisons).

- Seven accident prediction models found that non-traversable medians had about 75% to 85% the accident rates of highways with two-way left-turn lanes and usually less than half of the accident rate of undivided highways.

  The estimated total accidents per mile per year were as follows:

ADT	Undivided Highway	Two-Way Left-Turn Lane	Non-Traversable Median
10,000	48	39	32
20,000	126	60	55
30,000	190	92	78
40,000	253	112	85

- The Bonneson-McCoy safety model found about a 15% accident rate reduction for "midblock" median sections, as compared with TWLTLs ._However, it found no safety benefit of TWLTLs over "undivided" road sections without curb parking.

- Accident analyses in NCHRP 3-52 reported rates of 8.99, 6.88 and 5.19 for undivided roads, TWLTLs, and non-traversable medians, respectively.

- A limited number of operations studies found that removing left-turning vehicles from the through traffic lanes reduces delays whenever the number of through travel lanes is not reduced. Some 11 operations models developed over the past 15 years confirmed these findings.

- Where median width permits, U-turn movements at designated locations can reduce conflicts, increase capacity and improve safety. They make it possible to prohibit left-turns from driveway connections onto multi-lane highways and to eliminate traffic signals that would not fit into time-space (progression) patterns along arterial roads. When incorporated into intersection designs, they enable direct left-turns to be rerouted and traffic signal phasing to be simplified. Telegraph Road in the Metropolitan Detroit area is the best known example, but the treatment has been used successfully along many other highways.

- Michigan DOT reported a 20% accident rate reduction by eliminating direct left-turns from driveways and a 35% reduction when the turns were signalized. Roadways with wide medians and one direction cross overs had about half of the accident rates of roads with TWLTLs.

- “U” turns, coupled with two-phase traffic signal controls, result in about a 15% to 20% gain in capacity over conventional intersections with dual left-turn lanes and multi-phase traffic signal controls.

- Simulation studies found that a right-turn followed by a U-turn from a driveway can result in less travel time along heavily traveled roads than the direct left-turn exit when there is up to a half mile of additional travel.

- Indirect U-turns ideally require a median width of 40 to 60 feet at intersections depending upon the types of vehicles involved. Narrower cross sections may be sufficient when there are few large trucks.

The choice of a median alternative will depend upon land use, traffic, and policy factors for any given roadway. What is the access management policy for the roadway? Can the supporting street system provide opportunities for rerouting left-turns? What is the existing geometry like and is there space for widening? Will the land uses be adversely affected by prohibiting or redirecting left-turns?

Raised medians are generally more effective than painted channelization from an access management perspective. I have a preference for wide medians that allow indirect “U” turns, especially with two-phase traffic signal controls at cross streets and driveways. They should be considered for new arterials where space permits in view of both their safety and traffic signal timing/coordination benefits.

Finally, whatever the median option, it is essential to deal with left-turns on a system basis to avoid transferring problems upstream or downstream.

Influence of Signal Spacing On Arterial-Traffic Progression

Peter S. Parsonson, Georgia Tech

ABSTRACT

Session 15 of the Third National Conference on Access Management was a panel discussion titled "Medians and Two-Way Left-Turn Lanes". The author spoke on the subject of median-opening spacing and its relation to signal progression. This paper records the author's comments and offers additional material on the subject.

In 1997 the Florida DOT produced a Median Handbook that explains that a median-opening spacing of one-half mile has several advantages, including signal progression. This paper explains how a one-half-mile spacing can produce two-way progression at speeds of 45 to 55 mph, with cycle lengths of 80 to 65 seconds, respectively, by means of the single-alternate system of signal timing. One-half-mile spacing can produce two-way progression at speeds of 45 to 55 mph, with cycle lengths of 160 to 130 seconds, respectively, using the double-alternate scheme. The timing plan can be changed back and forth from single-alternate to double-alternate as required by needed cycle length.

PRESENTATION

In 1997 the Florida DOT produced a *Median Handbook* (1) that explains that a median-opening spacing of one-half mile has several advantages, including signal progression. (Signals would be spaced at half-mile intervals, within which interval, every one-sixth-mile, there would be a channelized opening permitting left turns and U turns from the arterial, but not left turns out of driveways or public roads within the one-half mile section.) This paper explains how one-half-mile spacing can produce two-way progression with various speeds, cycle lengths and signal-timing plans.

The 1961 edition of the *Manual on Uniform Traffic Control Devices (MUTCD)* (2) included a discussion of the provision of Signal Warrant 4, Progressive Movement, that calls for the proposed and adjacent signals to constitute a progressive signal system. The *MUTCD* considered a signal-timing plan known as the single-alternate system, the time-space diagram for which is shown herein as Figure 1. The figure shows that two-way progression is achieved for equally spaced signals if every second intersection goes green at the same time. If a 50-50 split of the cycle length is chosen, then the through band fills the entire main-street green at every intersection, an obvious advantage capacity-wise. The figure also shows that if the cycle length is 60 seconds and the signal spacing is 1200 feet, then the resulting speed of progression is 27 mph. Such calculations are based on the fact that a vehicle moving in the through band travels two blocks (2400 feet) in one cycle length (60 seconds), or 40 feet per second (equivalent to 27 mph). The *MUTCD* showed a table of progression speeds resulting from a range of cycle lengths and a variety of signal spacings. The table is reproduced herein as Table 1. The author has added the column for one-half-mile spacing. Table 1 shows that, for speeds of 45 mph and higher, the signal spacing should be no less than one-half mile. However, the single-alternate system is limited to cycle lengths of no more than 80 seconds, if speeds are to be no less than 45 mph. During heavy-traffic periods of the day, when higher cycle lengths are needed, the double alternate system gives better results, as shown in Figure 2.

Figure 2 shows that at time zero the double-alternate signal system has the first two signals turning green, the next two turning red, etc. For a 50-50 cycle split, however, the through band is only half the width of the green, so the capacity to move platoons is only half as great as the single-alternate system. On the other hand, the speeds are twice as high, because a vehicle now moves four blocks, instead of two, during a cycle. Using that fact, the figure shows that if the cycle length is 60 seconds and the signal spacing is 600 feet, then the resulting speed of progression is 27 mph. Similarly, if the cycle and spacing are held to 60 seconds and 1200 feet, as was done in the single-alternate example, it is easy to see that a vehicle moving in the through band travels four blocks (4800 feet) in 60 seconds, for a speed of 80 feet per second (equivalent to 54 mph. Table 2 shows the progression speeds resulting from a range of cycle lengths and a variety of signal spacings. The table shows that, for the high speeds and long cycle lengths often required on major arterials, a signal spacing of one-half mile is most appropriate.

The timing plan can be changed back and forth from single-alternate to double-alternate as required by needed cycle length.

TABLE 1. System Design Speeds in Relation to Cycle Length and Signal Spacing for Single-Alternate Systems[1] (2)

Cycle Length of System	Design Speed for Signal Spacing of--			
	2,640 feet (½ mile)	1,320 feet (1/4 mile)	1,000 feet (3/16 mi.)	660 feet (1/8 mile)
Seconds	*M.p.h.*	*M.p.h.*	*M.p.h.*	*M.p.h.*
40	90	45	34	22
45	80	40	*30*	20
50	72	36	*27*	18
55	65	33	*25*	16
60	60	*30*	23	15
65	55	*28*	21	14
70	51	*26*	19	13
75	48	24	18	12
80	45	22	17	11

[1] With identical speeds in both directions

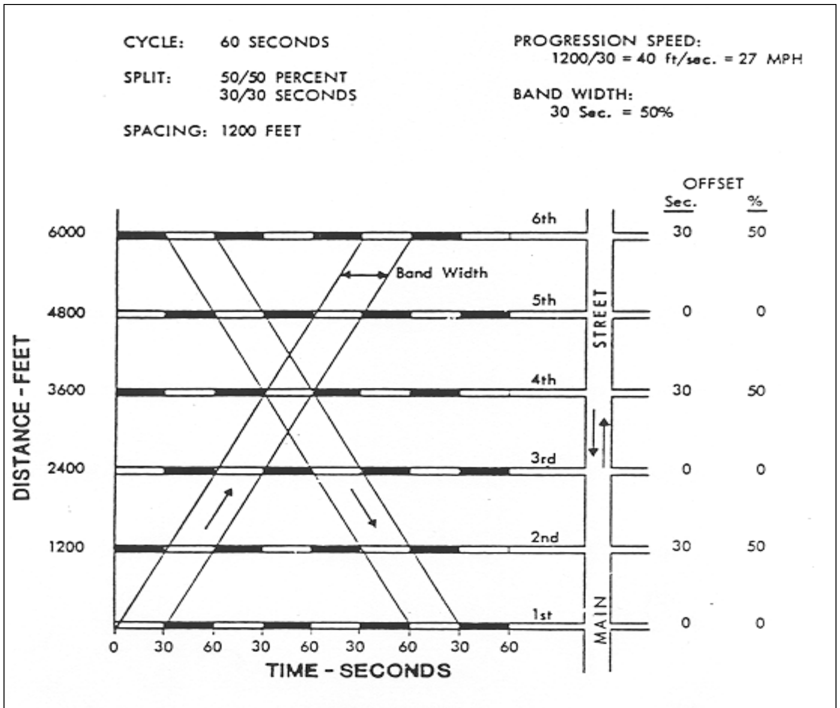
TABLE 2. System Design Speeds in Relation to Cycle Length and Signal Spacing for Double-Alternate Systems

Cycle Length of System	Design Speed for Signal Spacing of--			
	2,640 feet (½ mile)	1,320 feet (1/4 mile)	1,000 feet (3/16 mi.)	660 feet (1/8 mile)
Seconds	*M.p.h.*	*M.p.h.*	*M.p.h.*	*M.p.h.*
40	180	90	68	45
50	144	72	54	36
60	120	60	46	30
70	103	52	39	26
80	90	45	34	22
100	72	36	27	18
120	60	30	23	15
140	51	26	19	13
160	45	22	17	11

REFERENCES

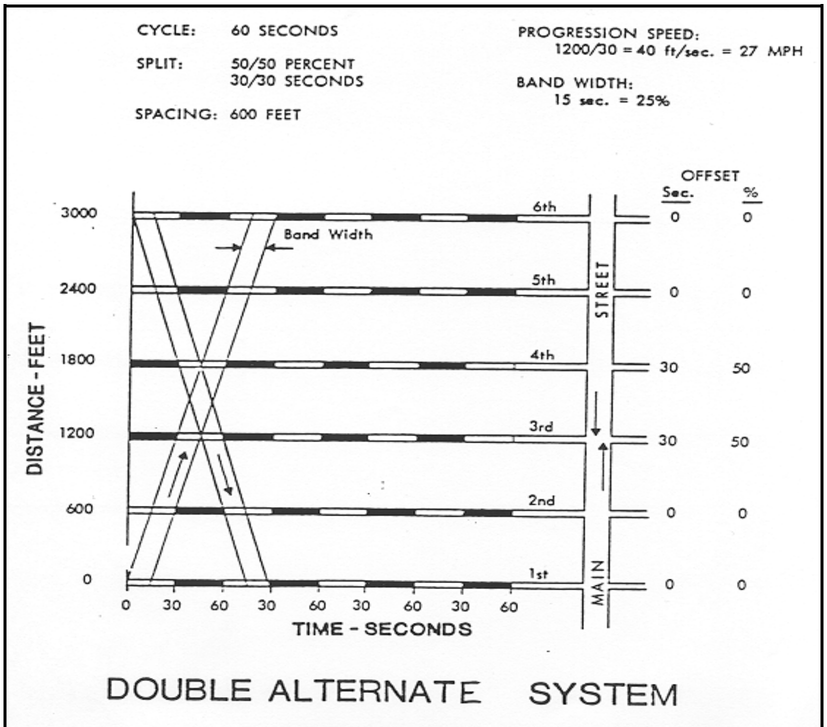
1. Florida DOT, Systems Planning Office, District Median Task Team, *Median Handbook*, Tallahassee, Florida, January 10, 1997, Chapter 2, page 19.

U.S. Department of Commerce, Bureau of Public Roads, *Manual on Uniform Traffic Control Devices for Streets and Highways*, Washington, D.C., June, 1961, page 188.



SINGLE-ALTERNATE SYSTEM
ONE-HALF CYCLE OFFSET

FIGURE 1



DOUBLE ALTERNATE SYSTEM

FIGURE 2

Session 16

The Role of Highway Classification In Access Management and How to Institute a Useful Classification System

Moderator: Philip Demosthenes, Colorado Department of Transportation

Session 17

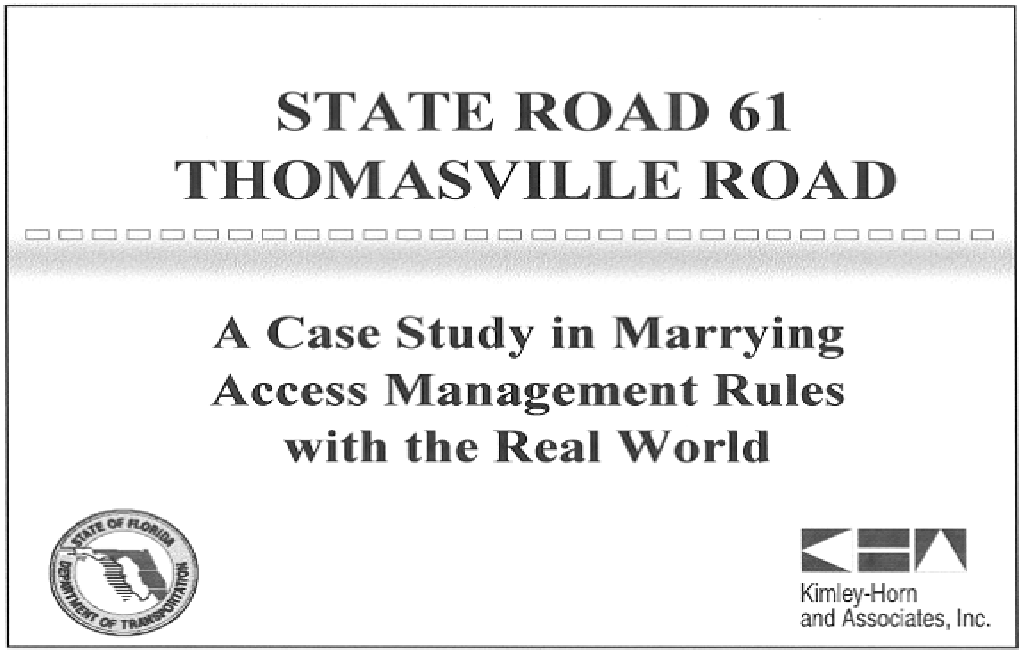
Working with the Public

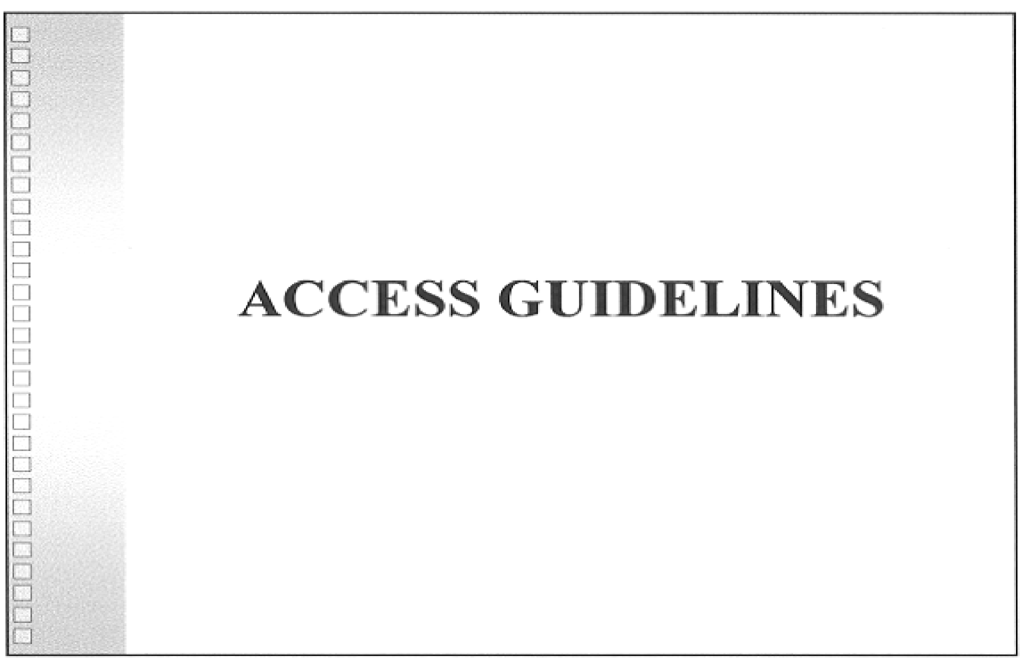
Moderator: Stephen Ferranti, SRF and Associates

Participants: Laura Firtel, Kimley-Horn Associates
Jerry Schutz, Washington State Department of Transportation

State Road 61 - Thomasville Road
A Case Study in Marrying Access Management Rules With The Real World

Laura Firtel, Kimley Horn and Associates



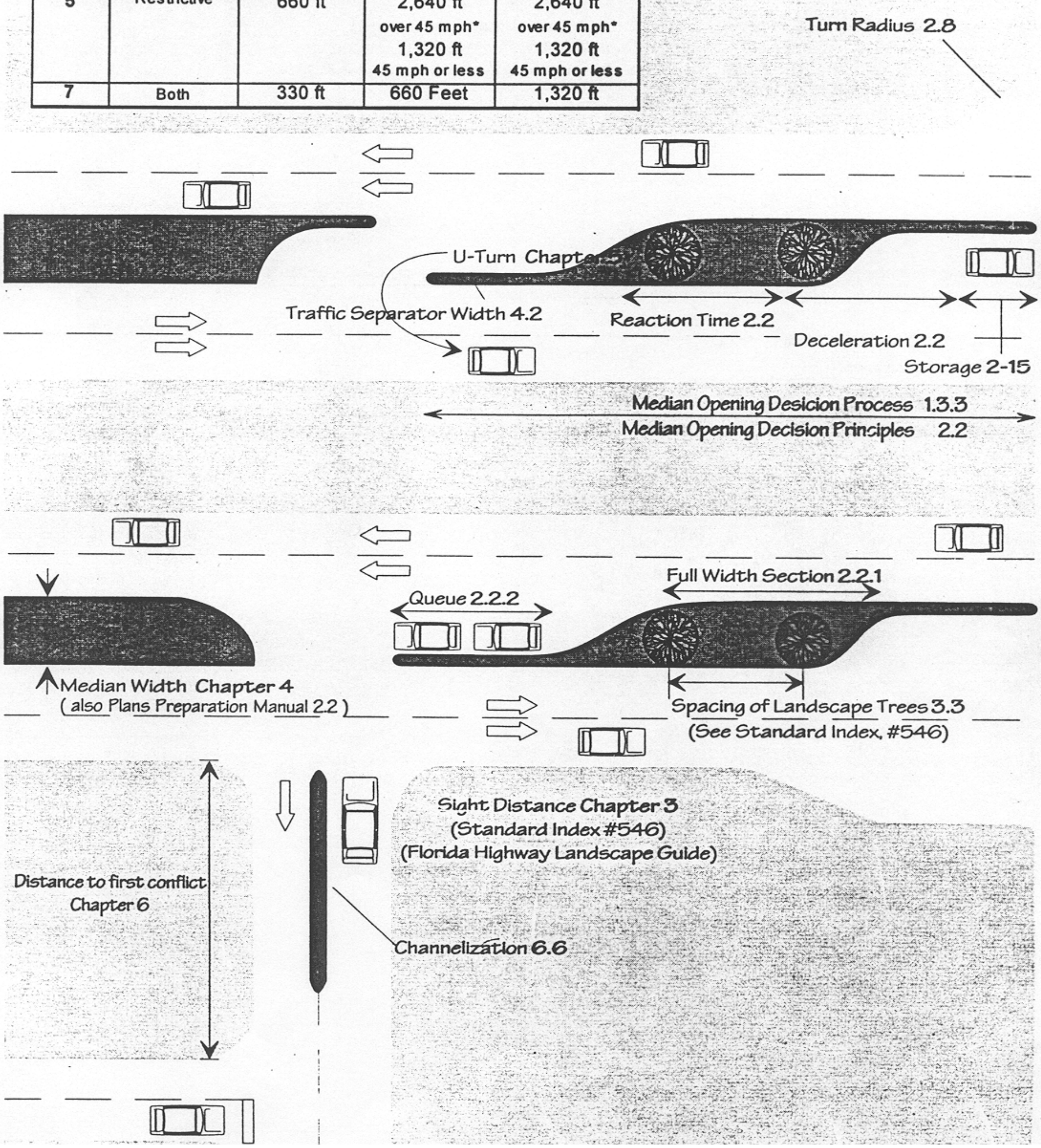


Visual Index

Median Handbook

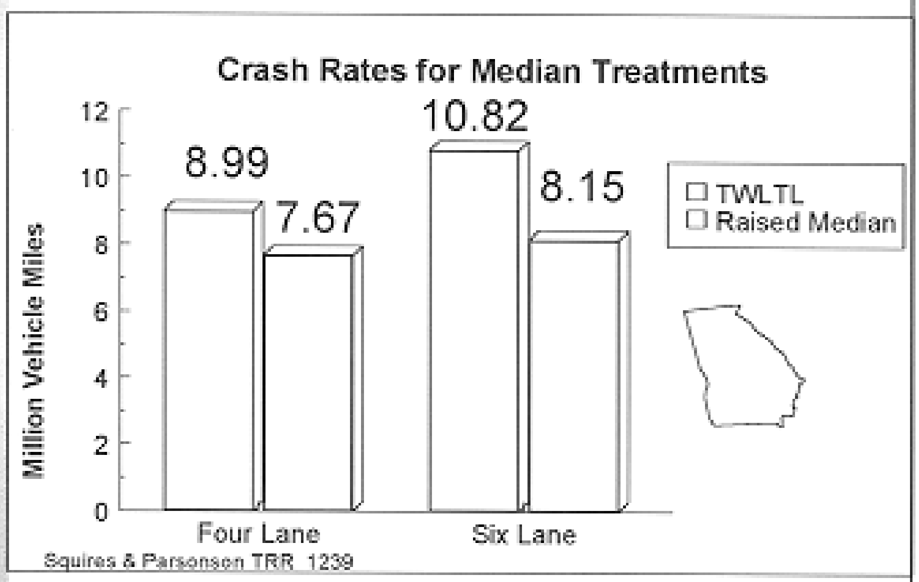
Standards 1.3.1

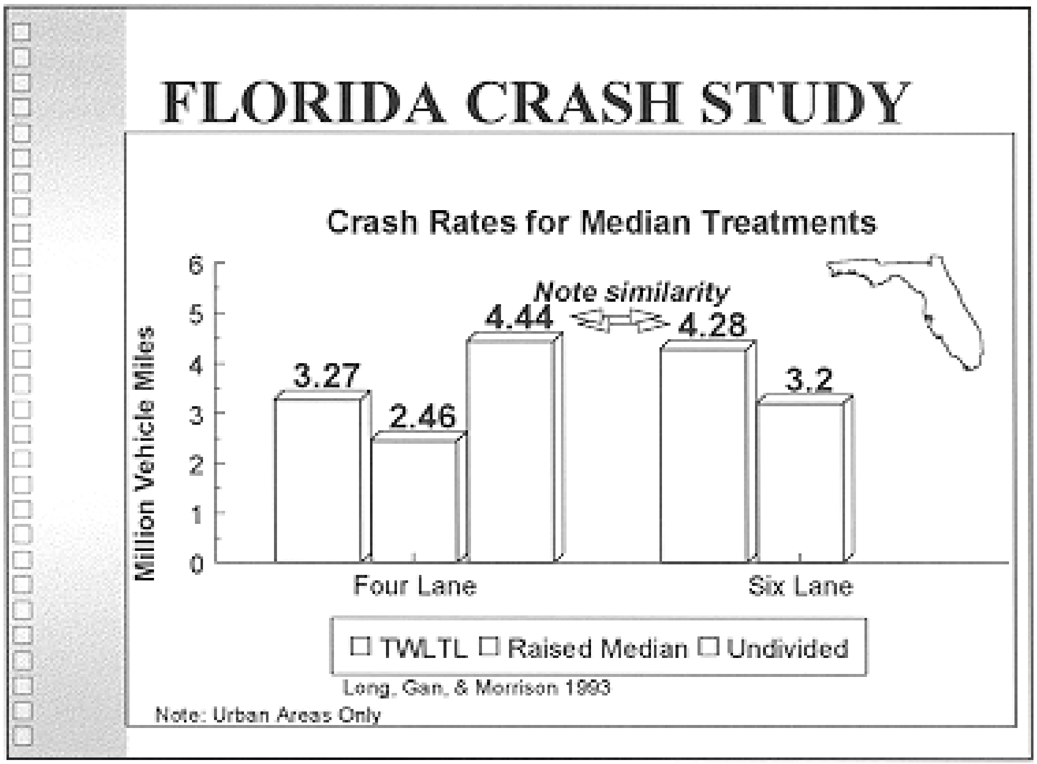
Access Class	Facility Design Features	Minimum Directional	Minimum Full	Minimum Signal Spacing
2	Resitrictive w/ service roads	1,320 ft	2,640 ft	2,640 ft
3	Restrictive	1,320 ft	2,640 ft	2,640 ft
5	Restrictive	660 ft	2,640 ft over 45 mph* 1,320 ft 45 mph or less	2,640 ft over 45 mph* 1,320 ft 45 mph or less
7	Both	330 ft	660 Feet	1,320 ft

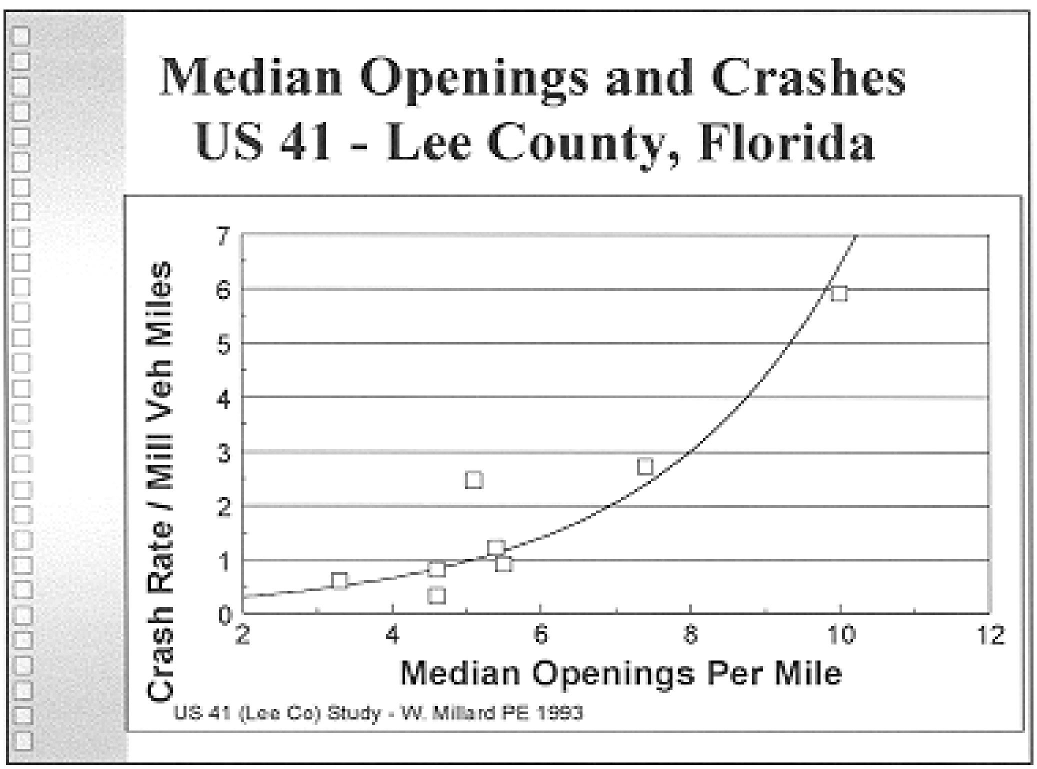


BASIS FOR ACCESS RESTRICTIONS

GEORGIA CRASH STUDY




FLORIDA CRASH STUDY
Crash Rates for Median Treatments
Note similarity
3.27
2.46
4.44
4.28
3.2
Million Vehicle Miles
0
1
2
3
4
5
6
Four Lane
Six Lane
TWLTL Raised Median Undivided
Long, Gan, & Morrison 1993
Note: Urban Areas Only


Median Openings and Crashes
US 41 - Lee County, Florida
Crash Rate / Mill Veh Miles
0
1
2
3
4
5
6
7
2
4
6
8
10
12
Median Openings Per Mile
US 41 (Lee Co) Study - W. Millard PE 1993

KEYS TO SUCCESS

KEYS TO SUCCESS

1 Careful Public Communication

KEYS TO SUCCESS

1 Careful Public Communication

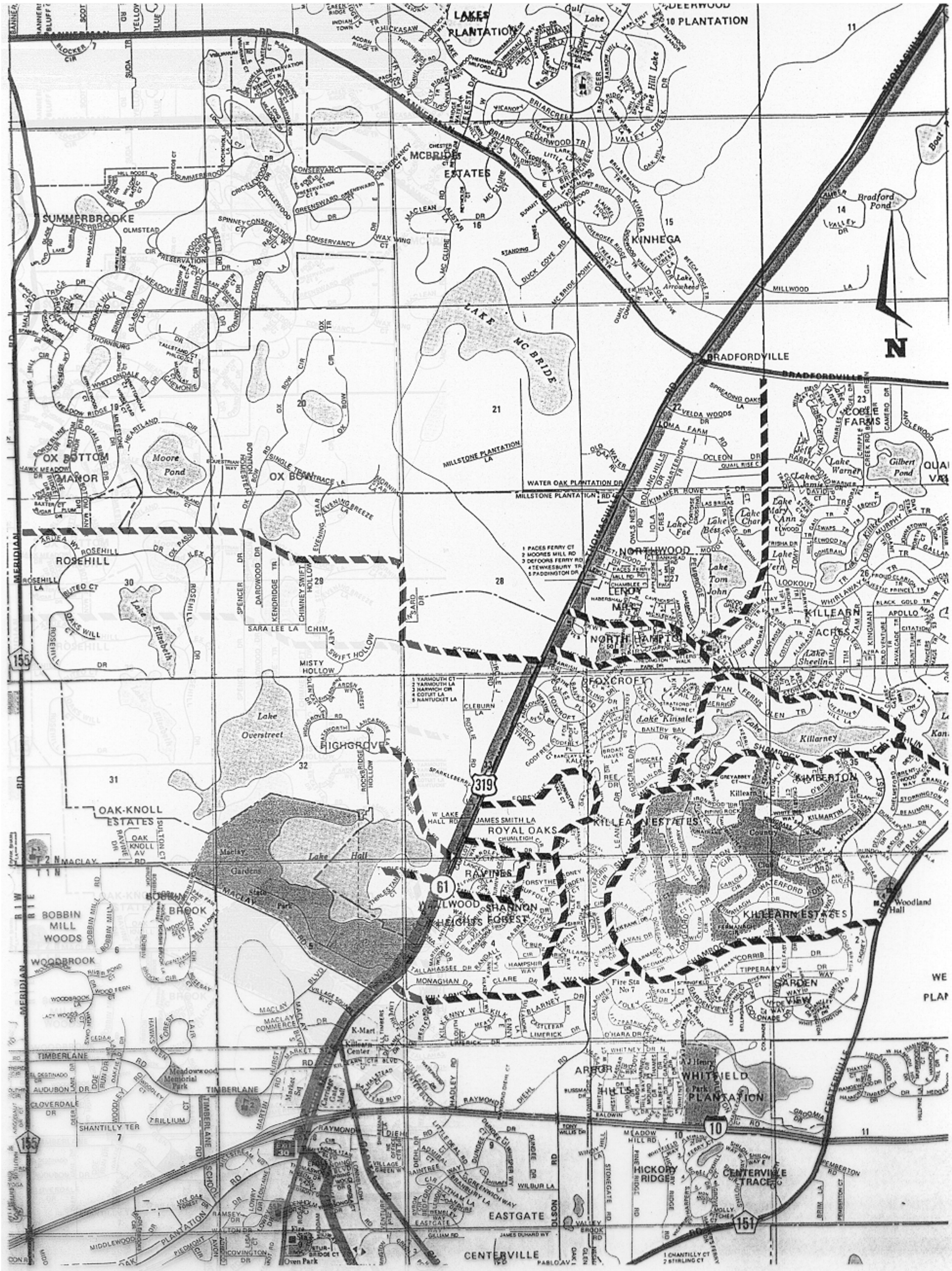
2 Regular Communication with Staff and Elected Officials

KEYS TO SUCCESS

1 Careful Public Communication

2 Regular Communication with Staff and Elected Officials

3 Multi-Departmental Team Work


LAKES PLANTATION
10 PLANTATION
MCBRIDE ESTATES
SUMMERBROOKE
KINHEGA
BRADFORDVILLE
LAKE MC BRIDE
OX BOTTOM MANOR
Moore Pond
OX BOW
ROSEHILL
Lake Elizabeth
NORTHWOOD
LENOX
NORTH HAMPTON
FOXCROFT
KILLEARN ACRES
Lake Overstreet
HIGHGROVE
Lake Kinsale
Killarney
KIMBERTON
OAK-KNOLL ESTATES
ROYAL OAKS
KILLEARN ESTATES
Lake Hall
Maclay Gardens State Park
RAVINES
SHANNON FOREST
BOBBIN MILL WOODS
WOODBROOK
BOBBIN BROOK
GARDEN VIEW
TIMBERLANE
ARBOR HILLS
WHITFIELD PLANTATION
HICKORY RIDGE
CENTERVILLE TRACE
EASTGATE
CENTERVILLE
Bradford Pond
Gilbert Pond
Woodland Hall
Meadowwood Memorial Park
319
61
155
10
151
N

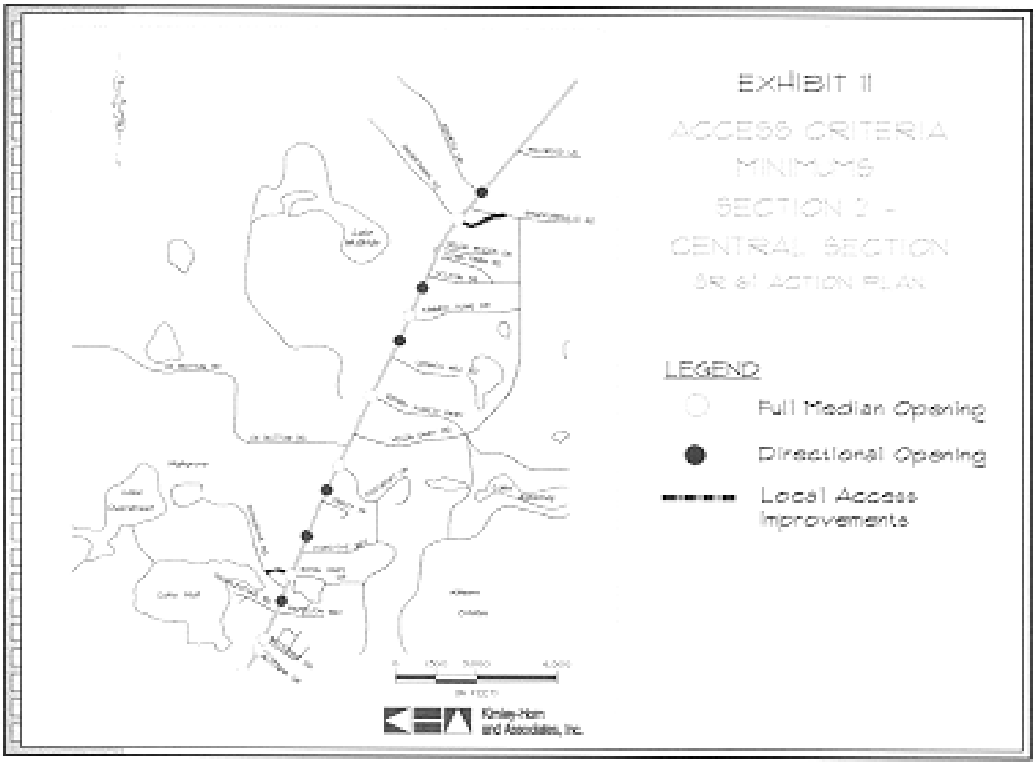
APPLICATION OF ACCESS MANAGEMENT GUIDELINES TO SR 61

STEP ONE

- ❐ Guidelines as Minimums
- ➢ *Use Controlling Intersections*

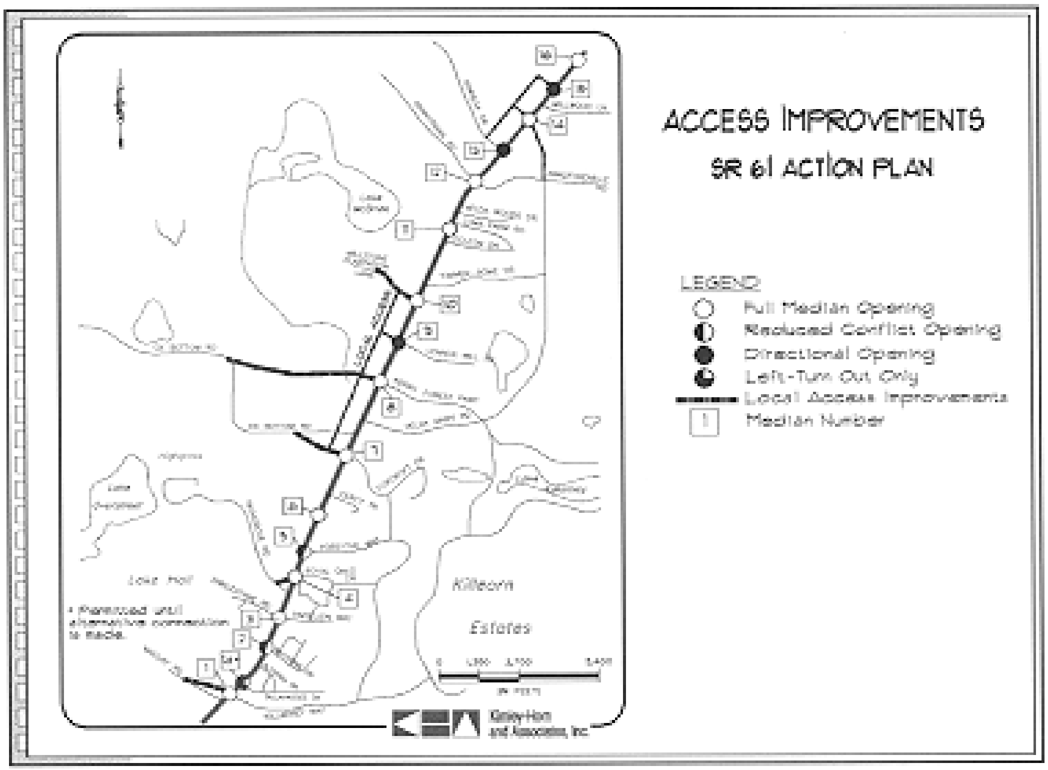
THOMASVILLE ROAD MEDIAN OPENING SUMMARY - CONCEPT TWO

NO	LOCATION	MILE POST	SPACING (FT)	CUM DIST(FT)	UM STANDAR	OPEN. TYPE
1	KILLARNEY WAY	26300				FULL
2	WOODBINE DR.	28347	2047	2047	1320	DIR-EAST
3	PAPILLION WAY/THIRLESTANE RD.	29444	1097	3144	2640	DIR N/S
4	ROYAL OAKS DR./HIGHGROVE RD.	30945	1501	4645	3960	FULL
5	**FORSYTH WAY**	**31851**	**906**	**5551**	**5280**	**DIR-EAST**
6	GOOD SHEPARD CHURCH	33220	1369	6920	6600	FULL
7	**OXCROFT DR./OX BOTTO**	**35473**	**2253**	**9173**	**9240**	**FULL**
8	KERRY FOREST PKWY/KFP EXT.	38285	2812	11985	11880	FULL
9	LENNOX MILL RD	39738	1453	13438	13200	DIR
10a	MILLSTONE PLANTATION	41100	1362	14800	14520	DIR-WEST
10b	OLD WATER OAKS PLANTATION	42500	1400	16200	15840	DIR-WEST
11	OCLEON DR.	43568	2468	17268	17160	FULL
12	BANNERMAN/BRADFORDVILLE	45920	2352	19620	19800	FULL
13	KINHEGA DRIVE	47340	1420	21040	21120	DIR
14	SOUTH OF MILLWOOD LN,100M(148+40M)	48692	1352	22392	22440	FULL
15	MEDIAN OPENING	15240	1312	23704	23760	DIR
16	MEDIAN OPENING	15640	1312	25016	25080	FULL
17	MEDIAN OPENING	16521	2890	27906	27720	FULL
18	MEDIAN OPENING	17422	2955	30861	30360	FULL
19	MEDIAN OPENING	18519	3598	34459	33000	FULL
20	MEDIAN OPENING	19522	3290	37749	35640	FULL
21	MEDIAN OPENING	20132	2001	39750	38280	FULL
22	MEDIAN OPENING	21321	3900	43650	40920	FULL
23	MEDIAN OPENING	22381	3477	47126	43560	FULL
	PROJECT CHANGE	73550	203	47329		
24	MEDIAN OPENING	74700	1150	48479	46200	FULL
25	MEDIAN OPENING	77287	2587	51066	48840	FULL
26	MEDIAN OPENING	80300	3013	54079	51480	FULL
27	MEDIAN OPENING	82100	1800	55879	54120	FULL
28	MEDIAN OPENING	84800	2700	58579	56760	FULL
29	MEDIAN OPENING	87500	2700	61279	59400	FULL
30	MEDIAN OPENING	89600	2100	63379	62040	FULL
31	MEDIAN OPENING	91540	1940	65319	64680	FULL
32	**MEDIAN OPENING**	**94375**	**2835**	**68154**	**67320**	**FULL**
	STATE LINE	94950	575	68729		



STEP TWO

- ❒ Adjust Other Access Locations
  - ➢ ***Consider Guidelines as Averages***



STEP THREE

- ❐ Combine Access

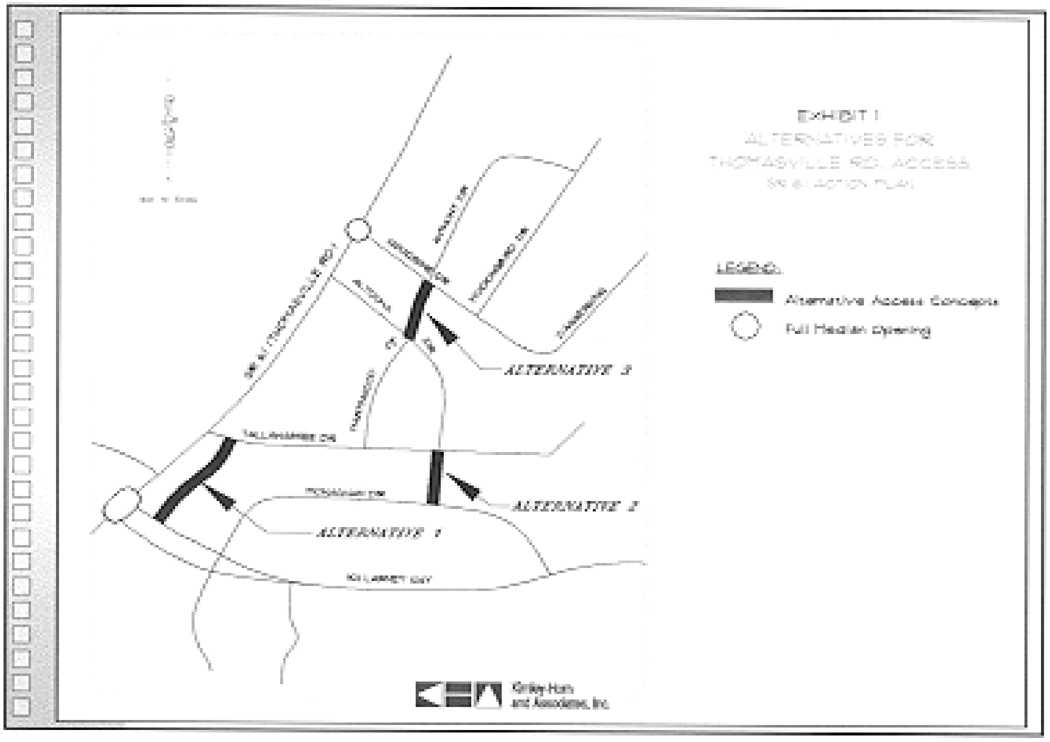


EXHIBIT 1
ALTERNATIVES FOR
THOMASVILLE RD. ACCESS
SR 61 ACTION PLAN
LEGEND:
Alternative Access Concepts
Full Median Opening
ALTERNATIVE 3
ALTERNATIVE 2
ALTERNATIVE 1
TALLAHASSEE DR
KILLARNEY WAY
Kimley-Horn
and Associates, Inc.

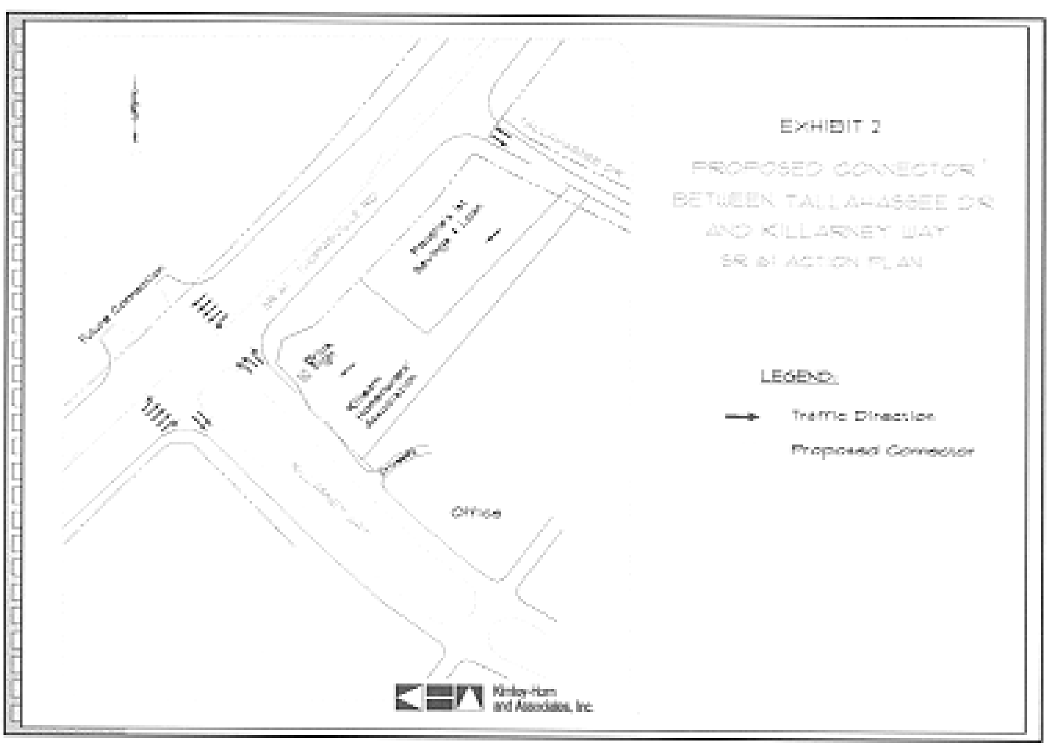
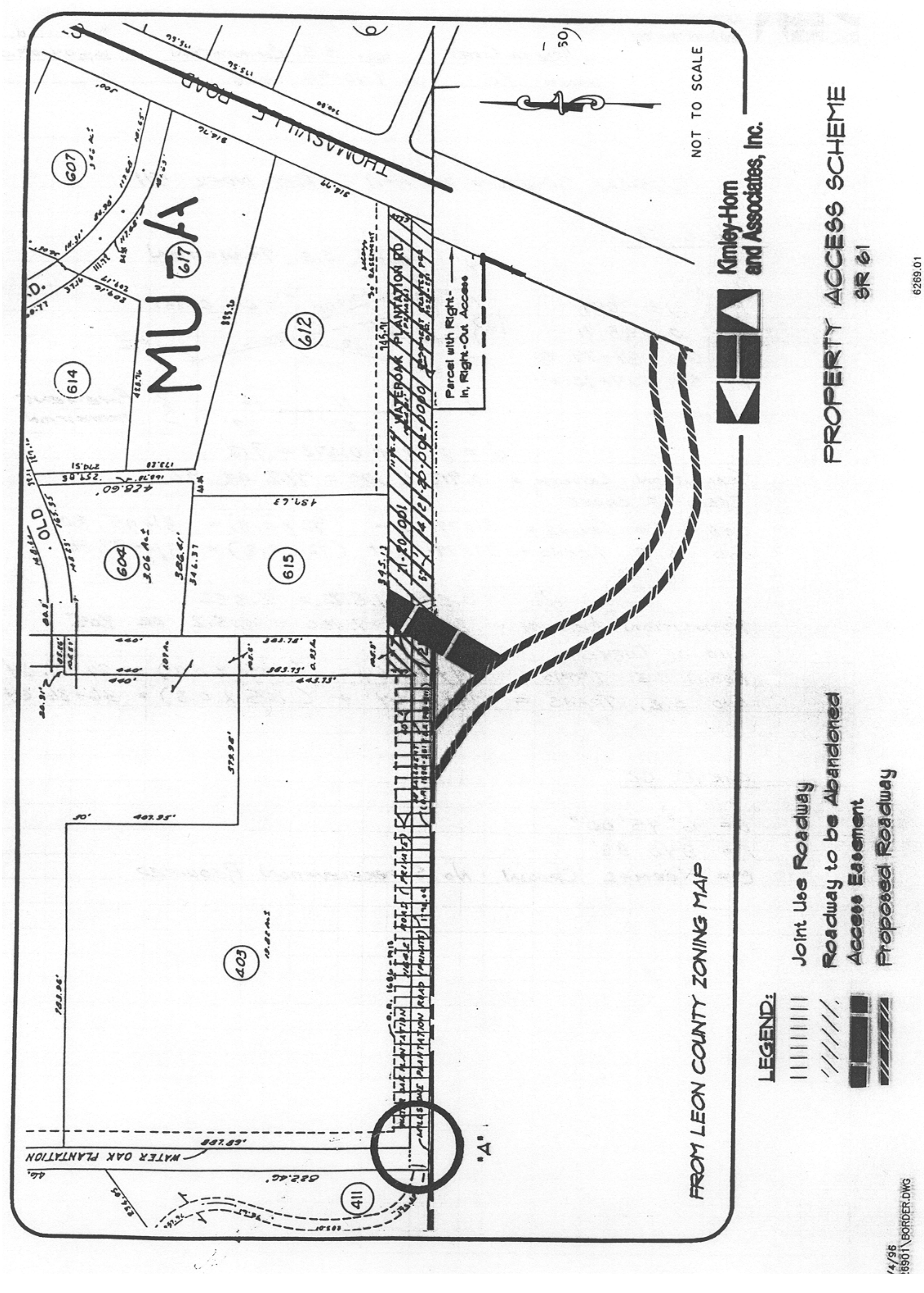
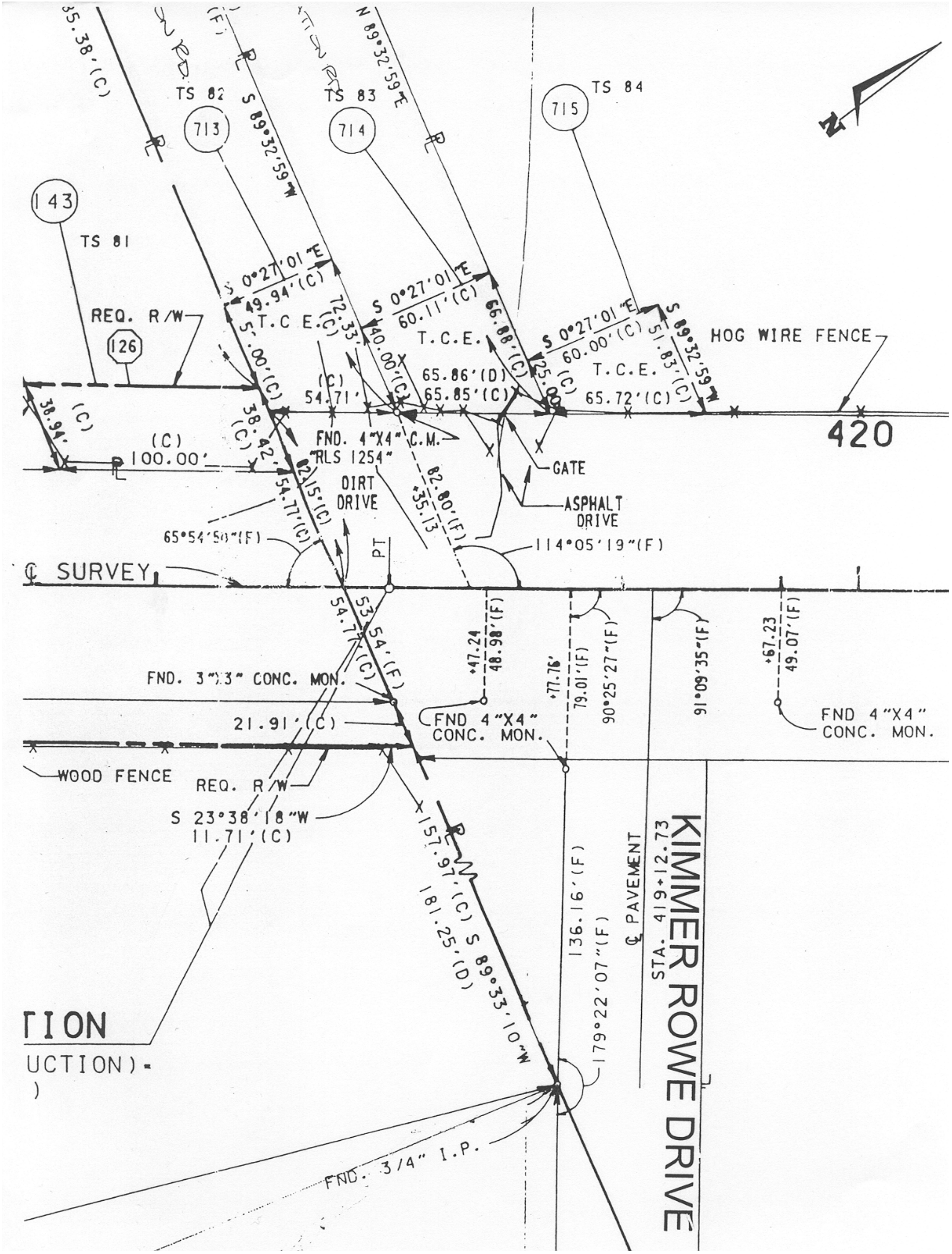


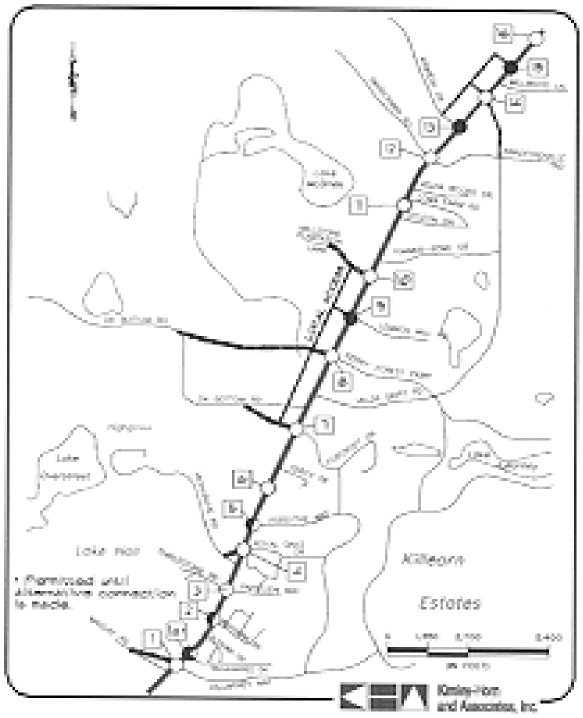
EXHIBIT 2
PROPOSED CONNECTOR
BETWEEN TALLAHASSEE DR
AND KILLARNEY WAY
SR 61 ACTION PLAN
LEGEND:
Traffic Direction
Proposed Connector
Office
Kimley-Horn
and Associates, Inc.



THOMASVILLE ROAD
MU-A
OLD
WATER OAK PLANTATION
607
617
612
614
604
615
403
411
"A"
Parcel with Right-In, Right-Out Access
FROM LEON COUNTY ZONING MAP
NOT TO SCALE
Kimley-Horn and Associates, Inc.
PROPERTY ACCESS SCHEME
SR 61
6269.01
LEGEND:
Joint Use Roadway
Roadway to be Abandoned
Access Easement
Proposed Roadway
BORDER.DWG


TS 81
TS 82
TS 83
TS 84
143
713
714
715
126
REQ. R/W
T.C.E.
HOG WIRE FENCE
420
FND. 4"X4" C.M.
"RLS 1254"
DIRT DRIVE
GATE
ASPHALT DRIVE
℄ SURVEY
PT
FND. 3"X3" CONC. MON.
FND 4"X4" CONC. MON.
WOOD FENCE
REQ. R/W
S 23°38'18"W
11.71'(C)
21.91'(C)
KIMMER ROWE DRIVE
STA. 419+12.73
℄ PAVEMENT
FND. 3/4" I.P.
TION
UCTION)-
S 0°27'01"E
49.94'(C)
S 0°27'01"E
60.11'(C)
S 0°27'01"E
60.00'(C)
S 89°32'59"W
N 89°32'59"E
S 89°33'10"W
65.86'(D)
65.85'(C)
65.72'(C)
54.71'
100.00'
38.94'
65°54'50"(F)
114°05'19"(F)
90°25'27"(F)
91°09'35"(F)
179°22'07"(F)
136.16'(F)
157.97'(C)
181.25'(D)
FND 4"X4" CONC. MON.

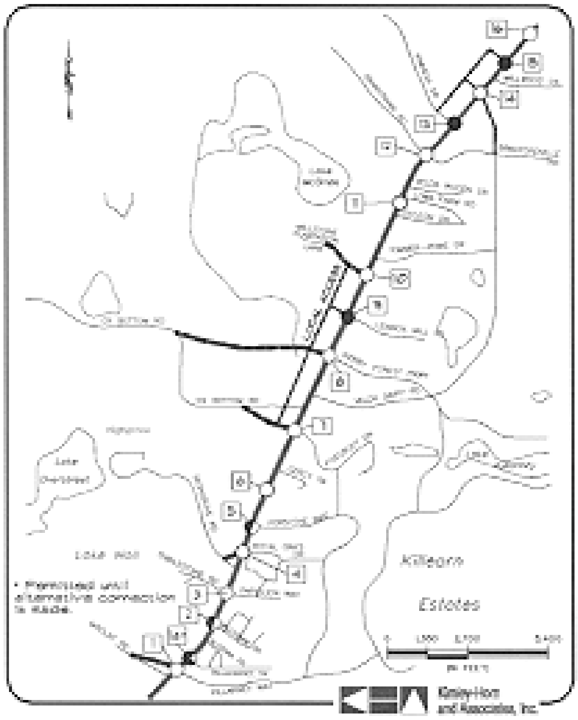
ACCESS IMPROVEMENTS
SR 61 ACTION PLAN



LEGEND
- Full Median Opening
- Reduced Conflict Opening
- Directional Opening
- Left-Turn Out Only
- Local Access Improvements
- Median Number

STEP FOUR

- ❒ Look for Excessive U-Turns



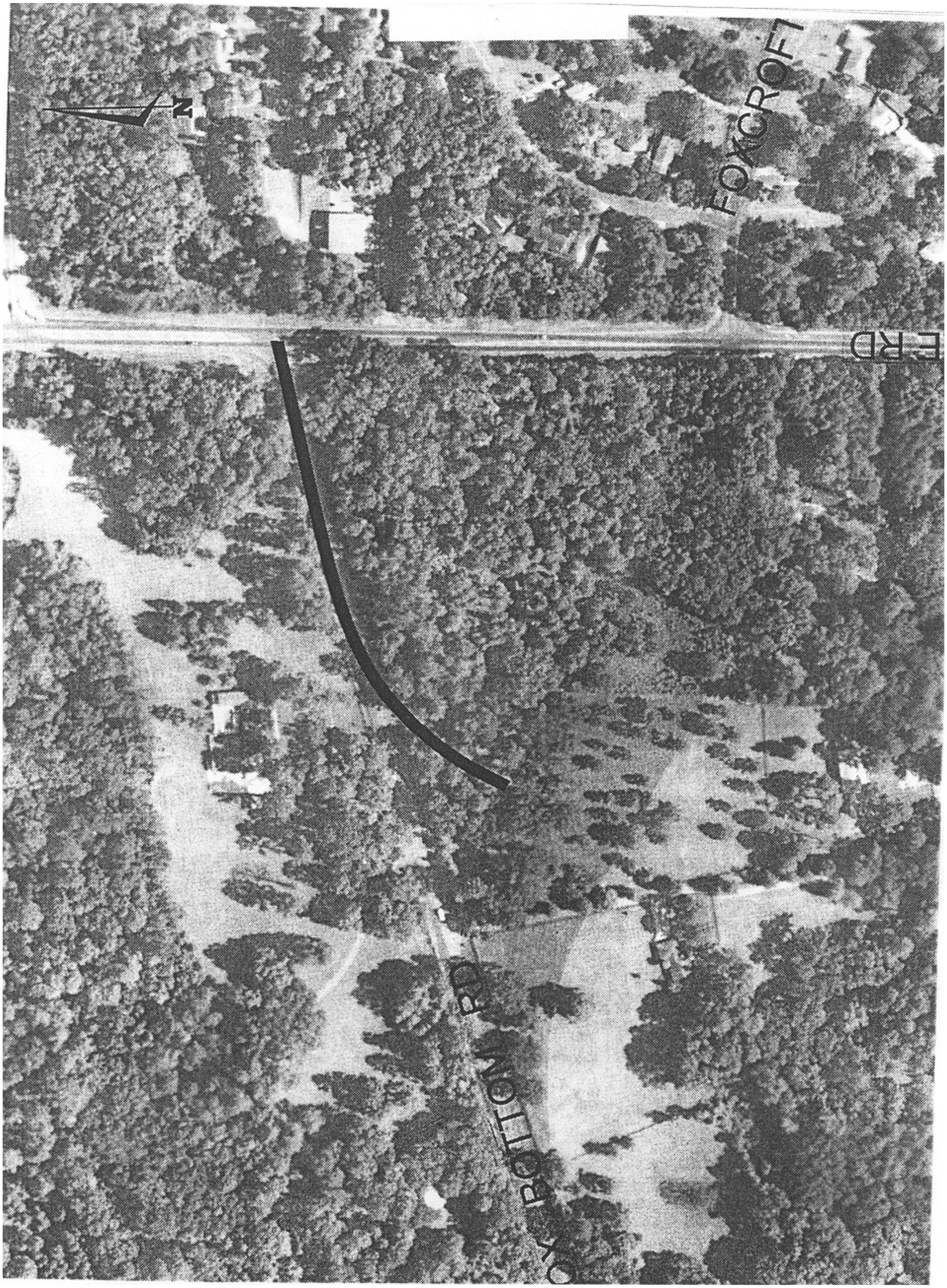
ACCESS IMPROVEMENTS

SR 61 ACTION PLAN

LEGEND
- Full Median Opening
- Reduced Conflict Opening
- Directional Opening
- Left-Turn Out Only
- Local Access Improvements
- Median Number

STEP FIVE

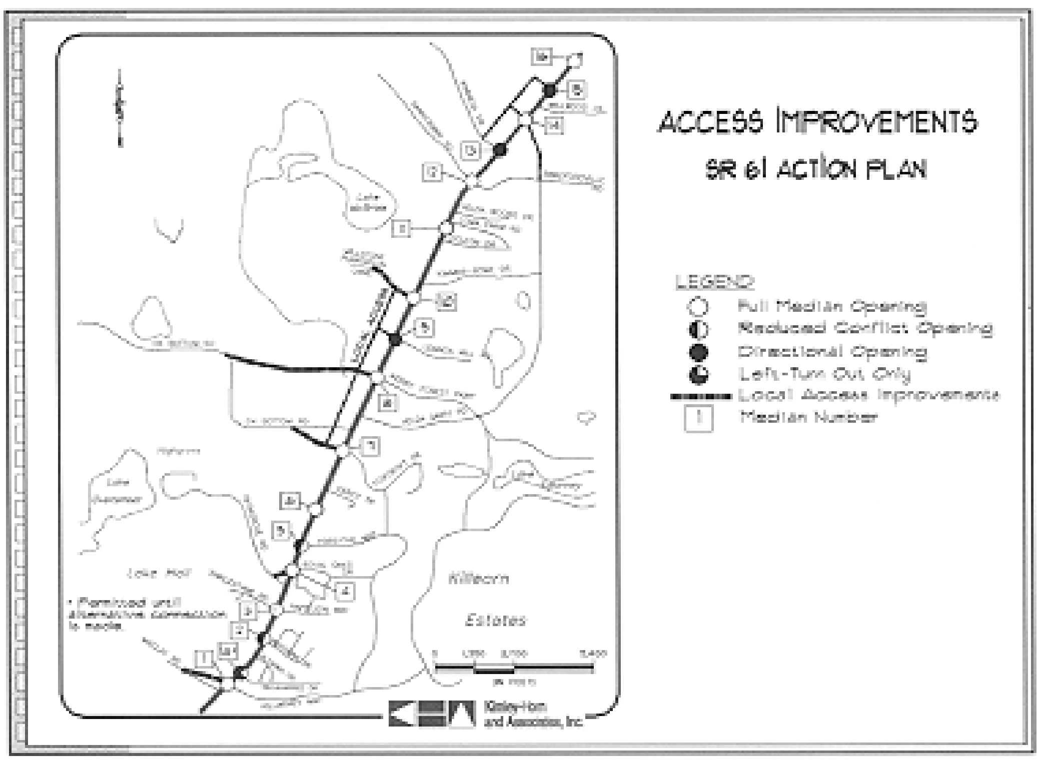
❒ Side Street Re-alignments


N
FOXCROFT
E RD
BOTTOM RD


GHGROVE RD
New Connection
SR 61
ROYAL OAKS DR
N

STEP SIX

- Acquire Access Rights

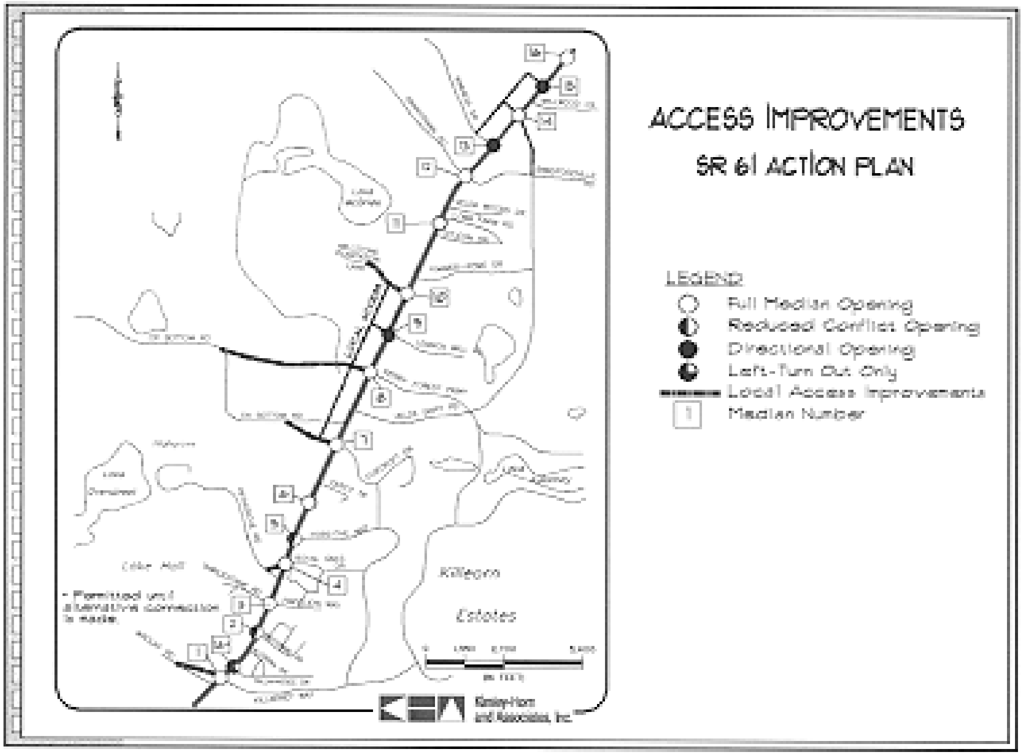


STEP SEVEN

- ❒ Local Meetings
  - ➢ *Stakeholder Interviews*
  - ➢ *Neighborhood Gatherings*
  - ➢ *Listen*
  - ➢ *Educate*

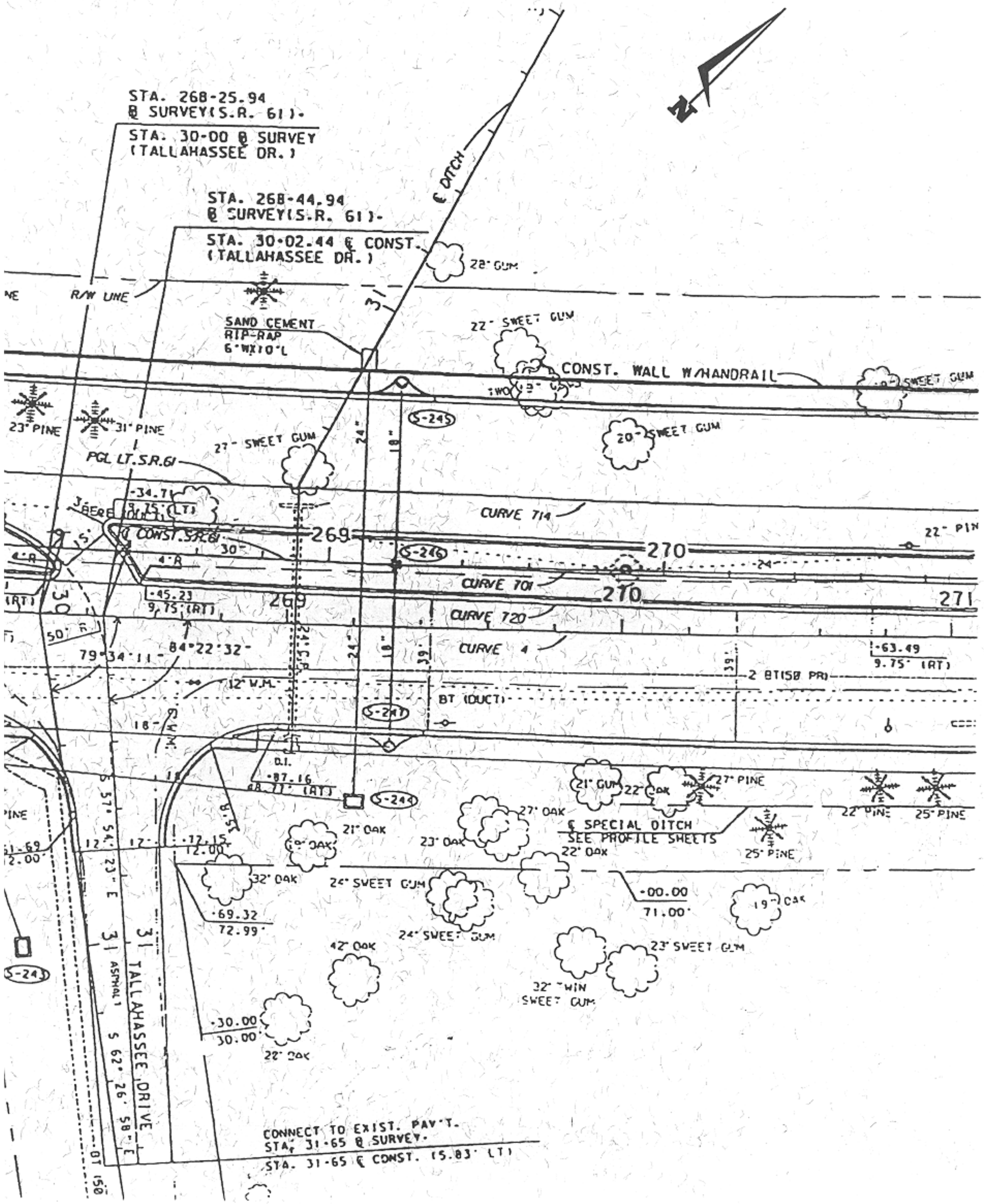
STEP EIGHT

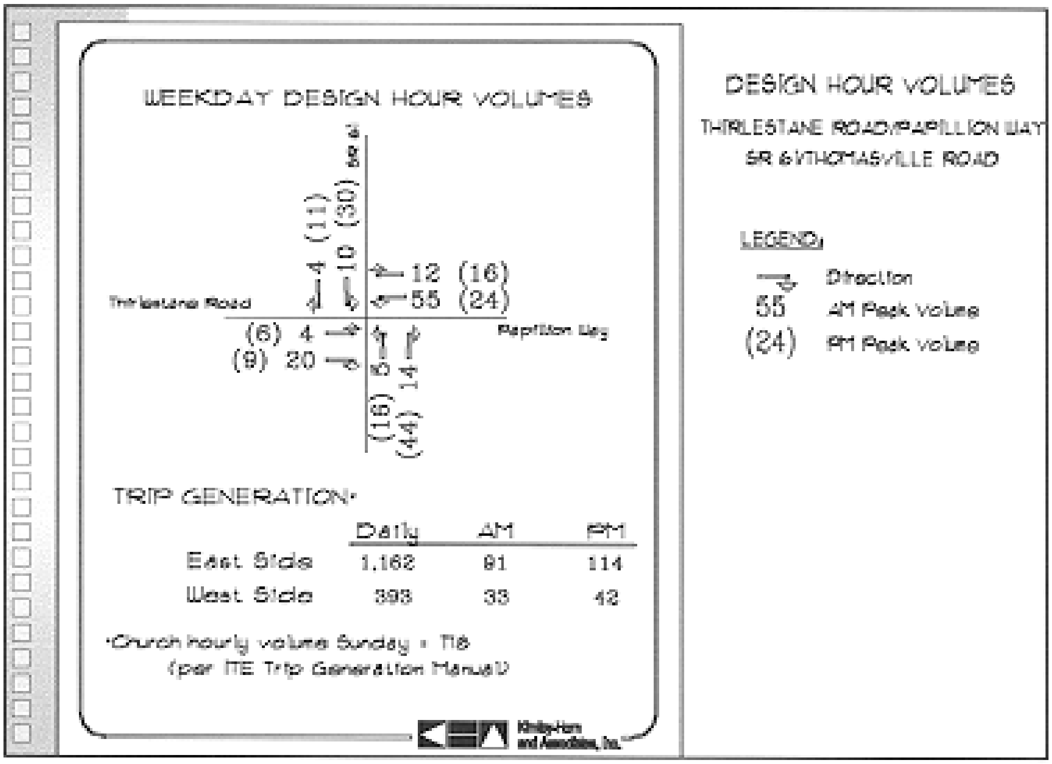
- ❒ Be Reasonable



STEP NINE

- ❒ Refine Access - Assure Safety Minimums
  - ***Storage***
  - ***Deceleration***
  - ***Reaction Area***
  - ***Driver Expectation***
  - ***U-Turns***


STA. 268-25.94
℄ SURVEY(S.R. 61)-
STA. 30-00 ℄ SURVEY
(TALLAHASSEE DR.)
STA. 268-44.94
℄ SURVEY(S.R. 61)-
STA. 30+02.44 ℄ CONST.
(TALLAHASSEE DR.)
℄ DITCH
22" GUM
R/W LINE
SAND CEMENT
RIP-RAP
22" SWEET GUM
CONST. WALL W/HANDRAIL
23" PINE
31" PINE
27" SWEET GUM
20" SWEET GUM
PGL LT.S.R.61
CURVE 714
CURVE 701
CURVE 720
CURVE 4
269
270
271
79°34'11"
84°22'32"
12" W.M.
BT (DUCT)
2 BT(SB PR)
-63.49
9.75' (RT)
-45.23
9.75' (RT)
-34.71
9.75' (LT)
21" GUM
22" OAK
27" PINE
22" PINE
25" PINE
℄ SPECIAL DITCH
SEE PROFILE SHEETS
22" OAK
25" PINE
21" OAK
23" OAK
27" OAK
19" OAK
32" OAK
24" SWEET GUM
-00.00
71.00'
-69.32
72.99'
24" SWEET GUM
42" OAK
23" SWEET GUM
32" TWIN
SWEET GUM
-30.00
30.00'
22" OAK
TALLAHASSEE DRIVE
S 62° 26' 58" E
S 57° 54' 23" E
ASPHALT
CONNECT TO EXIST. PAV'T.
STA. 31-65 ℄ SURVEY-
STA. 31-65 ℄ CONST. (5.83' LT)


WEEKDAY DESIGN HOUR VOLUMES
Thirlestane Road
Papillion Way
4 (11)
10 (30)
12 (16)
55 (24)
(6) 4
(9) 20
5 (16)
14 (44)
TRIP GENERATION*
Daily AM PM
East Side 1,162 91 114
West Side 393 33 42
*Church hourly volume Sunday = 718
(per ITE Trip Generation Manual)
Kimley-Horn and Associates, Inc.
DESIGN HOUR VOLUMES
THIRLESTANE ROAD/PAPILLION WAY
SR 61/THOMASVILLE ROAD
LEGEND:
Direction
55 AM Peak Volume
(24) PM Peak Volume


QUESTIONS ?
STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION
Kimley-Horn
and Associates, Inc.

The Practice of Public Involvement In Access Management Projects

Jerry B. Schutz, Washington State Department of Transportation

Abstract

Current literature on public involvement is access management describes techniques and principles to be used and describes case studies of various applications. Until now no survey of practitioners has been conducted to determine what techniques are being used in what situations and how effective they have been. As part of developing the public involvement portion of the access management manual, a survey has been sent out to determine: What techniques are being used in four different situations, planning, spot improvements, corridor projects, and development of policies and regulations: how effective these techniques have been; and why other available techniques have not been used. The survey also asked respondents to indicate how controversial each application was. Finally, the survey asked if individuals would be willing to try techniques not usually used on access management applications to determine their effectiveness.

This paper will present the findings of the survey with an emphasis on what has worked well, what has not worked well, and why some techniques are not being used. The results of the survey will be compared to the national literature on the practice of public involvement in access management. Finally, if enough practitioners show interest in trying unused techniques, a description of the approach to the proposed research will be presented.

Presentation

Public involvement is an essential part of any successful access management project (1), be it establishing a program, adopting rules or legislation, planning, or designing an improvement. The techniques employed in a successful public involvement plan vary by level of controversy, public attitudes for the geographic area, and the type of project. In January, 1998 a questionnaire was mailed to 490 practitioners as identified from two lists received from the TRB Access Management Committee, A1D07.

The purpose of the questionnaire was to determine what public involvement techniques are being used on what types of projects; how successful those applications of techniques have been; what techniques are not being used; why techniques are not being used; and how often formal public involvement plans are being used. This information is being used to help develop the public involvement section of the National Access Management Manual (2). Ninety questionnaires were returned by the respondents and 23 came back undelivered. Of the 90 returned, 64 met the criteria for use in the survey. Those criteria where a response on a project that involved access management and had employed at least one public involvement technique. The 64 responses contained 81 usable case studies.

Projects are classified by four types. The types and their response level are: regulation or program development - 9 responses or 11percent; planning - 23 responses or 28 percent; corridor improvements - 38 responses or 47 percent; and spot improvements - 11 responses or 14 percent.

The questionnaire was structured loosely to reduce its size in the hopes that the response rate would be improved. The response rate was good, but uniformity of the data types was sacrificed. Table 1 lists the types of techniques and their level of usage by the respondents.

The most used techniques are similar for regulatory, corridor, and spot improvement applications, but for planning the emphasis is somewhat different, especially in the upper half of the table. The distribution from most often used to least often used shows a fairly steady slope, with the largest sequential difference being between the most and second most used, with a gap of six occurances.

Table 1
Techniques Used

Technique	Regulatory	Planning	Corrido	Spot	Total
Public meeting	6	5	17	3	31
Presentation to target group	5	8	12	0	25
Hearing	3	5	16	1	25
Key person interview	4	3	9	8	24
Open house	1	8	13	1	23
Public information	6	7	7	0	20
Workshop	4	6	8	0	18
Citizen advisory committee	2	8	8	0	18
Press release	1	7	7	0	15
Newsletter	1	4	8	0	13
Collaborative task force	2	5	2	0	9
Public opinion survey	1	1	4	0	6
Video presentation	2	1	2	0	5
Drop-in-center	0	3	2	0	5
Computer presentation	2	2	1	0	5
Focus group	1	3	0	0	4
Charrette	1	0	2	0	3
Internet/web site	1	1	1	0	3
Visioning	2	0	0	0	2
Under-served groups	1	1	0	0	2
Speaker bureau	1	1	0	0	2
Small group meeting	0	1	0	0	1
Television	0	1	0	0	1
Special event	0	1	0	0	1
Booth at Special Event	1	0	0	0	1
Public display/kiosks	0	0	0	0	0
Newspaper insert	0	0	0	0	0
Hotline	0	0	0	0	0
Post office box	0	0	0	0	0

The ten most popular techniques were evaluated as to whether they were primarily used for one-way communication or two-way. Five were one-way from the practitioner to the public, one was one-way from the public to the practitioner, and four were primarily two-way. The category "key person interview" was, in most cases, actually a one-on-one meeting. The difference being that a key person interview occurs at the outset of a project for the purpose of determining how individuals feel about the project, in order to get a sense of the community and to discover hidden issues, while one-on-one meetings occur during the project, often to work out agreements. Therefore key person interview was counted as two-way communication.

These results indicate that there is a pretty healthy dialog going on between the project personnel and the public, overall. When one-way techniques are used, they need to be paired with one-way communication techniques in the other direction or with two-way techniques. One such common pairing was one-on-one dialog on access rights acquisition projects, paired with hearings, usually a formal requirement.

Public meetings, the most popular technique, is primarily a one-way technique, although there is usually a question and answer period. Those who speak up most readily are the most aggressive individuals or those who feel comfortable speaking in front of groups. Those uncomfortable with speaking in front of groups or afraid to share views unpopular with their more vocal neighbors will not be heard. Therefore, a public meeting should usually be paired with a questionnaire, comment sheet, or some other technique that encourages two way communication.

As already noted, the techniques most commonly used in planning are different than those in the other three categories. Citizens advisory committees and open houses were tied with presentations to target groups as those most often used. The first two techniques emphasize participation from citizens while most popular techniques overall emphasize one-way communication. One possible explanation may be that planners are generally considered to be stronger communicators than engineers, and thus, would tend to rely on techniques that result in more dialog. A second possible explanation is that by the time a project is undertaken, a preferred solution has often been defined and communicating this concept to the public for their reaction becomes a natural choice of techniques. If dialog has not previously occurred, such as in a planning process, an adversarial relation may develop between the project personnel and the public (3).

If the public has not had a chance to provide input when a project is first presented to them, it is important to not give the impression that the project is a done deal. This can be difficult since most projects are accompanied by scopes, budgets, and schedules. If a planning phase cannot be included, flexible scoping is a must.

The Public Involvement Plan.

Regardless of the size of a project (or plan, etc.) it is advisable to develop a Public Involvement Plan (PIP). In the survey, 31 of the 81, or 38 percent of the usable case studies, had a PIP.

Involving Citizens in Community Decision Making: A Guidebook (4) does an excellent job of describing how to develop a public involvement plan. For larger projects it is well worth while to go through the entire process to develop a plan. For smaller projects, three of the steps are particularly important to consider. They are:

- Identify the goals of the public involvement process;
- Identify the decision points in the process and key the public involvement plan to those points.
- Identify issues that threaten a project and develop strategies to manage them.

Techniques Not Used

The questionnaire asks practitioners to identify which public involvement techniques they did not use and why they did not use them. Tables 2 a, b, c, and d show the results of this portion of the questionnaire by the reason not used. The information obtained from this portion of the questionnaire provides good direction for areas needing coverage in the national manual.

Techniques Not Used

Table 2a
UNFAMILIAR

Technique	Response
Charrette	10
Under-served Groups	8
Speakers Bureau	8
Internet/Web Site	7
Visioning	6
Special Event	3
Computer Presentation	3
Drop-in Center	3
Collaborative Task Force	2
Booth at Special Event	2
Public Display/Kiosk	2
Workshop	1
Newsletter	1
Key Person Interview	1
Public Opinion Surveys	1
Citizen Advisory Committee	1
Press Release	0
Focus Group	0
Presentation to Target Group	0
Public Information Materials	0
Public Meeting	0
Video Presentation	0
Open House	0
Total	59

Table 2b
TOO COSTLY

Technique	Response
Computer Presentation	13
Video Presentation	12
Public Display/Kiosk	9
Drop-in Center	9
Public Opinion Surveys	8
Internet/Website	7
Booth at Special Event	7
Visioning	4
Charrette	4
Newsletter	4
Workshop	3
Focus Group	3
Public Information Materials	3
Speakers Bureau	3
Special Event	3
Open House	2
Collaborative Task Force	1
Key Person Interview	1
Press Release	1
Public Meeting	1
Under-served Group	1
Presentation to Target Group	1
Citizens Advisory Committee	0
Total	

Table 2c
LACK CONFIDENCE

Technique	Response
Booth at Special Event	17
Charrette	16
Visioning	15
Public Display/Kiosk	14
Public Opinion	14
Drop-in Center	13
Special Event	13
Internet/Website	13
Under-served Group	11
Focus Group	11
Collaborative Task Force	11
Speakers Bureau	10
Citizens Advisory Committee	9
Video Presentation	8
Workshop	8
Newsletter	7
Computer Presentation	7
Key Person Interview	5
Press Release	5
Public Information Materials	5
Open House	4
Public Meeting	3
Presentation to Target Group	1
Total	**220**

Table 2d
OTHER REASONS

Technique	Response
Booth at Special Event	17
Public Display/Kiosk	12
Internet/Website	12
Under-served Group	11
Special Event	11
Speakers Bureau	9
Video Presentation	8
Focus Group	8
Visioning	7
Charrette	7
Key Person Interviews	6
Collaborative Task Force	6
Drop-in Center	5
Computer Presentation	5
Press Release	5
Citizens Advisory Committee	5
Newsletter	5
Presentation to Target Group	5
Public Opinion Survey	5
Workshop	4
Public Information Materials	3
Open House	3
Public Meeting	2
Total	**161**

The number of votes given to each category is strikingly different with unfamiliar receiving 59 votes, too costly 100, lack confidence 220, and other 161. The following commentary is aimed at offering suggestions where the survey results indicate that opportunities may have been overlooked for various reasons.

<u>Unfamiliar</u>

The 59 check marks for the Unfamiliar category represented 11 percent of the total check marks made. The top five within the category received 67 percent of the check marks within the category and are worth commenting on.

- The **charrette** is a special tool for solving a specific problem. Those participating in a charrette commit to finishing the process at a given time and selecting a solution at that time. A description of this technique can be found in *Public Involvement Techniques for Transportation Decision-Making (5)*. The charrette could be used when trying to develop access from a large development to a major arterial where the positions of the parties are well apart. An advantage to using the charrette in this situation is that a process is agreed upon at the outset. The survey results indicate that the national access manual should elaborate on this subject.

- It is important that the needs and concerns of **Under-Served Groups** be recognized and addressed. *Public Involvement Techniques for Transportation Decision-Making* (6) explains how to do both of these.

- A **Speakers Bureau** uses non-staff speakers and requires training, thus it is productive only in specific circumstances such as projects expected to last for an extended time period. Because the speakers are usually unpaid volunteers, they may also be undependable.

- Because the responses only consist of a check mark, we do not know if people are unfamiliar with how to set up a **web site** or how to make use of one for support on an access management project. Detailed instructions for setting up a web site are beyond the scope of the National Access Management Manual, but advice on where that information is available and what resources are available is not. The list of uses includes posting meeting dates, telephone numbers of project personnel, questionnaires, meeting minutes, alternatives, and background on the agency's access management program or law. Information on access permits is an excellent use of a web site. A hyperlink to the FHWA site at accessmanagement.com and other good sites is also of value.

- **Visioning** is a technique for developing a concept of how something should look at some point in the future by setting goals and defining implementation strategies (7). This technique can be used for corridor planning or projects where no local comprehensive plan exists. The value to access management is in developing a concept that is agreed upon before the specific issues are addressed. This is another area for elaboration in the national manual.

Too Costly

Fifty-one percent of the 100 check marks for too costly are distributed over the top five techniques. An assessment of those techniques follows:

- **Computer presentations** can be done at a relatively low cost and it is worthwhile presenting more information on this technique in the manual.
- **Video presentations** are expensive to produce, if they are done professionally. An alternative is to do an in-house production that may be short on quality but less costly. If specific information on local conditions is not a must, the national video, produced by FHWA(8), can be used.
- **Public displays/kiosks** can be an inexpensive tool if the kiosk is already available. Relatively inexpensive kiosks can be built by jurisdictions with a shop and used effectively if an appropriate location is available.
- A **drop-in-center** is expensive because of the usual requirement to staff the center. It can still be a cost-effective approach to public involvement for a large, costly project.
- **Public opinion surveys** can be handed out during public meetings and other events, but they will not provide representative sampling, if desired.

Lacked Confidence

This category received more check marks than any other, by a significant margin. Comments on the techniques that received the most votes follows:

- The technique receiving the most check marks was **Booth at special event**, a surprise to the author. This technique is resource intensive, but the rewards can be significant. A frequent application is a booth at a county fair. Very high volumes of visits are usually experienced, with a good deal of opportunity for discussion, distribution of literature, and distribution of questionnaires. The greatest advantage is the opportunity to reach people who will not usually attend a meeting unless a project immediately threatens them.

- **Charrettes** are likely to be of limited value for access management projects. If a project is well enough funded to hold one, the breadth of issues is too likely to be beyond the scope of a charrette. Why there was so much lack of confidence in the technique can only be speculated on. Possibly it is because charrettes are usually used for creative problem solving, not dispute resolution, which is a more likely goal on an access management project.
- **Visioning** is usually applied to long-range planning while access management projects more often seek to solve more immediate problems. However, the process can be applied to develop a vision for a corridor and is a useful technique for a corridor management plan (9).
- **Public display/kiosk** can describe a range of techniques, from a passive display of public information materials to an interactive computer program that requires special software and a secure place to put the computer.
- **Public opinion surveys** have drawbacks, but are just about the only way of getting a sense of how the public feels about a project. If a representative sampling is taken it is still limited to those who will respond. If a questionnaire is distributed at a public meeting, it is limited to those who attend. Thus it is important to identify and document the survey methods and audience.
- A **drop in center** can provide a convenient means for the public to participate in a non-threatening atmosphere. It can also broaden the range of public reached because it does not require the public to make a special trip to participate.
- When well conceived, a **special event** can be very successful. The appeal of a special event, such as a transportation fair can be enhanced by participation from a variety of transportation service providers, including private providers.
- The use of **the internet** to communicate with the public, for either information or feedback purposes, has received a bad repetition because it is seen as appealing to a narrow audience. Especially as low cost computers reach more and more people, experience has shown that a significant number of people can be reached. One of the most appealing qualities with use of the internet is convenience to the user.
- Special efforts to involve the **under-served** my not result in a representative sampling, but public involvement without participation by the under-served is even less representative.

Conclusions

The use of public involvement techniques in access management projects shows a good mixture of one and two way techniques. Planners, in particular, use techniques that involve the public in developing solutions rather than asking for feedback on projects that have already been decided on. This process is a natural outcome of the process of identifying solutions for budgeting and scoping purposes. Project designers can improve relations with the public by allowing for more early involvement in developing the alternatives to be analyzed, if they are not already doing so.

Major projects will benefit from a thorough analysis when developing a public involvement plan, but even smaller projects should develop a plan considering at least three important factors. Those factors are: establish goals for the public involvement process; identify issues early and develop a strategy to address them; and focus the public involvement process on the decision points.Many techniques are not being used because of perceptions about them that may not necessarily be accurate. The National Access Management Manual should be used to debunk some of these perceptions and encourage a wider application of useful techniques.

End Notes

1. In this paper "project" will refer to any of the categories surveyed, including rule making, program development, planning, corridor improvements, and spot improvements.
2. The Federal Highway Administration has contracted with the Center for Urban Transportation Research to work with the TRB Access Management Committee, A1D07, to produce a manual of access management practices.
3. Kristine M. Williams and Margaret Marshall, in A Public Involvement Handbook For Median Projects, Center for Urban Transportation Research, October 1995, pg. 10, say, "Concerns that are raised early in the process are more likely to be resolved than those that arise after the project has been designed."
4. James L. Creighton, Ph.D., Involving Citizens in Community Decision Making: A Guidebook, Program for Community Problem Solving, Washington DC, 1992
5. Howard/Stein-Hudson Associates, Inc. and Parsons Brinckerhoff, Quade and Douglas, Public Involvement Techniques for Transportation Decision-making, Federal Highway Administration, September, 1996, pg 103-106
6. ibidem, pg. 17-26
7. ibidem pg. 107-110
8. Access Management Overview, Federal Highway Administration Office of Technology Application, May 1997
9. The corridor management planning process is described in "Managing Corridor Development, A Municipal Handbook", Kristine M. Williams, AICP, and Margaret A. Marshall, Center for Urban Transportation Research, October, 1996

Session 18

Corridor Case Studies
Part I

Moderator: Ron Giguere, Federal Highway Administration

Participants: John L. Carr, Kentucky Transportation Cabinet
Thomas Heydel, Wisconsin Department of Transportation
Richard Brauer, Sear-Brown Group

Lessons Learned with Corridor Access in the Bluegrass State

John Carr, State Highway Engineer's Office, Frankfort, Ky

Introduction

I had hoped to have three (3) completed experiences to share with this group. Unfortunately, these three efforts are still works in progress. What I can share from these efforts are three experiences and our lessons learned to date.

Therefore, I have retitled my presentation:

"Lessons Learned with Corridor Access in the Bluegrass State"

Background

In 1995-1996, we looked at seven (7) proposed corridors in the Central KY Bluegrass Region.

There were four major players:

- Kentucky Transportation Cabinet (KYTC)

- Lexington Area MPO

- Bluegrass Area Development District – which is the Regional Planning Agency for 15 counties

- Bluegrass Tomorrow (BGT) – which is a Private Non-Profit organization to promote a balanced approach to planned growth and preservation of the unique character of the Bluegrass.

BGT's regional vision for the Bluegrass

Lexington serves as the large Urban Center "hub" surrounded by one of the world's most recognized and beautiful rural landscapes…thoroughbred horse farms.

Smaller urban centers surround Lexington as satellite communities.

Each has its own distinctive and unique character and connect to Lexington by way of an arterial highway which acts as a "greenway" for these connections.

BGT did much consensus building towards this vision through a partnership of local and state governments and private institutions and individuals.

The Challenge was "How to achieve this vision by a partnership of local, regional and state governments and the private sector?"

Transportation was recognized as a key and the Transportation and Landuse Link was realized by all of the major players.

The question we needed to answer was "How to balance landuse/development and transportation improvements?"

All of the connecting roads from the satellite communities were "access by permit". This means that access points and driveways could be located along the highway wherever safe with stopping sight distances being the control.

The Cabinet's challenge was "How to balance mobility and accessibility?"

After reading an article by Kristine Williams on Corridor Access Management, we decided that this technique should be tried in the Bluegrass.

In June 1997, a Corridor Symposium entitled "Bluegrass Corridors – The Corridors that Connect Us" was held. Its purpose was to expose those in attendance with the concepts of corridor access management or in other words: "Tools for the Tool Box".

Corridor Management Planning is a method to fully understand implications and consequences of decisions regarding landuse and transportation that are made by both the public and private sector.

Presentators included:

Kristine Williams of the USF Center for Urban Transportation Research (CUTR)

Walt Kulash; Tim Jackson of the consulting firm Glatting, Jackson, Kercher, Anglin, Lopez, Rinehart

Charles Siemon of the law firm Siemon, Larson and Marsh

Harold Peaks of FHWA, Washington.

Elizabeth Courtney who was the Former Chairman, Vermont Environmental Board

Over 200 participants attended, including elected officials, planners, highway engineers, corridor organizations, consultants and interested citizens.

This corridor symposium was described as a "watershed" event and piqued interest in corridor access management in Commonwealth.

KYTC moved to initiate three corridor management studies.

These studies described three separate and distinct situations.

US 27

US 27 connects Lexington (Lexington is the “Hub” for the Bluegrass) and Nicholasville.

The existing Corridor is five lanes with a continuous left turn lane. Driveway is allowed by Cabinet permit.

The current Traffic is 50,000 vpd while the 2020 Projected Traffic is 90,000 vpd.

Rapid development is causing landuse changes from rural farms to commercial strip development.

The Goals of the Corridor Access Study is:

- plan and control of access points for US 27;
- thus impact landuse changes;
- thus impact location of future traffic signals.

Our decided outcome was to plan and control accessibility while preserving mobility along corridor.

This study should be completed in November, 1998.

US 68

US 68 connects Lexington to Wilmore, a small satellite community which is rapidly becoming a “bedroom” community for Lexington.

The situation can be described by an existing narrow two-lane road without shoulders. Also, this route is designated as a Kentucky Scenic Highway.

US 68 is quickly becoming a proliferation of residential subdivisions. There are several quality of life issues: a quasi – rural area close to the city along a scenic byway. There are one acres residential lots and rock fences line US 68.

Existing traffic counts currently justified construction of four lanes.

There are strong preservation groups which want improved no improvement or, at best, 2 lanes only.

There are also strong residential development interests for the large farms from developers and property owners.

This is county planning and zoning; however, there is much “Room for Improvement”.

In this situation, the Corridor Access Management study was incorporated into Preliminary Design/Environmental Phase.

Accomplishments to date include the following:

- $ Recognize need for Landuse Planning
- $ Considering FHWA "Flexibility in Highway Design"
- $ Consideration of living with a lower level of service

The major accomplishment to this point is that all parties are still at table and still talking. With the diverse interests represented, this is not a minor task.

Study still underway and will not be completed until 1999.

US 460 – Georgetown to Paris

US 460 connects two satellite communities, Georgetown and Paris. This route also provides a connection for Paris to I75.

The situation is that US 460 is two lane. The pavement is 18 foot wide with no shoulders. This route cannot accommodate 102 in wide trailers.

There were three primary issues:

1. Safety
2. Truck access to Interstate for businesses in Paris
3. Uncontrolled Development along US 460

Also, truck access to Georgetown and the Georgetown Toyota Plant (which make all of the Camry's in the U. S.) by Paris part suppliers.

There is direct access via US 460 from Paris to Georgetown. Alternate access by US 27 which can accommodate 102-inch trailers. However, the trip is almost 30 minutes longer.

In Georgetown and in its county, landuse planning is weak.

In Paris and in its county, there is no landuse planning.

We are started with conflicting goals from the citizens of Paris and Georgetown.

Unfortunately, we could not work through conflicts.

There was no real resolution. The Cabinet recommended two lane spot improvements. The cost of two lane spot improvements is $37 million.

The cost of a full two lane rebuilt is $45 million.

This project is not in federal STIP or the Cabinet's 20 year Long Range Plan. This project will be reevaluated as part of the 20-year Long Range Plan update.

Corridor Access Management was recommended as part of the consultant's report.

Local citizens liked limiting the neighbors' ability to develop the neighbors' property while having complete freedom develop of their own property as they saw fit. Obviously this would not work.

The locals didn't want the flexibility of limiting access control and dealing with landuse issues.

The locals wanted trucks banned, speed limits lowered and traffic signals installed.

The locals did not want the road widen in its entire length because it would "bring more trucks".

As a result, this study was at impasse.

LESSONS LEARNED

Some of the lessons we learned so far from these studies:

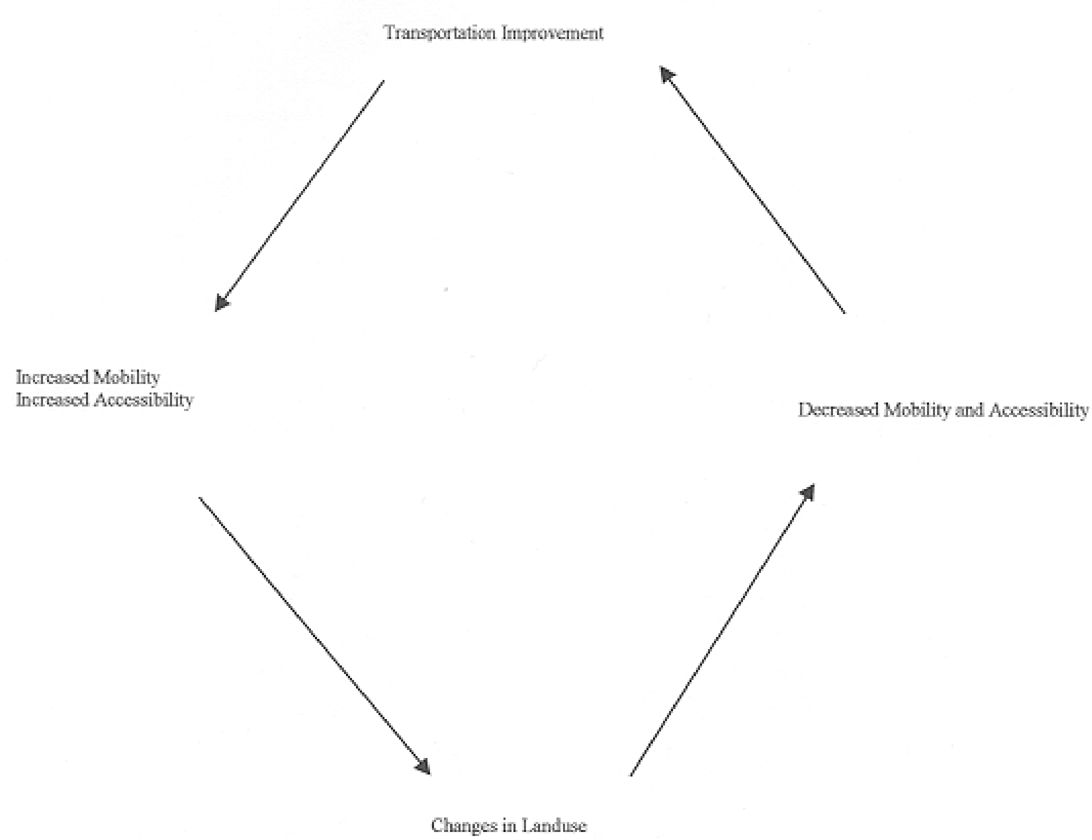
1. Landuse and zoning are sensitive issues in Kentucky.
2. Don't start during a local government election year. Too much posturing by candidates.
3. Landuse Plan for Corridor - developed first. Transportation helps achieve plan's vision.
4. Make sure that sufficient funding is available for developing a Corridor Management Plan. (Underestimated based on Florida experience and Florida Development Laws.)
5. Need a political leader in region to champion – must know local players and personalities.
6. Elected political leaders must have political will and backing to make unpopular decisions by leadership in the private sector.
7. Differing expectations of what end product would be. Tried to accommodate all concerns – not enough time or dollars – too many conflicting agendas.
8. Held individual meetings along corridor. These worked better than large public meetings. Property owners along corridor don't want public arguments with neighbors; want private consultation.
9. Need complete buy in from government entities – some government officials said yes publicly and then involved passively.
10. Do not force partnerships between consultants.
11. Steering committee must have diverse representation of all interest.

12. Pick a consultant with a team leader/project manager with corridor access management experience.
13. Must be flexible in approach – One size never fits all.
14. Local private sector leaders must support elected leaders.
15. Need cooperation between local and state agencies.
16. Expect conflict and pain.

What is Next?

Governments move in small increments not giant leaps.

Other groups across Commonwealth interested in Corridor Access Management as a tool to coordinate landuse and transportation.



As a result of exposures to corridor access management, now we have other groups in other parts of state attempting corridor access management planning.

What can corridor access management planning do in Kentucky?

- Reinforce distinct character of communities of region.
- Preserves distinct edge between town and rural countryside.
- Provides mobility and accessibility and interconnections for a diverse competitive regional economy.
- Improve communication between diverse interest
  - won't immediately resolves issues;
  - moves conversations from the periphery among "like-kind" thinkers to "serve as a focal point to discuss issues in context of regional goals."

Access Management Planning For Long Range Interchange Reconstruction - I-94 Corridor In Southeastern Wisconsin

Thomas Heydel, Wisconsin Department of Transportation
Timothy R. Neuman, CH2M, Chicago, Illinois

Introduction

The Wisconsin Department of Transportation WisDOT) recently completed a major planning effort involving 12 interchanges along I-94 in Southeastern Wisconsin. Reconstruction plans for these interchanges were developed to serve as a blueprint for future project improvements and local land use development. The plans incorporated significant access management actions, including relocation of frontage road access, crossroad reconstruction and access control, and interchange reconstruction.

Reconstruction plans were developed well in advance of actual programmed construction. The long time frame between planning decisions and actual construction has produced special challenges to WisDOT and affected landowners and local governments.

This paper describes the project issues related to access management, WisDOT's unique planning approach, and keys to success of the project. The paper presents two major phases of work—*plan development*, discussed through completion of the design study phase and environmental approvals, and *plan implementation*. The latter phase is ongoing, and is expected to occur over the next 20 years as individual construction projects are advanced.

The Wisconsin DOT was assisted in this project by an engineering, public involvement and environmental planning team led by CH2M HILL of Milwaukee, Wisconsin. Subcontractors to CH2M HILL included HNTB of Milwaukee and TEM, Inc. of Madison, Wisconsin. The paper authors are Tom Heydel, I-94 Project Manager for WisDOT, and Tim Neuman, CH2M HILL 's Project Manager.

Phase I – Plan Development

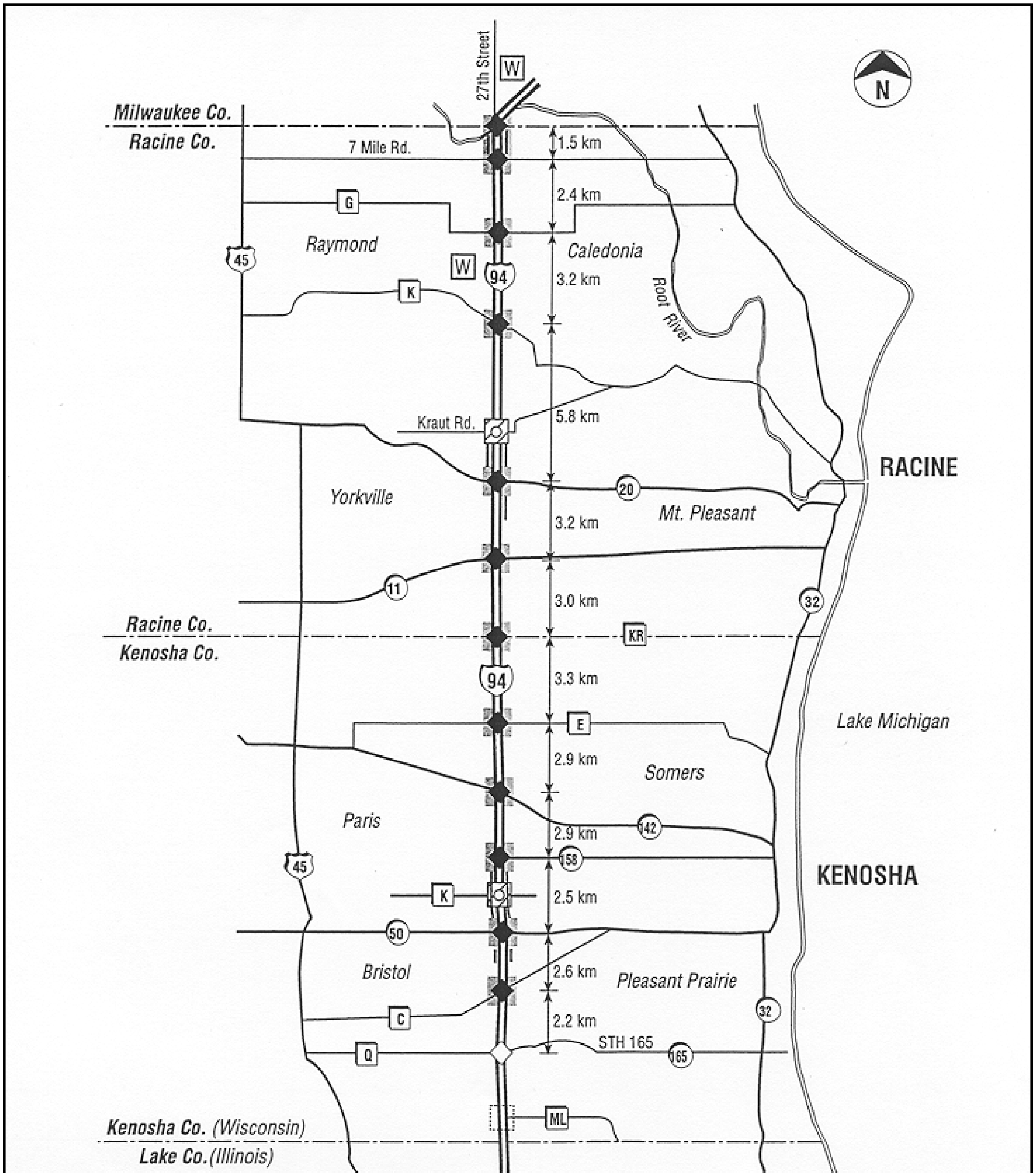
Project Background

Figure 1 shows the study area. The I-94 corridor runs for about 40 km (25 miles) from the Illinois State Line, through Kenosha and Racine Counties, to the Milwaukee County Line. The corridor is the primary highway link between Chicago and Milwaukee, carrying from 50,000 to 80,000 vehicles per day.

Much of the corridor passes through rural and sparsely developed land. Pockets of development around some of the major crossroads and to the west of the Cities of Kenosha and Racine are the focus of development pressures. In total, 12 of the 14 interchanges in the two counties were included in the study, the southernmost two interchanges having recently been reconstructed.

Project Objectives

Figure 2 illustrates the existing condition at most of the interchanges. The corridor was originally designed and constructed in the 1950's and 1960's as a freeway through rural areas. Two-way frontage roads immediately adjacent to the freeway serve as local north-south facilities. Ramps are braided "at-grade," producing an operationally undesirable condition that has begun to produce serious safety problems. The basic objective of the study was to produce plans for the reconstruction of each such interchange, relocating the frontage roads



LEGEND

- W Potential Weigh Station Site (New)
- Interchange Included in Study
- Interchange not Included in Study
- Auxiliary Lanes for Year 2020 Operations
- Study Areas
- Per SEWRPC Plan — Possible Future Interchanges not to be Precluded by I-94 South Corridor Study
- Interchange Being Studied by Others

Figure 1
Study Area Boundaries
I-94 SOUTH CORRIDOR STUDY
RACINE AND KENOSH COUNTIES
CH2MHILL

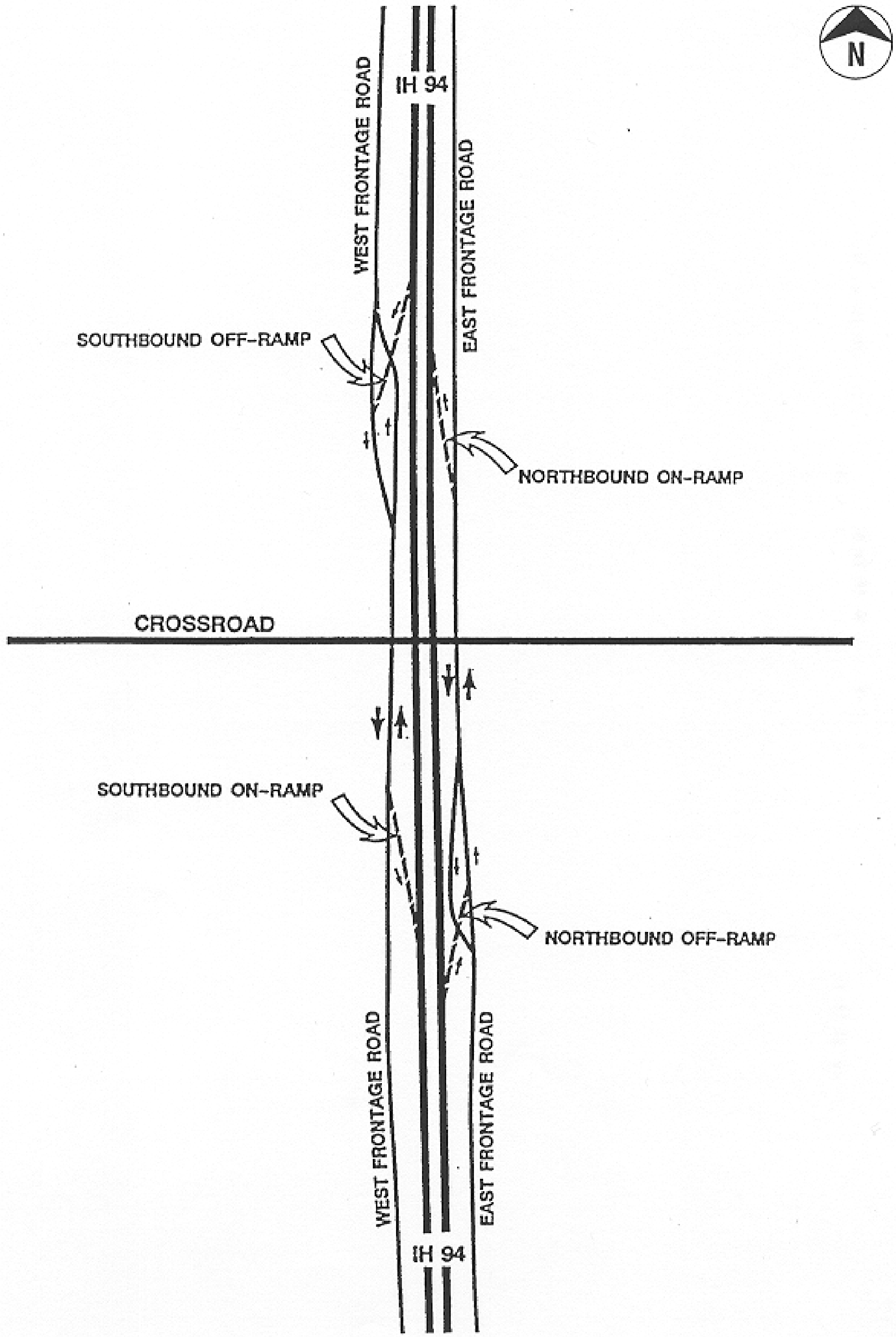


Figure 2
Typical Existing Braided Interchange
I-94 SOUTH CORRIDOR STUDY
RACINE AND KENOSH COUNTIES

to eliminate the unsafe ramp braids, and constructing new ramps. A related objective was to coordinate future roadway improvements with local land use planning, including location of future access to the highway system.

The interchange plans, which specified geometry, cross section, right-of-way, and access control, would in effect result in corridor preservation plan, for each interchange, to be followed by both WisDOT and local units of government over time.

Project Scope

The project included development of design year traffic for each interchange, collection and evaluation of local land use plans, agency and local government coordination, public involvement, alternatives development, functional geometric design, and environmental studies. Design study reports, FHWA Interchange Justification Reports, an Environmental Assessment with a Finding of No Significant Impact (FONSI) were produced.

Planning Issues

It was recognized from the outset that an important aspect of reconstructing each interchange was planning for future needs. These include traffic growth, expected land use changes in the vicinity of each interchange, and other changes to the local and regional highway system. Twenty-year travel forecasts prepared by the Southeastern Wisconsin Regional Planning Commission, and a related land use plan for the corridor formed the basis for the planning framework. The existing and future traffic forecasts are shown in Table 1. The net effect of the forecasts was to plan for expansion of some of the crossroads within the interchange area.

Even in the few interchanges where only modest growth in traffic was expected, good planning called for addressing the crossroad within the interchange area. WisDOT design practice is to provide a barrier median between directions of travel within interchanges for traffic movement and access control.

Finally, a common planning concern at all interchanges was consideration of future access needs or pressures. These could relate to existing development, redevelopment of residential or agricultural lands, or new development near the crossroad.

Other Issues

The project objectives and potential impacts at each location clearly indicated the need for WisDOT to work closely with local officials to achieve consensus on an acceptable, workable plan. A number of other planning and policy issues further complicated progress within the I-94 corridor. *Jurisdictional Transfer* of the frontage roads arose as a contentious issue. WisDOT for the most part retained jurisdiction of the frontage roads. Their stated policy objective was to turn these "local" roads over to units of government once relocation was accomplished, consistent with their primarily local traffic function. *Cost sharing* of reconstruction of the interchanges and frontage roads was also contended. Again, the WisDOT policy is to identify local traffic contributions to future interchange needs, and assign some portion of the construction costs based on these local effects. Not surprisingly, the counties and municipalities believed that WisDOT should pay 100% of the costs of the project.

Unprogrammed Projects became an issue as work proceeded. Based on previous history, WisDOT believed strongly in the need to develop a plan, regardless of the current ability to construct any of it. While the need to achieve corridor preservation appeared logical and desirable to most, it became a problem for landowners and some governments directly affected by the project. They became frustrated with project staff showing an impact or relocation, but being unable to state when the project would actually occur.

Table 1.
Existing and Design Year Traffic for I-94 and Kenosha and Racine Counties

Interchange Crossroad	I-94 Average Daily Traffic 1994 [2020]	Crossroad ADT West of I-94 1994 [2020]	Crossroad ADT East of I-94 1994 [2020]
	62,500 [106,400]		
County Trunk Highway C		5,400 [9,600]	5800 [13,200]
	62,000 [104,800]		
State Trunk Highway 50		18,200 [25,000]	22,100 [34,400]
	61,000 [101,200]		
State Trunk Highway 158		----------	10,100 [19,400]
	63,000 [110,400]		
State Trunk Highway 142/ County Trunk Highway S		3,700 [6,800]	5,000 [14,000]
	62,800 [115,600]		
County Trunk Highway E		700 [3,000]	4,800 [7,800]
	63,800 [118,800]		
County Trunk Highway KR		1,700 [4,600]	1,900 [6,800]
	63,000 [118,800]		
State Trunk Highway 11		5,600 [10,000]	11,800 [18,000]
	62,600 [106,000]		
State Trunk Highway 20		10,000 [20,200]	20,000 [34,000]
	65,400 [106,000]		
County Trunk Highway K		2,300 [3,800]	6,100 [13,600]
	68,500 [119,400]		
County Trunk Highway G		1,300 [3,700]	1,800 [5,500]
	69,600 [124,000]		
7 Mile Road		1,900 [4,300]	2,500 [5,700]
	71,000 [127,400]		
US 41		5,400 [10,400]	----------
	65,600 [117,000]		

Project need, somewhat related to the above issue, also became an issue for many. Again, there was not an evident capacity or traffic operational or safety problem at many of the locations. Although some would praise WisDOT for having the foresight to plan in advance of a problem, others directly affected by the project demanded to know what the problem was that was creating the impact. In any event, the type and severity of existing local problems became an important input to prioritization of individual projects, a task that involved local units of government at the conclusion of the planning phase.

Access Management Planning Issues

Developing an access management plan for each interchange required addressing three areas of concern—existing crossroad in the vicinity of the interchange, existing frontage roads at the interchange, and the alignment of the relocated frontage roads.

Figure 3 graphically illustrates a typical "before" condition, with various land uses along the crossroad, lack of access control, some existing access along the frontage roads near their intersections with the crossroad, and the closely spaced intersections and ramp terminals. Many of the crossroads had two-lane cross sections with no turning lanes and no median.

The desirable after condition is illustrated in Figure 4. Widening and separation of the crossroad with a median, median access control, relocation of existing access to the new frontage roads, and provision for future development to access the frontage road rather than the crossroad within the interchange area were all desirable features of a typical plan.

Existing Crossroads

Project design criteria established the need for access control within the influence area of the interchange. This was defined as that portion of the crossroad between the relocated frontage roads. Access planning had to consider the types of existing land uses, and the potential for redevelopment of land fronting along the crossroad.

Initial thinking suggested that all access be relocated. Recognizing, however, that many of the crossroads carried low volumes and had residential frontage, it was agreed after much discussion that compromises in this approach would be acceptable. With very few exceptions, the following policy was established and used to plan the crossroads.

1. Barrier medians would be established along all crossroads between the relocated frontage roads. No median breaks would be allowed.

2. Existing commercial access between the intersections of the relocated frontage roads would be relocated when the new frontage roads were constructed.

3. Existing residential access between the intersections of the relocated frontage roads could remain (right-in, right-out only), as long as the property remained residential. Local units of government agreed that, should properties be re-zoned and/or redeveloped, the existing driveways would be closed and only new access off the relocated frontage road would be allowed.

Interchange planning also included provision for implementing barrier medians between the new frontage road intersections, within the limits of the interchange. This safety and access management measure created special concerns regarding existing residential properties along the crossroad. Wisconsin state law prohibits U-turn movements at unsignalized intersections. Should a median be constructed, significant out-of- direction travel would be imposed on residents.

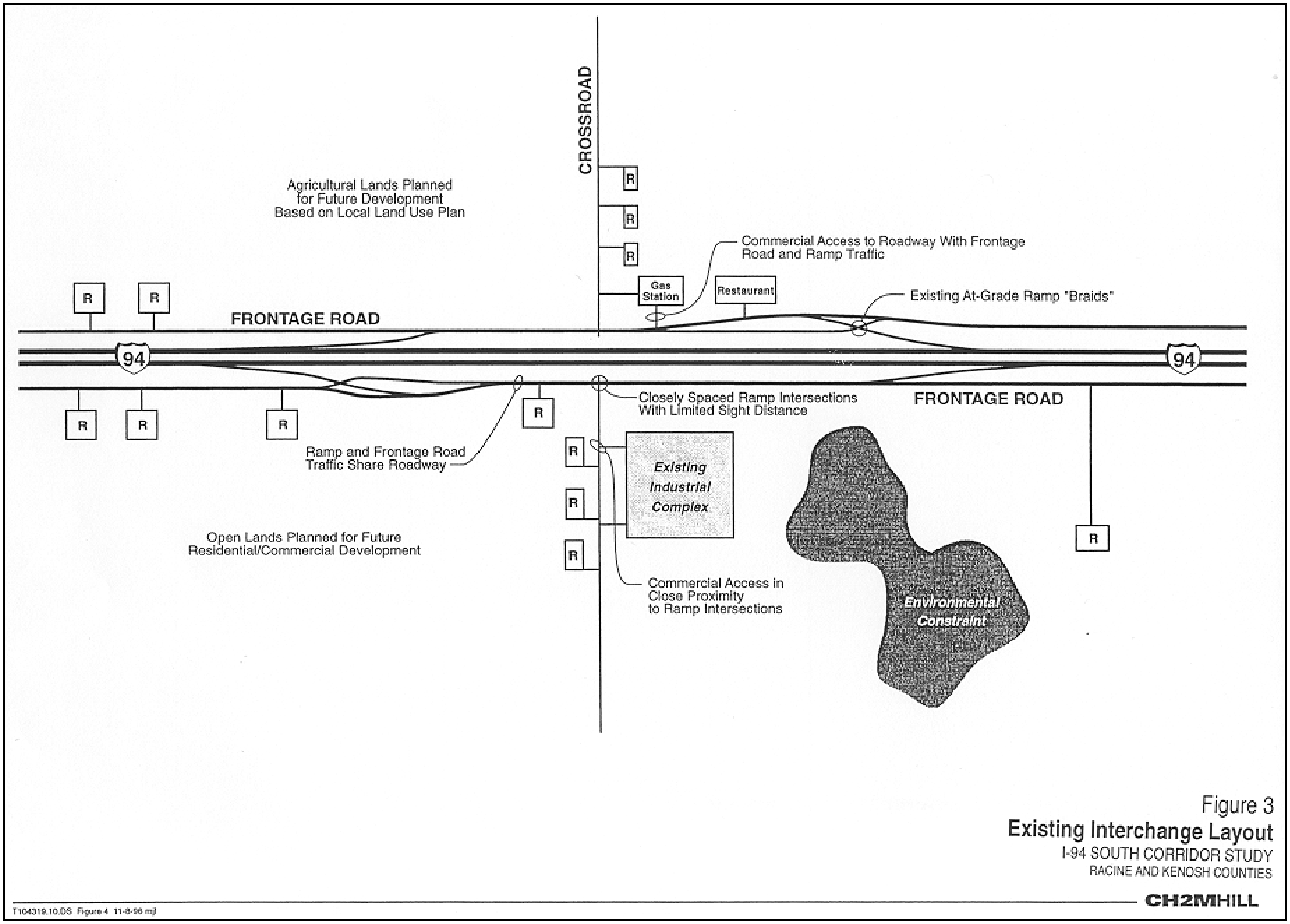


Figure 3
Existing Interchange Layout

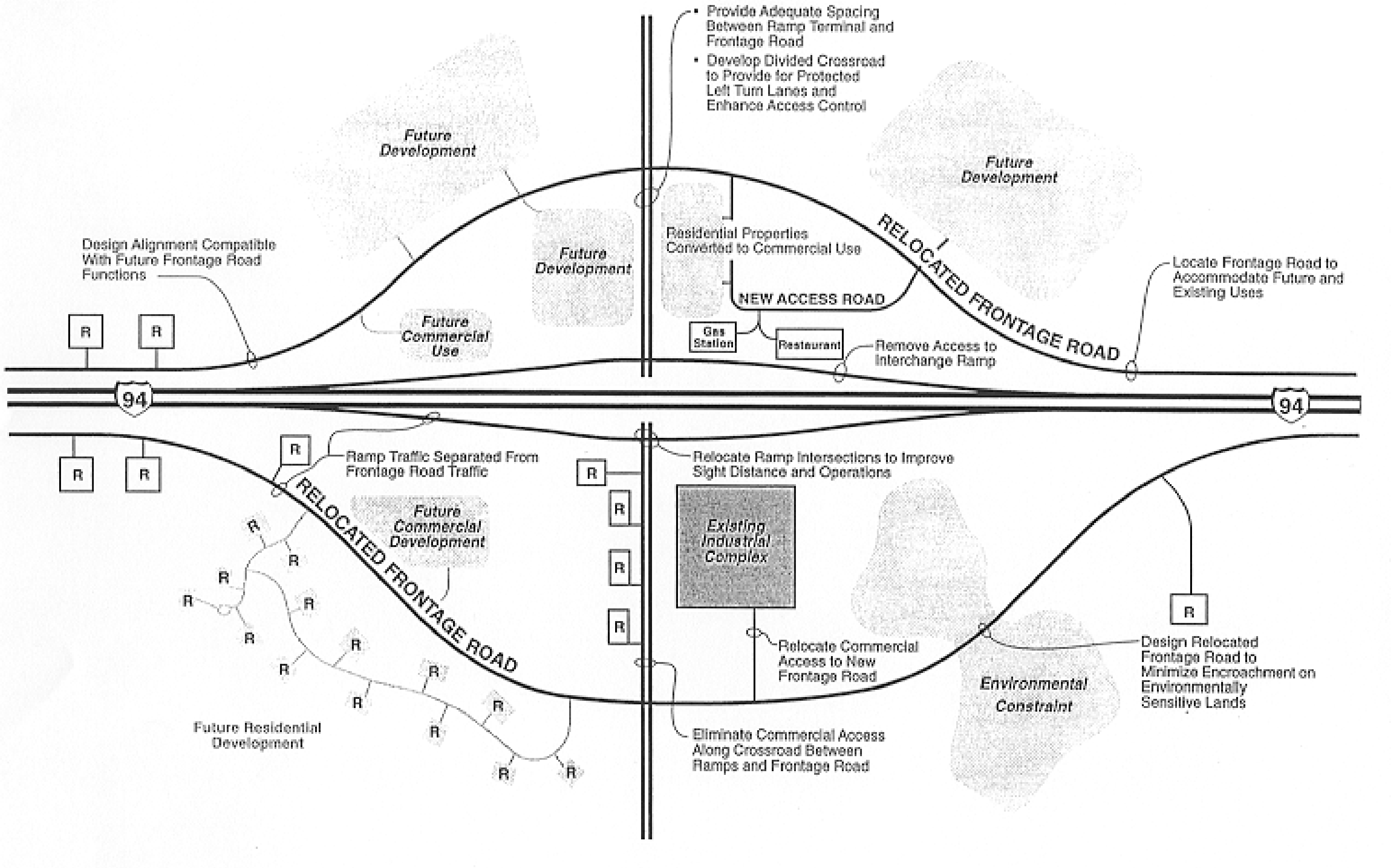


Figure 4
Future Interchange Layout
I-94 SOUTH CORRIDOR STUDY
RACINE AND KENOSH COUNTIES

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CH2MHILL

The solution was to plan for specially designed U-turn median openings, as shown in Figure 5. These were located to facilitate movements from properties within the limits of the frontage roads. They were purposely designed to not provide for movements in all directions, nor for large vehicles.

Existing Frontage Roads

Frontage road relocation posed special access problems. At some interchanges, commercial land uses tied to the interchange have access off the frontage road near its intersection with the crossroad. Relocation required establishment of replacement access for these businesses. Not surprisingly, many perceived the change as representing a radical degradation to the value of their business.

In other cases, there was a need in the interchange planning to provide for future access to small, potentially landlocked parcels near the frontage road/crossroad intersections.

Frontage Road Alignment

Establishing acceptable alignment for the relocated frontage roads also posed special problems, many of which related to access issues. The primary design control was selecting an optimal frontage road/crossroad intersection location. WisDOT planning criteria emphasized placing this intersection as much as 1000 feet (330 meters) from the ramp terminal intersection. In many cases, however, this dimension proved unworkable. Optimal locations considered property lines, to provide maximum flexibility for serving multiple developments in the future. Also, attention was paid to the concerns of existing businesses whose access would be shifted to the new frontage road. The greater the distance to the intersection, there was more perception of harm to the business.

Horizontal alignment issues were also a concern at many locations. The frontage roads were intended to operate at design speeds of 80 km/h. Again, compromise geometry was necessary to avoid environmental and other land use conflicts, and to reflect sensitivity to desires of future development.

Keys to Plan Success

The success of this planning project can be measured in a number of ways. With respect to WisDOT staff, their primary concerns were development of firm, specific plans for reconstructing each interchange to eliminate the outmoded, unsafe geometry. This entailed separating the crossroads from the frontage roads, and instituting access control along the crossroad. At every interchange, a feasible, reasonable plan was accomplished.

A related measure of success is the acceptance of the plans by local units of government as the basis for their land use and transportation planning efforts. WisDOT recognizes that the plan has no value if local governments do not accept it as their own, and make zoning, plan review and local access decisions with it in mind.

Finally, and perhaps most important, is the extent to which the plans will in fact be followed and “hold up” over time as WisDOT programs reconstruction funds. This is perhaps the most difficult aspect of the I-94 corridor study. The 12 interchanges will require expenditure of over $120 million over the next 15 years. As of the completion of the project in 1997, none of the improvements had been funded or programmed. (Note that since completion of the planning, four projects have been programmed and funded for 1999. These are discussed below.)

Achieving plan success required a special approach and much effort. The following are considered keys to project success that address each of the areas noted above.

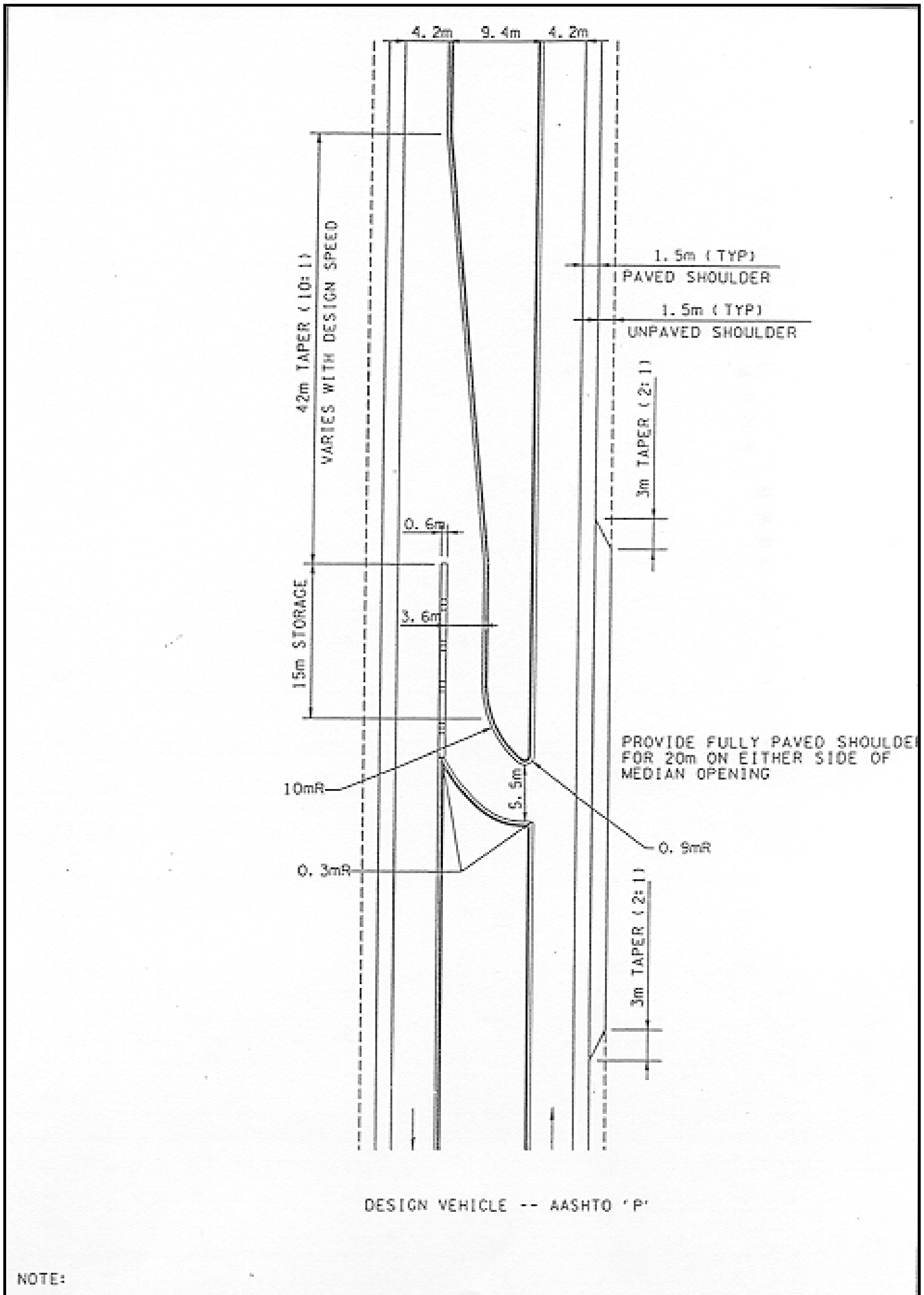

Figure 5
I-94 South Corridor Study
TYPICAL U-TURN OPENING AT NARROW MEDIAN
RACINE AND KENOSH COUNTIES

Corridor Planning and Design Approach

The WisDOT/consultant team developed a tailored design approach to the corridor. Corridor specific design criteria were established using both WisDOT Facilities Development Manual values, and other references. More importantly, the technical work focused on identifying the most critical aspects relating to traffic operations and safety.

Not all criteria were considered of equal importance. The WisDOT and consultant team worked to identify those aspects of a plan that were of utmost importance to the operational integrity of the interchange. Interchange design criteria (horizontal and vertical alignment, ramp configuration) were not compromised. *Separation of the ramps from the frontage roads,* achieving *firm median access control*, and establishing the *relocated frontage roads as the facilities for future access* were the highest priorities to WisDOT.

When conflict with landowners or units of government occurred over proposed alignments or alternatives, the team focused on retaining the above important features, and compromising on those considered of lesser importance. Compromises in frontage road alignment geometry were made to show sensitivity to businesses and residential communities. Some compromises in frontage road/crossroad intersection locations were made, although there were limits (90 meters, or 300 feet) to the dimensions considered acceptable. In a few cases, retention of existing right in only business access was allowed to remain where 1) there was no indication of an existing problem, 2) future traffic and land use changes at the location were not expected to be substantial, and 3) it was understood that the compromise would apply to the existing use only. Finally, the special treatment of existing residential land uses described above represented a compromise from WisDOT's traditional approach to access planning and design.

Multidisciplinary Team

WisDOT executed this "planning" project in a unique manner. Working with the consultant was a multi-disciplinary team of DOT specialists, including representatives from planning, traffic, highway design, environmental, maintenance, construction and right-of-way.[1]

The assistance of staff from WisDOT's Real Estate section was particularly helpful in the access management issues. Their experiences and "lessons learned" helped the team make appropriate decisions that could be managed during right-of-way acquisition. Also, inclusion of their staff and staff from the other disciplines provide a sense of partnership and ownership in the end result. It is hoped that this will enhance the chances that important plan features will be retained through plan implementation.

Extensive, Proactive Public Involvement

The I-94 project was similar to most access management projects. It required a substantial, proactive public involvement program. Components of the Public Information plan included 28 town meetings, 26 meetings with individual landowners, business owners and community groups, 5 meetings with state legislators, 3 Public Information meetings, a Project Advisory Committee (PAC) that met 5 times during the project, comprised of representatives from the two counties, cities and towns, and the DOT, 4 newsletters with a mailing list that eventually grew to over 800 addresses, and a Public Hearing.

The most valuable aspects of the public involvement process were the one-on one meetings with landowners, individual town representatives, and state legislators. The latter assured there was understanding of the objectives and need, and that constituents were being treated fairly.

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[1] *(1) The Wisconsin DOT received a 1997 National Trailblazer Award from AASHTO for their unique use of a multi-disciplinary team for project execution.*

Of course, the true success of the public involvement program was in its true execution as a two-way exchange of concerns and ideas. By the end of the project, most everyone understood the need, what was being proposed, and issues of timing. From WisDOT's perspective, the willingness to listen and compromise demonstrated the true value of public involvement in projects such as this one.

Phase II – Implementation of Corridor Plans

The nature of the planning effort resulted in significant, unique challenges to WisDOT. No immediate right-of-way acquisition or construction projects occurred directly after competition of planning. Indeed it was assumed that implementation would occur over a very long time period—perhaps over 20 years.

WisDOT undertook a number of unique management actions to assure the plans were implemented. These actions included maintenance of staff continuity, development of a formal corridor preservation map, and programming of a special hardship right-of-way acquisition fund for the corridor.

Staff Continuity

WisDOT's normal project delivery process would involve "handing off" the project from the project manager for the planning phase to other staff in design, right-of-way, etc. For this project, WisDOT is taking a different approach. Tom Heydel, project manager for the planning phase, is continuing as project manager for ongoing activities described below. The advantages to this management decision are clear. WisDOT retains the valuable institutional memory about decisions, issues, etc. that occurred during planning. Interaction with local units of government is more consistent. Finally, there is a naturally greater sense of ownership in the plan itself. Continuity in other staff also assists in implementation. The multi-disciplinary team approach is proving its value with respect to right-of-way issues, driveway permits, and eventually, design.

A practical example of how project continuity is maintained is illustrated in the driveway permitting process. Often, driveway permits are requested through the DOT. WisDOT permit employees have been instructed to route all applicable driveway requests through the corridor project manager for input as it relates to this study to assure that permits are not granted without a review to check their compliance and consistency with the overall plan.

Corridor Preservation Mapping Project

The IH 94 South Corridor study in Racine and Kenosha Counties, a segment of IH 94 which contains 12 interchanges, was the first step in planning to the year 2020 with interchange modernizations. Since the interchanges will not be rebuilt for anywhere from 5 to 20 years, it is imperative that the preliminary (functional) plans that have gone through the public hearing process be retained into the future. The best mechanism for accomplishing this is by formal corridor preservation, a process not historically used in Wisconsin. This led to the initiation of a unique corridor preservation project (mapping) for the corridor.

Local Support for Corridor Preservation As noted above, a Project Advisory Committee (PAC) was formed at the beginning of the IH 94 Corridor Study to develop the framework and eventually endorse the interchange plans, access methodology and R/W needs. The PAC is made up of all the towns, cities, villages, counties and other government agencies within the corridor area or which have influence over the corridor. Following the Public Hearing and completion of initial planning, the PAC made the recommendation that to retain the preliminary plans into the future, it was necessary to formally adopt the plans and to put property owners on notice of R/W needs. What method could be used to accomplish this? The Wisconsin Statutes contain a chapter on corridor preservation, which had never been tested until this time in Wisconsin. The Legal Counsel of Wisconsin DOT supported the use of this statute, which thus led to the next phase of this project, i.e.: Corridor Preservation (Mapping).

Why do corridor preservation mapping? Fifteen or twenty years from now, local government representation can change and the plans on file may be ignored or forgotten over time as representation changes. The corridor preservation mapping project provides a vehicle to make sure this doesn't happen.

The purpose of this mapping project is to preserve the R/W proposed under the above referenced planning projects under the IH 94 South Corridor Study (ID 1032-07-05) until the real estate and construction projects are implemented for each respective interchange.

The preservation of the location of relocated frontage roads, relocated ramps, and expanded crossroads will be done under the following strategy:

1. Map the corridor under Wisconsin Statute 84.295. This gives the State the *opportunity* to purchase a property if the owner is proposing any significant changes or additions. It *does not require* the State to purchase the property.
2. Assist local units of government in officially mapping the proposed roadway locations.
3. Assist the Southeastern Wisconsin Regional Planning Commission in adopting the relocated routes to the regional plan.

In selected key areas, the state and local governments might elect to purchase access rights to prevent a change in land use from affecting the level of service of the highway.

Formalize the access decisions shown on the functional plans by entering into multi-jurisdictional land use/access agreements with appropriate townships and counties. Under this type of agreement access points are decided, and changes can only be made with the concurrence of all cooperating governmental bodies.

The Vehicle of Corridor Preservation

The method of accomplishing the mapping is by use of a Corridor *Preservation Document*. This document is filed with the appropriate county Register of Deeds and mailed to the individual property owner impacted by R/W future purchase. This document (attached) basically states that the property owner in question cannot rebuild, alter or add to any existing structure on the property or subdivide the lot without first giving the Department of Transportation 60 days written notice. The Department can then either purchase the property, give the property owner release to proceed with their planned changes, or give partial release. This notice of Corridor Preservation includes the full interchange map with property lines overlaid onto the preliminary plans so that impacted properties by future R/W needs can be established.

Public Hearing

The Wisconsin Statutes 84.295 require that a public hearing be conducted prior to the notice of corridor preservation documents being released.

Data Gathering

Right of Way Plats - County R/W plats were obtained and electronically overlaid onto the preliminary plans to establish impacted properties. Properties may be impacted by proposed future R/W, Access changes, or Grade changes. It is imperative to work closely with the counties involved and particularly with the Register of Deeds offices, since they will be filing the notice of corridor preservation documents.

Standards of Highway Access

The mapping project also shows the following access management elements:

Spacing between ramps and relocated frontage roads
Crossroad access control
Driveway access control
Median access control
Frontage Road access control
Commercial Driveway guidelines
Median opening guidelines

By clearly identifying the access control for the corridor, the intent of the policy can continue to be known and enforced as development occurs prior to construction projects at each interchange.

Newsletters

Newsletters are sent to the impacted property owners, local units of government and newspapers to keep property owners and government officials abreast of the project.

Status of Mapping Project

The mapping project is in process and the public hearing is scheduled for October 1998. Meetings have been held with public officials and the property owners notified of the upcoming hearing by the newsletter and newspaper ads. A Project Advisory Committee meeting was held in July 1998 to obtain local input and continued support.

Hardship Right-of-Way Purchases

WisDOT recognized the problem in delineating future right-of-way for unprogrammed projects. Both lack of definitive time and financial commitment create burdens on property and business owners.
To provide a fiscal backing to this project, WisDOT has included a yearly budget for hardship purchases along the I-94 corridor. This budget applies primarily to residential property owners who as a result of this “Black cloud” over their property are unable to sell their property. If they can show a hardship, the DOT will purchase their property. This applies only to properties the DOT has shown as relocations under the corridor study for each particular interchange.

Hardship right-of-way acquisition is not unique to WisDOT. However, the corridor specific line-item programming for such acquisition represents a unique management decision. This proved to be essential to achieving local governmental support of the corridor plan.

Project Update

Since the Public Hearing for the planning study held in October 1998, WisDOT has formally adopted to functional plans for all 12 interchanges. Development of the corridor preservation mapping project began in July 1997. One of the two counties has also officially adopted the plans as part of their county transportation plan. Although the second county has not taken official action, their staff has expressed support and agreement with the plans.

The WisDOT Central Office Program Committee has approved the corridor priorities as shown in the attached figure. (These priorities were established with direct input from the PAC.) As of the writing of this paper, individual project programming awaits development of the entire WisDOT program initiative, with the exception of those projects listed below.

Four projects at one of the interchanges have been approved and funded:

- Wetland mitigation for the entire corridor
- State Trunk Highway 50—Phase I construction, including median closure, widening and frontage road relocation
- Purchase of property for Right-of-way
- Relocation of one business conflicting with right-of-way

Other ongoing activities include a continuation of work with property owners and public officials to coordinate local development plans with future roadway plans and access requirements.

Conclusions

The entire I-94 project has represented an opportunity for the Wisconsin DOT to be proactive in achieving the access management and other roadway design needs for the future. Both the planning process and subsequent management of the implementation of I-94 recommendations include many new approaches for WisDOT.

An interesting aspect of the project is that it influenced WisDOT's business practices. This project has resulted in the inclusion of standards into the Facility Development Manual (WisDOT's standards for project development) for the use of the Corridor Preservation statute. There are many legal aspects to this project and the Legal counsel has been closely involved and has assisted in the writing of the corridor preservation document. The use of multi-disciplinary teams for large, complex projects has been proven successful, and is being continued. Perhaps most importantly, WisDOT has found it possible to achieve public and private endorsement of proactive planning, when the right approach is used.

Attachments

Notice and Order Establishing Locations and Right-of-Way Widths for Future Freeways or Expressways under S.84.295, Stats.

Partial Release from Order Establishing Locations and Right-of-Way Widths for Future Freeways or Expressways under S.84.295, Stats.

Affidavit Regarding Notice and Order Establishing Locations and Right-of-Way Widths for Future Freeways or Expressways under S.84.295, Stats.

Programming Initiatives

Example Corridor Preservation Plan

Technical Memorandum – Subtask 6.8 – Access Control Policy for I-94 Corridor

Document Number

NOTICE AND ORDER ESTABLISHING LOCATIONS AND RIGHT-OF-WAY WIDTHS FOR FUTURE FREEWAYS OR EXPRESSWAYS UNDER S.84.295, STATS.

Wisconsin Department of Transportation
DT1536 98

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Return to

The State of Wisconsin, Department of Transportation, pursuant to the provisions of s.84.295(10) Stats., approves the map establishing a corridor to preserve real estate for future construction of a freeway or expressway and to prevent conflicting costly economic development on areas of lands to be available as rights-of-way when needed for future construction.

The approved corridor map shows the location of the planned freeway or expressway and the approximate widths of the rights-of-way needed for the freeway or expressway, including the right-of-way needed for traffic interchanges with other highways, grade separations, frontage roads and other incidental facilities and for the alteration or relocation of existing public highways to adjust traffic service to grade separation structures and interchange ramps. The map also shows the existing highways and the property lines and record owners of lands needed. The map is related to department project no. , is dated , and has been recorded in the office of the Register of Deeds for this county.

The lands affected by the map are more particularly described as set forth in the attached schedule of property.

No person may erect or locate any structure not currently existing on lands affected by the map without first serving 60 day notice by registered mail on the Wisconsin Department of Transportation, in the manner and form required by s.84.295(10) Wis. Stats. Service may be made on the department's district director having oversight authority of in . As of the date of this recording, the address for the district director is . A person who fails to comply with this notice requirement shall not be entitled to compensation in condemnation proceedings for any structure erected or relocated within the corridor, or for any improvements of any nature made on lands within the corridor. This prohibition does not apply to any normal or emergency repair or replacement necessary to maintain an existing structure or facility in approximately its previously existing condition.

Any lands within the corridor may be acquired by the State, or the county or municipality in which the lands are located.

As required by s.84.295(10)(a), notice of this action and recording shall be published as a Class 1 notice under Ch. 985 in each affected county, and notice registered mail shall be served on the owners of affected lands.

____
(Date)

Wisconsin Department of Transportation

____
(By)

State of Wisconsin)
) ss.
____________________ County)

Signed and sworn before me this ________ day of ____________,
_________.

____
(Signature, Notary Public, State of Wisconsin)

____
(Print or Type Name, Notary Public, State of Wisconsin)

____
(Date Commission Expires)

This instrument was drafted by the Wisconsin Department of Transportation.

Project ID

Document Number

PARTIAL RELEASE FROM ORDER ESTABLISHING LOCATIONS AND RIGHT-OF-WAY WIDTHS FOR FUTURE FREEWAYS OR EXPRESSWAYS UNDER S.84.295, STATS.

Wisconsin Department of Transportation
s.84.295(10) Wis. Stats.
DT1576 898

The State of Wisconsin, Department of Transportation, pursuant to s.84.295(10), Stats., established a corridor to preserve real estate for future construction of a freeway or expressway and to prevent conflicting costly economic development on areas of lands to be available as rights-of-way when needed for future construction.

The corridor and lands affected by the order are shown on the map of affected lands recorded in the office of the Register of Deeds for County, in Volume of , and as Document Number and are legally described in that NOTICE AND ORDER ESTABLISHING LOCATIONS AN RIGHT-OF-WAY WIDTHS FOR FUTURE FREEWAYS OR EXPRESSWAYS UNDER S.84.295, STATS. dated and recorded in the office of the County Register of Deeds in Volume of , and as Document Number .

("owner") has applied to the department for release of that portion of owner's property which the department anticipates will not be affected by the corridor or project.

The property to be released is more particularly described as:

The department has determined that it's proposed project will not impact the lands owner desires to be released from the building restrictions adopted by the department under s.84.295(10), Stats.

This space is reserved for recording data

Return to

Parcel Identification Number/Tax Key Number

Now, therefore, the Wisconsin Department of Transportation does hereby release and discharge the following described lands from the effect of that MAP, NOTICE AND ORDER ESTABLISHING LOCATIONS AND RIGHT-OF-WAY WIDTHS FOR FUTURE FREEWAYS OR EXPRESSWAYS UNDER S.84.295, STATS. dated which are more fully described above.

By this instrument, the Department does not release any other lands from the effect of said MAP, NOTICE AND ORDER ESTABLISHING LOCATIOSN AND RIGHT-OF-WAY WIDTHS FOR FUTURE FREEWAYS AND EXPRESSWAYS UNDER S.84.295, STATS. dated . In particular, all other lands of the owner described therein remain subject to the provisions of s.84.295, Stats., including, but not limited to, the following described real estate:

____
(Date)

Wisconsin Department of Transportation

(SEAL)

____
(By)

State of Wisconsin)
) ss.
_______________ County)

Signed and sworn before me this _________ day of _____________, ___________.

____
(Signature, Notary Public, State of Wisconsin)

____
(Print or Type Name, Notary Public, State of Wisconsin)

____
(Date Commission Expires)

This instrument was drafted by the Wisconsin Department of Transportation

ID _____________

Document Number

AFFIDAVIT REGARDING NOTICE AND ORDER ESTABLISHING LOCATIONS AND RIGHT-OF-WAY WIDTHS FOR FUTURE FREEWAYS OR EXPRESSWAYS UNDER S.84.295, STATS.

Wisconsin Department of Transportation
s.84.295(10) Wis. Stats.
DT 98

This space is reserved for recording data

Return to

State of Wisconsin)
) ss.
_______________ County)

_______________, being first duly sworn on oath, deposes and says as follows:

1. I am an adult resident of County, Wisconsin, and am employed by the Wisconsin Department of Transportation.

2. The State of Wisconsin, Department of Transportation, pursuant to s.84.295(10), Stats., established a corridor to preserve real estate for future construction of a freeway or expressway and to prevent conflicting costly economic development on areas of lands to be available as rights-of-way when needed for future construction ("the corridor").

3. Prior to the establishment of the corridor, the department conducted a public hearing at - , which was advertised in the manner required by s.84.02(3)(a), Stats., for changes to the state trunk highway system.

4. The map establishing the corridor was approved by the department on , and recorded on , in Volume of , at Page , and as Document Number .

5. A NOTICE AND ORDER ESTABLISHING LOCATIONS AND RIGHT-OF-WAY WIDTHS FOR FUTURE FREEWAYS OR EXPRESSWAYS UNDER S.84.295, STATS. describing the properties affected by the approved map was recorded on , in Volume of , at Page , and as Document Number .

6. Notice of the recording of said map was published by a Class 1 notice on the following date in the following newspaper(s) which is located in county affected by establishment of the corridor:

   Date:

   Newspaper:

7. Notice of the recording was served on the owners of record of lands within the corridor within 60 days after the recording consistent with the requirements of s.84.295, Stats.

8. This affidavit is recorded for the purpose of providing public notice that the requirements of s.84.295, Stats., have been met in the establishment of the corridor.

____
(Date)

Wisconsin Department of Transportation

____
(By)

State of Wisconsin)
) ss.
_______________ County)

Signed and sworn before me this _________ day of _____________, __________.

(SEAL)

____
(Signature, Notary Public, State of Wisconsin)

____
(Print or Type Name, Notary Public, State of Wisconsin)

____
(Date Commission Expires)

This instrument was drafted by the Wisconsin Department of Transportation

ID ____________

IH 94 Corridor Study

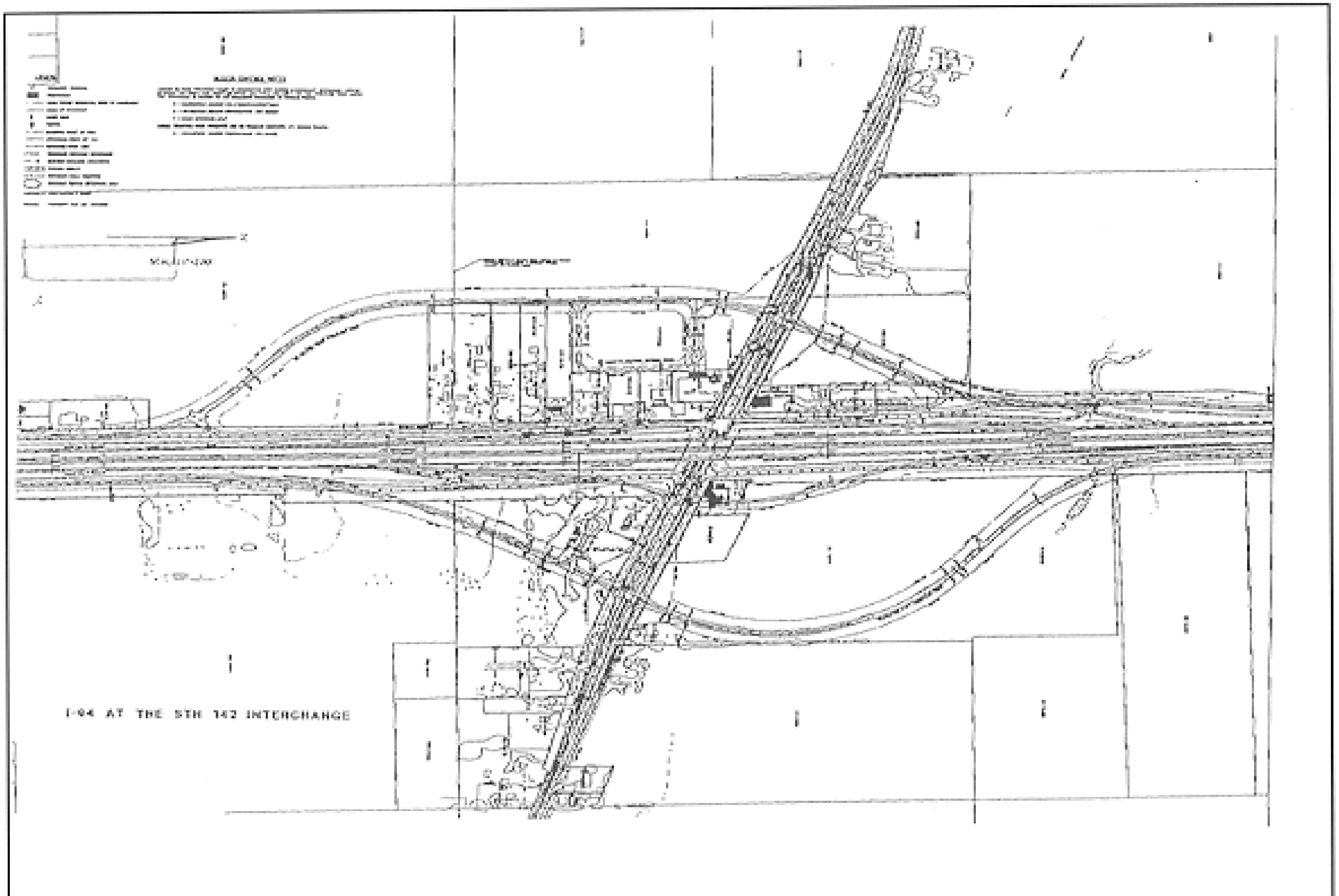
Project I.D. 1032-07-05

Racine/Kenosha County

Programming Initiatives

LOCATION	COST	PRIORITY	PROGRAM YEAR	FUNDED
Taco Bell - Advanced acquisition STH 50 Northwest Quadrant	$800,000	1	1999	X
Land acquisition - SW quadrant access road - STH 50	$1,200,000	2	1999	X
STH 50 - Phase I - median closures, expansion of STH 50, signals, access road	$200,000 (R/W) $6,449,000 (Const)	3	2000 (R/W) 2002(Const)	X -
Wetland mitigation - IH 94 Corridor N-S	$486,000 (R/W) $411,840 (Const)	4	1999 (Acqui) 2001 (Const)	X X
STH 158	$1,200,000 (R/W) $12,345,900 (Const)	5	2001 (R/W) 2003 (Const)	- -
STH 50 - Phase II - split diamond	$4,320,000 (R/W) $19,664,400 (Const)	6	2004 (R/W) 2006 (Const)	- -
STH 142	$3,700,000 (R/W) $15,248,800 (Const)	7	2003 (R/W 2005 (Const)	- -
7-Mile Road/27th Street	$4,020,000 (R/W) $12,776,700 (Const)	8	2003 (R/W) 2005 (Const)	- -
CTH K	$3,400,000 (R/W) $13,953,000 (Const)	9	2005 (R/W) 2007 (Const)	- -
CTH C	$2,500,000 (R/W) $10,303,700 (Const)	10	2005 (R/W) 2007 (Const)	- -
STH 11	$1,000,000 (R/W) $12,766,100 (Const)	11	2007 (R/W) 2009 (Const)	- -
CTH KR	$1,500,000 (R/W) $10,613,000 (Const)	12	2009 (R/W) 2011 (Const)	- -
STH 20	$1,000,000 (R/W) $10,520,100 (Const)	13	2011 (R/W) 2013 (Const)	- -
CTH G	$2,700,000 (R/W) $9,777,000 (Const)	14	2013 (R/W) 2015 (Const)	- -
CTH E	$2,800,000 (R/W) $11,950,900 (Const)	15	2015 (R/W) 2017 (Const)	- -
Advanced Acquisition (Preserve Right of Way)	200,000/Yr		1998 - 2015	x

NOTE:
With the exception of those projects noted as funded, none of the projects have been approved for funding. The Department of Transportation has adopted the functional plans (Dated Dec. 96) presented at the Oct. 96 Public Meeting



EXAMPLE CORRIDOR
PRESERVATION
PLAN

Subtask 6.8 -- Access Control Policy for I-94 Corridor

PREPARED FOR:	Tom Heydel/WisDOT Ken Voigt/HNTB Dan Dupies/CH2MHill Mary O'Brien/TEM
PREPARED BY:	Tim Neuman
COPIES:	Project File
DATE:	July 20, 1999

Subtask 6.8 of the I-94 Scope of Work calls for development of an Access Control Policy. This memorandum serves to collect all information and decisions made to date regarding access control, for the purpose of formalizing the corridor-level policy.

The following documents served as reference to the development of the corridor-specific policy:

1. *Access Management Issues* , prepared for the Project Advisory Committee meeting held on September 18, 1995.
2. *Access Control Policy for I-94 South Study*.
3. *WisDOT District 2 Access Management Guidelines* dated January 26, 1996.

The above referenced documents establish a rationale and quantitative guidelines for development of access control at each of the interchanges.

Spacing Between Ramps and Relocated Frontage Roads

Guidelines for desirable spacing between reconstructed ramps and relocated frontage roads are as follows:

	Desirable Spacing	Minimum Spacing
Along State Trunk Highway	300 m (1000 ft)	180m (600 ft)
Along County Trunk Highway	230 m (750 ft)	150 m (500 ft)
Along Local Road	150 m (500 ft)	150 m (500 ft)

The above dimensions are based on traffic operational needs and design requirements for channelization, transitions, etc. Lesser dimensions are appropriate to meet site-specific needs. Avoidance of environmental constraints, accommodation of appropriate local development plans, and consideration of other traffic and design requirements beyond the interchange area are all reasons for using lesser dimensions for spacing. The design study report and environmental documentation for the study will acknowledge where lesser dimensions are accepted and explain the reasons for the spacing recommended in the preferred design.

Crossroad Access Control

An objective of interchange reconstruction is to maximize the safety and operational efficiency of the crossroad in the vicinity of the interchange. This entails elimination of access to the crossroad between the ramps and frontage roads. Elimination of land access is accomplished by removal of existing driveways through purchasing of access rights, and closure of the median between the ramps and frontage roads. It also includes establishment of firm access control between the ramp and frontage roads, prohibiting future driveways from locating in this critical area.

The access control policy explicitly acknowledges the potential hardship and cost of establishing complete access control at every interchange, given the existing conditions. Guidelines for application of access control and design treatments for existing access points to remain are established to recognize the needs of existing land uses abutting the crossroad.

Driveway Access Control

Existing driveways along the crossroad between the ramps and relocated frontage roads will be dealt with in the following manner:

1. Driveways to commercial properties fronting the crossroad will be moved to the relocated frontage road. Access rights will be purchased where necessary. The reconstruction plan for the interchange will include necessary access connections to the relocated frontage road to maintain access to commercial properties.

2. Residential and agricultural access along the crossroad will be allowed to remain. Driveways to residential properties fronting the crossroad will be relocated to the frontage road where this is necessary.

3. Where residential and agricultural driveways remain along the crossroad, access rights will be purchased and access will be limited to existing conditions. Should the residential or agricultural property be converted to non-residential use in the future, access to the property will be from the relocated frontage road only.

Median Access Control

Reconstruction of the interchange and crossroad will incorporate a raised median along every crossroad. A basic access control objective is to eliminate cross median movements between the ramp and frontage roads. The policy in developing the crossroad design will be to close existing median openings between the ramp and frontage road, and not provide for new median openings once the road is reconstructed. Median openings will be restricted beyond the reconstructed frontage road intersection for an appropriate dimension. This dimension, generally 150 m (500 ft) as a minimum, reflects the design requirements for transition from a two lane rural cross section to a divided road. The only situation where a median opening would be provided within 150m of the reconstructed frontage road intersection would be to provide for a residential U-turn opening if deemed necessary. No U-turn openings would be provided within the transition area.

Frontage Road Access Control

All existing driveways currently on the frontage roads between the crossroad and entrance or exit ramps will be closed and relocated. The reconstructed interchange will have no private driveways to or from what would be a future interchange ramp.

Once reconstruction of the frontage roads and interchanges is completed, DOT has plans to transfer jurisdiction of the frontage roads to the respective local governments. Guidelines for access control along the frontage roads have been developed. In general, a minimum dimension of 80m (250 ft) is to be maintained from the centerline of the crossroad to the first driveway or intersection on the frontage road.It will be the policy of the DOT to adhere to these guidelines in the development of frontage road geometry and right-of-way preservation while the frontage roads remain under DOT control. Application of these guidelines will ultimately be the responsibility of the local unit of government.

Exceptions to Desirable Access Control Guidelines

As noted above, existing conditions present special problems in applying desirable access control guidelines. Exceptions to the guidelines are expected to reflect site-specific concerns. It is also important that the DOT evaluate exceptions to the guidelines in an even-handed, objective manner. To assist this evaluation, the following guidelines were developed as part of the I-94 access control policy.

Commercial Driveways.-- Driveways to existing commercial properties between the ramp and frontage road may be retained for those land uses that depend on "drive-by" business and easy access to the freeway. For this study, this refers exclusively to service stations. Retention of access to this land use along the crossroad will be considered if the following conditions are met:

1. The existing driveway(s) do not currently create safety or operational problems.

2. An existing driveway or relocated driveway can be provided to the land use no closer than 90 m (300 ft) from an intersection of the crossroad with either the ramps or the relocated frontage road.

3. Access would be limited to right turn movements into the property only. Cross median access would not be permitted, and egress movements would not be permitted. Relocated access off the new frontage road would continue to be the primary access solution for the property.

4. Access rights for the driveway would be purchased, and a revocable permit for the driveway would be issued. The DOT would retain the right to revoke the permit should a safety problem develop.

5. The property owner understands and agrees that the permit is for the existing use and owner. Should the property be redeveloped for a different use, the driveway would be removed and all access would be provided off the relocated frontage road.

Median Openings.--Closing the median between the ramps and relocated frontage roads in some cases will result in unique problems involving traffic patterns to/from residential properties along the crossroad. Significant out of direction travel would be required if no median openings are provided for these properties. As part of the access control planning for the corridor, consideration will be given to providing median openings for U-turning vehicles only between the ramps and relocated frontage roads in order to serve existing residences. The following conditions should be met:

1. There is a demonstrable need to provide a median opening for one or more residential properties. This need is associated with out of direction travel required should no opening be provided.

2. The median opening is designed for and intended for residential use only. An AASHTO 'P' vehicle is to be used for the U-turn geometry.

3. The median opening can be located in a manner that precludes its use by commercial or other uses.

4. Landowners and local units of government understand that the U-turn is for existing residential land use only. Should the properties for which it serves be converted to commercial use, the DOT would require removal of the U-turn from the median.

Access Control Policy
For I-94 South Study

The following guidelines have been set in order to preserve the capacity and safety of the interchange once the improvements are made.

Existing developments may make total compliance very difficult. Exceptions are possible with sufficient justification.

Reasons for good Access Control:

- eliminates additional conflict points (improve safety)
- preserves capacity
- separates through and local traffic
- improves mobility (reduce delays)
- lessens the need for retrofit projects (signals, median cross-overs, driveway relocations)

SPACINGS

Location of the frontage road will be dependent upon the Jurisdiction of the crossroad. Our goal for the distance of the frontage road from ramp terminal:

State Highway Cross Road	1000'	(300 m)
County Highway Cross Road	750'	(230 m)
Local Road Cross Road	500'	(150 m)

The above distances are guidelines based on the District 2 Access Management Guidelines (May 14, 1991).

Distance between Ramp terminals as measured along the crossroad should be a minimum of 300 feet (90 m) up to a maximum of 500 feet (150 m), with no ramp terminal being closer than 100 feet (30 m) from a structure. These criteria are taken from the State Facilities Development Manual (Procedure 11-30-1).

Location of driveways on frontage roads should be 250 feet from the center line of the crossroad. This is based on the left turn stacking distance needed for commercial development, and taken from the District 2 Access Management Guidelines.

Beyond the frontage roads, median openings (if divided highway) should be 500 feet (150 m) from the frontage road. This 500 feet (150 m) is the minimum acceptable transition from a 4 lane to a 2 lane highway. In addition, where possible access will be controlled in this 500 feet (150 m) to preclude immediate access to the intersection.

DRIVEWAYS

The goal of the project is to remove private access to the crossroad in between the ramp and frontage road. In conjunction, no median openings would be built in this section if a divided section is constructed. Existing median closures will be evaluated based on safety problems and ability to provide alternated access.

Given the amount of existing development already present at most of the interchanges several strategies have been formulated to accommodate these owners:

- Existing Residential access will be maintained
- Existing Residential access points will be limited so that new commercial developments will not have driveways directly on the crossroad
- Attempts will be made to change access of exiting commercial developments. Most commonly this will involve reversing access so that driveways will be off new access roads which connect to the relocated frontage road.

SIGNALS

Signalization will be considered at all locations that meet warrants. Signalizations is usually at public street crossings. Spacing of public streets will consider the progression of signal timing. Progress flow requires 1000' (300 m) spacing between signals.

COSTS

The goal for cost sharing policy is to accurately assign costs to those driving the "need" for the improvement and those responsible for the land use decisions. In many cases this will involve a negotiation with local units of governments and private developers.

It is expected the State would finance the construction of new access roads if they are needed to provide access to existing developed properties.

Design Issues and Public Concerns When Considering a Raised Median on a Highly Commercialized Urban Arterial

Richard Brauer, The Sear-Brown Group

3rd National Conference on Access Management

presents:

Design Issues and Public Concerns when Considering a Raised Median on a Highly Commercialized Urban Arterial

THE SEAR-BROWN GROUP

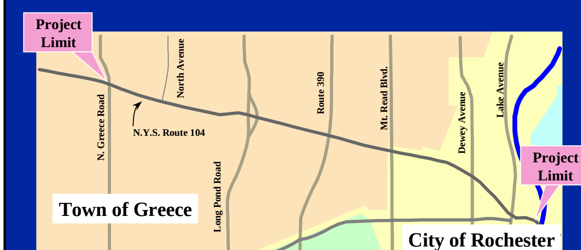
Presentation Overview

- Project Overview
- Raised Median Design Considerations
- Public Involvement Approaches

Project Overview

- NY Route 104
- 6.0 Mile Corridor
- Dense Commercial Land Use
- 35,000 to 70,000 AADT
- 40 to 60 Driveways/Mile
- 5 Signals/Mile
- 5 Lane CTWLTL - Need 7 Lanes

Project Limits



North Greece Road to Veterans Memorial Bridge

Project Objectives

- Restore Pavement
- Improve Safety
- Improve Traffic Flow
- Maintain Economic Vitality
- Enhance Visual Environment
- Minimize Construction Disruption

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Project Conflict

- Narrow Corridor
- Over 600 Businesses
- Single Point Access
- 70,000 vpd
- Poor Accident Record

vs.

Full
Direct
Accessibility

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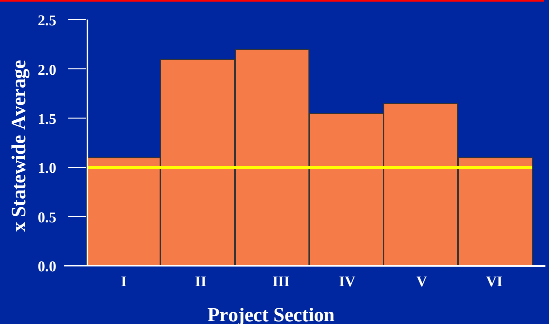
Accident Rates



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Access Management Goals

- Limit the Number of Conflict Points
- Spread Out Conflict Points
- Separate Turning Vehicles
- Improve Off-Roadway Circulation and Storage

IMPROVE SAFETY

THE SEAR-BROWN GROUP

Access Management Applications

THE SEAR-BROWN GROUP

Access Management Potentials

- Raised Center Median *
- Driveway Consolidation and Design *
- Shared Access
- Signal Location/Spacing
- Exit/Entrance Treatments *
- Access/Frontage Roads
- Rear Access
- Right-Turn Lanes *

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Raised Median Evaluation
Route 104 Case Study

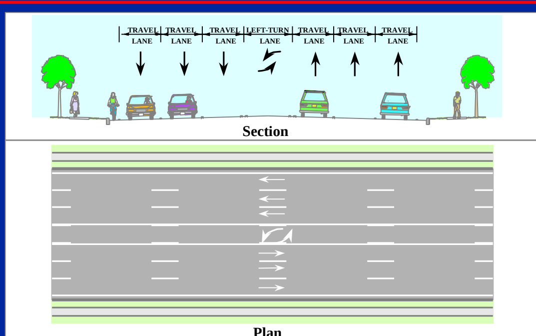
DESIGN ISSUES

Primary Corridor Alternatives

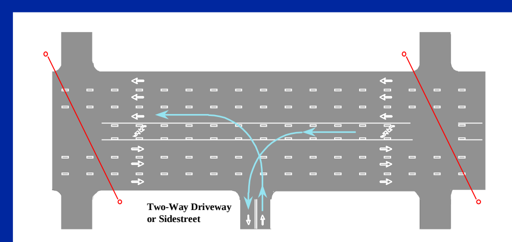
Continuous Two-Way Left-Turn Lane (CTWLTL)

Raised Median (RM)

CTWLTL

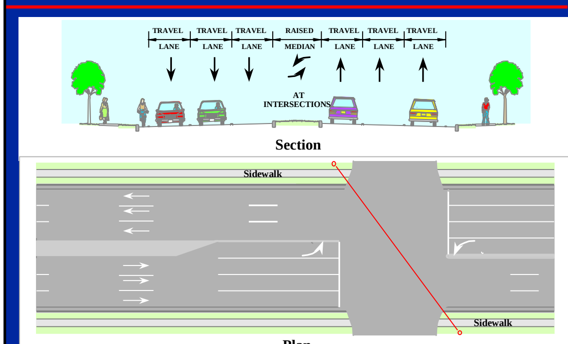


CTWLTL Left-Turns

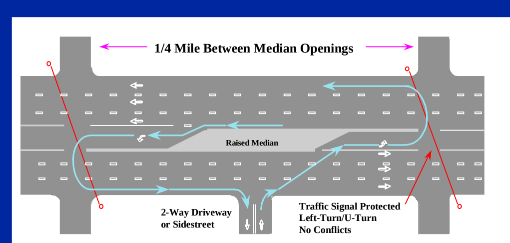


Traffic Movement
Lane Stripe

Raised Median

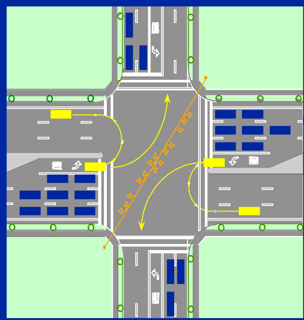


Raised Median Left-Turns



Traffic Movement
Lane Stripe

Raised Median *Left-Turns and U-Turns*



- All Opposing Traffic is Stopped
- No Right-Turn on Red during U-Turns

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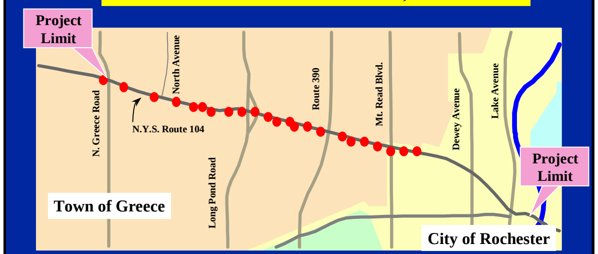
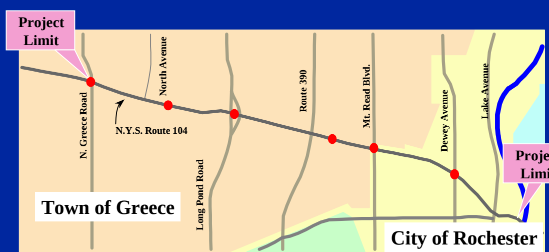
RM - Median Openings

U-TURNS LOCATED EVERY 1/4-MILE, ON AVERAGE



Raised Median from North Greece Road to Mayflower Street and Lake Avenue to Veterans Memorial Bridge
Inadequate Corridor Width

RM - Truck U-Turn Locations



North Greece Road to Veterans Memorial Bridge

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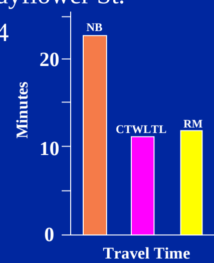
Travel Time

- Limits - N. Greece Rd. to Mayflower St.
- Peak Hour/Design Year 2024
- Average Travel Time:

No Build	- 22.8 min.
CTWLTL	- 10.8 min.
RM	- 11.6 min.



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Level of Service

Intersection	Level of Service	
	CTWLTL	RM
N. Greece/Elmgrove	C	D
Elmridge	B	B
North	C	C
Mason/Greece Outlet	B	B
Ridgemont West	-	C
Tully/Ridgemont West	C	-
U-Turn Signal	-	C
Fairmont/Ridgemont Center	B	D
Harvest/Ridgemont East	D	-
Ridgemont East	-	B
U-Turn Signal	-	C
Long Pond	B	C
Mitchell	C	C

Intersection	Level of Service	
	CTWLTL	RM
Grecian Gardens	A	A
Duxbury	B	B
Greece Ridge/Cole Muffler	B	C
Somerworth/Standish	B	C
Fetzner/Latona	C	D
390SB	B	B
390NB	B	B
Hoover	B	B
Buckman	B	B
Stoneridge Plaza	-	B
Corona	-	-
Stone	C	C
Kodak/Home Depot	C	C

- Right-Turn on Red Accommodation

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Raised Median Evaluation Route 104 Case Study

PUBLIC ACCEPTANCE

THE SEAR-BROWN GROUP

Accessibility Evaluation

- Time to Access
- Left-Turn Safety

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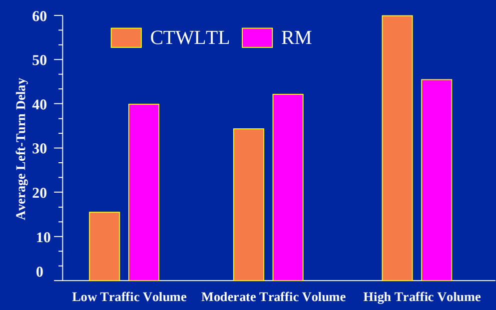
Left-Turn Delay vs. Volume



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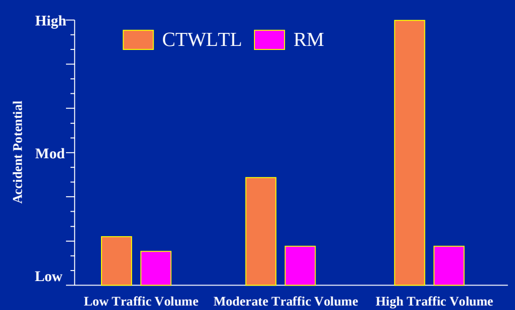
Left-Turn Safety vs. Volume



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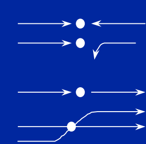
Vehicle Conflict Analysis

- Conflict Points

Major

Minor



- Potential for Accidents
- Create Friction in Traffic Flow

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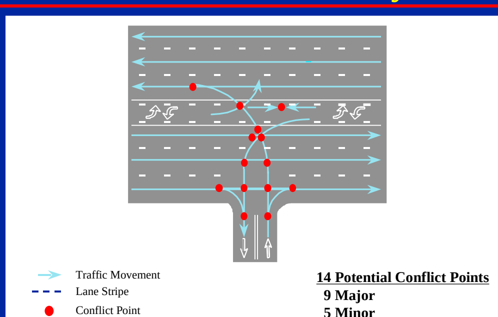
CTWLTL - Conflict Analysis



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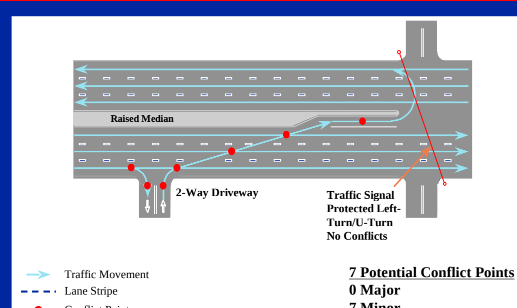
RM - Conflict Analysis



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Conflict Analysis Summary

- 215 Driveways/Side Streets
- 30,000 Average Left-Turns/Day
- 450,000 Conflict Points/Day

2020 (CTWLTL)	2020 (RM)
650,000 Conflicts	250,000 Conflicts
400,000 Major	0 Major
250,000 Minor	250,000 Minor

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Accident Rates (1992-1995)

Segment	Accident Rate	Statewide Avg. Accident Rate	#x SWA
N. Greece Road- Tully Lane	7.9	7.5	1.1
Tully Lane- Long Pond Road	15.4	7.5	2.1
Long Pond Road- Latona Road	16.5	7.5	2.2
Latona Road- Stone Road	9.5	6.2	1.5
Stone Road- Mt. Read Boulevard	9.8	6.2	1.6
Mt. Read Boulevard- Devitt Road	6.6	6.2	1.1

Accident Rates are Accidents/Million Vehicle Miles

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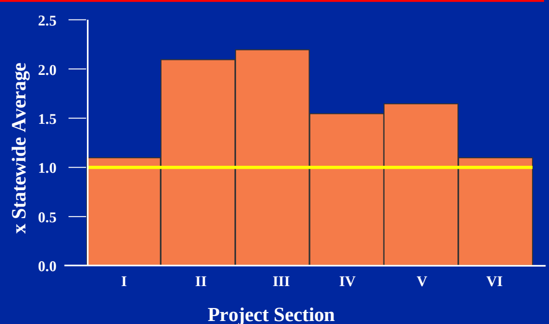
Accident Rates



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Existing Condition Summary

- Annual Accident Data
  - Over 600 Accidents
  - 220 with Personal Injury
  - Estimated Costs $9.0 million
- Accidents will Increase Exponentially with Traffic Growth (1996 - 2026)
- Users Have Personal Safety Concern

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Driver Perspective

- Focus Areas
- Approach Directions
- Reaction Time

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CTWLTL - Driver Perspective

Focus Areas - 3 Approach Directions - 6

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RM - Driver Perspective

Focus Areas - 2 Approach Directions - 2

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Reaction Time

- Reduced Reaction Time (RT) Increases Accidents
- Causes of Reduced Reaction Time
  - More Focus Areas
  - More Approach Directions
  - Increased Traffic
  - High Number of Left-Turns

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Previous Safety Studies

- CTWLTL vs. RM
  - FHWA (1994)
  - NCHRP (1995)
  - Florida (1993)
  - Georgia (1992)
  - New York (1992-1995)

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FHWA Study

- Comprehensive Analysis of Previous Studies
- Results
  - CTWLTLs adequate where traffic volumes are not high (<25,000 ADT)
  - RMs reduce accident severity
  - RMs enhance pedestrian safety

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NCHRP Study

- Evaluated Existing Accident Prediction Equations
- Compilation of 12 Other Studies

AADT	RM % Accident Reduction
20,000	2
30,000	7
40,000	11

- As Traffic Volumes Increase, RM is Safer

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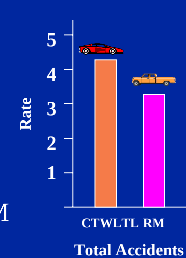
Florida Study

- Analyzed Accident Rates for 400 Miles of Urban Arterials

Six Lane Arterials

Type	AADT	Accident Rate
CTWLTL	39,000	4.3
RM	41,000	3.3

- 23% fewer accidents with RM



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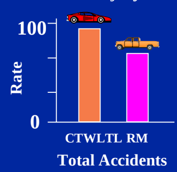
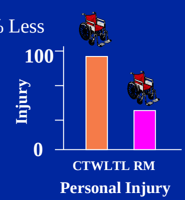
Georgia Study

- Studied Accident Rate for nine six-lane corridors
- ADT Avg. 32,000, with 60 Driveways/Mile
- Results
  - RM Accident Rate 25% Lower
  - RM Personal Injury Accidents 50% Less





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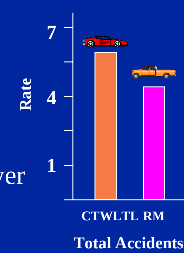
New York Study

- DOT Maintains Accident Rates for All State Highways

Four-Lane Arterials

CTWLTL	6.63 Acc./MVM
RM	5.47 Acc./MVM

- RM Accident Rate 18% Lower



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Design Guidelines

- AASHTO
  - "CTWLTL should only be used...where there are no more than two through lanes of traffic in each direction."
- NCHRP
  - Developed a Design Chart Based on Safety, Congestion and Economics

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NCHRP Design Chart

Through Lanes	AADT	Driveway Density	Left-Turn Percent Per 1,320-ft. Segment Length				
6		0	5	10	15	20	30
	26,250	30					
		60					
		90					
	33,750	30					
		60	I		II		
		90	Consider a Raised-Curb Median				
	41,250	30					
		60	III				
		90					
	48,750	30	IV				
		60	V				
		90					
	56,250	30	VI			Congested Flow	
		60	VII				
		90					
	63,750	30					
		60				Stay with Existing	
		90					TWLTL

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Visual Environment Evaluation

- Existing Conditions
- Alternative Evaluation

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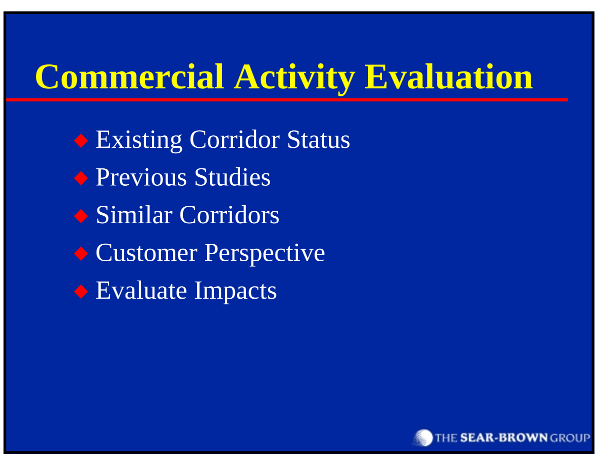
Commercial Activity Evaluation
Existing Corridor Status
Previous Studies
Similar Corridors
Customer Perspective
Evaluate Impacts
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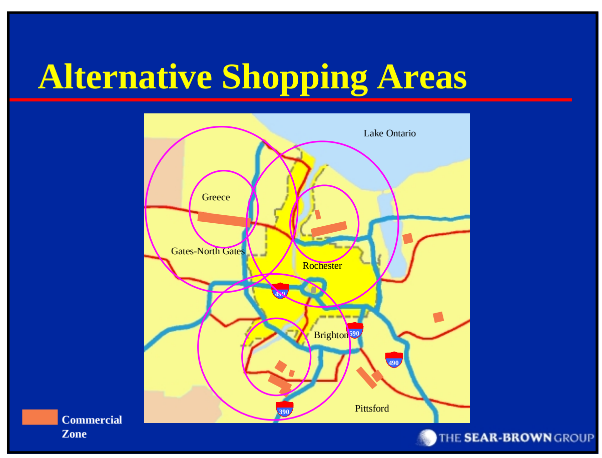
Alternative Shopping Areas
Lake Ontario
Greece
Gates-North Gates
Rochester
Brighton
Pittsford
Commercial Zone
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Store Selection

Pass By	Destination
Gas Stations	Car Dealers
Fast Food	Furniture Stores
Pharmacies	Department Stores
Ice Cream Shops	Supermarkets
	Building Supply
	Appliance/Electronics

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Previous Studies

- Limited Studies Available
- NCHRP
  - Total Market Volume
  - Safety Issue
  - Market Redistribution
  - Location Relative to Median Opening

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Similar Corridors

- Locations
  - NY Route 324 (Buffalo)
  - NY Route 62 (Buffalo)
  - NY Route 9 (Poughkeepsie)
- Occupancy, Mix and Assessed Value
- No Visible Difference Between CTWLTL and RM

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Memorial Drive

- Commercial Urban Arterial
- 50,000 Vehicles/Day
- 4.4 Miles
- 55 Driveways/Mile
- Signals at 1/3 Mile Spacing

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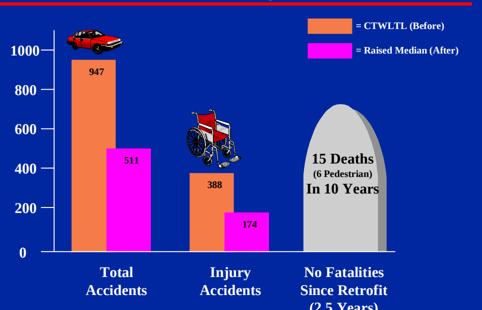
Memorial Drive Study



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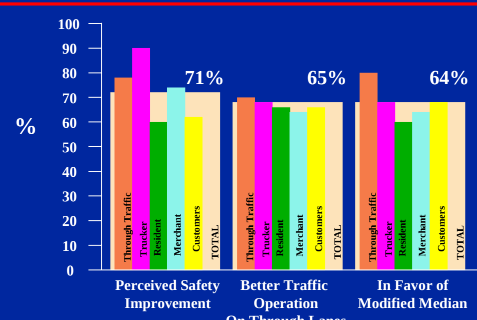
Public Attitude *Regarding Median Change*



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Public Involvement Techniques

- Newsletters
- Focus Groups
- Open Houses
- Political Entities
- Media Campaigns
- Video of Corridor Problems *

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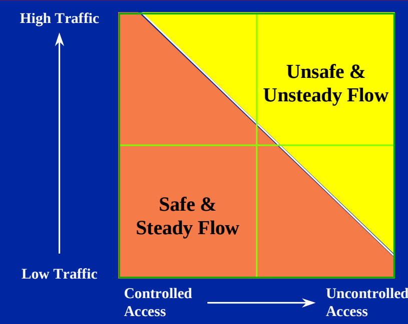
Access Management



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Summary

- Raised Medians will be Resisted
- Public Perspective
  - Benefits from their Perspective
- Be Accessible and Responsive

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Questions and Discussion

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Session 19

Mock Hearing and Trial Workshop

Moderator: Rindy Lasus, New Jersey Deputy Attorney General

Participants: Pam Leslie, Florida Department of Transportation
John Beck, Beck & Barios Law Firm

Session 20

Impacts of Access Management On the Business Climate

Moderator: Eddie Shafie, Rust, Lichliter, Jamerson Associates

Participants: David Plazak, Iowa State University
Gary Dickens, Ivey, Harris & Walls
William E. Frawley,. Texas Transportation Institute
John Beck, Beck and Barrios Law Firm

The Impact of Access Management On Business Vitality

David Plazak, Iowa State University
Paul Chao, University of Northern Iowa
Pola Gupta, University of Northern Iowa
Tom Sanchez, Portland State University
Ken Stone, Iowa State University

ABSTRACT

The impact of retrofit access management projects on the vitality of existing businesses along the improvement corridor is a continuing source of concern for business owners, city officials, chambers of commerce, and transportation professionals. As part of a major research, education, and outreach project conducted for the Iowa Department of Transportation's Access Management Task Force, a variety of secondary data sources and analytic methods were used to assess the impact of completed access management projects on local business activity and vitality. Methods developed and used included:

- *Community-level business market share "pull factors" and business survival rates developed using original source data made available by the Iowa Department of Revenue and Finance (IDRF).*

- *Detailed "before and after" business profiles along access management project corridors. Sources used to develop these profiles included R.L Polk city directories as well as local government data, including plat maps, tax assessment records, and aerial photos.*

- *Detailed retail sales trends for selected businesses along access management project corridors. The sales tax trend data were also developed with the assistance of the IDRF staff.*

These methods and data sources were used in combination with the results of surveys of business owners and customers conducted by a team from the University of Northern Iowa (UNI) to assess business vitality impacts of selected access management projects. The results strongly suggest that the impact of access management projects on business vitality is at worst neutral, and may in fact be beneficial in a number of cases. Still, business owners and managers are very skeptical of access management and must be convinced projects will be worthwhile and not damaging to their business prospects if they are to be successfully implemented. One way this can be done is through early involvement of the business community in project planning and development, including education about the benefits and impacts of access management.

BACKGROUND

It is widely known and agreed that access management projects such as consolidating driveways, building two-way left-turn lanes, and installing raised medians can dramatically improve both traffic safety and traffic operations. For instance, recent research in Iowa shows that access management projects have reduced accident rates by an average of 40 percent and improved traffic operations by one level of service (e.g. from Level of Service “D” to “C”).

However, a common sticking point in the implementation of access management projects, particularly those that involve dramatic changes such as installing raised medians, is strong skepticism and fear on the

part of adjacent business owners and managers. This fear can easily turn into political opposition that can lead to counterproductive changes in projects or abandonment of attempts to manage access.
This sort of problem has been encountered often in Iowa as access management has become a more common strategy for safety and congestion management has ramped up.
One businessperson in Spencer Iowa was so convinced that a two-way left-turn lane and driveway consolidation project would harm his business that he offered a substantial reward to anyone in the community who could stop an access management project their from moving forward. [1]

An effort is now being made by the Iowa Access Management Task Force and the Iowa Department of Transportation to disseminate factual information on the business vitality impacts of completed access management projects. This is being done through an 18-minute videotape, several presentations at conferences and meetings, and printed materials.

ANALYTIC METHODS USED

Community-Level Data
Community-level business market share "pull factors" and business survival rates were developed using original source data made available by the Iowa Department of Revenue and Finance (IDRF). These data were used to put the performance of the access-managed corridors into perspective. As will be shown later, the case studies selected had a wide variety of business conditions from slow growth to extremely rapid growth.

Corridor Profiles
Detailed "before and after" business profiles were developed along access management project corridors. Sources used to develop these profiles included R.L Polk city directories; as well as local government data such as plat maps, tax assessment records, and aerial photos. The most useful data source for developing these profiles turned out to be the R.L. Polk directories. These profiles were used for a variety of purposes, including determining business losses from corridors and to select businesses to be surveyed for their opinions on access management.

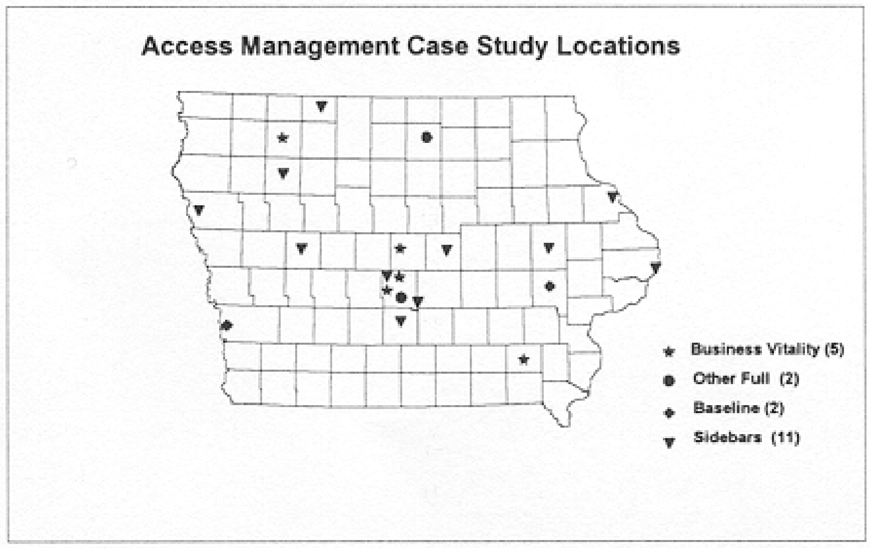
Sales Tax Data
Detailed retail sales trends were developed for selected businesses along access management project corridors. The sales tax trend data were also developed with the assistance of the IDRF staff. Iowa has one of the most extensive databases of sales tax data and the IDRF staff was able to provide aggregate sales tax trend data for address ranges along the case study corridors for a multi-year period. Aggregation was required in order to protect the confidentiality of individual businesses.

Business and Customer Surveys
As a part of the Iowa access management research project, the University of Northern Iowa Marketing Department conducted extensive personal interviews of business owners and managers as well as business customers in each of the case study corridors.

CASE STUDY SELECTION

The Iowa Access Management Task Force e selected five case studies for a detailed study of business vitality. Each was studied in terms of the impact of access management projects on traffic safety, traffic operations, and business vitality. The case studies were selected on the basis of their ability to be examined in depth on a before and after project basis. A mixture of project types (raised medians, two-way left-turn lanes, and driveway consolidation only) was selected. Finally, cases were chosen that reflected varying community types (metropolitan and rural).

The five business vitality case studies examined included:



- Ames. A two-way left-turn lane project in a modestly growing university community of approximately 48,000 persons.

- Ankeny. A raised median project in a fast-growing suburb with a population of over 21,000 persons.

- Clive. A raised median project in a very rapidly growing suburb with almost 10,000 persons. The southern few blocks of this project was completed with a two-way left-turn lane instead of a median because retail development only existed on one side of the street.

- Fairfield. A driveway consolidation project along a US highway in a rural trade center with a population of about 10,000 persons. Fairfield is located in southeast Iowa.

- Spencer. A two-way left-turn lane project in a slow-growing rural trade center with about 11,000 residents. Spencer is located in northwest Iowa.

Both Ankeny and Clive are suburbs in the Des Moines metropolitan area, which is the largest and fastest-growing (in population terms) metropolitan area in Iowa. Ames is located within commuting distance of Des Moines.

The case study results from this portion of the research effort were deemed so successful by the Task Force that one additional case study has already been completed, and three more will be completed before summer 1999.

RESULTS

Corridor Business Composition

There was no discernable pattern in net change of businesses by type along the five access-managed corridors on a before and after-project basis. Some categories of business grew, while others declined; the types of businesses that grew and declined were not the same across the five corridors studied.

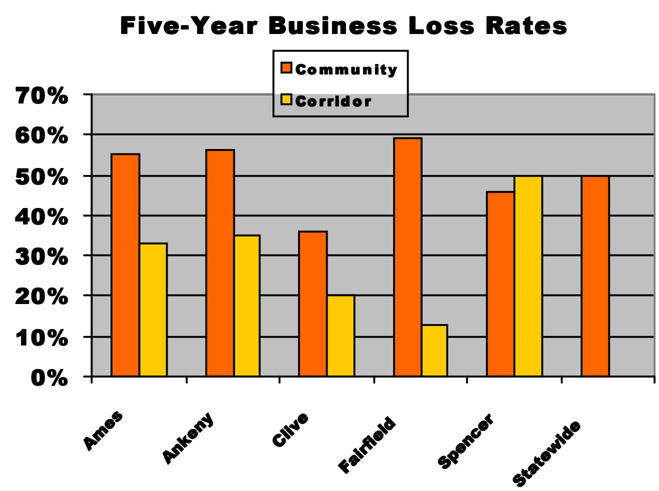
Business Loss Rates

In Iowa, about half of all businesses that require sales tax permits do not renew them beyond a five-year period. This indicates that these businesses fail, leave the state, change ownership, or simply change their name. In order to be as conservative as possible in making comparisons, for this study a business was deemed to be "lost" if it failed to re-apply for a sales tax permit under the same name or failed to appear under the same name in the local R.L. Polk City Directory.

In general, the five-year business loss rates for the case study communities in Iowa were about the same as that for Iowa as a whole. This rate was around 50 percent. One very rapidly growing suburban community, Clive, had a much lower loss rate (about 35 percent); while the slower-growing rural community of Fairfield had a significantly higher rate than the statewide figure (around 60 percent).

In all but one case studied, the five-year business loss rate for the access-managed corridors was substantially lower than that for their communities. In four of the five communities, the corridor business loss rate was some 15 to 20 percent lower than the rate for their community. The one exception to this pattern was the rural community of Spencer.

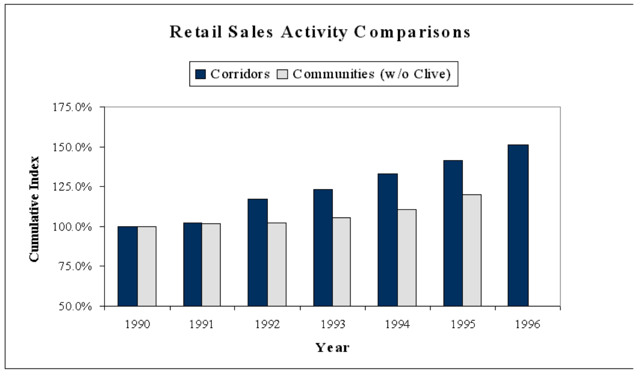
In Spencer, the corridor business loss rate was a few percentage points above the figure for the



community, but still at about the level that would be expected given the statewide pattern of business loss, around 50 percent over five years.

Sales Tax Trends

On average, retail sales grew at an annual rate of 7.3 percent in the access-managed corridors and by only 3.3 percent in the communities that contain them. Put another way, sales in the case study corridors outpaced their communities by ten to twenty percent once projects were completed. An exception to this was "retail magnet" Clive, where the community sale grew at an explosive rate and much new retail square footage came on-line. But the corridor experienced rapid growth as well. The typical Iowa statewide retail trade growth rates for the past decade has been 4 to 5 percent.[2]

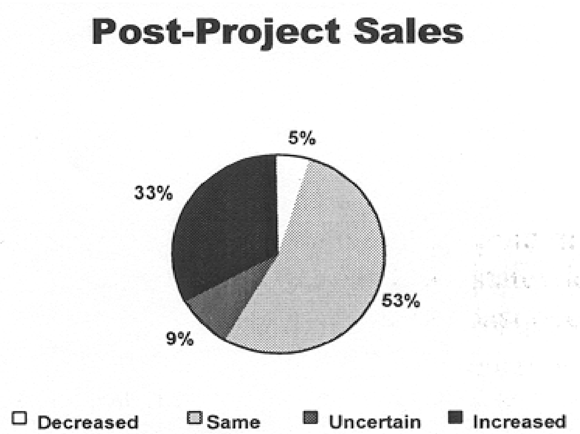


Another corridor that was studied more recently in another phase of the research project, US Highway 6 in Coralville (a suburb of the university town Iowa City), showed a similar pattern. Annual sales growth was over ten percent in the study corridor, and less than ten percent in the community as a whole.

These sales tax trends suggest that access-managed corridors are not only good places to do business, but actually tend to outperform other locations in their communities and the state as a whole in terms of retail activity.

Business Owner Survey Results

The most important result of the survey of business owners and managers was that for all of the five projects combined, over 85 percent of the businesses reported their post-project sales were either the same (53 percent) or higher (33 percent) than their pre-project sales. Only five percent of businesses reported a post-project sales decline, and this decline was not necessarily attributable to the access management project. [3]



In Spencer, the businessperson that had unsuccessfully offered the reward to stop the project later noted that he had over-reacted. “If anything, our business increased after the project, which very much surprised me”, he noted.

Customer Survey Results

The University of Northern Iowa’s opinion survey results indicated that customers (who are usually also motorists) overwhelmingly support the improvements made to the case study corridors, including the better-managed access. Motorist support rates of between 90 to 100 percent are common. Interestingly, business customers are almost always more supportive of the projects than the owners and managers of the businesses they patronize.

The City Public Works Superintendent of Spencer related his observation that "the general publics' sentiments about our access management project are very positive."[4]

CONCLUSION AND IMPLICATIONS

The perception of business persons regarding access management retrofit projects is very often worse than the reality. Experience and research in Iowa shows that the great majority of businesses do as well or better once access management projects are put in place. Corridors where access management has been improved tend to outperform their surrounding communities and the state as a whole in terms of business activity. It may be hypothesized that access-managed corridors are better places to conduct business because motorists feel more comfortable driving on them. Business customers surveyed in Iowa indeed indicate that they are more comfortable driving on corridors where access has been managed.

This said, retail trade is an extremely volatile endeavor. In Iowa, half of all businesses that require a sales tax permit turn over during a five-year period. This is equivalent to saying that one in ten businesses are lost each and every year. Implementation of access management projects, particularly those that involve major changes such as installing raised medians or closing large numbers of driveways and median openings, can be alarming to local business persons. They often view them as one additional event that could put them out of business or at least dramatically hurt their sales.

Involving business persons early on in the project planning and development process and educating them about actual past business experiences with access management is necessary to avoid potential opposition to projects. Engineers, planners, and other officials planning and implementing access management clearly must keep in mind the unique perspective of local business persons.

ACKNOWLEDGMENTS

The Iowa Department of Transportation and the Iowa Highway Research Board funded this research project. The Iowa Access Management Task Force, an interdisciplinary group with representatives from federal, state, city, and county agencies and the private sector, provided considerable guidance.

NOTES

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1. This story is told in Iowa's 18- minute videotape entitled, "Access Management: the Sensible Solution." This tape is now being used to educate business persons and local officials about access management and its impacts.

2. Clive's community sales growth numbers were excluded from this analysis because they were so large as to obscure the results.

3. The complete research and all business and customer survey results may be found in Maze, Tom and David Plazak, "Access Management Awareness Program Phase II Report", Iowa DOT Project TR-402, Center for Transportation Research and Education, Iowa State University, Ames, IA, December 1977. This report is also available on the World Wide Web at:
http://www.ctre.iastate.edu/access

4. "Access Management: the Sensible Solution" videotape.

Orlando Area Business Surveys for Median Retrofit Projects

Gary Dickens, Ivey, Harris & Walls

PRESENTATION

Within the previous five years, the Florida Department of Transportation (FDOT) has completed the construction of roadway median modifications to several corridors within District 5. These include SR 423(Orange County), SR 520 (Brevard County), SR 600/US 92 (Volusia County and SR 436 (Seminole County). Improvements to the medians were supported through the use os various traffic analyses and traffic modeling efforts. Such results indicated that the subject corridors were in need of medians improvements for various reasons; to better facilitate the flow of traffic along and entering and exiting the roadway, to decrease accidents and to improve the response time of public service providers to emergency situations. This report provides further analysis of these activities from a post-implementation perspective.

Elements of this analysis were as follows: Corridor field surveys were conducted for every parcel along each roadway to determine the type and magnitude of land use. Aerial photographs and County tax maps were also analyzed to determine the parcel ID codes as well as parcel boundaries and building square footage. U.S. Census data for 1990 was also reviewed relative to the residential uses which border roadways. Individual tax records were reviewed to determine the altered economic status of selected parcels in the before and after period of the median modifications. Finally, a large scale, attitude oriented mail back survey of businesses, drivers and agency representatives was also performed for this report.

PURPOSE

There are several purposes for this research. The main purpose for this document is to measure and evaluate the public's response to prior median modifications undertaken by the Department. This document provides a companion reference to a traffic engineering analysis documented under separate cover. It allows the reader of that analysis to better understand the context area of that traffic engineering evaluation. It also provides the opportunity to gauge the response of the Department's 'customers" to specific projects.

This project is also an attempt to more precisely determine the expanded list of variables, if any, that may be affected and should be considered as part of future median operations analysis. To date, previous median operations analyses have, for the most part, focused on the traffic operational aspects of different types of median uses on high and medium volume urban roadways. Typically, turning movement and driveway counts, traffic accident reports, modeling, etc. have been used to determine the necessity or magnitude of improvements needed per roadway. Research literature has also followed a similar format where, for example, several case studies and arguments have been posed for and against restrictive medians and two-way left turn lanes (TWLTLs). A summary of pertinent related research and its relationship to this project is found in the report Appendix.

Although previous studies have identified several elements that, in general terms, would affect the corridor, this study may provide one basis to warrant an expansion of evaluation criteria in future FDOT roadway planning and improvement efforts. For example, refined analytical approaches by the Department to strategically site median openings such that a stimulus to change adjacent corridor settings could potentially benefit both the users of the corridor and the corridors economic and visual appearance. Through the understanding of user attitudes along these corridors, it is also believed that future methods can be considered so that inconvenience to users of other corridors is minimized to the extent feasible. This research may also provide the basis for amended public relation or project management activities which might increase public support in the project planning and construction period. Through application of the study results, impacted local users and public officials alike may develop a greater understanding of FDOT's median operations process and might better assist the Department in public outreach efforts.

A Methodology to Determine Economic Impacts of Raised Medians on Adjacent Businesses

William E. Frawley Texas Transportation Institute
William L. Eisele, Texas Transportation Institute

ABSTRACT

A very common remark at public hearings related to the construction of raised medians is that there will be detrimental economic impacts on adjacent businesses. Raised medians restrict access to businesses along a corridor by limiting turning movements to select mid-block locations. To date, little research has been available on the economic impact of raised medians on adjacent businesses and properties.

The authors of this paper have recently completed two years of a multi-year research project for TxDOT in which they are investigating economic impacts on adjacent businesses due to the installation of raised medians for the (TxDOT) (1). In the first year of the project, the research team developed and tested a methodology to identify, collect, and analyze data for determining economic impacts on adjacent businesses. The data include property values, gross sales, employment trends, and other economic indicators. During the second year the research team revised the methodology and tested it on ten case study corridors. In the subsequent years of the research project, the data collected will be analyzed and additional case study work will be performed.

This paper summarizes the process of developing the methodology and discusses the experiences of testing the methodology on case studies in Texas. The experiences of the research team are shared here for those who may be considering future evaluations. Initial conclusions of value to the sponsor, and likely to others, that can assist in the public involvement process are included. It is anticipated that the final research product, when completed, will be a valuable asset for transportation professionals, in both public and private sectors, who must provide estimates and expectations of the economic impacts of raised medians.

METHODOLOGY

The primary purpose of this research project is the development of a methodology to determine if there are any economic impacts on adjacent businesses when a raised median is installed. The research team developed a methodology and tested it on a case study in the first year of the project. After analyzing the procedures and results of that test, the research team revised the methodology and tested it on ten case studies in the second year of the project. The current methodology, consisting of eight main steps, provides a logical structure by which the user can identify case studies, collect data and analyze data. Each step has some specific details which are discussed below.

1. Identify sites (cities) with potential corridors;
2. Identify corridor characteristics;
3. Contact sources of information;
4. Inventory businesses and establishments along the subject corridor;
5. Obtain information about businesses;
6. Prioritize businesses to be surveyed;
7. Collect data by personal interviews; and
8. Analyze and summarize data.

1. Identify Sites (Cities) with Potential Corridors
The first step of the methodology is to identify cities or areas that have corridors in which a raised median has been installed in the last three to five years. This time period is desired so that enough after-construction data will be readily available to develop historical trends before and after installation.

2. Identify Corridor Characteristics
After a site has been selected, one needs to identify the characteristics of the subject corridors. These characteristics include, but are not limited to, abutting land uses, street cross section, and corridor length. This part of the methodology can be performed through discussions with local officials and by reviewing land use maps.

3. Contact Sources of Information
Once a satisfactory corridor has been identified, the research team should make contact with local data sources and support agencies. The researcher should contact the chamber of commerce or other organization, such as the Spring Branch Revitalization Association in Houston. Such an agency could assist in explaining the purpose of the study and gaining local support of the research. The researcher should specifically request a letter of endorsement regarding the survey process which can be sent to business owners along the corridor. Often the chamber or other organization can also provide valuable information about the project itself, history of the corridor, community concerns, and additional information of interest. The chambers and similar organizations are generally supportive of these study efforts since they provide insight into business owners' economic concerns.

The local appraisal office should also be contacted to establish a working relationship with their staff. The methodology requires property values for the corridor, as well as for the entire city, from the appraisal districts. The city property value information is used as control data to compare against the individual values. Data from up to five years prior to the median installation, through the time of the study, is desired. Experienced appraisers can also provide useful anecdotal information about the corridor as well.

The city comptroller, or similar staff member, should also be contacted to determine the amount of revenue from taxes obtained by the city in which the corridor is located. These data will provide a control value of the gross sales for the city to compare to the gross sales trends obtained from the survey responses. This information is also available from the State Comptroller's Office.

4. Inventory Businesses and Establishments Along the Subject Corridor
The first part of this step is to perform a "windshield survey" of the businesses along the corridor. The researchers drive the corridor, record the names of operating businesses, and document vacant buildings. The business names should be recorded on a list, as well as on a map of the corridor. From this step in the process, businesses can be classified by their type of primary operations, such as gasoline stations, hotels, specialty retail, durable goods, and others.

5. Obtain Information About Businesses
In addition to the official names of the businesses, researchers should obtain the addresses, phone numbers, and any other relevant information. Most of this information is available through local phone books and can be verified with phone calls if deemed necessary.

6. Prioritize Businesses to be Surveyed
Next, the research team needs to prioritize the businesses for inclusion in the interview survey process. This step is necessary due to the expense involved in conducting interview surveys and can be performed using the basic information gathered for each business along the corridor. The researchers analyze the types and

numbers of businesses and determine which ones are the best candidates for being surveyed. Three priority levels should be assigned: priority 1 (high), priority 2 (moderate), and priority 3 (low). Examples of priority 1 establishments are gasoline stations, convenience stores, restaurants, hotels, and retail stores. Priority 2 businesses should be surveyed in the case that not enough priority 1 businesses participate in the survey process. Priority 2 businesses can also be surveyed to help provide an even geographic distribution of respondents. Priority 3 establishments are those that do not appear to be as obviously economically impacted by the raised median installation, or that are represented by extremely few examples of their type on the corridor. Priority 3 establishments often include municipal facilities, corporate offices, medical facilities and businesses that deal in very high-priced and durable items.

7. Collect Data

The data collection process begins with the research team making an initial contact with the targeted businesses along the corridor by sending a letter of introduction explaining the study. The letter of support from the chamber of commerce or other organization needs to accompany the researcher team's letter. This initial contact "breaks the ice" so when the research team makes a second contact over the telephone, the business will hopefully already be familiar with the research project. The telephone contacts are made with the goal of identifying the person at each business who will participate in the survey process and can provide the needed information. An interview appointment should be scheduled during this telephone contact, if possible. Otherwise, another call needs to be made to set the appointment with the appropriate person. It is best to try to schedule appointments to begin every hour, as consecutively as possible, and grouped geographically, if possible. One or two days before each appointment, the prospective respondent should be contacted to confirm the appointment. Finally, a project team member will go to the business and conduct the survey interview.

Interview questions, along with the survey instrument, are described in detail in the research report upon which this paper is based (1). These questions generally ask the business owner their perception of, or actual changes experienced (depending on the interview time relative to the construction of the median), due to the raised median installation. Factors such as gross sales, property values, customers per day, and employment trends of the business are investigated.

8. Analyze and Summarize Data

The final step of the methodology is to analyze the data collected in the survey, as well as by other means. Quantitative survey responses should be summarized and statistically analyzed, where applicable. Qualitative data, including business owner comments, should be given strong consideration when evaluating the potential economic impacts of a project. It is necessary to obtain data for the before-, during-, and after-construction phases of the project to estimate potential economic impacts on adjacent businesses. During-construction data are collected if one is interested in potential impacts of the construction phase itself. The analysis steps below can be used to aid in estimating the economic impact of the raised median installation.

1. Stratify data by appropriate variables for further analysis (e.g., business type, whether a business is in a shopping center or is strip development, whether a business is adjacent to a median opening).

2. Investigate sample sizes for different analyses of interest (e.g., gross sales, change in parking spaces, change in employees) to determine possible levels of disaggregation of the analyses.

3. Calculate percent change values for gross sales, parking spaces, employees, or property values between construction phases of interest (i.e., during- or after-construction with before-construction). Investigate mean and standard deviations of these values.

4. Investigate perceptions of individual business owners or managers compared to actual values computed in step 3.

5. Investigate perceptions of individual business owners based upon responses to questions evaluating the estimated percentage of passer-by trips and likeliness of regular customers to return after installation of the raised median.

6. Determine perceived importance to customers of items such as customer service, product quality, product price, distance to travel, hours of operation, and accessibility. This can be compared to actual customer surveys regarding the value they place on such issues.

7. Consider business owner comments. Valuable information can be obtained from business owners about their concerns. These comments should be considered on a business-by-business basis for consideration of estimated economic impacts.

These steps were determined based upon literature review, previous studies, and experiences of the research team in the first year of the project. When selecting sites and performing the survey in the second year, some recommended changes are worth noting. In step three, making contacts can often go beyond the chamber of commerce or the appraisal district office. In larger cities, local neighborhood and/or business groups may be more influential than the local chamber of commerce. Various business or neighborhood associations may also provide support for the research as well as being a valuable source of corridor history, additional contacts, and other valuable information. Other contacts of importance that can be made at this stage include the State Comptroller's Office where gross sales-related information can be obtained for different cities. This information can be used as a "control" for comparison of the data obtained in the field. The State Employment Commission can also provide employment rates for different areas for use as a "control" for employment changes that may be noticed along the corridor. Finally, some private companies sell compact discs containing appraisal data for larger metropolitan areas. This facilitates the collection of appraisal data, though it can be short term in nature.

Additional knowledge has been gained in Step Six: Prioritization of Businesses, as well. In the first year of the study, the surveys were administered through personal interviews along the entire Texas Avenue corridor. During the second year of the study, the research team wanted to obtain as much data as possible from the largest number of sites possible with the available resources. The best way to conduct this effort was to contact some sites with personal interviews and some with mail-out surveys. This also allows the research team to evaluate what method may be best for data collection. Mail-out surveys are much less costly to administer and, therefore, setting priorities is not necessary. When mail-out surveys were used, surveys were sent to all possible business managers/owners and undeveloped land owners along the corridor. Therefore, step seven of collecting data included both personal interviews and mail-out surveys.

In the first year of this study, a recommended methodology was developed and tested on one case study location in College Station, Texas. Data were collected before and during construction along this corridor, where a raised median was being installed. In the second year, the research team sought additional case study locations to test the methodology for estimating the economic impacts of median design. The second year of the research effort was used to identify and collect data at these additional case study locations. After investigating several potential case study locations, the research team selected ten sites in the following cities: McKinney, Longview, Wichita Falls, Odessa, Houston, and Port Arthur. The third year of the study will be used to analyze the data collected in the additional case study locations identified in the second year, and the final year of the research effort will be used to collect after-construction data along Texas Avenue and complete all analysis.

As previously noted, in the first year of this research effort along Texas Avenue, data were collected during construction along one portion of the study corridor, and before construction along the remainder of the corridor. In two of the sites selected in the second year of the study, data were collected before construction had begun. These sites were Call Field Road in Wichita Falls and Long Point Road in Houston. If the construction is completed during the research project time frame, the research team will attempt to collect after-construction data along these corridors in the last year of the study. For the other eight additional case studies identified in the second year of the study, data collection was performed after the construction was completed.

Administer Suggested Surveying Techniques
Participants in the survey included business owners/managers adjacent to the corridors of interest. The research team first conducted a "windshield" survey to determine which businesses and land uses were present along the corridors in which the survey was to be administered. Business information (e.g., address and contact name) for each location was then obtained from the chamber of commerce, appropriate neighborhood/business groups, county appraisal district office, and/or telephone directories. Five of the ten additional case studies identified in the second year were performed with personal interviews similar to Texas Avenue in the first year of the study. For these sites, the research team contacted all businesses by telephone to determine their interest in participating, and arranged an interview at each of the locations to administer the survey. Mail-out surveys were sent to businesses owners/managers and undeveloped land owners along the other five case studies of interest. For all the sites, a letter of support of the research effort was sent, endorsed by the local chamber of commerce or neighborhood association, to encourage them to participate in the survey. Finally, reminder cards were sent to the five case studies where mail-out surveys were administered to encourage individuals to return the surveys.

III. CASE STUDIES

BACKGROUND

While refining the survey instrument, the research team identified potential case study corridors on which to test the refined surveys. The attributes, including age, length, and cross section, vary among the case studies the team investigated. Researchers made telephone calls to TxDOT District Offices, Metropolitan Planning Organizations (MPOS), and city planning and public works departments to determine where raised median projects are located. This step yielded several potential case studies, many of which became part of the project. This section describes the selected case studies as well as additional locations of interest that may be useful for related future studies. Table 1 summarizes the case studies added in the second year of the research study.

SITE INVESTIGATIONS

Site Selection
The research team decided it was necessary to investigate all potential case study corridors to determine their applicability to this project. The process of investigating potential case study corridors included several steps. The first step of the site investigation process was to talk to local officials (TxDOT, MPO, city, etc.) in order to obtain as much preliminary information as possible about each corridor. This information included the type of construction project, the construction time period, the types of abutting development, and the amount of abutting, undeveloped land. The research team used this information to rule out corridors that did not fit the parameters established in the refined methodology. Preferable corridors included those that had been constructed within the last six years or so and were primarily abutted by commercial property. The vast majority of the corridors the research team investigated involved the installation of raised medians. However, the team also looked into median removals in Amarillo, Port Arthur, and La Joya.

Site Visits
At least one researcher visited each corridor to obtain a perspective of the type of development. The only potential corridors not visited were located in La Joya. The research team did not visit these corridors due to the age of the projects. When possible, the researchers visited several corridors on one trip, minimizing travel time and expenses. All of the corridors visited, with the exception of one series of corridors, are located in cities within Texas. The research team also investigated a series of corridors along 71st Street and adjacent intersecting streets in Tulsa, Oklahoma. The researchers looked for corridors which contained large percentages of retail development compared to residential development, office development, or undeveloped land. The site visits also entailed performing windshield surveys and photographing the corridors.

Windshield Surveys
To get the most detailed information possible during the site visits, the researchers performed windshield surveys of the corridors. In doing so, they recorded the names, addresses, and telephone numbers (when available) from store fronts. The researchers recorded this information by sketching maps of the corridors and noting specific details such as parcel location, site circulation, driveway locations, and median opening locations.

Photographing the Corridors
This business inventory process also included photographing the corridors. Researchers took slides of the roadway cross sections, as well as examples of adjacent businesses. The researchers used the slides as a record of specific attributes of the corridors. The slides provided an opportunity for other members of the research team and interested individuals to get a realistic view of the corridors. Some of the slides appear as figures in this report. The slides will also prove useful in presentations related to this project.

Table 1. Case Study Locations

Street Name	City and State	Before Const.	After Const.	Age	Length (mi)	Survey Type	Land Use	Total # of Establishments
Texas Avenue	College Station, TX	TWLTL	Raised Median	Under Const.	1.0	Interview	Retail, University	
South Post Oak	Houston, Texas	Undivided	Raised Median	8	1.5	Interview	Retail, Industrial	155
Clay Road	Houston, Texas	Undivided	Raised Median	2	2.3	Mail-out	Retail, Industrial, Undeveloped	63
West Fuqua Road	Houston, Texas	Undivided	Raised Median	9	1.5	Mail-out	Retail, Undeveloped	68
Long Point Road	Houston, Texas	Undivided	Raised Median	Within the next year	0.7	Mail-out	Retail	41
Twin Cities Highway	Port Arthur, Texas	Raised Median	TWLTL	13	2.0	Mail-out	Retail, Office	90
9th Avenue	Port Arthur, Texas	Undivided	Raised Median	18	1.5	Mail-out	Retail, Residential, Undeveloped	66
University Drive	McKinney, Texas	Undivided	Raised Median	6	1.4	Interview	Retail, Residential	132
Loop 281	Longview, Texas	Flush Median	Raised Median	2	0.6	Interview	Retail	65
Call Field Road	Wichita Falls, Texas	Undivided	Raised Median	Under construction	0.3	Interview	Retail	55
Grant Avenue	Odessa, Texas	Undivided	Raised Median	6	0.6	Interview	Retail, Office	42

Table 2. Additional Sites of Interest

Street Name	City and State	Before Const.	After Const.	Age (years)	Length (km)	Land Use	Reason for Not Including
71st Street	Tulsa, Oklahoma	Undivided	Raised Median	Varies (under construction to 3 years)	6.4	Retail, Undeveloped	Budget Constraints
Yale Avenue	Tulsa, Oklahoma	TWLTL	Raised Median	5	1.6	Retail, Office	Budget Constraints
Various	Amarillo, Texas	Raised Medians	TWLTLs	4 to 6	Varies[1]	Retail	Budget Constraints
Loop 323	Tyler, Texas	Depressed Median	Raised Median	Under Construction	5.0	Retail, Undeveloped	Previously Separated by Depressed Median
Various	La Jaya, Texas	Raised Medians	TWLTLs	About 30	Varies[1]	Retail	Age

[1]There were numerous segments ranging from very short to significant lengths where medians were removed.

CASE STUDY DESCRIPTIONS

These case studies include corridors with a variety of business mixes. Most of the corridors are in suburban type areas with shopping centers and strip retail development. One of the corridors, Grant Avenue in Odessa, is located in a central business district. The specific types of development on the individual corridors ranges from completely retail to a mix of office, institutional, and retail. These development mixes drove the numbers of potential survey participants on each corridor. In addition,
the cities included in the study reflect a variety of population sizes. The populations range from approximately 25,000 in McKinney to approximately 1.7 million in the City of Houston. Table 1 at the end of this section summarizes several different characteristics of interest for each of the ten sites.

ADDITIONAL SITES OF INTEREST

During this year of the study, the research team also investigated other potential case studies. These locations are discussed in this section, and key characteristics of each location are shown at the end of this section in Table 2. For various reasons, these corridors were not included in the methodology testing.

IV. FINDINGS

The research team spent this year of the research effort primarily on data collection, with analysis of the data to be performed in the next fiscal year. However, the research team did make some preliminary observations and general findings. Most of these observations are related to the process of data collection and survey administration. This section of the report discusses the preliminary observations the research team made in reference to the processes involved in collecting the data through two types of survey techniques, interviews and mail-outs.

The following discussions in this section describe several observations and findings about the data collection effort. These discussions will cover participation rates, issues related to mail-out versus personal interviews, and the overall project status. These observations will provide the research team and TxDOT with future implementation of this methodology.

Data Findings/Year One

The data collection for this project will be completed in the fourth year of the study when the "after" data are collected along Texas Avenue. However, preliminary findings of importance are described below. These findings are based upon results of the in-person surveys of business owners along the entire segment of Texas Avenue.

Survey participation

Of particular interest in this study was the response rate and relative success of such a study. A significant portion of the methodology development depended upon the accuracy and quantity of data obtained in the surveys. Seventy-three percent of the businesses that were contacted, participated in the scheduled personal interview. A total of 95 businesses were surveyed. Twenty-five were from the northern segment (during-construction), and 75 from the southern segment (before-construction).

Gross sales perceptions

The results of table 1 indicate survey responses from business owners. A majority (67 percent) of the responding business owners in the northern segment (currently under construction) believe that their gross sales will go down due to the construction along Texas Avenue. This demonstrates that there is considerable concern for gross sales during the construction phase. After the median is installed, a majority of the business owners

(65 percent) believe that gross sales will either increase or remain the same as prior to the construction. Similar expectations were found in the southern segment as shown in table 1. Therefore, the construction phase is the most financially difficult stage for the businesses. The business owners in the southern segment have similar expectations as shown in table 1.

Gross sales data
The ability to collect gross sales data from business owners was an important element. Fifty out of the 95 businesses surveyed provided sales data in either actual figures by year (n=30) or by indicating a range representing their gross sales (n=20). Preliminary before- and during-construction comparisons along the northern segment were difficult since the sample sizes were relatively small.

Table 3. Gross Sales Perceptions of Business Owners

Construction Stage	Down	No change	Up	Unsure
All businesses in northern segment, currently under construction (n=24)				
During	67%	21%	12%	--
After	22%	30%	35%	13%
All businesses in southern segment, prior to construction (n=69)				
During	61%	26%	7%	6%
After	16%	44%	29%	11%

No significant differences were found when comparing the before- and during-construction data. These are just preliminary analyses along the northern segment, and these analyses will be completed in the year 2000 when the after-data is available. The research team is still optimistic of the methodology and the suggested technique to collect data by in-person surveys since it provides the most meaningful data. Future work includes looking into the question of survey development to produce even higher response rates.

Employment perceptions and data
A number of business owners indicated that they would not alter their number of staff during the construction phase of the project. Only one business in the northern segment indicated that they would be decreasing their number of part-time employees. Similarly, only one business in the northern segment indicated that they would decrease the number of full-time employees as well. Therefore, it was found that businesses tend to be loyal to their employees during the potential financial constraint caused by construction. Clearly, there are other economic factors potentially affecting employment trends (e.g., the local business cycle), but this does indicate that employers are usually very loyal to their employees.

Additional perceptions
Business owner perceptions were also obtained for customers-per-day and property values. It was found that the results of these factors were similar to those of the gross sales shown in table 1. This indicates that there is a clear effect on these indicators during construction, however, a majority of business owners generally feel that, after construction, there will be either an increase or no change, relative to the before condition.

Perceptions of customer preferences
One question on the survey asked business owners to rank the following items according to their importance

to customers in selecting their businesses: customer service, product quality, accessibility to store, product price, hours of operation, and distance to travel. It was found that business owners generally indicated that accessibility to the store ranked either third or fourth (third for the northern segment and fourth for the southern segment). This indicates that, according to business owners, the most important elements used by customers to determine what businesses they will patronize are factors that may be controlled by the business owners themselves (e.g., customer service, product quality and price). Similar results were obtained in recent research performed by Bonneson and McCoy (2).

Business owner comments

Some of the most useful information provided by this research in developing the methodology has been gained through discussions with business owners during the personal interviews. The following are some of the comments and concerns expressed by citizens in the personal interviews.

Usefulness of access restrictions: Business owners generally understand the usefulness of access restrictions, but many business owners wished they could have been more involved in the public involvement process.

Concern for future traffic diversion: Many business owners expressed their concern that the restricted access would lead to a diversion of traffic to side streets that provide access to their businesses.

Lacking knowledge and concerned about construction: Many individuals asked questions and/or expressed concerns over issues that could be addressed with more information about the project initially and project progress reports throughout construction. Questions and concerns such as, "when will the construction be completed?," "what is the construction schedule?," "what is the project phasing?," and "why are certain elements of a project performed at different times?," can be addressed in the public hearing phases of the project and through media efforts throughout the project. Many business owners knew this information due to efforts along the Texas Avenue corridor. However, there was generally a desire for faster construction and shorter construction phases.

Methodology Findings/Year Two

One of the initial considerations of the research team was the ability to obtain valuable data from the business owners (i.e., would business owners be willing to volunteer accurate data?). In addition, the research team desired to obtain data from as many respondents as possible. As a result, the team developed two survey instruments - one for interviews and one for mail-outs. Utilizing two types of survey instruments provided useful information with which to compare their effectiveness. Tables 4 and 5 present participation rates for the mail-out surveys and personal interviews, respectively.

To aid in obtaining as much data as possible, given the time and financial constraints of the project, the research team sent mail-out surveys to businesses along five of the case study corridors. This process yielded additional data for the research from different study locations, and provided an opportunity for evaluating different data collection techniques.

The participation rates for the five mail-out surveys performed in the second year of the research effort are illustrated in Table 4. This table breaks down the participation rate by corridor and parcel type (e.g., business or undeveloped land). The participation rates ranged from 6 to 17 percent. Overall, the total participation rate for both businesses and undeveloped land was six percent. It is important to note that surveys were sent to all businesses and undeveloped land owners identified along the corridor during the windshield survey and through the appraisal district data. Therefore, businesses that moved, did not want to participate, or were not likely to be affected by the median were not removed from the mailing list prior to sending the surveys. Since the mail-out surveys were relatively low-cost, the time was not taken to remove these individuals from the list.

Further, it was possible that some of these establishments might provide additional information of interest. The result is that the participation rates are lower than they would have been had these businesses been removed from the original sample.

It should also be noted that the Spring Branch area is in the process of revitalizing the areas near the Clay Road and Long Point Road corridors in Houston. The Spring Branch Revitalization Association was performing public hearings discussing the plans for the Long Point Road corridor and discussing the economic developments and revitalization along Clay Road. The research team was able to attend one such meeting. It is likely that these ongoing efforts in this area contributed to the higher participation rates of these corridors.

Finally, for a very small cost, the research team sent out reminder cards about three to four weeks after the mail-out surveys were originally sent. This reminder did seem to help in obtaining a response from some businesses and undeveloped land owners as a few more surveys were received. It also prompted several individuals to call the research team and thank them for the reminder. Usually these individuals would simply respond that they regretted to inform the researchers that they did not believe their information would be of value since their business had arrived so far after the completion of the raised median. However, this technique was still useful to the research team because these individuals could sometimes supply anecdotal information of use about the corridor. The reminder card process also helped in keeping track of what business or undeveloped land owners had, or had not, participated.

Table 5, previously presented, displays the participation rates for the personal interviews in the five other case study corridors from this year of the study, as well as the original test of the methodology in the first year of the study along Texas Avenue. The participation rates are generally much higher when performing personal interviews than when mailing out the surveys. The participation rates range from 36 percent (South Post Oak) to 73 percent (Texas Avenue). It is expected that the participation rates along South Post Oak could be relatively low because the raised median was installed at least eight years prior to the survey administration. In addition the site was located in a very large city rather than a smaller community where business and undeveloped land owners may be more likely to the take time to sit through a personal interview. Along Texas Avenue in College Station, the proximity to the Texas A&M University campus, and the construction being underway during the research project, were likely reasons for that higher participation rate.

There were only three undeveloped land parcels along the South Post Oak case study location. The land owners for two of these three parcels were contacted, but they requested a survey be mailed to them. Although these surveys were mailed out, unfortunately they were not returned. Many of the business owners along South Post Oak requested that the survey be mailed to them, rather than participate in a personal interview survey. In addition, mail-out surveys were sent to many of the businesses along South Post Oak if there was difficulty contacting them. Of these additional surveys mailed out, nine additional surveys were returned for the South Post Oak corridor.

Table 5 contains the number of business establishments that were contacted and the number of businesses that participated in the personal interviews. Some of the business owners that were contacted simply did not want to participate. Numerous owners claimed their business were not affected by the median installations. Further, some owners or managers failed to show up for the scheduled interview. The research team recorded this information and will evaluate any possible trends in these responses (e.g., a particular type of business does not want to participate and/or does not feel the median installation would affect their business type) and the impacts on participation rates.

Table 4. Participation Rates for Mail-Out Surveys

Street Name	City and State	Number of Parcels		Total Number Sent	Returned Surveys		Participation Rates (Percent)		
		Businesses	Undev Land		Businesses	Undev Land	Businesses	Undev Land	Total
Clay Road	Houston, Texas	61	11	72	8	1	13	9	13
Fuqua Road	Houston, Texas	62	28	90	4	2	6	7	7
Long Point Road	Houston, Texas	35	0	35	6	0	17	N/A	17
Twin Cities Highway	Port Arthur, Texas	90	0	90	5	0	6	N/A	6
9th Avenue	Port Arthur, Texas	68	23	91	5	3	7	13	9
Totals =		464	65	529	28	6	6	9	6

Table 5. Participation Rates for Personal Interviews

Street Name	City and State	Total Number of Establishments Contacted[1]	Number of Business Participants	Participation Rates (Percent)
Texas Avenue	College Station, Texas	130	95	73
South Post Oak	Houston, Texas	50	19[2]	36
University Drive	McKinney, Texas	47	29	62
Loop 281	Longview, Texas	40	22	55
Call Field Road	Wichita Falls, Texas	27	17	63
Grant Avenue	Odessa, Texas	21	15	71
Totals =		315	197	62

[1]There were no undeveloped land parcels along any of the corridors except South Post Oak. This corridor had three such parcels, but two of them requested a mail-out survey and one was not able to be contacted.
[2]Nine additional surveys not reflected here were received from the South Post Oak businesses. These were from individuals who had requested that they be sent a survey instead of performing a personal interview, or responses to surveys sent to many of the businesses along South Post Oak if there was difficulty contacting them.

Although the data have not been thoroughly analyzed yet, the research team's preliminary observation is that the personal interviews provide the researcher with more reliable and more useful data than the mail-out surveys. Being with the interviewee allows there to be no confusion about how to answer questions and, after a comfortable conversation is begun, the business and undeveloped land owners appear likely to provide the best information, data, and first-hand accounts of any economic impacts.

V. FUTURE WORK AND RESEARCH CONSIDERATIONS

Future work for this multi-year effort includes finding additional locations in which the recommended methodology can be tested, to determine more case study information about the concerns of business owners and the potential impacts of raised median design. Several sites are being identified for additional case studies. These future case study locations include corridors where a median is already installed and sites where the surveys are performed before-, during-, and after-construction. Locations where medians have been removed are also being considered for analysis. Finally, the "after" data collection phase and subsequent analysis along Texas Avenue will be performed in the year 2000.

The research effort which this paper describes has addressed many of the concerns about the potential impacts that a raised median may have on adjacent businesses. The authors would like to highlight a few of the areas that arise as research considerations for those agencies or individuals considering studies of this sort in the future. These issues do not "stand alone," but should be considered together.

"Quality" vs. "quantity" issue
Informal discussions about this project have led to a question about the amount of data to collect. The first question that one must address in a study of this sort is whether more samples should be collected at a single case study or fewer samples should be obtained from several case studies. Clearly, the more information that can be obtained, the better; however, it is important to obtain data from several locations to determine if impacts are similar at different locations. In the first year of this study, a local case study was evaluated.

Mail-out survey vs. in-person interview
In the opinion of the research team, more discussion and potentially more accurate information can be obtained in an in-person interview that has been scheduled with a particular contact person. However, this is more costly than a simple mail-out survey. The in-person interview and the administration technique used was found to be very successful and, therefore, will be recommended in the final methodology.

When to administer surveys
The research team may perform the surveys before-, during-, and after-construction phases for a particular project (traditional before-and-after technique) or attempt to obtain all the data after the median has been installed for the "before," "during," and "after" construction phases (post-facto technique). The major drawback to the traditional before-and-after technique is the need to wait for the project to progress; however, it may result in data that is more accurate, since one is requesting information while the project is at a particular stage. The research team is evaluating this concern further by evaluating both types of locations in future case studies.

Determination of the most useful questions
It is important that questions be phrased in the most useful form to gain the type of information that is desired, while not providing additional bias from those responding. Each question and what it is intended to determine should be clearly defined. In this study it was found that questions asking the number of parking spaces (to determine any changes) were not found to be useful since many businesses had shared parking. It was also found that it may be too "intimidating" to ask for specific gross sales values. Therefore, revised surveys ask for a change in the sales between years.

Inference of results
One of the most significant concerns with studies of this sort, is the ability to infer the results to the entire corridor and what a business owner may expect when moving to the corridor. Inferring beyond the study corridor to a roadway in a different geographic location is also very difficult due to the different economic influences that may or may not be present. The final year of the research study will provide insight into the similarity between results at different locations.

CONCLUSIONS AND IMPLEMENTATION

Much insight into the perceived economic impacts of raised median design surfaced as a result of this methodology development. Not only can preliminary conclusions be drawn about the Texas Avenue corridor, but insight for future studies investigating the economic impacts of median design, including a methodology, survey development, and survey administration, were also found. This information is valuable for the sponsor and others, for both future studies of this type, and for use in the public hearing process of raised median installation projects. The experience gained in this research effort will assist future studies. The methodology revealed many of the concerns that business owners and managers have, but had not communicated through previous channels made available by the sponsor.

Survey Development and Administration
The response rate of this study was relatively high at 73 percent. The research team considered the survey development and administration used in the study quite successful. Key elements in the success were: conducting the interviews in person; gaining the support of the local Chamber of Commerce; setting up personal interviews with an identified contact person; and confirming the interviews two days prior to the interview. Therefore, this survey technique is recommended in the methodology.

Gross Sales
It was found that there is considerable concern for gross sales during the construction phase. However, a majority of business owners believe that gross sales will either increase or remain the same as prior to the construction period. This information was very valuable to the sponsor as there was a much more negative impression of raised median installation from feedback at public hearings.

Number of Employees
The research found that a majority of business owners indicated that they would not alter their number of staff during the construction phase of the project. They tend to stay very loyal to their employees during the potential financial constraint of the construction period.

Accessibility to Businesses
Study results indicate that, according to business owners, the most important elements used by customers to determine what businesses they will patronize are factors that may be controlled by the business owners themselves (e.g., customer service, product quality, product price). This is concluded by the fact that the vast majority of business owners/managers responded that access to businesses would be a lesser consideration to the consumer than issues the businesses can control themselves.

Personal Interview Comments
Comments from business owners show a general desire to have been more involved in the public hearing process. They also expressed concern for the diversion of traffic to side streets to access businesses. There was a concern about the construction phasing and rate of completion of the project as well. The public involvement process attempts to raise and address many of these concerns, but as a practical matter many business owners do not react to plans and instead wait until the median is being installed to voice concern.

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2. Bonneson, J. A. and P. T. McCoy. National Cooperative Highway Research Program. Report Number 395. *Capacity and Operational Effects of Midblock Left-Turn Lanes*. Transportation Research Board. National Research Council. Washington, D.C. 1997.

INTRODUCTION

- ▲Sponsor - TxDOT
- ▲Purpose
  - –Public Meeting Knowledge
  - –Business Concerns Insight

PROJECT SCOPE

- ▲Develop Methodology
- ▲Test Methodology
- ▲Recommend Methodology

PROCEDURES

- ▲Literature Review
- ▲Identify Existing Methodologies
- ▲Develop Survey
- ▲Develop Methodology

METHODOLOGY

- ▲Identify Potential Corridors
- ▲Identify Corridor Characteristics
- ▲Contact Info Sources
- ▲Inventory Businesses

METHODOLOGY

- ▲Obtain Business Info
- ▲Prioritize Businesses
- ▲Conduct Surveys
- ▲Analyze / Summarize Data

CASE STUDIES - BEFORE

- ▲Texas Ave (College Station)
- ▲Long Point Rd (Houston)
- ▲Call Field Rd (Wichita Falls)

CASE STUDIES - AFTER

- Post Oak (Houston)
- Clay Road (Houston)
- West Fuqua (Houston)
- Loop 281 (Longview)

CASE STUDIES - AFTER

- University Dr. (McKinney)
- Grant Avenue (Odessa)
- 9th Avenue (Port Arthur)
- Twin Cities Hwy (Pt Arth) - Removal

FINDINGS - DATA

- Business Owner Perceptions
  - Gross Sales
  - Employment
  - Customer Preferences

GROSS SALES PERCEPTIONS

Texas Ave. Businesses - Under Const

	Down	No Change	Up	Unsure
During	67%	21%	12%	0%
After	22%	30%	35%	13%

Texas Ave. - Prior to Const

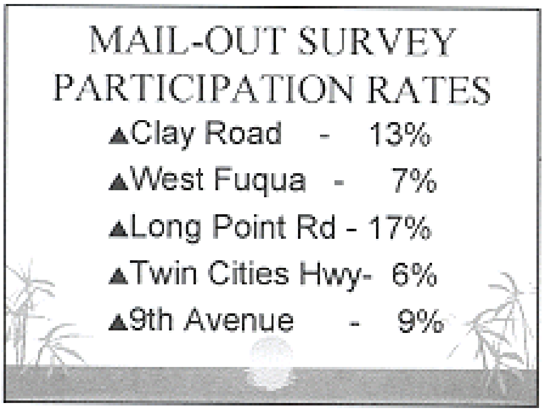
	Down	No Change	Up	Unsure
During	61%	26%	7%	6%
After	16%	44%	29%	12%

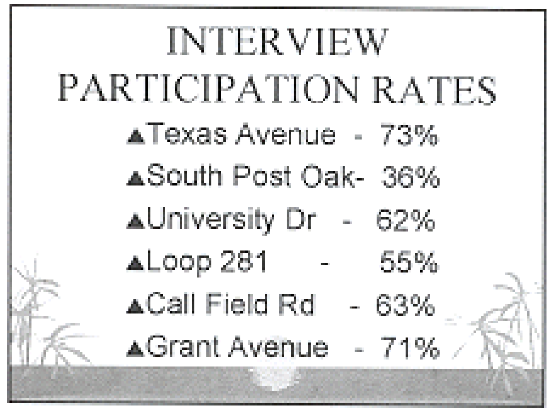
FINDINGS - COMMENTS

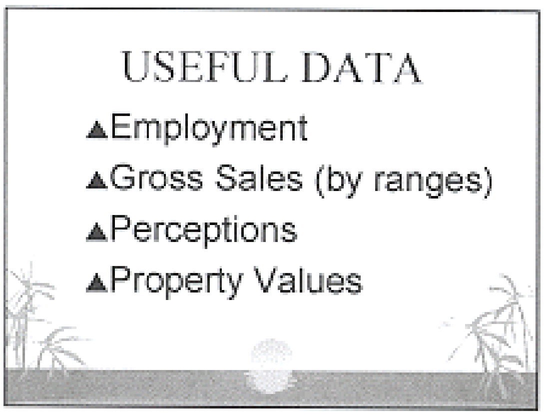
- Usefulness of Access Restrictions
- Traffic Diversion Concerns
- Construction Information

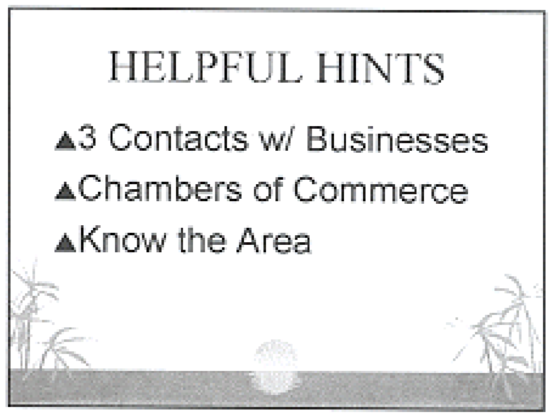
FINDINGS - SURVEY METHODS

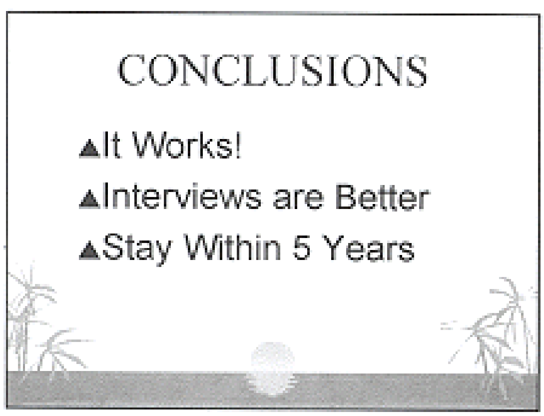
- Mail-Out
- Interview

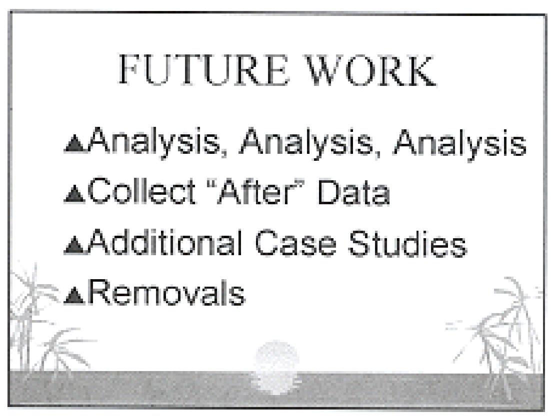

MAIL-OUT SURVEY
PARTICIPATION RATES
▲Clay Road - 13%
▲West Fuqua - 7%
▲Long Point Rd - 17%
▲Twin Cities Hwy- 6%
▲9th Avenue - 9%


INTERVIEW
PARTICIPATION RATES
▲Texas Avenue - 73%
▲South Post Oak- 36%
▲University Dr - 62%
▲Loop 281 - 55%
▲Call Field Rd - 63%
▲Grant Avenue - 71%


USEFUL DATA
▲Employment
▲Gross Sales (by ranges)
▲Perceptions
▲Property Values


HELPFUL HINTS
▲3 Contacts w/ Businesses
▲Chambers of Commerce
▲Know the Area


CONCLUSIONS
▲It Works!
▲Interviews are Better
▲Stay Within 5 Years


FUTURE WORK
▲Analysis, Analysis, Analysis
▲Collect "After" Data
▲Additional Case Studies
▲Removals

Session 21

Corridor Case Studies
Part II

Moderator: Del Huntington, Oregon Department of Transportation

Participants: Donald P. Nims, Jr., Clark Patterson Associates
Chris Huffman, Kansas Department of Transportation
Tim Bevan, CH2M Hill

Approaches to Median Opening Decisions During the Highway Design Phase Opportunity or Not?

Don Nims, Clark Patterson Associates
Stephen Ferranti, SRF & Associates

ABSTRACT

One of the first projects undertaken by the New York State Department of Transportation to implement comprehensive access management is the Route 332 Corridor Improvement Project. Route 332, a seven-mile principal arterial with access, is a major link between the City of Canandaigua and the New York State Thruway and one of the major gateways to the Finger Lakes Region that attracts over 8 million visitors a year. Equally important, Route 332 is used for commuting to the City of Rochester metropolitan area. The growth along this corridor is expected to continue a trend of residential and business development. Thus, the Route 332 corridor must function safely and effectively for commuters, residents, tourists, customers, and businesses.

Route 332 is being improved from a two-lane facility to a four-lane facility with a restrictive median. This paper presents the various approaches to and viewpoints regarding median openings that were considered as part of the decision-making process during the design phase. It discusses the NYSDOT's experience and the local community's position on the median issue.

A restrictive median is a traffic control device. The installation of a restrictive median, and conversely, partial removal for a median opening, should follow a systematic review procedure, similar to a traffic signal warrant investigation. Decisions on where and when to install median openings rely on various guiding principles related to traffic safety, efficiency, and highway function. Yet as experience shows, traffic signals, stop signs and other traffic control devices are occasionally installed less judiciously, at locations that do not necessarily satisfy traffic engineering criteria. This leads to the questions:

- *Where access spacing criteria is met, are overall community goals and needs better served by initially locating and installing median openings into the highway improvement project? Is it better to wait and respond when development pressures and resulting traffic increases necessitate the need for new median openings, at locations potentially less suitable?*

- *Are highway safety, efficiency, and function better served and optimized by designing for the median openings as part of the highway design project, or is the traditional reactionary approach to traffic control installation/modifications more applicable to median openings?*

Route 332 project engineers realized that local involvement was imperative in developing solutions that met local needs and acceptance. Together, they answered these questions in the development of warrants for median openings. As the warrants developed they saw how this was an opportunity to be proactive and shape the community.

INTRODUCTION

One of the first projects undertaken by the New York State Department of Transportation to implement comprehensive access management is the Route 332 Corridor Improvement Project. Route 332, a seven-mile principal arterial with access, is a major link between the City of Canandaigua and the New York State Thruway. It is one of the major gateways to the Finger Lakes Region that attracts over 8 million visitors a year. Equally important, Route 332 is used for commuting to and from the City of Rochester metropolitan area.

The corridor is located in the Towns of Canandaigua and Farmington, Ontario County. These towns and the City of Canandaigua have a combined population of 28,200. The economic vitality of this region is dependent on attracting visitors, and on the ability of residents and visitors to travel safely and efficiently along Route 332. Current land use consists of agricultural, commercial, and residential concentrations along this corridor. A significant portion of the land between concentrations is undeveloped. The comprehensive plans for the Towns indicate commercial land use along most of Route 332 with some industrial use near the New York State Thruway. The Route 332 corridor has experienced significant growth over the past twenty years in commercial and residential development. The growth along this corridor is expected to continue a trend of residential and business development, resulting in a projected AADT of up to 41,000 vehicles.

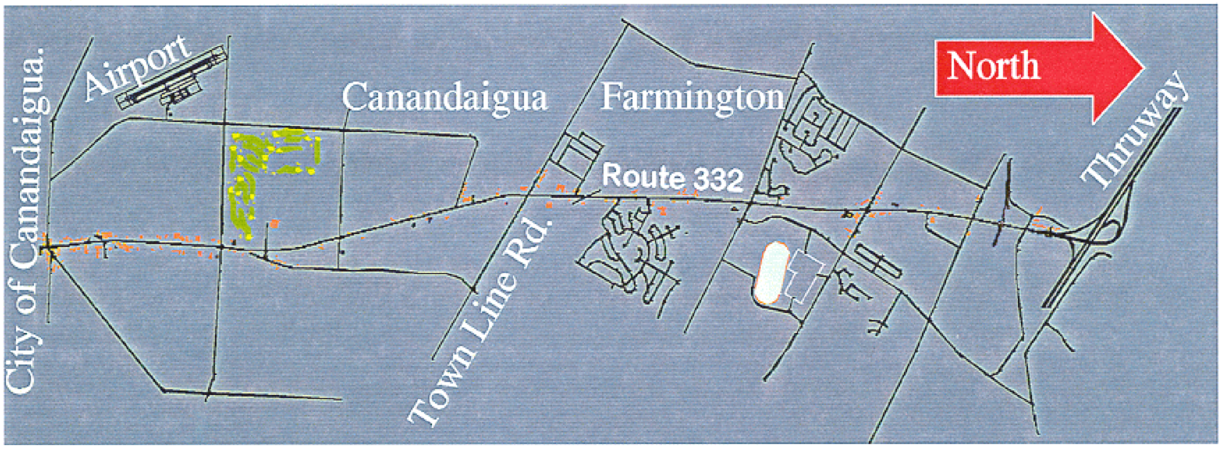
Recognizing the increase in traffic, the existing capacity and safety problems, and Route 332s importance to the region, NYSDOT commissioned a planning study in 1992 to determine the most appropriate means of addressing short and long-term transportation needs. Adding lanes or building an alternative route on a new alignment to supplement the existing facility were investigated. Adding lanes to Route 332 was determined to be the most appropriate, resulting in the development of a $30 million project to widen 11 km (7 miles) of Route 332 from two to four lanes.

In the early 1980's, the Towns of Canandaigua and Farmington took the initiative in investigating the concepts of access management to see how these strategies might be applied to the Route 332 corridor. They devised strategies and plans for implementation, which each Town Planning Board could refer to when developers applied for site plan approval. The result was adoption of local laws that modified zoning ordinances and referred to a network of rear access roads that have been planned and partially implemented. The access road plan helps to define the locations of future major intersections.

OBJECTIVES

Route 332 is a principal arterial that means mobility, or the movement of people and goods, is its primary purpose. The design of this project strove to find a suitable balance between the two conflicting goals of providing a facility which allows uninterrupted free flow of traffic on Route 332 and of providing reasonable and safe access to Route 332 from adjacent residences and businesses. In other words there are two types of travelers on Route 332 - the one who wants to get from point A to point B the quickest, like a commuter or a vacationer; and the other who wants to enter and exit driveways safely, like a shopper or a resident.

These conflicting goals and the need to improve capacity deficiencies while preserving the capital investment prompted the New York State Department of Transportation to consider this project a prime candidate for



implementing access management strategies.

PROJECT DEVELOPMENT

Development of this project to include a comprehensive access management plan required that NYSDOT and community leaders work together throughout the process. This ensured that access management strategies affecting elements under the jurisdiction of the towns or NYSDOT were both included in the plan. Getting the community leaders involved in the decision making process at the beginning of the project also ensured that their needs and ideas were incorporated into the design, whenever feasible. Each town had different needs and ideas because the Towns of Canandaigua and Farmington differ in their vision, zoning, terrain, and development. Their involvement was also essential later, during the public involvement phase.

Learning from the experience of others' efforts to advance access management, the project team was able to implement many strategies. For instance, during the development of this project, representatives of the Towns and the New York State Department of Transportation met several times to produce a document for Access Management Standards that would be equally and fairly applied to the entire corridor. The Access Management Standards consist of criteria for driveway design (including geometry, number, location, and spacing), use of shared and/or cross access driveways, intersection spacing, front or rear access roads, median type and application, median opening locations, etc. The Towns of Canandaigua and Farmington have passed resolutions to adopt and are in the process of incorporating these standards into their local laws and ordinances.

As a major arterial, Route 332's primary objective is to accommodate the safe and efficient movement of through traffic. The construction of a median along the Route 332 corridor is essential to the attainment of this objective. In addition to separating opposing traffic on this high-speed multi-lane facility, medians reduce conflict points, congestion, and travel time such that existing and future traffic will be accommodated safely and efficiently along the corridor.

The speed limits, traffic volumes, type of traffic, and existing right-of-way all factored into the decision making process. NYSDOT and each town contemplated restrictive and non-restrictive median alternatives. The medians were viewed by the towns as a means of shaping and advancing the desired development pattern along Route 332. Restrictive medians were chosen because they would best meet the project objectives. A restrictive median would increase safety, driver comfort, and efficiency.

In the further development of the Route 332 project, median openings were selected such that safe and reasonable access to adjacent properties would be provided. The spacing criteria in the Access Management

Standards were used to determine the location of median openings. Median openings that would accommodate all movements were provided at major intersections. Minor intersections would only accommodate right-in/right-out movements. At first, U-turns would only be accommodated at signalized intersections. This was considered too restrictive; therefore U-turns were permitted at two unsignalized intersections. Mid-block median openings were not included in the design because the introduction of mid-block median openings would expose the motorist to added conflict points and impede the smooth flow of traffic, thus reducing the safety and capacity of the roadway.

The increased mobility provided by the additional lanes and restricted medians proposed by the project would enhance the purpose of the access roads, which therefore are more likely to become a reality. The proposed design and the planned access roads will complement each other. Direction can be reversed utilizing U-turns or the access roads by either circulating back to Route 332 or accessing property by way of the access road(s). The Route 332 Corridor Improvement project was, however, designed to function without the planned access roads.

The design development and assessment of social, economic, and environmental consequences that alternatives would have were documented in a transportation report called the Route 332 Corridor Improvement Design Report/Environmental Assessment. This document was distributed for public comment.

PUBLIC INVOLVEMENT

Initially, access provided by the project was considered reasonable with median openings only at existing major intersections. For better safety and mobility, mid-block openings were not included. However, restrictive medians are not very common on arterials in New York State. During the public involvement process intense pressure and public opposition to the restrictive medians were received. Comments in the form of petitions, letters to state and national congressmen, and newspaper articles all stated that restrictive medians were going to limit accessibility, decrease property values and negatively affect business.

In response to these comments, the need for a restrictive median was reinforced with additional information. As stated previously a restrictive median was essential to the attainment of safe and efficient movement of through traffic. Based on public comments the need to provide additional median openings to enhance reverse access was, however, re-evaluated. Besides, adding median openings was viewed as an opportunity to help shape the community. Developers would focus their plans in an attempt to benefit from the median openings. Additional openings would be included, provided that they were warranted and safe and did not detract from Route 332's primary function.

MEDIAN OPENING REQUIREMENTS

Route 332 project engineers realized that local involvement was imperative in developing solutions that met local needs and acceptance. Together they asked the following questions:

> Who decides where additional median openings go?
> What are the design criteria for locating median openings?
> What are the warrants for additional median openings?
> When do additional median openings get installed?
> What will the additional median openings look like?

Who Decides?

During development of the median opening requirements it became apparent that one town felt additional median openings were not necessary. The other town felt that if one segment gets additional median openings all segments get them. While the towns might not withstand political pressures from residents and businesses, NYSDOT could. NYSDOT could best evaluate the warrants, plus it is primarily responsible for Route 332 and the safe and efficient movement of traffic along it. The towns best understand their community goals, access road networks, and development demands and time frames. The location of additional median openings had to be decided by NYSDOT with input and guidance from the towns.

Design Criteria

The following design criteria for the location of median openings are needed to ensure that Route 332 will operate efficiently and safely:

- median openings must meet the spacing criteria included in the Access Management Standards developed for this corridor;
- sight distance, as recommended in AASHTO, must be available in all travel directions at the median opening; and
- adequate deceleration length for an auxiliary turn lane must be provided at a median opening.

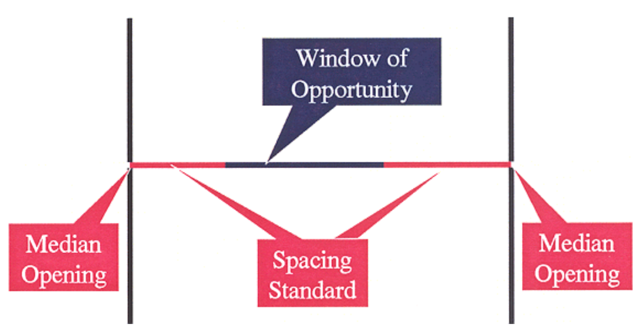
Warrants

Existing reference material covers the spacing of full or directional medians as well as the spacing and warrants for signals. The warrants for mid-block median openings that met the spacing standards, however, were not found. Strong requirements that would stand up to the test of time and pressures from landowners and developers were needed.

The following issues were considered when the warrants for median openings were developed:

- a median opening must be installed to benefit the traveling public not just a particular property;
- priority will be given to existing side streets for median openings; and
- transportation needs for existing and/or future development must be reasonably met.

The towns have expressed and emphasized in their comprehensive plans that strip development was not desired along Route 332. They want planned development in clusters in order to preserve green space and farmland, creating a positive image for Route 332 as a gateway to the Finger Lakes. They have planned access roads to facilitate future development. Nonetheless, will development be small and sporadic occurring over many years and how many trips will it generate? Projecting where and when new development will occur is difficult.



With this in mind the first step in the development of warrants for additional median openings simply determined the windows of opportunity (locations for possible median openings) along the corridor using the Access Management Standards. Only directional median openings were identified because it was assumed that full median openings would not be justified. Windows of opportunity were identified regardless of the warrants and other design criteria. The number of possible median openings was alarming.

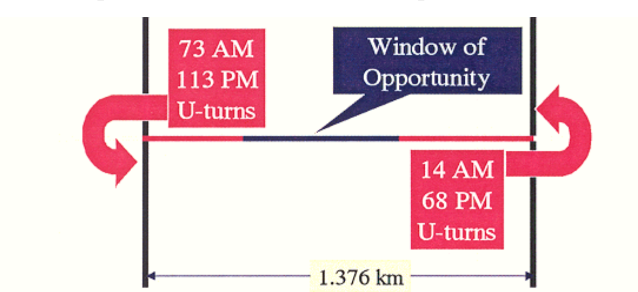
Placing a median opening wherever one could be physically accommodated was considered inappropriate. Conflicts would increase and throughput would decrease with little return because some segments had few projected U-turns. Quantifiable warrants for mid-block median openings that would treat all properties fairly were needed. Otherwise, a mid-block opening at one location would lead to a proliferation of mid-block openings. This warrant had to quantify inconvenience to the traveling public. One option considered using the warrants for signals or a fraction thereof. However, they were considered too complicated. A simple concise system of evaluation was needed to address the additional mid-block median openings.

To develop a warrant the project team took a look at what would happen after the project was completed. As new development occurs mainline traffic and vehicles turning at the proposed median openings will increase. This new development was considered when growth factors were established and design year 2019 traffic volumes were computed. As such, improvements to the Route 332 corridor were designed to safely provide an acceptable level of service for the increased traffic - without additional mid-block median openings - until the year 2019 or beyond. If more development than anticipated occurred and approaches to an existing median opening exhibited signs of failure (level of service E or F) then improvements would be necessary. Either the existing median opening is improved or another median opening is added in order to achieve a level of service of D or better at the existing median opening. These same improvements would be required if based on projected traffic generated by a proposed development, the mainline approach level of service of an existing median would become E or F within two years of completing the development. This condition allows the improvements or the median opening to be included with construction of the development.

These median opening requirements were developed for long-term usage to determine the need for and location of additional median openings. The main line approach level of service at most intersections along Route 332 for the design year 2019 are mostly B and C. It was clear that the level of service warrants would not be met for some time.

While the median opening requirements were being developed, work was continuing on the development of access management standards that the towns would enact. These standards were considered essential for achieving the project goals and objectives. The project team did not want to jeopardize the access management gains. Adding mid-block median openings at appropriate locations was viewed as a reasonable compromise to advance the overall transportation and community goals.

A different approach was then taken to develop an interim warrant for median openings. A warrant that could be used prior to construction of improvements to the Route 332 corridor. This warrant had to quantify inconvenience to the vehicles making the U-turns. At first computing travel time and/or distance between U-turns was considered. However, these methods of measurement proved to be inadequate. If the travel time or distance was large between U-turns and the number of vehicles making U-turns was small, then putting in a median opening for a small number of vehicles was not justified.



Reverse Access Trips
1.376 km x (87 AM + 181 PM U-turns) = 368.8 Vehicle-Kilometer

Another form of measurement that is more in line with how other transportation elements are measured was needed. Reverse access trips that are the product of the segment length between adjacent median openings multiplied by the number of U-turns that occur at adjacent median openings were computed for all segments (see Table 2). Since existing forms of measure did not exist, the values within the corridor were compared to each other. The segment from Townline Road to Farmbrook Drive and from Farmbrook Drive to C.R. 41 stood out from the rest. These segments have the most existing and projected traffic, they are located in the area that is most likely to be developed, and they have the only main line approaches to intersections with a level of service of D in the design year. A value of 200 vehicle-kilometers yielded a reasonable threshold for the total (AM plus PM) reverse access trips that warranted an additional median opening.

When?

Based on the interim warrants two segments are candidates for mid-block median openings. Three different approaches to deciding when these median openings should be installed were considered:

> **Non-traditional Approach –** proactively locating, designing and constructing median openings as part of the highway project, in advance of development and traffic pressures;
>
> **Traditional Approach –** reactively locating and constructing median openings when justified in the future, as a result of increased traffic and congestion;
>
> **Hybrid Approach –** proactively planning to react by identifying and mapping the desirable location of median openings on the highway design plans, but not installing until justified in terms of traffic safety, and operational benefits.

Designers still felt that reasonable access would have been provided without the additional median openings. However, the Hybrid Approach was chosen and openings were included in the final design of this project for the following reasons:

- adding openings would be responsive to the community needs and goals;
- new development was considered imminent;
- adding median openings later would be less cost effective;
- the median openings would provide a clear plan for developers to work with;
- the new median openings could be designed to be safe; and
- the number of U-turns at other locations would be reduced.

Conversely, a more traditional approach will be used for future median opening decisions because the time frame for future development is not known and other median openings would not be beneficial.

Final Design

A directional median opening that permitted U-turns from both directions would improve the access to adjacent properties while Project engineers considered two layouts for the new directional openings. The back-to-back layout was chosen over the head-to-head layout because it would provide access to more property. A sketch of the back-to-back layout was moved within the windows of opportunity to help deter mine the most appropriate location. With input from the town, the locations of the new directional median openings were based on:

- avoiding conflicts with side streets and driveways;
- providing maximum access to adjacent property; and
- the potential for a future intersection near the mid-point.

Requirements

The following is a summary of the Median Opening Requirements:

1. Directional and full median openings must be physically located at:

    - locations that will benefit the traveling public not a particular property;
    - intersections of existing roads;
    - locations that meet the spacing criteria in the Access Management Standards;
    - locations that can provide adequate sight distance; and
    - locations that can provide adequate deceleration.

6. A full median opening at a mid-block location will be allowed if NYSDOT MUTCD warrants for signals are met.

7. Except as noted in Item 4, a directional median opening will be allowed if one of the following conditions at an adjacent median opening are met:

    - the mainline approach level of service is already at an E or F; or
    - the mainline approach level of service is projected to become an E or F in two years without the median opening.

    In-lieu of adding the directional median opening, the adjacent intersection(s) may be improved to achieve a mainline approach level of service of D or better.

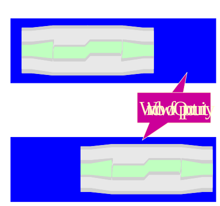
3. During the design of the Route 332 Corridor Improvement Project and until February 1, 1999, a directional median opening will be installed if the following conditions are met:

    - the reverse access trips on the segment exceeds 200; and
    - a 15-meter wide median can be accommodated at the directional median opening.

CONCLUSIONS

At first, project engineers, local planning staff, and officials chose an approach that limited median openings in order to:

- underscore short and long term project intent and objectives;
- further enhance desired community planning goals and development patterns;
- fortify access management related project momentum; and
- accelerate and further access road network development.



After receiving comments from the public a more proactive approach was adopted. Additional median openings were investigated and two directional median openings were added. In essence the project team practiced Design Harmonization. It applied engineering design that addressed technical issues as well as community goals. It was able to do more than make it safe by taking into consideration: sense of place, livability, and land use patterns.

In conclusion, a restrictive median is a traffic control device. The installation of a restrictive median, and conversely, removal of it for a median opening, should follow a systematic review procedure, similar to a traffic signal warrant investigation. Decisions on where and when to install median openings rely on various guiding principles related to traffic safety, efficiency, and highway function. Yet as experience shows, traffic signals, stop signs and other traffic control devices are occasionally installed less judiciously, at locations that do not necessarily satisfy traffic engineering criteria. This leads to the questions:

- Where access spacing criteria is met, are overall community goals and needs better served by initially locating and installing median openings into the highway improvement project? Is it better to wait and respond when development pressures and resulting traffic increases necessitate the need for new median openings, at locations potentially less suitable?

- Are highway safety, efficiency, and function better served and optimized by including median openings as part of the highway design project, or is the traditional reactionary approach to traffic control installation/modifications more applicable to median openings?

- What are the short term and long term implications of allowing and constructing median openings now as part of the highway project design?

- As transportation planners, designers, and engineers, is it not our job to help shape community and a sense of place, not simply to move traffic safely and efficiently? In doing so, does being proactive with median openings better achieve that broader objective?

The following answers pertain to the Route 332 Corridor Improvement Project:

- Even though designers felt that reasonable access would have been provided without the additional median openings, some were added to better serve community goals. Development was imminent, therefore good locations for the median openings could be identified. Specific locations for other median openings were not mapped for future implementation. Instead, median opening requirements and windows of opportunity were established to allow for more flexible decisions.

- The Route 332 Corridor Improvement Project only included median openings (including the additional mid-block median openings), which were considered necessary at the time of design. Even though spacing standards would be met, other median openings were not added because Route 332 would be safer and more efficient without them, plus they would be under utilized.

- Some of the implications of installing median openings with the Route 332 Corridor Improvement project consist of:

    - Constructing median openings with the Route 332 Corridor Improvements is less expensive than constructing them alone later.
    - Installing median openings now, with the Route 332 Corridor Improvements provides a clear plan for developers. Developers know better what the access will be for a particular parcel of land.
    - The incremental cost of constructing median openings now will be incurred by NYSDOT instead of developers.

- ¨ Route 332 will be safer and more efficient for a longer period of time if median openings are installed when development does occur instead of now.

- · The towns have stated that they want planned development in clusters in order to preserve green space and farmland, creating a positive image for Route 332 as a gateway to the Finger Lakes. By being proactive with implementing a comprehensive access management plan, the project team did indeed achieve the broader objective. The benefits of being proactive are already being realized, <u>before</u> improvements to Route 332 are constructed. Owners of property on both sides of Route 332, near one of the additional median openings, had separate plans for developments that proposed independent access points to Route 332. They are now working together to create a network of roads with consolidated access points to Route 332. Their intent is to develop a long-term solution for improving access to their properties, and if possible justify a signal that could be included in the construction project.

The circumstances are different for each community. Community leaders must therefore decide what median opening requirements and plans for implementation are best for their community. They must determine whether it is an Opportunity or Not.

ACKNOWLEDGEMENT

This paper was prepared based on work performed for NYSDOT on the Route 332 Corridor Improvement Project. The Median Opening Requirements were developed through the efforts of the NYSDOT, the Towns of Canandaigua and Farmington, and especially:

Steve Munson, Corridor Management, New York State Department of Transportation, Albany, New York

Richard Twardokus, Region 4 Design, New York State Department of Transportation, Rochester, New York

Route 332 Median Opening Requirements
(Effective February 1, 1998)

Medians separating opposite direction travel lanes are installed primarily for the purpose of insuring the safe and efficient movement of traffic. The introduction of unwarranted median openings exposes the motorist to added conflict points and also impedes the smooth flow of traffic, thus reducing the safety and capacity of the road. Median openings will be considered in order to provide safe and reasonable access to adjacent properties. The following requirements shall be applied consistently throughout the Route 332 corridor.

1) A median opening shall not be installed or allowed simply to service or benefit any particular property, site or business, but only when it can be demonstrated that such an installation will benefit the overall safety, traffic flow, and efficiency of the highway.

2) Priority will be given to establishing median openings at appropriate intersections of existing public roads before other locations.

3) Minimum median opening spacing shall meet the criteria in Table #1.

Table 1
Minimum Spacing Between Median Openings

Posted Speed	Directional Opening*	Full Opening**
Less than 45 mph (70 km/h)	660 feet (200 meters)	1320 feet (400 meters)
45 mph (70 km/h) or greater	1320 feet (400 meters)	2640 feet (800 meters)

* Directional openings do not allow all traffic movements
** Full openings allow all traffic movements

4) Adequate sight distance, as recommended in AASHTO, in all travel directions, shall be available at a median opening.

5) Adequate deceleration for an auxiliary turn lane shall be provided at a median opening.

6) A proposed full median opening shall not be allowed unless NYSDOT MUTCD warrants for traffic control signals are met.

7) Except as noted in Item 8, a directional median opening will be allowed if a 15-meter wide median can be accommodated in the area of the additional opening including the area for auxiliary lanes and one of the following conditions are met:

    a) The level of service for traffic on the mainline (Route 332) approaches to an existing median opening and/or intersection, adjacent to the proposed median opening, shall be [improved to a D from] an E or F during the peak traffic periods.

    b) Based on the projected traffic generated by a proposed development, the Level of Service of an existing median opening or intersection would become E or F (within 2 years) on the mainline (Route 332) approaches without creation of an additional median opening.

The NYSDOT reserves the right to implement improvements to existing median openings or intersections, adjacent to a proposed opening, such that the level of service of the mainline approaches (Route 332) would improve to a D or better.

8) During the design of the Route 332 Corridor Improvement Project and until February 1, 1999, a directional median opening will be installed if the following conditions can be met:

    a) It can be demonstrated that the reverse access trips (see Table #2) on the segment in question exceeds 200 vehicle kilometers during peak hours.

    b) A 15-meter wide median can be accommodated in the area of the additional opening.

    The NYSDOT will evaluate volumes generated by a proposed development when an applicant submits a traffic study for approval.

These median opening requirements may be waived by the NYSDOT if it is in the best interest of the State (e.g., if it provides traffic and safety benefits to the traveling public).

Table 2
Reverse Access Trips[1]

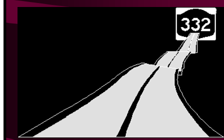
Segment (U-turn to U-turn)	Length of Segment (Meters)	Projected U-turns[2]		Reverse Access Trips		
		ETC+20		(Vehicle Kilometer)		
		AM	PM	AM	PM	Total
Parkside Drive to Future Airport Rd	667	36	34	24.0	22.7	46.7
Future Airport Rd to Campus Drive	1157	87	97	100.7	112.2	212.9[3]
Campus Drive to Yerkes Road	846	3	4	2.5	3.4	5.9
Yerkes Road to Purdy Road	1337	10	6	13.4	8.0	21.4
Purdy Road to Townline Road	815	18	59	14.7	48.1	62.8
Townline Road to Farmbrook Drive	1376	87	181	119.7	249.1	368.8
Farmbrook Drive to County Road #41	1149	68	139	78.1	159.7	237.8
County Road #41 to Collett Road	1938	9	58	17.4	112.4	129.8

Notes:

(1) Reverse Access Trip – The product of the segment length between adjacent median openings multiplied by the number of U-turns that occur at adjacent median openings.

(2) Projected U-turns were obtained from drawing B-2 contained in the February 1998 Final Design Report/Environmental Assessment for the Route 332 Corridor Improvement.

(3) Long range plans call for the signalization of the Thomas/Emerson Road intersection. When signalization does occur, U-turns will be permitted at this intersection, thereby reducing the Reverse Access Trip value to less than 200.



Route 332 Corridor Improvement

MEDIAN OPENINGS

OPPORTUNITY or NOT?

Presented By:

Don Nims

CLARK PATTERSON ASSOCIATES

Comprehensive Access Management

- Town Access Roads
- Town Laws
- Medians
- Median Openings
- Driveway Spacing
- Intersection Spacing
- U-turns
- New Signals
- Driveway Modification
- Permissive vs Protected
- Conversion to RIROs
- Directional Opening
- Access for Farm Vehicles
- Truck U-turns

TOWN OF FARMINGTON

1000 COUNTY ROAD 8, Farmington, New York 14425

TOWN OF CANANDAIGUA

Median Opening Decision

Are community goals and needs better served?

Install now or after the fact?

Is highway safety, efficiency, and function better?

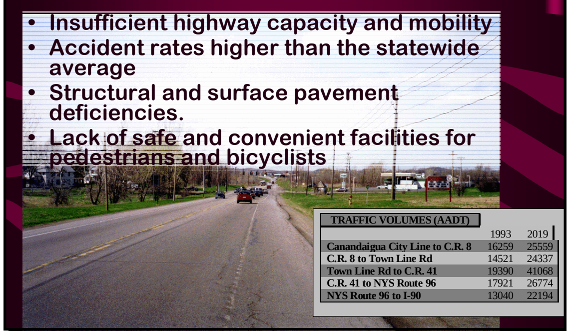
What are the implications?

Outline

- INTRODUCTION
- PROJECT OBJECTIVE
- PROJECT DEVELOPMENT
- PUBLIC INVOLVEMENT
- MEDIAN OPENING REQUIREMENTS
- CONCLUSIONS

Project Location

Existing Conditions

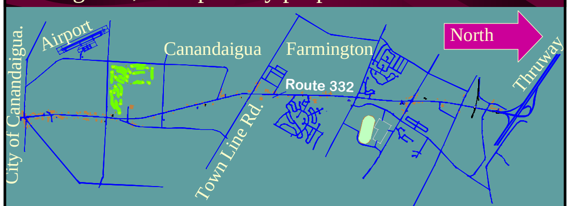


- Insufficient highway capacity and mobility
- Accident rates higher than the statewide average
- Structural and surface pavement deficiencies.
- Lack of safe and convenient facilities for pedestrians and bicyclists

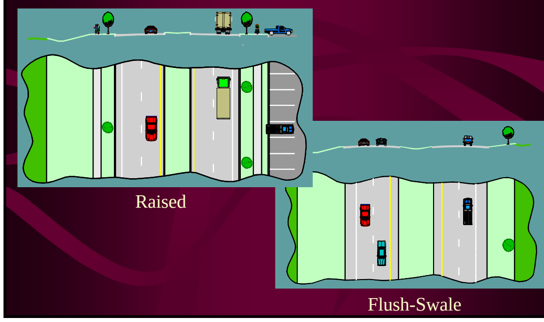
TRAFFIC VOLUMES (AADT)	1993	2019
Canandaigua City Line to C.R. 8	16259	25559
C.R. 8 to Town Line Rd	14521	24337
Town Line Rd to C.R. 41	19390	41068
C.R. 41 to NYS Route 96	17921	26774
NYS Route 96 to I-90	13040	22194

Route 332 Corridor

Route 332 is a principal arterial that means mobility, or the movement of people and goods, is its primary purpose.



Restrictive Medians



Median Opening Spacing Standards

Posted Speed	Directional Opening*	Full Opening**
Less than 45 mph (70 km/h)	660 feet (200 meters)	1320 feet (400 meters)
45 mph or greater (70 km/h)	1320 feet (400 meters)	2640 feet (800 meters)

* Directional openings do not allow all traffic movements

** Full openings allow all traffic movements

Public Involvement

Thought Process

Who decides where?

What is the design criteria?

What are the warrants?

When do they get installed?

What will they look like?

Who Decides Where?

- NYSDOT
- Towns Provide Input and Guidance

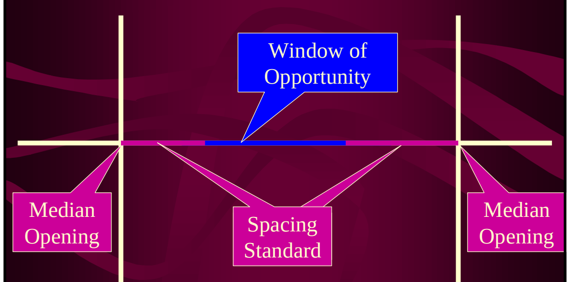
What is the Design Criteria?

- Minimum Spacing Criteria
- Sight Distance
- Deceleration Length

What are the Warrants?

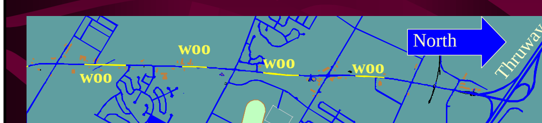
- No Existing Research
- Strong Requirements
- Encourage Development in Clusters
- Windows of Opportunity
- Treat all Properties Fairly
- Avoid Proliferation of Openings
- Quantify Inconvenience
- A simple Concise System of Evaluation

Window of Opportunity



Windows of Opportunity

Town of Canandaigua



Town of Farmington

What are the Warrants?

- No Existing Research
- Strong Requirements
- Encourage Development in Clusters
- Windows of Opportunity
- Treat all Properties Fairly
- Avoid Proliferation of Openings
- Quantify Inconvenience
- A simple Concise System of Evaluation

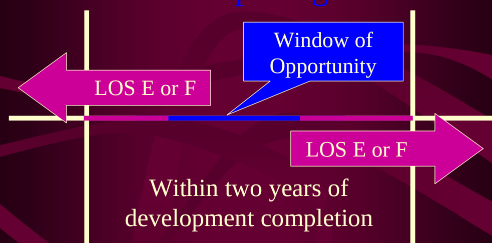
Median Opening Requirements
Locations

- The Traveling Public is Benefited
- Existing Intersections are first Priority
- Spacing Criteria is Met
- Sight Distance is Adequate
- Deceleration is Adequate

Median Opening Requirements
Full Opening Warrant

- Only allowed if MUTCD warrants for signals are met

Median Opening Requirements
Directional Opening Warrant



In-lieu of adding the directional median opening, the adjacent intersection(s) may be improved to achieve a mainline approach level of service of D or better.

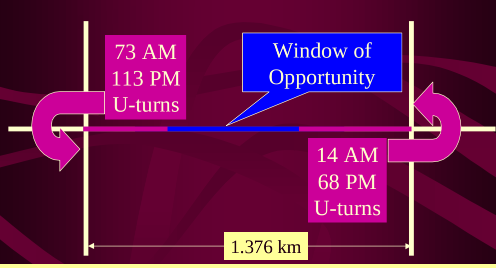
Access Management Standards
Laws Adopted by the Towns

- Building Setbacks
- Site Layout
- Driveway Spacing, Design, and Location
- Shared Driveways and Cross Access
- Corner Clearance
- Median Openings
- Provisions for Subdivided Lots
- Incentive Zoning

Interim Warrants

- Ensure Comprehensive Access Management Gains
- Advance the Overall Transportation and Community Goals
- Used Prior to Construction
- Quantify Inconvenience to the Vehicles Making U-turns
- Reverse Access Trips

Reverse Access Trips



Reverse Access Trips

1.376 km x (87 AM + 181 PM U-turns) = 368.8 Vehicle-Kilometer

Reverse Access Trips

Segment (U-turn to U-turn)	Length of Segment (Meters)	Projected U-turns(2) ETC+20		Reverse Access Trips (Vehicle Kilometer)		
		AM	PM	AM	PM	Total
Parkside Drive to Future Airport Road	667	36	34	24.0	22.7	46.7
Future Airport Road to Campus Drive	1157	87	97	100.7	112.2	212.9(3)
Campus Drive to Yerkes Road	846	3	4	2.5	3.4	5.9
Yerkes Road to Purdy Road	1337	10	6	13.4	8.0	21.4
Purdy Road to Townline Road	815	18	59	14.7	48.1	62.8
Townline Road to Farmbrook Drive	**1376**	**87**	**181**	**119.7**	**249.1**	**368.8**
Farmbrook Drive to County Road #41	**1149**	**68**	**139**	**78.1**	**159.7**	**237.8**
County Road #41 to Collett Road	1938	9	58	17.4	112.4	129.8

Median Opening Requirements
Interim Opening Warrant

- Reverse Access Trips Exceeds 200
- 15-Meter Wide Median can be Accommodated

When are Openings Installed?

- Non-traditional or Proactive
- Traditional or Reactive
- Hybrid or Proactively Plan to React

When are Openings Installed?
Interim Locations

- Responsive to Community Needs and Goals
- New Development Imminent
- More Cost Effective
- Clear Plan for Developers
- Safe
- Reduce U-turns at Other Locations

When are Openings Installed?
Future Locations

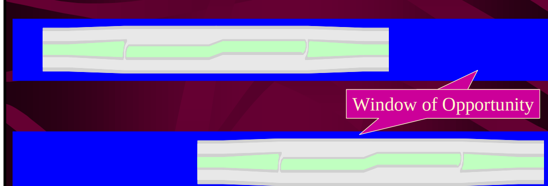
- Time Frame for Future Development is Unknown
- Other Median Openings Would not be Beneficial

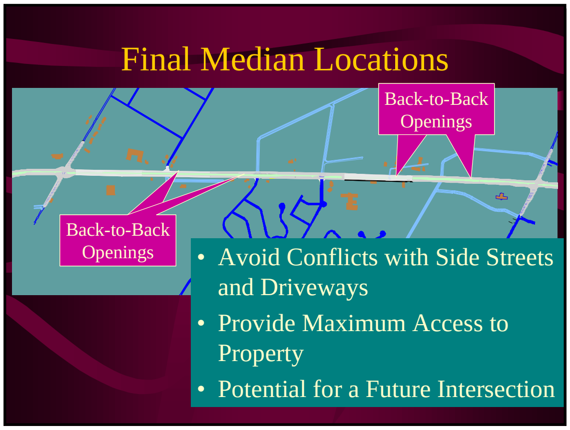
How will Openings Look?

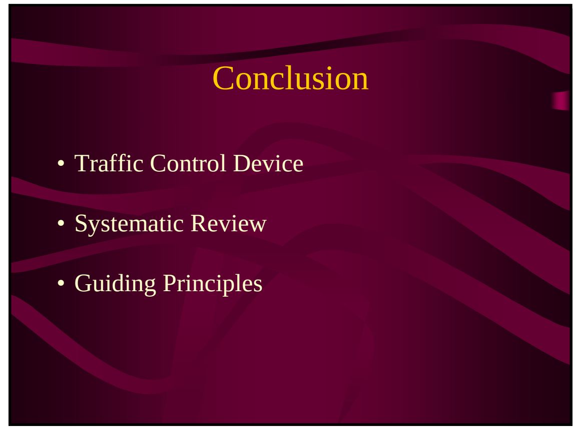
- Permitted U-turns from Both Directions
- Back-to-Back or Head-to-Head
- Provide Access to Several Properties

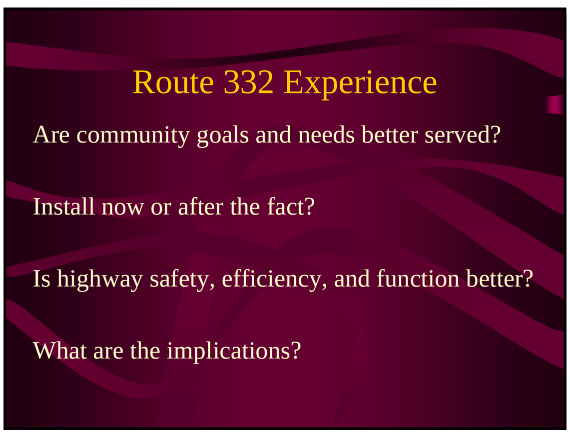
Possible Median Locations

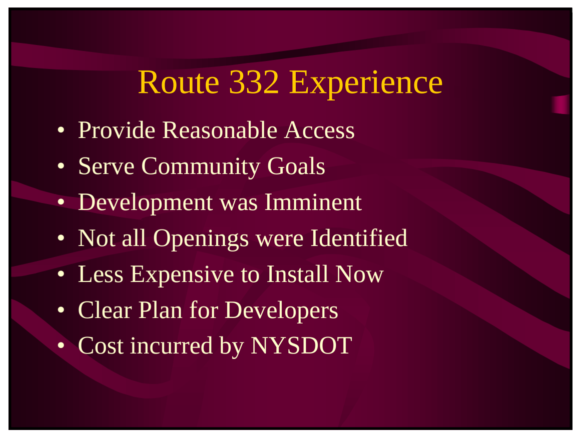
- Slide Back-to-Back in Windows of Opportunity
- Get Input from the Town



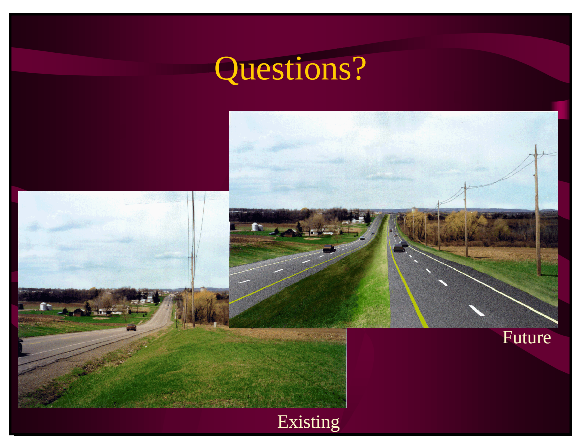

Final Median Locations
Back-to-Back Openings
Back-to-Back Openings
• Avoid Conflicts with Side Streets and Driveways
• Provide Maximum Access to Property
• Potential for a Future Intersection


Conclusion
• Traffic Control Device
• Systematic Review
• Guiding Principles


Route 332 Experience
Are community goals and needs better served?
Install now or after the fact?
Is highway safety, efficiency, and function better?
What are the implications?


Route 332 Experience
• Provide Reasonable Access
• Serve Community Goals
• Development was Imminent
• Not all Openings were Identified
• Less Expensive to Install Now
• Clear Plan for Developers
• Cost incurred by NYSDOT


Route 332 Experience
Property Owners Working Together
Back-to-Back Openings


Questions?
Future
Existing

Retrofit of a Major Urban Corridor
US-54 Highway in Wichita, Kansas
An Intergovernmental Partnership Under the Kansas Department of Transportation's Corridor Management Program

Chris Huffman, Kansas Department of Transportation

Introduction

The Kansas Department of Transportation (KDOT), in 1997, instituted a program to more effectively manage the interaction between land use and transportation. This program, called Corridor Management, contains several tools that are new to Kansas. First, access to the state highway system is now governed by engineering standards as opposed to the guidelines that were in place before. These standards represent minimums that require preparation of a variance for any exceptions. Second, access spacing standards now reflect functional hierarchy in highway classification. Third, procedures for advance acquisition of right of way are now in place. Fourth, each of the six districts now have their own corridor management plan where high growth corridors are identified and the partnering process with cities and counties is begun. Finally, a great deal of emphasis is placed on the formation of partnerships between KDOT, city and county officials to jointly manage these rapidly developing corridors from a combined land use/ transportation perspective. The primary purpose of Corridor Management is to prevent conflicts between land use and transportation through partnerships. The result being binding corridor master plans that identify planning standards for newly developing or redeveloping areas and operational retrofits for established areas. The first corridor chosen was a segment of US-54 highway in south central Kansas.

Background

The US-54 corridor, as seen in Figure 1, is a four-lane principal arterial that exists in a variety of divided and undivided configurations.

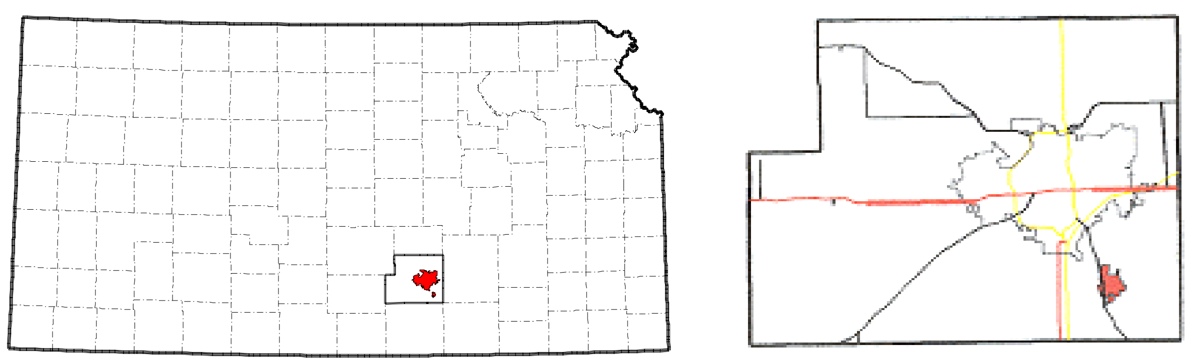


Figure 1: Wichita is located in the south-central part of Kansas. The study corridor consists of a segment of US-54 highway, the principal east-west corridor through the area. The segment under study begins approximately nine miles east of the western county line and proceeds east to the eastern county line.

On a statewide basis, US-54 is the primary corridor for east-west movement of people and goods through the southern half of the state of Kansas and carries average daily traffic volumes ranging from 4810 to 65425.

Further, it is the primary east-west route for Wichita, Kansas, one of the nation's 100 largest metropolitan areas. As such, it is a critically important route for both local and statewide interests. As with many urban corridors, incompatible development and poorly conceived access arrangements have brought incredible pressure to the highway. Capacity, especially at public street intersections, has been lost and safety has been compromised.

Within the study area, access connections number over 400 and include privately held access, public thoroughfare connections and median crossovers. Access accounts for 42% of the crashes reported to KDOT out of 1,099 within the study area in the three-year period from January 1, 1995 to December 31, 1997. This highway carries a higher than average crash rate for similar roadway types. Costs associated with access driven crashes alone within the study area averaged approximately $7.6 million per year during the same study period.

Land Use

Land use along the study corridor is as varied as the configuration of the highway. Uses range from light industrial to rural residential and agricultural along with significant commercial development. On highway segments that have been recently reconstructed to freeway configuration, access has been retrofitted to frontage roads or other means of alternate access. However, along older segments, particularly at the urban fringe, privately held access for each parcel is the norm. Further, growth in the Wichita area has been strong and threatens to overwhelm the entire transportation system. Over the next 20 years, the Wichita-Sedgwick County Metropolitan Area Planning Department (MAPD) forecasts that as much as 44% of the development will occur in the northwest quadrant of the city. Much of this development will be forced to depend upon US-54 for east-west movement.

Complicating the land use management picture, the development that has taken place has been diffuse and independent. Little thought has been given to alternate modes of transportation or to a long-term vision of integrating land use and transportation. A consistent access road concept is all but impossible in established areas without condemnation of portions of existing developments to accommodate the retrofit. This area has a strong land-use planning element, however, these efforts are sometimes frustrated by political influence and a Kansas judiciary that tends to favor property owners. A consistent approach to land use and transportation planning, and a shared vision for each, is necessary to overcome these limitations.

The Corridor Management Approach

The Corridor Management Program was initiated to act as the interface between land use and transportation and to provide the shared vision and consistent management necessary to reconcile the two. Transportation, when compared to land use, is invariably slow to react and is always behind the curve in dealing with changes in demand. Under these conditions, if access is allowed to proliferate, capacity will be lost. Regaining lost capacity means either condemning right of way to construct additional lanes or bypassing the area altogether. Both solutions are costly and potentially catastrophic to the property owners along the route.

Effective administration of a highway system means averting these problems. This is not, however, a matter the KDOT can resolve by itself. Statutory law in Kansas separates the responsibility for administering state highways from the administration of land use. Under Kansas's laws, responsibility for the state highway system belongs to the Secretary of Transportation. Land use management, however, does not rest with any state agency; rather, it is delegated to cities and counties under the concept of home rule. This has led to poorly coordinated, even conflicting, goals, efforts and objectives. As a result, the KDOT has been forced to build bypasses of bypasses of bypasses. Each represents a loss of public investment and a failure for the professionals charged with managing that investment.

The Corridor Management Program addresses this problem with a procedure that employs four distinct steps. In the first step, city, county and KDOT officials identify corridor segments that are experiencing, or are likely to experience, significant pressure due to increasing intensity of land use. These corridor segments are designated on the appropriate district plan as protected routes. Once this happens, the access management on the designated corridor takes on a higher intensity. Regardless of the corridor's actual classification, it is managed according to the highest standards. Next, a partnership is entered into between the Secretary of Transportation and the appropriate city and county officials. This partnership, called a Memorandum of Understanding, simply identifies who the partners are and what they are partnering about. The third step is a Corridor Master Plan. This document first sets out a vision of what the highway will look like when it is fully developed and has all the capacity and access that it will ever have. Then, to achieve this vision, a two pronged approach, planning and operations is utilized. The planning aspect identifies requirements for newly developing or redeveloping areas such as access roads, special setbacks or other requirements. The operational aspect involves identification of retrofit phases for established areas. Such retrofits may include median treatments, entrance shifts or consolidations, retrofitting access roads to provide alternate access or advance acquisition of right of way. The final step of the four-step process is identification of projects to achieve the operational goals of the Master Plan.

Corridor Management Applications in Wichita

The effort to retrofit the US-54 corridor to a freeway standard actually pre-dates the Corridor Management Program. Approximately nine miles of the corridor through the downtown area has been reconstructed to freeway configuration through a series of huge projects. Such retrofit projects have included relocation of access to frontage roads. In some cases, these frontage roads are limited to one-way traffic. While these projects are very desirable for their operational and safety benefits, they are extremely expensive and give no consideration for prevention on the segments remaining to be upgraded. A preliminary study of the eastern segment of the US-54 corridor remaining for upgrade attached a $290 million price tag to the prospect. Such funding levels are not immediately available, and development shows no signs of slowing. So, costs and impacts will continue to spiral unless preventive measures are put into place.

The Corridor Master Plan for US-54 is the means of coordinating development and transportation. The Master Plan is a contractual document that is binding upon all signatory parties and their successors in office. This particular Master Plan stipulates that the ultimate goal is to improve US-54 to freeway configuration throughout Sedgwick County. Thus, there will be no new direct access to US-54. Access control is in place along this corridor, however, it was purchased after the fact. This means that existing entrances were allowed to remain as breaks in the access control. Removal of these access points will involve relocation to side roads or access roads under the operational aspect of the Master Plan. Newly developing or redeveloping areas are required to comply with the provisions of the Master Plan at developer expense.

Since the US-54 corridor has a fully executed Master Plan, it is eligible for funding of small-scale spot improvement type projects from a dedicated corridor fund. Projects are targeted to the non-freeway segments of the study corridor. A major question is how to target such limited resources. In investigating ways to prioritize potential projects, KDOT is making use of three tools. Those tools are digital videolog, crash data and GPS travel time surveys. Digital videolog is a van-based system that travels the Kansas State highway system and takes digital pictures every ten meters (about 33 feet). This system also takes GPS readings at regular intervals and, through a data editing process, allows the pictures to be displayed along with location information including KDOT's location referencing system. From this source, access point take-offs can be performed with reasonable accuracy without having to travel. This information is then segmented to produce an access density in units of points per mile. Motor vehicle crash data is obtained from the Kansas Accident Recovery System (KARS) database. The information available includes crash location, vehicle maneuver and contributing factors and injuries as well as pavement, light and weather conditions. When access density in points per mile is plotted, and accident rate per million vehicle miles is added to density in a stacked line format, an interesting thing happens. **When viewing the graphs on the following pages, the reader should exercise caution.** These graphs are constructed using a stacked line format. This means that the value of the second series (accident rate) is added to the value of the first series (access density) in order to plot the second series. The stacked line format of the graphs implies a higher than actual strength of correlation between access density and accident rate. A correlation certainly does exist, and it is a positive correlation, but it is not as strong as the graphs would seem to indicate.

The stacked line format is used because of the way it displays the relationship between access and accident rate. What we are looking for on these graphs are gaps between the peaks on these series. For instance, on the west segment graph, (see Figure 2) both series peak in the 15.50-16.49 mile segment. However, there is virtually no gap between the peaks of the two series. This indicates that, while there are undoubtedly too many access points in this mile, there is not a crash problem. In looking for access driven crash problems, one would look at the areas of the graph at 12.50-13.49 or from 17.50 to 20.49. The gaps in these peak areas indicate both high access densities and significant crash rates. It is not a foregone conclusion that access is the only contributor to the crash rates in these mile segments, but it is a strong indicator of an access driven crash problem. Ironically, these locations are also, typically, very complex, requiring complex solutions that are beyond the scope of the Corridor Management Program. In fact, corridor management is designed for proactive improvements in areas such as the 15.50-16.49 mile segment so that these areas do not become problems. The more complex areas should not be ignored, this information will, hopefully, aid in targeting resources from programs better able to deal with these complexities.

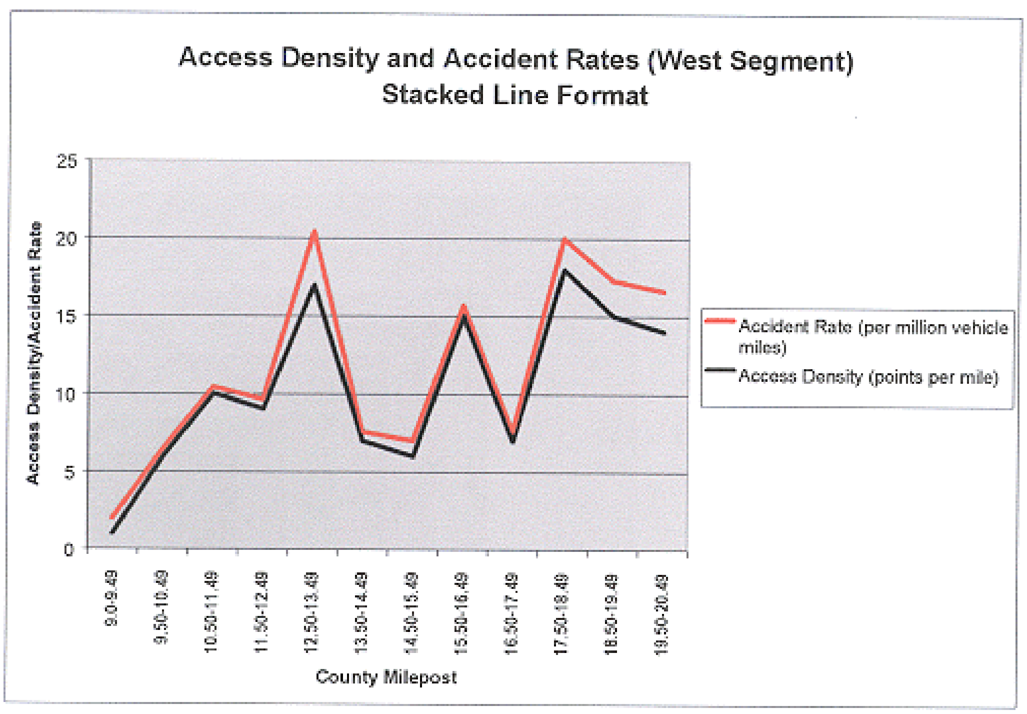


*Figure 2: **Exercise discretion when viewing this graph!** The level of correlation between access density and accident rate implied here is not a true correlation. This is a stacked line graph. Its purpose is to identify*

areas where there is likely to be an access driven crash problem. Gaps between peaks are a strong indication of an access driven crash problem.

The eastern segment of this corridor is more densely developed and populated, and so the graph of that segment displays these characteristics (see Figure 3). The area from 29.50 to 32.49 is a densely developed urbanized area that carries the most significant traffic volumes of any segment in the study area. Much of the commercial access in this area is confined to a frontage road system, however, the offset between the frontage road and mainline is completely insufficient, particularly at street intersections. Compounding the problem is the fact that there are numerous openings between the frontage road and US-54 that act as uncontrolled entrances. These intersections attempt to operate with geometries that are inadequate for the traffic volumes. Yet, closing these openings is not a realistic option. Closure of these intermediate access points would simply force the turning movements to the signalized city street intersections, which are unable to accommodate them. Again, this area is complex beyond the scope of the Corridor Management Program. It is in the area from 33.50 to 36.49 that corridor management can be applied to prevent a problem, or initiate a series of incremental improvements to prevent a problem from worsening. Corridor management can, however, be useful in the more complex areas in indirect ways. Advance acquisition of right of way can be used to take advantage of opportunities as they arise in working toward the vision of a freeway configuration. However, the primary purpose of the Corridor Management Program is to act proactively to prevent the major problems from occurring.

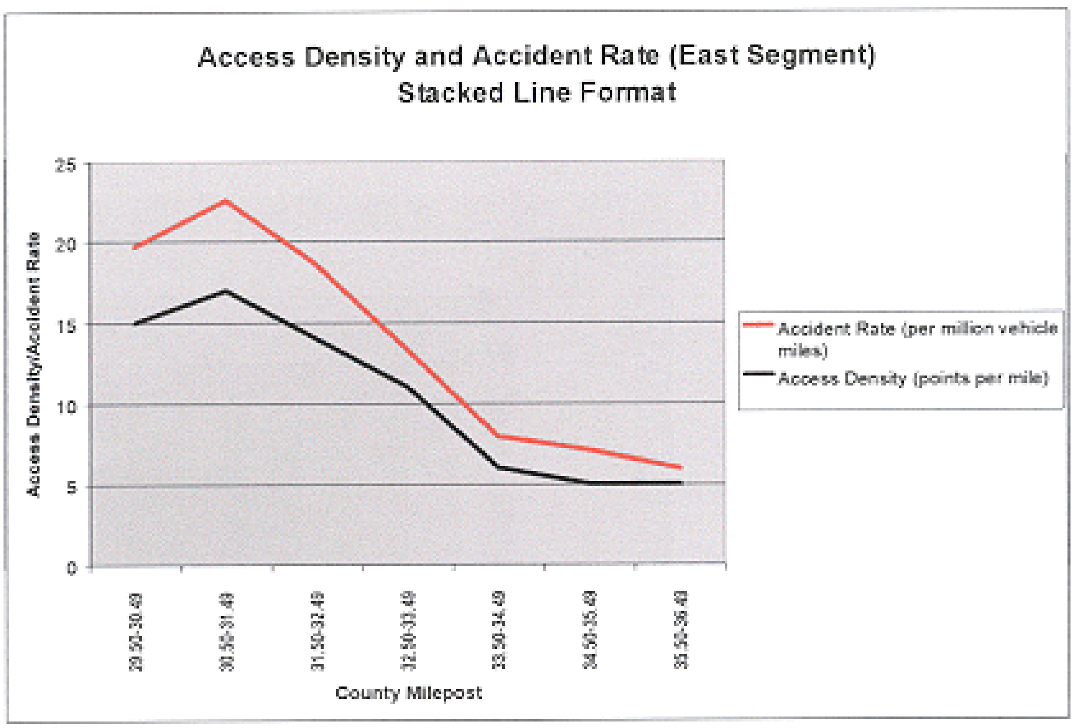
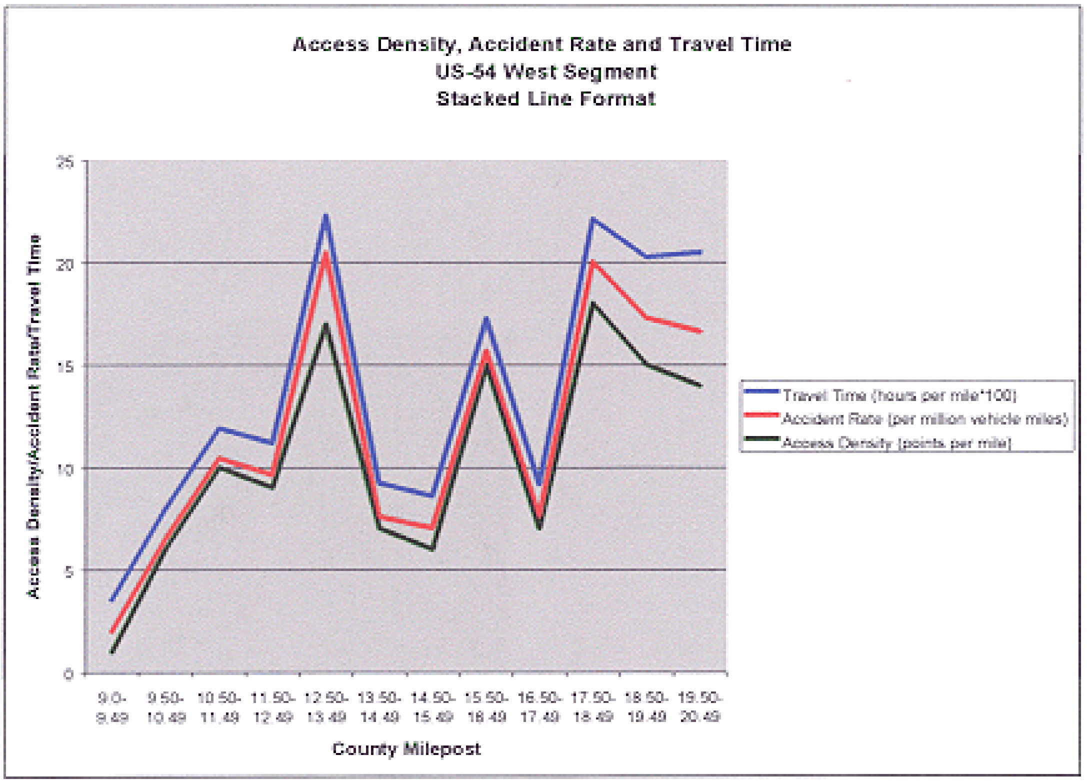


Figure 3: This graph of the eastern segment of the study corridor is indicative of a more densely developed urbanized area than the residential/agricultural areas that are more common on the western segment.

When travel time is analyzed in conjunction with access density and travel time information, the potential for identifying projects with maximum return increases dramatically. Travel time is analyzed by use of GPS technology using a floating car method of analysis. Repeated runs have been made along the US-54 corridor using a GPS receiver capable of receiving and processing up to six signals at intervals as short as one second. Satellite assay information is also downloaded for post-processing, or the unit can be coupled with a differential receiver for "on the fly" correction. The GPS unit advertises corrected accuracy of one to five meters horizontal. The corrected outputs from the unit contains, among other data, corrected latitude, longitude and date and time stamp. Using this information, distance between positions can be calculated which, in turn, allows calculation of speed over that segment. When the reciprocal of this velocity is taken to arrive at travel time and segmented to one-mile intervals to match the access density and crash data, it can be displayed as a third stacked series. Again, caution should be exercised in interpreting these graphs. The stacked series is plotted by adding the data values of each series to the previous series in order to obtain the plot. As such, we are looking for gaps between peaks as an indication of access generated problems.

Perhaps not surprisingly, the travel time analysis confirms much of what the previous plots of access density and crash rate indicated. On the western segment of the study corridor, (see Figure 4) significant gaps between peaks is seen in the interval between mileposts 17.50 to 20.49.



<u>Figure 4:</u> Adding travel time data in the stacked line format confirms much of what was indicated by the access density/crash rate charts.

The travel time analysis also helps to identify the access driven problem areas on the eastern segment of the study corridor. Similar to Figure 2, a significant problem area is seen in the segment between milepost 29.50 to 31.50 (see Figure 5).

At this point it is appropriate to discuss, in more detail, the differences between the eastern and western segments of this corridor that is seen in the graphs. The physical characteristics of the highway and the land use between the two segments are significant, but not significant enough to explain all the differences seen. The population centers of the region and the secondary highways must be examined to complete the explanation. On the eastern segment, trips on US-54 are heavily influenced by the towns of Andover and Augusta that lie to the east in Butler county. There are residential areas in eastern Sedgwick county, however, these areas do not lie adjacent to the US-54 corridor. The primary access into these areas is provided by minor arterials that parallel US-54. Many more turning movements characterize the western segment of the US-54 corridor. A great many more residential areas lie adjacent to US-54 and depend upon the highway as there principal, in some cases only, means of access. Further, conflicts with railroad right of way limit the potential of parallel minor arterials, many of which are gravel surfaced in that part of the county. Thus, the higher volume of turning movements, the proximity of the land use to the corridor and the lack of viable alternate routes explains the especially jagged nature of the western segment graphs.

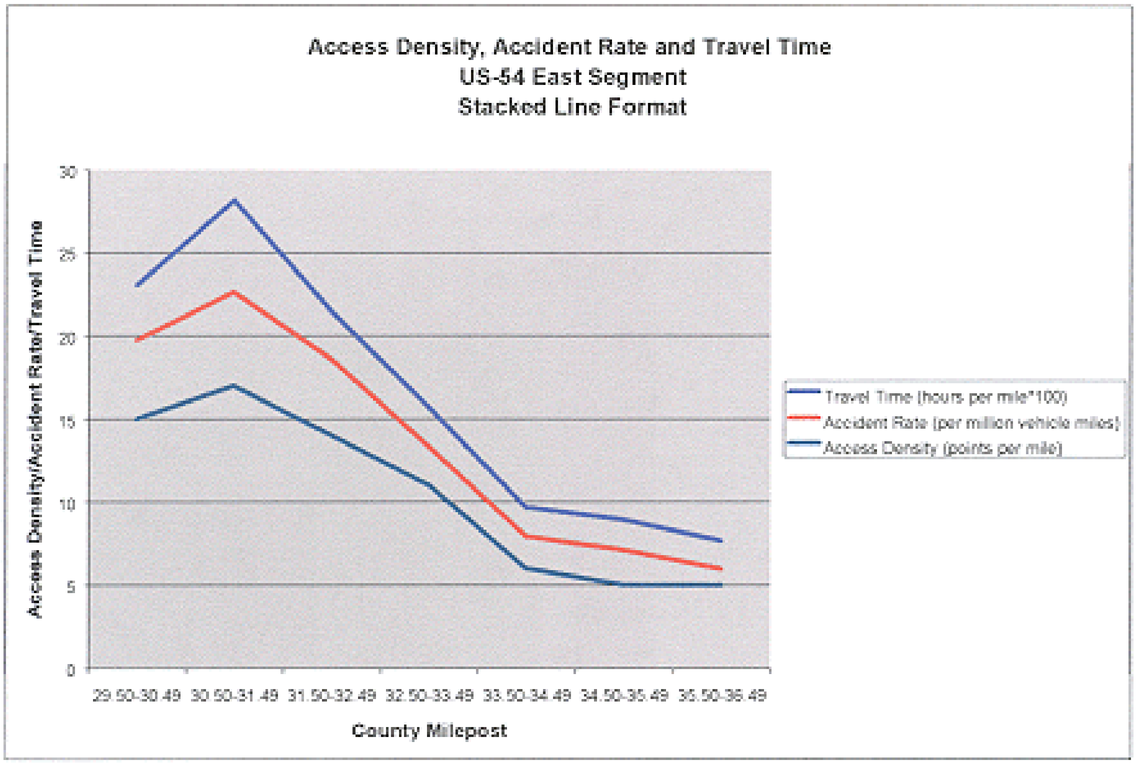


Figure 5: The travel time data on the eastern segment of the corridor confirms the trends displayed in Figure 3.

The Future of Corridor Management on US-54

Currently, nearly $250,000 in corridor management projects are under design for this corridor. Funding for corridor management projects comes from the corridor management fund with a minimum local match requirement of 33% of the project costs. Costs such as administrative overhead and construction engineering are not eligible, however, items such as consultant fees for design, adjustment of utilities on private property or market value of contributed right of way can be counted as local match. Such "soft match" allowances are unique in Kansas to the Corridor Management Program

.

Associated costs can be calculated for crashes and delay on this corridor. These parameters will be tracked over time to quantify benefits of corridor management efforts. Benefit/cost ratios will be calculated from this information. It is hoped that, over time, benefit/cost information can be obtained for specific types of projects to obtain maximum return on investment.

International Boulevard Case Study of Access Management Implementation

Tim Bevan, CH2M HILL
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ABSTRACT

Access management measures were part of a comprehensive design solution for a 1.1-mile section of International Boulevard, a major north/south arterial serving both local and regional traffic within the City of SeaTac, Washington. International Boulevard, which is a portion of SR 99, provides a regional link between cities in the Puget Sound region and a major route to SeaTac International Airport. Prior to reconstruction, the roadway was five lanes (including a center, two-way left-turn lane) with paved shoulders, intermittent sidewalks, and unrestricted access to and from adjacent properties. Traffic volumes ranged from 32 to 42 thousand vehicles per day. The existing land uses along the boulevard include some of the Puget Sound Region's largest motels, Sea-Tac International Airport, office buildings, and other retail uses. International Boulevard had suffered from significant traffic congestion, high traffic accident rates, and unsafe pedestrian conditions. The City's objectives for the reconstruction project have included improving traffic and pedestrian circulation, supporting transit use, and aesthetic enhancements.

The design included reconstruction consisting of access management measures (including conversion of two-way left-turn lanes to a median, and driveway reductions and consolidations), a high-occupancy lane, an arterial signal control system with area-wide integration, transit signal priority, pedestrian amenities, transit stop and rider amenity improvements, landscaping, illumination, and undergrounding of overhead utilities.

This paper presents a case study on how the project was developed and, in particular, how access management measures were implemented. The project environment and background conditions are summarized, and design issues and constraints are identified, along with the project development process. Specific case examples are discussed regarding consolidation of access, driveway reductions and U-turn accommodations.

Background

Project Location

The International Boulevard project is located within the City of SeaTac in King County, Washington (see Figure 1). King County, which includes the City of Seattle, is the most populous county in Washington. The City of SeaTac, incorporated in 1990, has an area of roughly 16 square miles and a population of about 23,000. Seattle-Tacoma (Sea-Tac) International Airport is located within the SeaTac city limits.

Project Background

The newly incorporated city developed Comprehensive and Transportation Plans that established land use goals and proposed transportation facility improvements. The city was designated as an urban center under the state's Growth Management Act and under that designation was identified for substantial increases in the development density along the city's existing commercial corridor. This development follows the International Boulevard corridor. Existing land uses include some of the region's largest motels, Sea-Tac International Airport, office towers, airport-related rental car and park-and-fly facilities, and other retail uses. The Transportation Plan proposed expansion of International Boulevard to increase traffic capacity and improve pedestrian access.

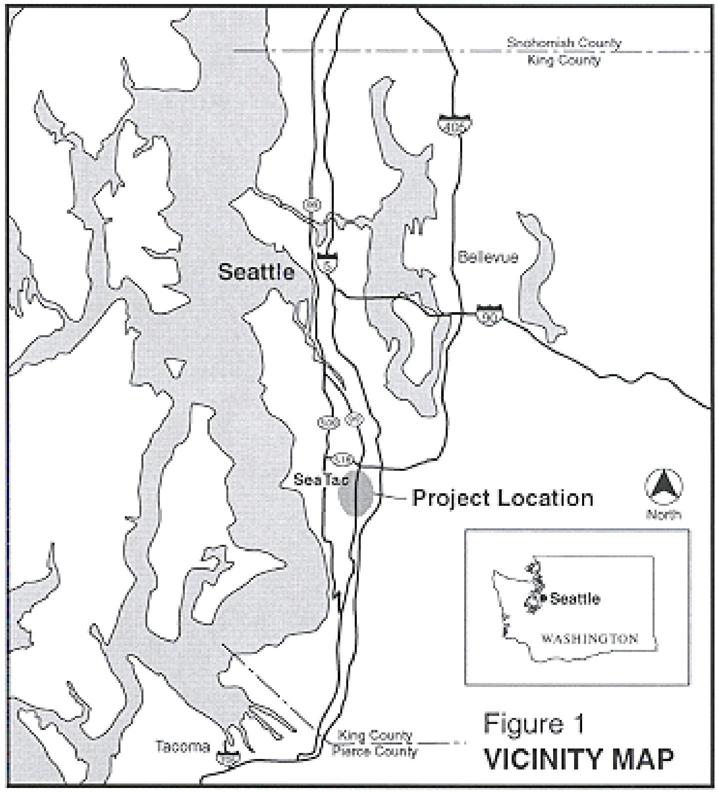


Figure 1
VICINITY MAP

International Boulevard is a major north / south arterial that serves local and regional traffic within the City of SeaTac, Washington (see Figure 2). International Boulevard, as named within the City of SeaTac, is part of signed State Route 99 (SR 99) that spans three counties and over 50 miles from South Snohomish County to North Pierce County. Prior to the construction of the Interstate System, SR 99 was a major Pacific coast route spanning Washington, Oregon, and California. Today, that portion of SR 99 within the Puget Sound region serves as a regional link between cities and as a major route to Sea-Tac Airport, with access to the terminal and airport parking. It is also a part of the State's urban arterial system, and has been designated as a National Highway of Significance, as well as an emergency evacuation route.

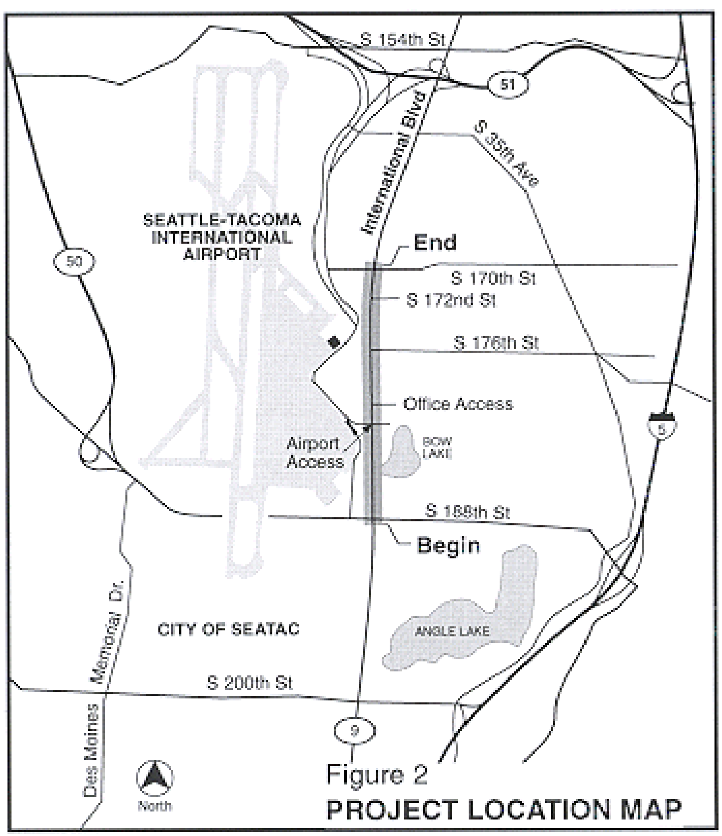


Figure 2
PROJECT LOCATION MAP

International Boulevard has experienced significant traffic congestion, poor pedestrian facilities and unsightly commercial "strip" development. The City of SeaTac planned four phases of improvement for International Boulevard, beginning at the south city limits and proceeding north. To date, Phases 1 and 2 have been constructed and Phases 3 and 4 are currently contracted for design. The project described in this paper is the first of these segments, from South 188th Street to South 170th Street. This section of International Boulevard fronts Sea-Tac Airport. Sea-Tac Airport and International Boulevard serve as a "gateway" to the United States and Puget Sound region for many visitors from around the world. The aesthetic enhancement of this part of International Boulevard was critical in providing a positive initial impression of the United States, the Puget Sound region, and the City of SeaTac.

The International Boulevard Phase 1 project was funded jointly by the City of SeaTac, the Washington State Department of Transportation (WSDOT) and the Transportation Improvement Board, King County Metro Transit, and the Port of Seattle (operator of the airport). The Phase 1 budget for design, construction and right-of-way acquisition was $7.3 million. The City contracted with CH2M HILL for design services and began design development work in the fall of 1993. The advertisement for construction bids was required by December 1994. Because SR 99 is within partial jurisdiction under WSDOT, the geometric design required review and approval by WSDOT.

Other Related Projects

Several projects were planned within, or adjacent to, the proposed project limits. These projects included: the International Boulevard Center Subarea Plan, which was being conducted to establish the land use plan and to set urban design guidelines; the SR 509 / South Access Roadway Project, which was investigating the potential extension of a major freeway through the City and the development of a south airport access road; Regional Transit Project (RTP) and Regional Transit Authority (RTA) planning for a regional light rail transit system that would extend to the airport and potentially would be aligned down the center of International Boulevard (a public vote approving funding for RTA did not occur until the fall of 1996); the Personal Rapid Transit (PRT) Project, under planning by the City for potential implementation to serve land uses in the International Boulevard corridor and the airport; and Airport Master Planning to determine whether Sea-Tac Airport would be expanded by adding a third runway to support a doubling of air travel volumes. Close coordination with these and other projects was required during design.

Physical Conditions Prior to Reconstruction

General

The project limits of the International Boulevard Phase 1 reconstruction are from South 188th Street to South 170th Street, a segment of approximately 6,500 feet (Figure 2). Prior to the project, the roadway consisted of four general-purpose lanes, a continuous two-way left turn lane, and paved shoulders. Sidewalks existed at spot locations.

Geometrics

The surface geometrics of International Boulevard consisted of:

- Two 11-foot-wide general-purpose through lanes northbound and southbound.
- A continuous, 12-foot-wide two-way left turn lane.
- Paved, 8- to 10-foot-wide shoulders.
- Spot locations where curb, gutter, and 6-foot-wide sidewalks had been constructed.

Horizontal and Vertical Alignment

The posted speed on International Boulevard is 45 mph. Horizontal and vertical alignments were within acceptable guidelines for the posted speed. The previous roadway centerline was the same as the right-of-way centerline. The existing right-of-way was generally 100 feet wide, except for a 150-foot-wide section from approximately South 186th Street to South 176th Street.

Intersections and Access

Six intersections with cross streets were within the project limits. Three were signalized, four-way intersections; two were signalized, three-way intersections; and one was a three-way, stop-sign-controlled intersection.

Numerous private driveways with undefined limits existed along both sides of the roadway. Driveway densities along the section were approximately 35 per mile on each side of the roadway where commercial land uses are adjacent to the roadway. No driveways exist along the Sea-Tac Airport frontage along the west side of International Boulevard (0.7 mile).

Pedestrian and Bicycle Facilities

Pedestrian facilities along International Boulevard were limited to the existing paved shoulders and spot locations where sidewalks had been constructed. A continuous 6-foot sidewalk existed on the west side of International Boulevard from 400 feet north of the Airport entrance to approximately 1,300 feet south of the Airport entrance. Pedestrian crossing opportunities existed at intersections and were deficient within the study area. Many pedestrians crossed at uncontrolled locations due to the long (1,500 to 2,000 feet) distance between crossing opportunities.

International Boulevard was classified as a Class IV Bikeway in the WSDOT bicycle classification system. Bicyclists previously used the paved shoulder. The undefined driveways that previously existed along International Boulevard presented a safety concern for bicyclists. This condition introduced potential conflicts between bicycles and vehicles entering and exiting commercial establishments along International Boulevard.

Utilities and Drainage

Eight utility companies maintained facilities within the project limits. Close coordination with the utility companies was required to identify potential conflicts and to provide relocations prior to construction. Utilities included water, sewer, drainage, overhead high voltage (115kv) transmission lines, overhead telephone, electrical distribution, cable television lines, and liquid petroleum pipeline. Of particular note was the lack of drainage facilities along much of the project extent.

Landscaping

The existing landscape along International Boulevard lacked continuity. Hotels and restaurants typically have a mixture of lawn, trees, shrubs and ground covers that provide screening of parking lots. Most of the park-and-fly lots did not have landscape screening. Existing conifers were of limited affect in visually unifying the boulevard, but fell short of creating a cohesive landscape character.

Traffic Conditions Prior to Reconstruction

Traffic Data

Average 1992 daily traffic volumes on International Boulevard varied from 31,600 vehicles per day (vpd) at South 170th Street to over 40,000 vpd at South 188th Street. The highest daily traffic volumes occurred directly adjacent to the airport entrance at over 42,000 vpd. The traffic data indicate that traffic volumes increased steadily through the morning and early afternoon, reaching a peak at 4 p.m. Traffic volumes were highly directional (roughly a 60/40 predominantly southbound/northbound split).

Traffic Safety

Accident data were prepared for the 3-year period (1990-1993) prior to the beginning of the planning/design process. The data were separated into roadway segment or mid-block accidents and intersection accidents. Accident rates for mid-block segment were as high as 4.9 accidents per million vehicle miles for the section between South 188th Street and the Airport Access. Accident rates at the intersections ranged from 0.13 accidents/million entering vehicles (acc/mev) at the Office Access to 0.95 acc/mev at South 188th Street. Approximately 55 percent of the accidents in the corridor are property damage only; the remaining 45 percent are injury accidents. There were two fatal accidents in the corridor during the period between 1990 and 1993.

Level of Service

Level of service (LOS) is a qualitative description of the delay a driver is expected to encounter on a specific facility. Grades range from LOS A (minimum or no delay) to LOS F (extreme delay and congestion). The LOS for 1993 p.m. peak hour conditions for the five intersections in Phase 1 ranged from B to F in the project corridor. The p.m. peak traffic volumes and LOS were substantially worse than a.m. peak conditions.

Transit Operations

There were previously 10 transit stops within the project limits, five northbound and five southbound. Stops were generally located on the downstream side of the existing signalized intersections. Three of the existing bus stops had shelters. The remaining locations had no amenities for transit users. Service was provided on weekdays and weekends with headways of 30 minutes during most times of the day.

Origin-Destination Survey

International Boulevard serves as both a local and regional facility. An origin-destination, license plate survey was conducted for the period from 3:00 p.m. to 4:30 p.m. to determine the amount of through (regional) traffic using International Boulevard. Regional traffic is defined as through traffic traversing the City of SeaTac; local traffic is defined as traffic having an origin or destination within the City of SeaTac. Southbound traffic volumes are generally higher in the afternoons on this portion of International Boulevard. Regional traffic tends to divert to International Boulevard as congestion increases on southbound I-5, which parallels International Boulevard (Figure 2). Through traffic volume as a percent of total traffic was estimated to be between 16 and 18 percent in the southbound direction. Through traffic volumes in the northbound direction varied from 10 to 12 percent.

Summary of Design Issues and Constraints

Various design issues and constraints were identified:

- Fixed project development (design, construction, right-of-way) budget of $7.3 million
- Required to advertise for bids by December 1994 (15 months from the beginning of the planning/design process)
- High accident rates (up to 5 accidents per million vehicle miles of travel)
- History of vehicle-related pedestrian fatalities and injuries
- Existing and projected heavy p.m. peak period traffic congestion
- Need to serve multiple modes, including autos, transit, trucks, shuttle vans, bicycles, pedestrians

- Auto-oriented land uses that depend upon unlimited property acces
- Conflict between serving heavy, high-speed regional traffic and establishing downtown main street for local traffic
- Limited existing right-of-way of 100 feet
- Substantial underground and overhead utilities
- Poor, discontinuous drainage facilities

Project Development

Process

Preparations for reconstruction of the project began in the fall of 1993. Funding had been obtained to widen the roadway to a 7-lane cross-section and to construct sidewalks. At the same time, the City's Department of Community Development was working with a citizen and business advisory committee (the International Boulevard Corridor Advisory Committee [IBC Committee]), to develop a land use plan for the corridor. This committee, was also addressing urban design and transportation infrastructure considerations. Therefore, the City assigned them responsibility to review the development of the street design.

Other major stakeholders for the project included the Washington State Department of Transportation (WSDOT), King County/Metro Transit (Metro), the Port of Seattle, and Puget Power. WSDOT, Metro, and the Port of Seattle each made financial contributions to the construction budget. WSDOT had partial jurisdiction for this project because they have responsibility and authority for geometric design and safety for SR 99. WSDOT had recently adopted a statewide Access Management Plan that required reconstruction projects along state routes to meet specified access management standards. Metro was concerned about the speed and reliability of transit services along SR 99. Because SR 99 is a primary access route to Sea-Tac Airport, the Port of Seattle was concerned about increasing the capacity of the roadway.

A planning process was used to identify issues and needs, develop alternatives, and evaluate and establish the preferred alternative. Traffic safety was only one of many issues identified by members of the IBC Committee. The alternative selected (presented in detail in the next section) included a center, raised median and other access management measures. Information on the planning work was provided at two open houses and in citywide newsletters. This effort was completed in May 1994 with the adoption of the plan at a City Council meeting. The plan began to unravel when meetings were held with property owners to discuss right-of-way needs and property interface designs. The IBC Committee included some representatives from adjacent businesses. However, the extent of the disfavor with potential reduction of access had not been expressed until the summer of 1994.

A series of meetings with property owners and WSDOT was held to develop solutions to property owner concerns regarding reduced access. Generally, the concepts developed consisted of various configurations for mid-block median breaks to enable partial or full access movements. Driveway consolidations were also considered, along with joint access between properties. Ultimately, in October 1994, a final public hearing was held to review the need for access management and the alternative access concepts that had been discussed with property owners throughout the summer, and to get City Council adoption of the access concepts that would be integrated into the final design. This hearing resulted in a majority consensus on acceptable access concepts, although a small number of property owners were not satisfied with the final plan. The final plan included some concepts that did not meet WSDOT standards. WSDOT was involved in the decision process and understood the required compromises. The City submitted requests and justifications for several design deviations to WSDOT and received approval to implement the adopted plan.

Project Design

The project design development process included consideration of three build alternatives and a no-build alternative. The alternatives included five-, six-, and seven-lane configurations for the roadway. The alternatives represented a spectrum of possible traffic improvements for International Boulevard. All alternatives provided sidewalks for pedestrians and widened curb lanes to accommodate bicycles and transit. Optional design features were also developed that could be incorporated into any one of the three build alternatives. The design options included either a raised, landscaped center median or a median consisting of a continuous two-way left turn lane. Alternative capacity improvements, HOV/transit treatments, access management measures, non-motorized mode options, signal system improvements, utility modifications, illumination concepts, and landscaping treatments were also developed.

Many of the design challenges on the International Boulevard project are described below, and discussed as to how they were accommodated.

Transportation Capacity

Public and agency opinions regarding capacity needs ranged from reducing the number of lanes and emphasizing local access to widening the arterial to seven or more lanes in order to provide additional regional capacity. Limited construction funding and right-of-way constraints made cost-efficiency an important consideration. Decisions were made to add an HOV lane in the p.m. peak flow direction (southbound), add approach lanes at congested intersections, incorporate access management measures, improve the signal system, and enhance facilities for transit and non-motorized modes.

HOV/Transit Treatments

Treatments to improve the accessibility, speed and reliability for transit and HOVs include the southbound HOV lane, new bus shelters, bus stop enhancements, and signal design to enable transit signal priority. New guidelines on arterial HOV lane signing and striping, recently established through a regional ad hoc committee, were incorporated into the design.

Non-Motorized Mode Improvements

Pedestrian amenities include sidewalks, decorative lighting at bus zones, sidewalk linkages to adjacent land uses, and two mid-block signalized pedestrian crossings (one of these is combined with a new signalized driveway access). Because this roadway is currently the only north-south route for bicycle travel, Class IV Bikeway lanes are also provided.

Signal System Improvements

All existing and new signals will be furnished with NEMA-type controllers to allow integration with the rest of the City's signal system. These signals were interconnected and controlled with an arterial master. In addition, the system includes equipment to enable signal priority in the future.

Utilities and Illumination

The need to relocate utilities due to the road reconstruction and public concern regarding the poor aesthetics of overhead utility lines led to a decision to underground and reconfigure the utilities. Electrical power distribution lines and telephone and television cables were placed underground. Power transmission lines were relocated on new poles at greater spacing. The illumination system was improved to meet current lighting standards. To save money and improve construction coordination, this work was included in the roadway construction contract (ordinarily the utility companies construct these improvements).

Landscaping Treatments

Aesthetics were improved by planting trees along the sidewalks, special sidewalk paving patterns, a landscaped median, and landscaped transitions with adjacent properties.

Access Management Measures

This was the most controversial issue for this project because International Boulevard provides local access to highly developed adjacent properties, as well as serving regional travel. High accident rates (e.g. five accidents per million-vehicle-miles), the 45-mph speed limit, high traffic volume, and number of lanes led to an agreement to replace the center two-way, left-turn lane with a raised median; driveway controls and consolidations were also included. Compromises included the incorporation of U-turn designs into key intersections and the development of two mid-block median openings (one of these was signalized to provide consolidated driveway access).

Summary of Design Features

In response to the design challenges described above, the eventual adopted project design included the following features:

0. Two general-purpose lanes in each direction
1. Additional southbound HOV lane
2. Additional approach lanes at intersections
3. 16-foot-wide landscaped median
4. Reduced and consolidated driveways
5. Interconnected signal system
6. Class IV (unstriped) bike lanes
7. Enhanced bus stop and shelters
8. Enhanced drainage system
9. Undergrounded utility lines
10. 8-foot-wide sidewalks
11. Two new signalized pedestrian crossings
12. Street trees and groundcover
13. Street and bus stop illumination

Because access management was the project's most controversial issue, the remainder of this paper covers access management in detail.

Access Management Case Examples

Successful implementation of access management was critical to allow for many of the design elements proposed for the roadway reconstruction. The case examples described below illustrate several methods of access management that were used successfully in the International Boulevard Phase 1 reconstruction project and were key in achieving support for the roadway design.

Consolidated Access

Double Tree Inn Vicinity

One 1,500-foot segment of International Boulevard was fronted by several large parcels, including the Double Tree Inn (formerly the Red Lion Inn), that were served by twelve full-access driveways (six on either side of the roadway) and a center two-way left turn lane (Figure 3). While this location with large parcels and long setbacks was a good candidate for consolidated access, several challenges had to be overcome for the design to be realized. In order for the Double Tree Inn parcel owner to forfeit the six full-access driveways on the property, a high level of alternate access had to be provided. This was done with the construction of a new signalized intersection. The intersection would allow the consolidation of nine full-access driveways. The intersection design presented challenges. Driveways on the west side of the roadway had to be consolidated and realigned to match the cross-street access. Also, access had to be preserved to drive-in windows at a bank operating adjacent to the intersection; the bank's driveway was replaced by a leg of the intersection. Driveway consolidations provided the opportunity to relocate a bus stop adjacent to the DoubleTree Inn to a more appropriate location in the segment (next to an intersection and pedestrian crossing location). Prior to the reconstruction, the bus stop was located much further from the intersection and was in between two driveways. That location created sight distance hazards for traffic and pedestrians. Another important accommodation was the provision of U-turn capability at all of the signalized intersections (see section below on U-turn accommodations).

Figure 3 shows a schematic illustration of the driveway consolidations for this example segment. With the reconstruction, the net result was the reduction of full-access driveways in the segment from 12 to 0, and the elimination of the center two-way left turn lane. What exists after reconstruction are 6 right-in, right-out driveways (of which 3 were existing), a relocated bus stop and shelter, a raised, landscaped median, and the new signalized intersection that also provides for another pedestrian crossing location. The improvements reduced the number of crossing conflicts over this segment from 55 to 28 (all of the potential crossing conflicts are within a signalized intersection), and reduced the total number of vehicle conflicts from 138 to 51 for the 1.1 mile roadway project.

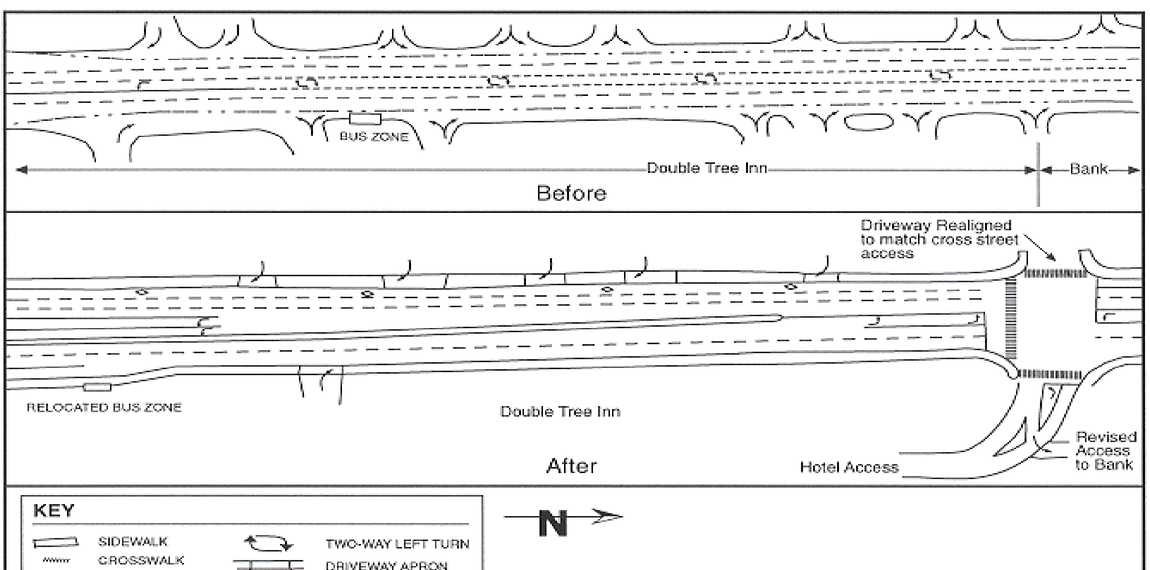


Figure 3
EXAMPLE OF DRIVEWAY CONSOLIDATION

Driveway Reductions

170th Street Vicinity

Prior to reconstruction, the section of International Boulevard immediately south of 170th Street had a two-way left turn lane, 7 full-access driveways, and 8 right-in, right-out driveways (Figure 4). In addition, there were no sidewalks and many of the parcels along the segment had continuous shoulder access. Several of the access points on this segment had to be preserved as the only access to some parcels that do not front directly onto International Boulevard. This restriction dictated which driveways could and could not be closed. With the reconstruction project, the center two-way left turn lane was removed, a raised, landscaped median was constructed, and the number of driveways was reduced to 12 right-in, right-out only driveways (Figure 4). A signalized, mid-block pedestrian crossing and a southbound HOV lane were also added. The pedestrian crossing provided a much-needed mid-block crossing in this segment. While the center two-way left turn lane was removed, a channelized left turn lane was provided for access into properties on east side of the roadway. This was a major controversy that caused many debates between property owners, City staff, and the City Council. Several parcels that did not directly front the boulevard demanded continued access from easements through parcels along the boulevard. The various property owners agreed to create access connections between properties that would enable traffic to enter the properties at one driveway from a channelized left turn pocket within the boulevard in the southbound direction.

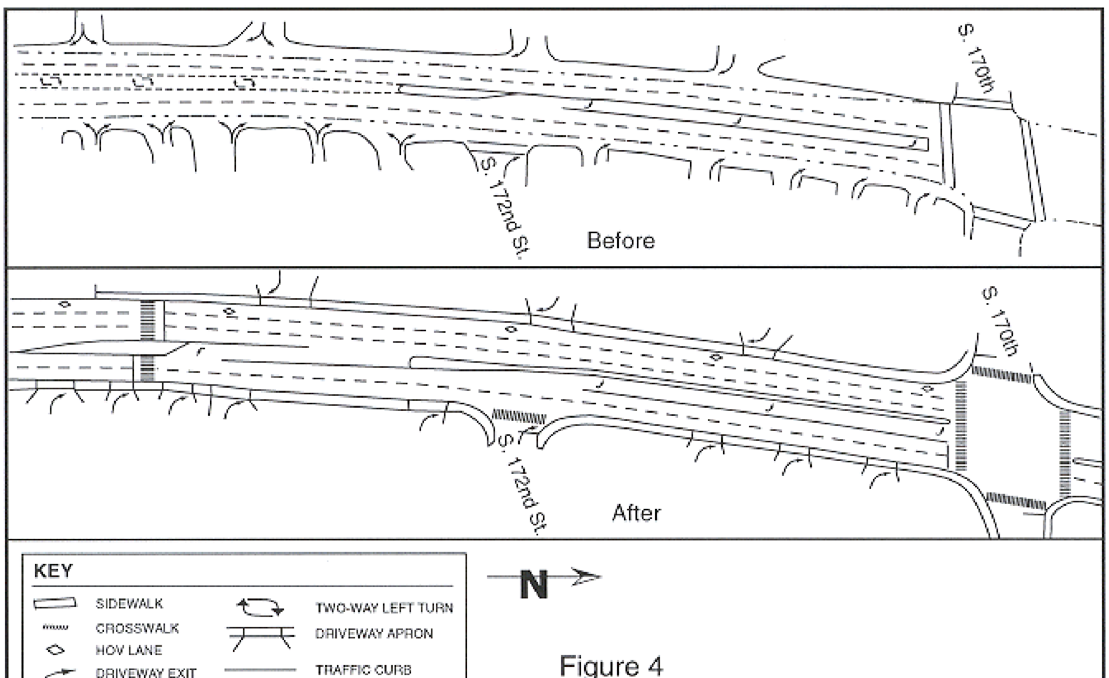


Figure 4
EXAMPLE OF DRIVEWAY REDUCTION

U-turn Accommodations

With the proposal to manage access through the development of a raised median, special consideration was given to accommodating U-turns. Because of the types of land use along the boulevard, substantial property access volumes were a concern. Many of the largest motels in the Puget Sound region are located along this road section. Other land uses with high access volumes included airport-related parking lots, rental car companies, and restaurants (including fast-food restaurants). Motel, parking lot, and rental car shuttle van traffic is very heavy due to the proximity of the airport.

Design issues related to developing U-turn accommodations included:

1. Lack of driver awareness or experience with U-turn maneuvers in the Puget Sound area.
2. Selection of the appropriate design vehicle versus the limited available width of roadway and right-of-way.
3. The existence of right-turn/left-turn signal overlap operations, which is prevalent in the corridor.
4. The proximity of far-side bus stops to intersections.

The U-turn design was developed to accommodate the largest shuttle van utilized in the corridor. All companies that operated vans were invited to have their vans' U-turn diameters measured. The design diameter (i.e., out-to-out distance) established as the minimum design standard for van U-turns was 60 feet. This distance was accommodated in the southbound direction with a 5-foot minimum median width (at left-turn pockets) and the combined width of the 3 southbound lanes. The northbound direction included only 2 lanes, so the intersection corners were modified with a taper to fit the U-turn diameter, or in some cases additional width was available from development of far-side bus stops. Signal operations were changed to remove the right-turn/left-turn signal overlap. Special signs were addedto alert drivers to yield to U-turn vehicles. Figure 5 illustrates typical U-turn accommodations.

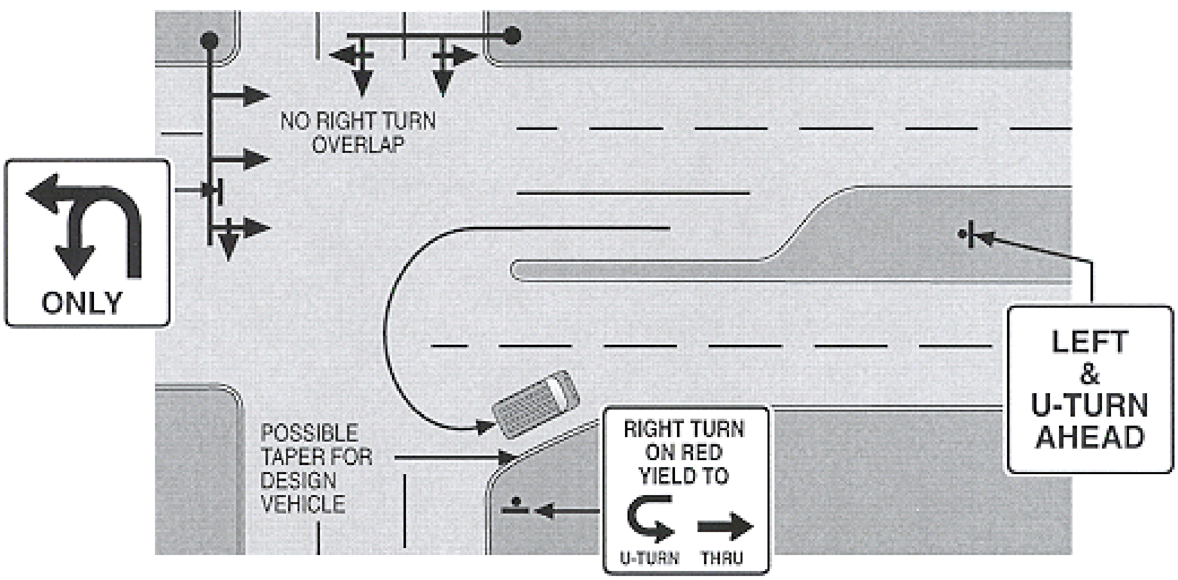


Figure 5
U-TURN ACCOMMODATIONS

Conclusion

This paper has presented the project background and the development process for the Phase 1 reconstruction of International Boulevard. Many design issues and constraints needed to be addressed during the course of planning and design of the project. The affected community and agencies were actively involved in the development and evaluation of alternatives, and negotiation of modifications to the design. Diverse views of the various community and agency stakeholders needed to be considered. The adopted design was a comprehensive solution to the conditions, and the design incorporated elements of transportation capacity, HOV/transit treatments, access management measures, non-motorized mode improvements, signal system improvements, utility and illumination enhancements, and landscaping improvements.

Access management was the most controversial and challenging aspect of the project, and several conclusions can be drawn relating to access management on arterial streets.

1. Access management is only one part of the design for reconstruction of an arterial street. Access management measures were integrated into the overall, comprehensive design. Access management measures alone would not have satisfied all of the conditions at hand, including the needs of the community and agency stakeholders.

2. Use of raised medians within the arterial cross-section are only one of the access management tools to be considered. Access management should be considered as a solution to solve traffic safety concerns. Other measures such as driveway designs, controls, reductions, and consolidations should also be emphasized to address safety problems.

3. Inclusion of medians on arterial reconstruction projects has some problems that need to be considered. These include change or reduction of access to some properties and generation of U-turn demand at intersections, which affects safety and traffic capacity. Therefore, it is likely that reconstruction to include a median may only be warranted under certain conditions such as high volumes (e.g. greater than 30 thousand vehicles per day), high speeds (e.g. greater than 40 miles per hour), and multi-lane cross-sections (e.g. greater than 4 lanes).

4. Medians can provide other benefits (beyond vehicle traffic safety) for a comprehensive design solution. These can include safety for transit, bicycles, and pedestrians. They provide opportunity for landscaping and aesthetic improvements. They can help reduce the amount of impervious surface and thereby reduce the amount of stormwater drainage and detention system requirements.

5. Substantial public education and involvement is needed when considering access management as a part of a major arterial design solution. Business owners are almost always going to oppose these measures at the beginning of the design process. The community and agency stakeholders need to be brought along slowly, first understanding the issues and problems (such as accident problems), then looking at the solutions (which may include some access management measures).

6. It is likely that compromises will need to be made in order to get agreement to include any access management measures in the design. In the case of the International Boulevard project, if compromise breaks in the raised median were not identified and accepted, the project may not have been possible.

Session 22

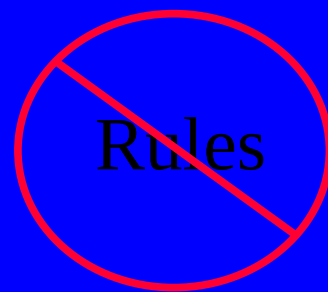
User's Forum:
Access Management Manual Workshop
and
The Attorney's Role
In an Access Management Program

Moderator: Ron Giguere, FHWA
Rindy Lasus, New Jersey Deputy Attorney General

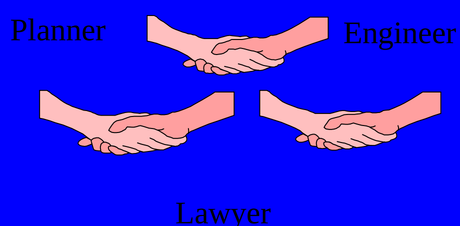
Richard Brauer, The Sear-Brown Group

Legal Issues Associated with Access Management

No National Rules

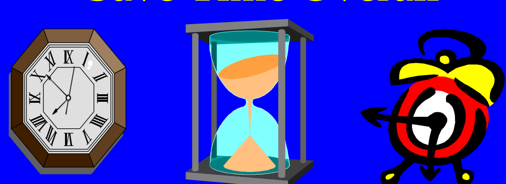


Work as a Team



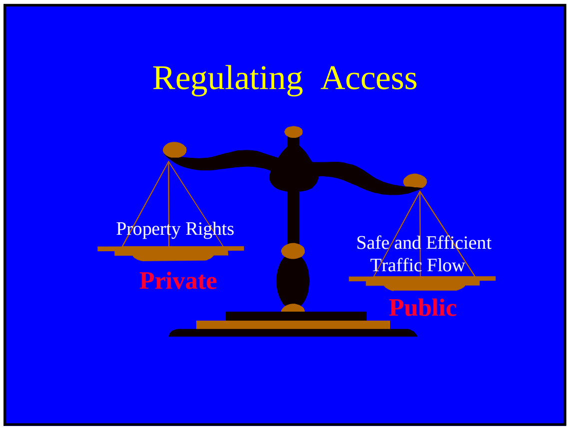
Your Lawyer is Your Friend

Invest Time Up Front to Save Time Overall

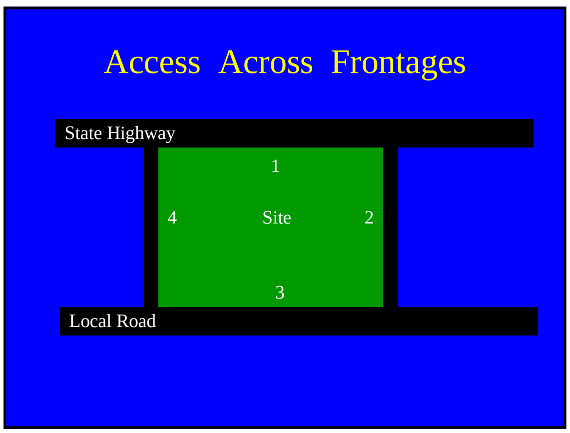


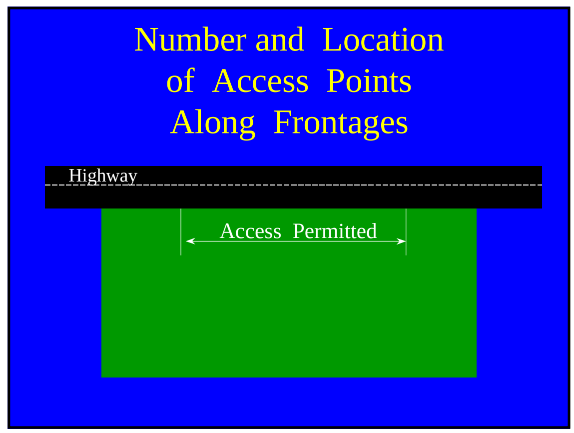
Access Components

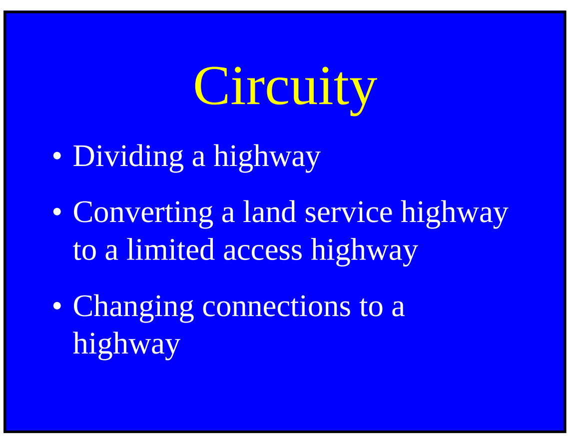
- Getting between the property and the general system of streets and highways.
- Driveways
  - Number
  - Location
  - Configuration

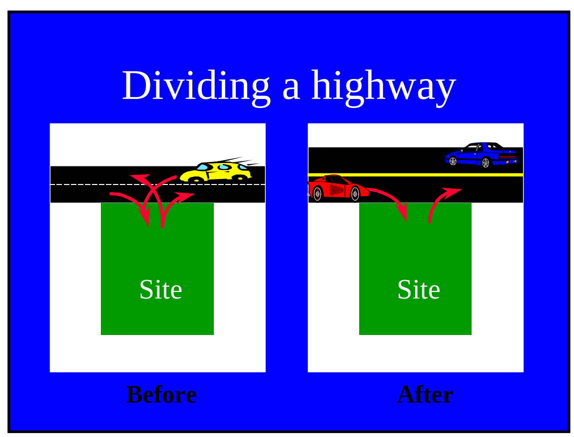

Regulating Access
Property Rights
Private
Safe and Efficient
Traffic Flow
Public

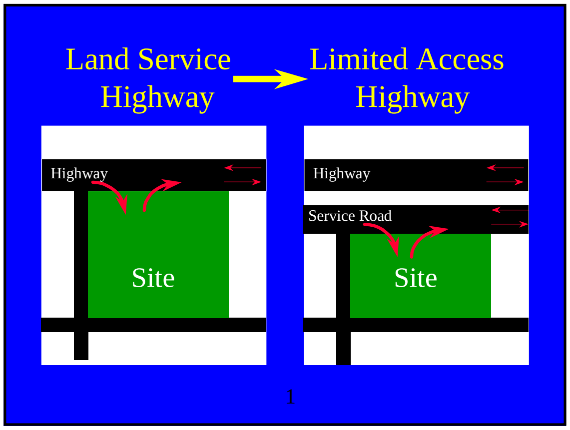

Reasonable Access

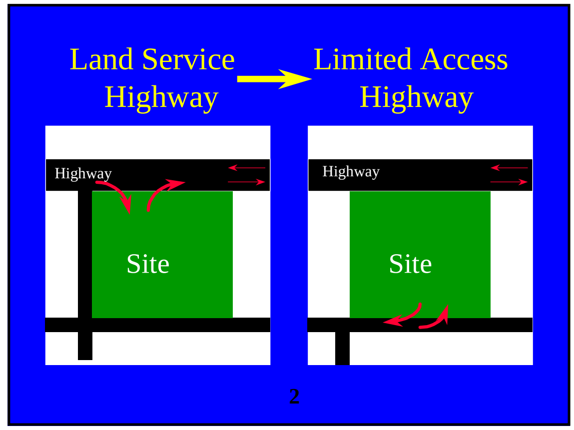

Access Across Frontages
State Highway
1
4
Site
2
3
Local Road

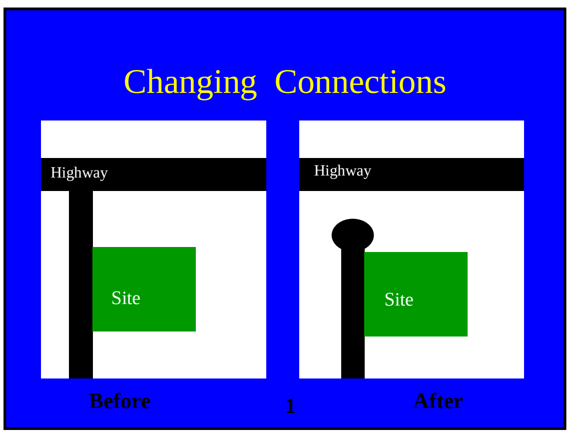

Number and Location
of Access Points
Along Frontages
Highway
Access Permitted

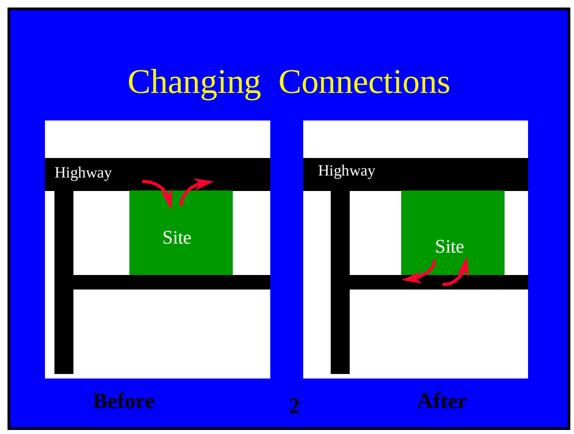

Circuity
• Dividing a highway
• Converting a land service highway to a limited access highway
• Changing connections to a highway

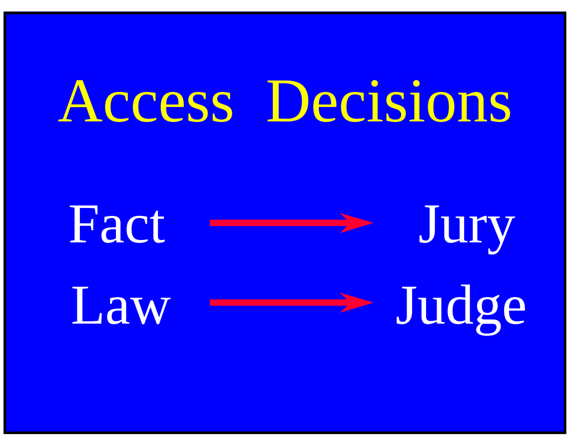

Dividing a highway
Site
Site
Before
After

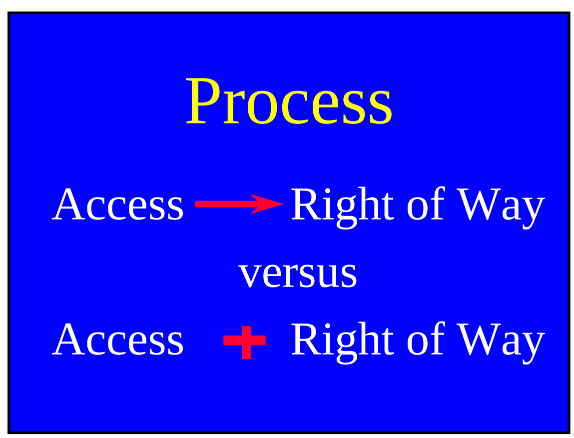

Land Service Highway
Limited Access Highway
Highway
Site
Highway
Service Road
Site
1


Land Service Highway
Limited Access Highway
Highway
Site
Highway
Site
2


Changing Connections
Highway
Site
Highway
Site
Before
1
After


Changing Connections
Highway
Site
Highway
Site
Before
2
After


Access Decisions
Fact
Jury
Law
Judge


Process
Access
Right of Way
versus
Access
Right of Way

Agency Decision Making

~~Arbitrary~~

~~Capricious~~

~~Unreasonable~~

Consistency
Consistency
Consistency
Consistency
Consistency
Consistency
Consistency
Consistency
Consistency
Consistency
Consistency
Consistency
Consistency
Consistency

Reasonable Regulations

Based on:

- Studies
  - –New
  - –Existing
- Other Standards

Ultimate Authority

- DOT
- Local Government

Exactions:

Dolan

vs.

City of Tigard, Oregon

Conclusion:

Know Your State Law

!!!!!!

Session 23

Connection Spacing and Other Issues for Research

Moderator: Bud Koepke, S/K Transportation Consultants, Inc.

Participants: Paul C. Box, Paul Box and Associates
Jerry Gluck, Urbitran
Michele Thomas, FHWA

Effect of Intersections on Driveway Accidents

Paul C. Box, Paul Box and Associates, Inc.

ABSTRACT

Detailed tabulation has been made of over 15,000 accidents in two Illinois suburbs --one adjacent to the City of Chicago and the other at the outer fringe of the continuously developed area. Breakouts were available of accidents by type of occurrence (pedestrian/bike, parked car, fixed object, driveway and other vehicle-vehicle collisions). Additional breakouts include inter- section versus midblock conditions and by functional classification of streets (major, collector, and local).

Driveway accidents related to intersections were found to represent only 1.2% of total accidents (6.3% of driveway accidents) in one city and in the second city 2.0% of total accidents (6.9% of driveway accidents). Neither of the cities placed any limitation on driveway proximity to intersections, other than clearing the corner radius. These findings suggest access management policies restricting driveways closer to intersections than distances such as Florida's 230 feet, have not been supported based upon safety. Similarly, policies on driveway spacing such as Michigan's 300 to 500 feet and Florida's 125 to 660 feet (if based on claims of traffic hazard) may be considered suspect.

Recommendations are listed relative to appropriate techniques for conducting studies of driveway accidents, including use of hard copies rather than printouts, access to location-type files, identification of police agencies producing high-quality reports, avoidance of systems containing only accident data limited to some property damage cutoff, and careful tabulation of appropriate data.

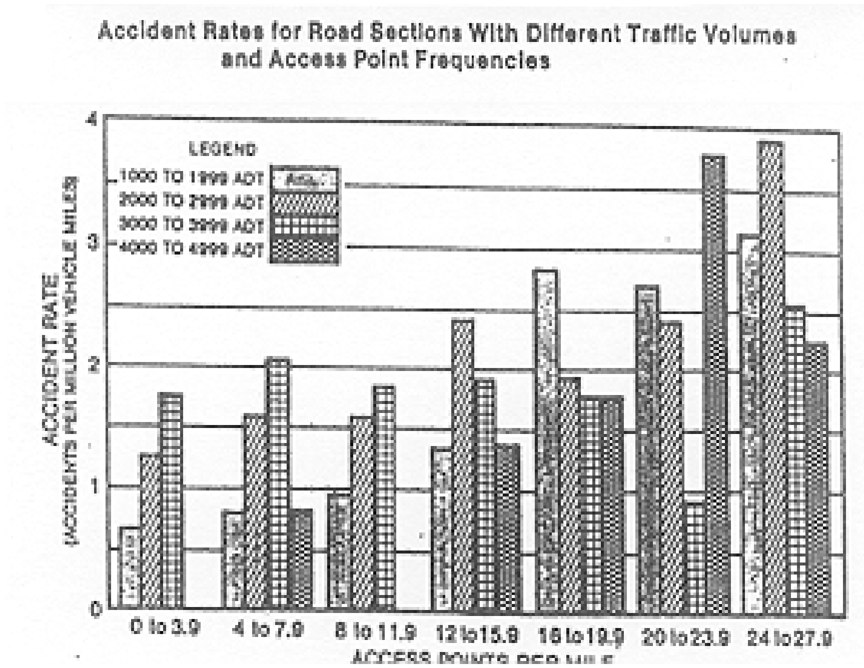
INTRODUCTION

The primary thrust of this paper is presentation of previously unpublished data on driveway accidents, including those found to be related to intersections. Additional published data are reviewed that raises questions on the value of partial control of access such as driveway spacing. Principles are listed as a guide to inform researchers of appropriate driveway accident study techniques and reports are identified on the value of 2WLTL to treat the greatest single driveway accident problem --the left turn entry.

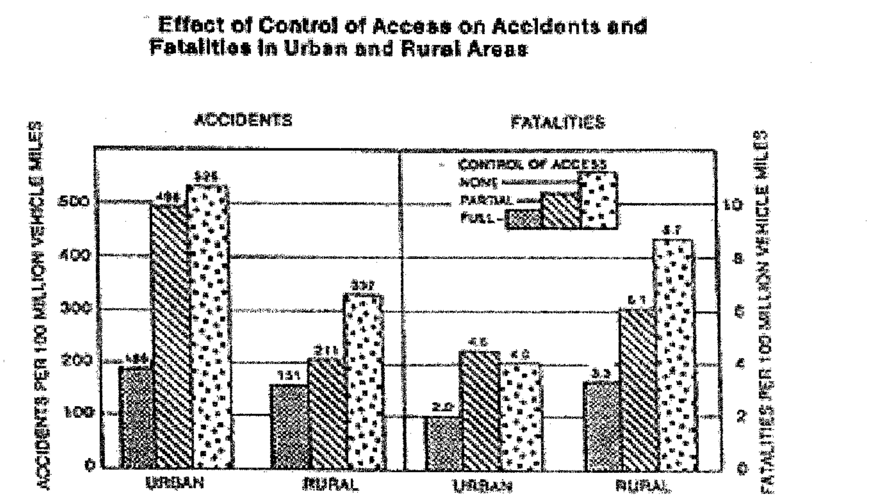
Value of Partial Access Control is Questionable

The FHWA report, Access Management for Streets and Highways (FHWA-IP-82-3, June 1982) introduces the subject of access as related to traffic flow and accidents, with two figures.(1) The first, reporting on a study by Staffeld, is entitled Accident Rates for Road Sections with Different Traffic Volumes and Access Point Frequencies, and is shown on the upper part of Figure 1. The average number of access points in the range of 2 to 26 per mile were grouped by four volume levels ranging from 1,000 to 2,000 up to 4,000 to 5,000 ADT. A general trend of increasing accident rates per 100 MVM appears to occur with an increase in access points per mile. A closer look will show inconsistency. For the low volume range of 1,000 to 2,000 ADT, there is a reasonably consistent climb in accident rates with increasing frequency of access. However, in the range of 2,000 to 3,000 ADT there is little change for an average of 2 to 10 points per mile. It is lower at 18 points than at 14 or 22 points. For 14 or 22 points per mile the same rate is found for this volume level. In the range of 3,000 to 4,000 ADT, little change is found going from an average of 2 to 18 points per mile. In fact, the lowest accident rate is found at 22 points per mile. In the range of 4,000 to 5,000 ADT, the rate is less at 26 than at 22 points per mile. While such findings cannot be said to prove that an increase in number of access points

ACCIDENT RATES RELATED TO DRIVEWAY FREQUENCY AND CONTROL OF ACCESS



SOURCE: Staffeld, P.R.; Accidents Related to Access Points and Advertising Signs in Study, <u>Traffic Quarterly</u>, ENO Foundation, Jan. 1953.



Source: Figure 4, The Federal Role in Highway Safety, report to 86th Congress, First Session, House Document #93, 27 Feb. 1959.

Figure 1

SOURCE: Figure 4, The Federal Role in Highway Safety, report to 86th Congress, First Session, House Document #93, 27 Feb. 1959.

Figure 1

necessarily increases the accident rate, they obviously apply to the conditions of the study, which were 420 miles of rural highway in Minnesota. Certainly, other elements should be considered, such as volume per access point, driveway and local intersection design, sight distance, etc. Without some consideration of these variables (such as land use as a surrogate for driveway volume and functional classification of intersecting streets as a surrogate for crossroad volume), any findings are likely to be inconsistent.

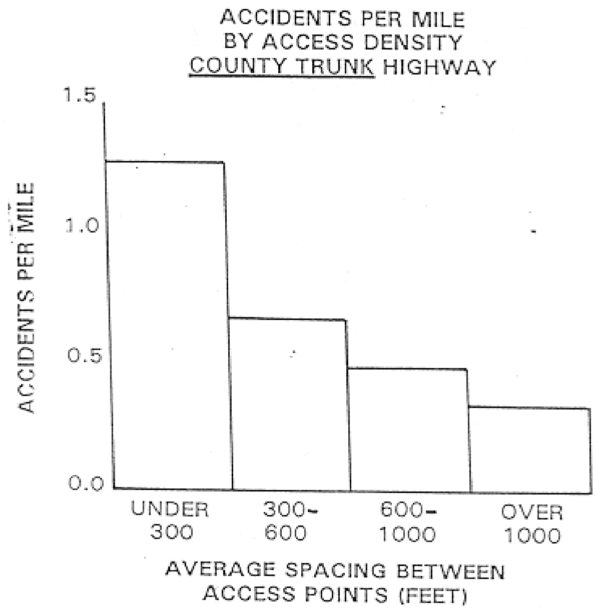
A second figure in the FHWA report (see lower part of Figure 1) concerns the effect of control of access on accidents and fatalities in urban and rural areas. Accident rates per 100 MVM are tabulated for three conditions of full, partial, or no access. In rural areas, a consistent pattern was found for both accidents and fatalities, with the partial access rate being about two-thirds that of the no access condition. Looking at urban areas, the accident rate with full access control, was found to be about 40% of that with partial or no control. Looking at only fatalities, this rate was about one-half of the partial or no control condition. Of interest also is the comparison of none versus partial access control. Little difference was found for accidents. For fatalities, there was actually a lower rate found for the no-control versus partial-control condition. A conclusion may be drawn from this study that little benefit appears in urban areas through the use of partial access control.

Driveway Spacing

A third study cited in the FHWA report was published in the Waushara County Access Control Plan, by the East Central Wisconsin Regional Plan Commission, September 1986. They have a figure showing the relationship between accidents per mile and average access spacing. However, a category of under 300 feet was used, with a second of 300 to 600, a third of 600 to 1,000, and the last for an over 1,000-foot grouping. For county trunk highways (see Figure 2), a steady decrease was found in accidents per mile as spacing increased. For state trunk highways (see Figure 3), in the under 300 group, the frequency was about three times that for the 300 and over. However, the access spacings of 300 feet and more showed no significant difference in accident rates per mile.

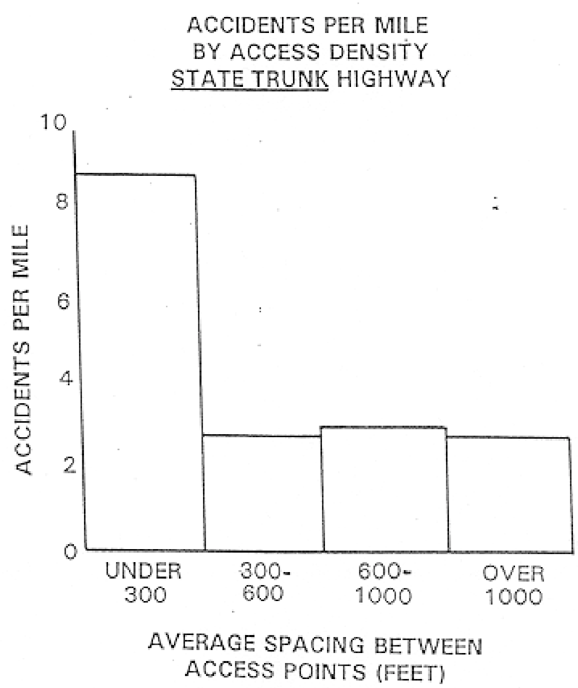
Evidently, the category of 'under 300 feet' covers the full range from driveways adjacent to each other to driveways separated by the length of an urban short block. Most of the accidents may have been occurring at very closely spaced driveways with rates tapering down approaching the limit of the grouping. The same may be said for the other ratings in the county trunk highway tabulation. One cannot automatically assume statistical significance of each of the groupings without further data.

The above three references were cited by the State of Florida in a legal hearing relative to the State's driveway spacing policy of 125 to 660 feet and 230-foot distance from intersections. It can be argued that these studies do not necessarily validate the State's policy and in fact one study suggests that no control of access may be better than partial. They also do not validate the State of Michigan's policy of 300 to 500-foot spacing between driveways.



SOURCE: Waushara County access Control Plan, the East Central Wisconsin Regional Plan Commission, September 1996.

Figure 2



SOURCE: Waushara County Access Control Plan, the East Central Wisconsin Regional Plan Commission, September 1996.

Figure 3

Principles of Driveway Accident Analysis

One explanation of inconsistencies found in studies may be the methods employed. There are at least five desirable conditions to perform an adequate analysis:

1. Manual reading of hard copies of police accident reports.
2. Well-prepared, detailed reports.
3. Location-type file system.
4. Full reporting level --no 'minimum' dollar damage to warrant a report.
5. Proper, accurate tabulation of accident types related to driveways.

It is this author's opinion that a credible study must employ manual reading of hard copies of each report, by an experienced traffic engineer. A mere tabulation of data from a printout, while very 'convenient' seldom includes the data from the narrative. It must be remembered that the physical location of an accident does not necessarily reflect the triggering point. To illustrate, assume a typical queuing, or backup of traffic from a highly congested intersection. A rear-end collision at the end of a queue 200 meters away from the intersection is related to the intersection and not to any driveways in that section. On the other hand, a rear-end collision occurring at this point could be caused by a vehicle stopping to make a left turn into a driveway, causing the vehicle behind to stop, and a third vehicle to strike the second one (or to make a sudden lane change and have a sideswipe or rear-end impact with a fourth vehicle). This is a common type of accident but such reporting detail is critical in any study of driveway accidents, and is usually beyond the capability of a data processing system. This accident type has been christened a 'non-involved' vehicle accident[2] although 'non-contacted' might be a better term.

Well-prepared police accident reports evidently are a pre-requisite to effective analysis. Such studies are possible only in jurisdictions where the police reports are of high caliber and complete as to location, driver intended actions and non-contacted vehicles. Small to medium size cities are more likely to produce such detailed reports than the larger cities.

A third element essential for analysis is a location-type filing system for the reports. The usual serial number sequence method used by police agencies --appropriate for their needs-- is far too cumbersome for retrieval of the thousands of reports to be screened. Again, location-type files of hard copy reports are more likely to be found in traffic engineer offices of small to medium size cities.

The fourth element; extremely critical to driveway accident analysis, is the reporting level. Every accident that is investigated by the police should be used, regardless of the dollar cost of damages. Most state systems throw out a significant number of reports that do not involve some arbitrary damage amount. Some studies have found differences of 19% to 62% between the actual number of reports in the local agency police file, versus those in the state printout.[3]

A quick test of the suitability of accident data may be made by calculating the proportion of injury or fatal type accidents to the total accidents. In urban areas, studies have shown that this seldom exceeds about 25%. If injury/fatal accidents (not the number of persons injured or killed) exceeds about 30% to 35%, it is likely the data base is suspect; i.e., property damage accidents below some arbitrary dollar amount have not been included. Such omissions may seriously degrade the usefulness of any analysis.

Because the conditions allowing creditable tabulation are so difficult to locate, it is no surprise that inconsistent or conflicting results spring from reported studies.

The fifth element --proper tabulation of data-- also must be carefully considered. Appropriate breakouts include:

1. Driveway movement.
    a. Left turn in (separate by rear-end and by left turn head-on type accidents).
    b. Left turn, out (separate by right angle and 'other').
    c. Right turn, in.
    d. Right turn, out.
    e. Other (backing, fixed object, pedestrian).

2. Relation (if any) of turning movements to adjacent elements:
    a. Intersections.
    b. Other driveways.

3. Severity.
    a. PDO (property damage only).
    b. Injury or fatal.

4. Street cross section.
    a. Left turns from through lane.
    b. 2WLTL.
    c. Barrier median.
    d. At barrier median crossover.

5. Other midblock accidents.
    a. Pedestrian or bicycle.
    b. Parked car.
    c. Fixed object.
    d. Other non-driveway, non-intersection related vehicular collisions such as sideswipes or rear-end that cannot be traced to a specific roadway element.

6. Intersection accidents.
    a. Right angle.
    b. Left turn, rear-end.
    c. Left turn, head-on.
    d. Right turn.
    e. Fixed object.
    f. Pedestrian or bicycle.
    g. Miscellaneous other.

<u>Driveway Spacing from Intersection</u>

It is assumed by most engineers that driveways close to intersections are hazardous, but in fact, proof is lacking. Obviously, full access, <u>high volume</u> driveways with all turns allowed must be removed sufficiently from intersections to allow space for left turn lanes (for both intersection and driveway) plus at least a short taper between these lanes.[(4)] This is a matter of operating efficiency for the roadway. It is also a matter of safety --removing the driveway left turns out of the through traffic stream by use of separate left turn lanes.

What, however, is the problem of a 'traditional' service station at the intersection of two major routes, with two driveways on each street, including one near the corner? One answer to this question might be that few 'traditional' service stations are built anywhere --most now include convenience goods sales. However, convenience goods do not add greatly to the volume. Most buyers also purchase gasoline. Furthermore, drivers tend to favor stations that are on the same side of the street and can be entered by right turn. Also, a very high proportion of service station/convenience goods sales involve passerby traffic, continuing in the same direction. Thus, a second driveway near the intersection acts largely as a right turn exit.

The upper part of Figure 4 illustrates the two types of entry and three types of exit driveway movements that may specifically relate to intersection accidents. The lower part shows the six types of accidents that may occur at driveways in any place, but which are <u>not intersection related</u>.

Accident studies have been made utilizing the appropriate methods and conditions previously cited. Table 1 gives data from two such studies involving over 7,000 accidents. The significance of driveway intersection conflict is very low relative to both the number of total accidents or if limited only to proportion of driveway accidents.

TYPES OF DRIVEWAY ACCIDENTS

INTERSECTION-RELATED

2 ENTRY **3 EXIT**

NON-INTERSECTION RELATED

3 ENTRY **3 EXIT**

FIGURE 4

TABLE 1. DRIVEWAY ACCIDENTS ALONG MAJOR STREETS

	Location	
	Skokie, IL*	Naperville, IL**
Total Accidents		
Number	6,450	674
Intersection-related driveway	81	29
Proportion	1.3%	4.3%
Accidents Involving Driveways		
Number	1,167	374
Intersection-related	81	29
Proportion	6.9%	7.8%

*Speed limits 30 to 40 MPH, 5-year study.
**Speed limits 25 to 55 MPH, 1-year study.

Study results of over 12,000 citywide accidents spanning five years are shown in Table 2. Data are given by functional classification of street, accident type and intersection versus midblock condition. A negligible proportion of driveway accidents related to intersections was found for any type of street. Table 2 also shows that some 80% of the accidents involve the major street system. These are the streets, of course, which provide access to most of the higher volume commercial land uses.

TABLE 2. SKOKIE, ILLINOIS ACCIDENTS BY STREET CLASSIFICATION, LOCATION AND TYPE

		Proportion of Group		
Classification	Accident Type	Intersection	Midblock	Total
MAJOR	Pedestrian/Bike*	2.6%	2.2%	2.5%
	Parked car	1.4	30.6	11.7
	Fixed Object*	3.6	6.8	4.7
	Vehicle/Vehicle*	91.1	29.3	69.3
	Other, including driveway	1.3	31.1	11.8
COLLECTOR and LOCAL	Pedestrian/bike*	3.2	6.7	5.3
	Parked car	8.4	65.5	42.7
	Fixed Object*	3.7	5.6	4.8
	Vehicle/Vehicle*	83.9	7.0	37.8
	Other, including driveway	0.8	15.2	9.4
PROPORTION OF CITYWIDE (12,490 ACCIDENTS)				
Major	....	51.6%	28.1%	79.7%
Collector/Local	....	8.1	12.2	20.3
ALL	....	59.7%	40.3%	100%

*Not including driveways.

Table 3 gives data from another city with comparable findings. It is important to note that these data are from cities with no significant spacing limits from intersections or between driveways, other than those in the Recommended Practice of the ITE, Guidelines for Driveway Location and Design.[5] Furthermore, during tabulation of these data, an insignificant number of accidents were found to be related to adjacent driveways --so few that a separate breakout was not needed.

TABLE 3. NAPERVILLE, ILLINOIS ACCIDENTS BY STREET CLASSIFICATION, LOCATION AND TYPE

		Proportion of Group		
Classification	Accident Type	Intersection	Midblock	Total
MAJOR	Pedestrian/Bike*	2.2%	1.6%	1.0%
	Parked car	0	3.3	1.2
	Fixed Object*	3.6	9.5	5.6
	Vehicle/Vehicle*	91.6	31.3	70.9
	Other, including driveway	2.6	54.3	21.3
COLLECTOR	Pedestrian/bike*	1.2	5.6	3.5
	Parked car	0	26.0	13.6
	Fixed Object*	9.5	10.7	10.1
	Vehicle/Vehicle*	86.3	13.0	48.7
	Other, including driveway	3.0	44.7	24.1
LOCAL	Pedestrian/bike*	1.0	2.4	1.9
	Parked car	6.7	50.8	37.8
	Fixed Object*	14.4	18.1	16.9
	Vehicle/Vehicle*	77.9	10.2	29.7
	Other, including driveway	0	18.5	13.7
PROPORTION OF CITYWIDE (2,668 ACCIDENTS)				
Major		48.4%	25.3%	73.7%
Collector		6.3	6.6	12.9
LOCAL		3.9	9.5	13.4
ALL		58.6%	41.4%	100%

*Not including driveways.

The issue of driveway spacing is discussed in the ITE Recommended Practice for Driveways.[5] Of three studies cited, one by J. A. head of 186 miles of urban highways found the number of driveways to be a relatively unimportant factor in predicting accident rates. He found the number of commercial units to be a much greater factor.

A 5-year study by the author of over 1,500 establishment years (commercial units in place one year) related annual accident rates to establishments and to driveways. Extracted data are listed in Table 4. Of particular interest are service stations. Each station averaged about three driveways connecting to major streets. Typical spacing between driveways was about 20 meters and from intersections about 10 meters. Note that the hazard (annual accident rate) was 0.54 per establishment; or 89% of the average. However, the rate per driveway was only .15; or 45% of the average. For most of the other land uses, the establishment rate (as a percent of the average) closely parallels the driveway rate percent of the average. Such findings suggest that the establishment and the conflict introduced by its total traffic generation is a more important factor than the number of driveways.

TABLE 4. DRIVEWAY ACCIDENT SUMMARY ANALYSIS (MAJOR STREET ACCESS ONLY)

Land Use	Exposure Years* Establish.	Exposure Years* Drive.	Annual Acc. Rate per Establishment PDO	Annual Acc. Rate per Establishment Injury	Annual Acc. Rate per Establishment Total	Overall # of Acc.	Overall Rate per Drive-way
Industrial	229	398	0.21	0.07	0.28	65	.12
Service Station	274	764	0.41	0.13	0.54	147	.15
School	63	82	0.21	0.05	0.26	16	.16
Small Retail	170	184	0.20	0.08	0.28	48	.18
Restaurant							
Seat type	119	173	0.48	0.23	0.71	84	.33
Drive-in	49	91	0.93	0.41	1.34	59	.45
Office Buildings	54	93	0.35	0.09	0.44	24	.20
Auto Repair Shops	43	63	0.16	0.02	0.18	8	.11
Neighborhood Shop.Cntrs	65	125	1.14	0.58	1.72	112	.59
Miscellaneous Sales	62	93	0.11	0.11	0.22	14	.08
Taverns	55	70	0.44	0.13	0.57	31	.34
Garden Centers	34	44	0.00	0.00	0.00	--	.00
Municipal Parking Lots	30	45	0.20	0.03	0.23	7	.13
Grocery Stores	40	68	0.75	0.27	1.02	41	.44
Liquor Stores	25	30	0.84	0.12	0.96	24	.70
Misc. Commercial	25	30	0.24	0.12	0.36	9	.20
(16 uses listed)							
TOTAL FOR 30 USES	1,507	2,746	0.43 Avg.	0.18 Avg.	0.61 Avg.	912	.33 Avg.

*Number of establishments and driveways times years in operation during the study.

SOURCE: Extracted from Driveway Accident and Volume Studies, Public Safety Systems, May/June 1969, by author.

Driveway Accident Types

Any consideration of driveway control or regulation should begin with study of the types of accidents that occur at driveways. Table 5 draws from three detail studies of accidents at 1,350 driveways. It shows that the movement responsible for about one-half of the accidents is the left turn entry. Provide for this movement (such as by a 2WLTL design) and much of the problem has been treated.

TABLE 5. MISCELLANEOUS MAJOR STREET DRIVEWAY ACCIDENT STUDIES

Location and Land Use	Proportion of Accidents by Movement — IN: Left Turn	IN: Right Turn	OUT: Left Turn	OUT: Right Turn
Skokie, IL*				
Mixed uses	43%	15%	27%	15%
Ogden Avenue, Naperville, IL**				
4-lane	55%	8%	31%	6%
5-lane with 2WLTL	30%	18%	32%	17%
St. Charles, IL***	78%	6%	14%	2%
Average without 2WLTL	58%	10%	26%	8%

*2-year study, 317 accidents at 1,238 driveways.
**2-year before and 2-year after study, 200 accidents, 109 driveways. (Driveway accidents were reduced by 20%).

***3-year study, 63 accidents, 3 driveways.

Median Designs

Many studies of 2WLTL benefits have been published, giving accident reductions. Notable are:

Sawhill & Neuzil(6) 26%
ITE Southern Section(7) 31%
Walton & Machemehl(8) 26%
Conradson & Al-Ashari(9) 33%
Box(10) 40%
Harwood(11) .... 24% to 53%

The Sawhill/Neuzil study was remarkable in that they utilized both motorist reports of accidents and reports by the police. Only about one-half of the motorist reports were investigated by the police. The Smith study in Washington, D.C. found only one-third of the total accidents to be reported to the police, representing only 62% of the total accident costs.(12) This reinforces the preceding admonition on securing the maximum possible accident data for every study section.

Considering the extensive positive findings available from numerous studies of 2WLTL installations, it is surprising that the latest AASHTO Highway Safety Guide does not even mention this design under Access Management.(13) However, the AASHTO Design Guide lists several significant advantages of 2WLTL.(14)

Studies also have been made of barrier medians, which restrict rather than provide for left turns into driveways. Findings are mixed --some researchers report lower accident rates for barrier versus 2WLTL-- others found higher. A summary of findings and a listing of advantages and disadvantages is given in a recent paper.(15)

U-turn accidents at intersections have been reported as a problem associated with barrier medians.[16] It also should be noted that typical, if not all, studies of barrier median omit analysis of accidents added to local streets due to round the block circulations. In the absence of detail study, we do not know whether the added accidents at median noses and on cross streets equals the number apparently 'prevented' by the barrier. Furthermore, a loss of trade may have occurred, thus reducing the right turn conflict. As subsequently will be noted, there are conditions where landscaped barrier median use is ideal, but this does not mean every street should be a candidate.

Squires and Parsonson studied 50 2WLTL sections and 32 barrier median sections on 122 miles of urban state highways in Georgia.[17] They found barrier medians to be safer than 2WLTL's for 4-lane roads, but the advantage decreased as the frequency of signalized intersections increased. For 6-lane roads, 2WLTL's were safer with high numbers of driveways (75 per mile), with two or fewer signals and more than five or six crossroads per mile.

Conclusions

This paper has briefly addressed issues, approaches to definitive accident analysis, and accident findings (previously unpublished as well as research). A positive case for restrictions on driveway spacings from intersections, or between driveways, other than those in the ITE Recommended Practice, has not been found, based upon safety. Therefore, the ITE values are briefly summarized in Table 6 as suggested guidance.

TABLE 6. COMMERCIAL DRIVEWAY SPACING GUIDELINES

From Intersection

Corner radius plus 1.5 meters plus driveway radius but not more than 15 meters required from cross street curb line. (See Figure 7 in Source).

Between Driveways

Sum of both driveway radii plus 1.5 meters.

Minimum Radii

Residential, 2 meters.
Commercial, 5 meters.
Industrial, 15 meters.

Suggested Maximum Number Driveways per Property

1 for 0 - 15 meter frontage.
2 for 16 - 50 meter frontage.
3 for 51 - 150 meter frontage.
4 for over 150 meter frontage.

SOURCE: Ref. 5, ITE Guidelines for Driveway Location and Design.

Certainly it is true that right turn movements into driveways can reduce capacity in the curb lane by interfering with through traffic flow. This also is the case for right turns at intersections, other than the few with added right turn lanes. In the absence of a 2WLTL, left turns from the inner lane can have an enormous and usually unacceptable adverse effect on through traffic. Hence the need to either provide for, or block, left turn entry movements to the degree practical. The Naperville study found a 57% reduction in driveway left turn entry accidents after installation of the 2WLTL.[10]

Reference to Table 5 will show that the second highest cause of driveway accidents is the left turn exit. This movement is aided by the 2WLTL which allows drivers to pull into the lane during a gap in their near-side flow of traffic and wait in the lane for a gap in flow on the other side of the street. An 18% reduction in driveway left turn exit accidents was found in Naperville with the 2WLTL. This safety feature does not exist with a barrier median less than about 13 meters wide (a 9-meter passenger car U-turn plus acceleration lane on the far side). This width does not accommodate trucks to the degree found with 2WLTL. Another point is that many collisions with barrier medians are never reported when the vehicle, though damaged, can be driven away.

There are two unquestionable advantages of the barrier median --a haven for pedestrians crossing the road, when the nose at an intersection is about two meters wide, and the opportunity to place landscaping to soften the 'sea of concrete'. In areas where advance planning has limited access to well-spaced intersecting streets (using reverse frontage residential lots or parallel service roads), use of a landscaped barrier median may be ideal. For the more typical condition, however, the 2WLTL offers many compelling advantages when incorporated into 3-lane through 7-lane cross-sections.

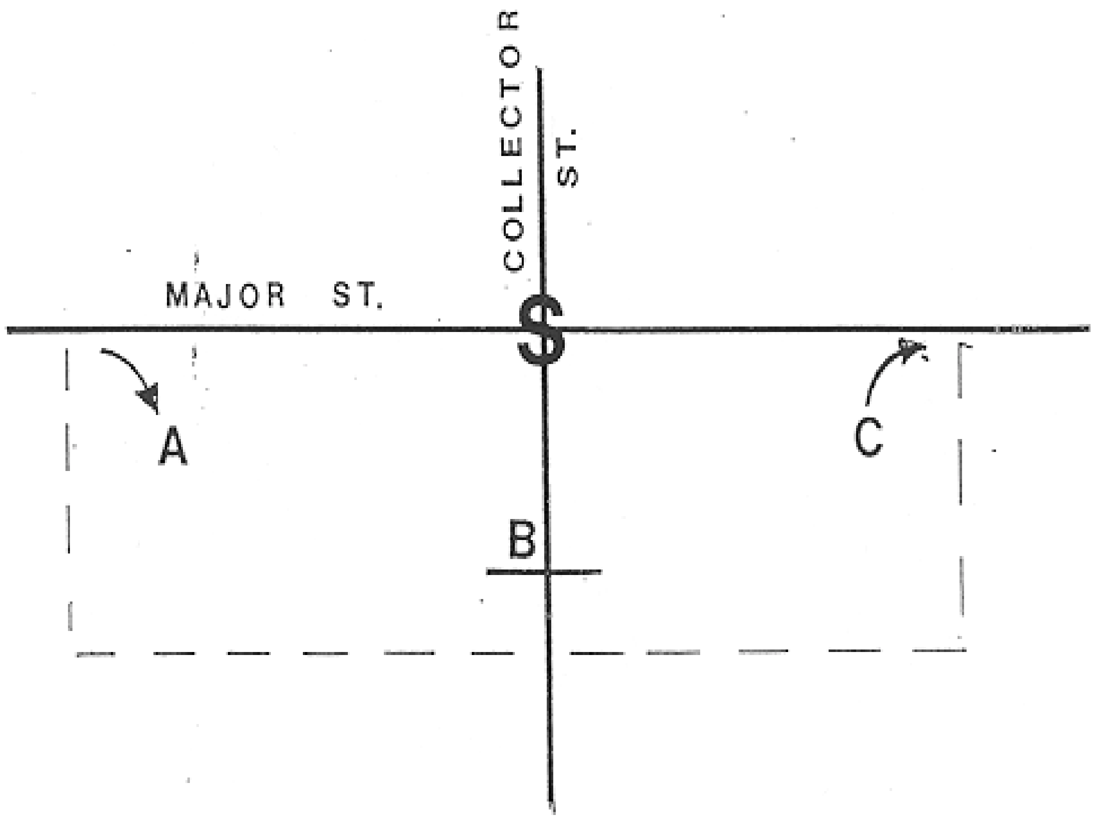
Another factor concerns 'intercept' or 'relief' driveways near signalized intersecting cross streets. Figure 3 shows a condition where the intercepting driveway A in advance (a right-in only, operation) will reduce the volume of right turn conflict (and perhaps capacity need) at the intersection, as opposed to requiring all traffic to enter at driveway B. On the far side, the relief driveway C (for right-out only) reduces the volume of right turn exit from the cross street --perhaps reducing the green time requirement to the advantage of the major street.

An additional issue is the allowance of a driveway within a right turn lane at an intersection. Some state engineers have rejected such permits on the basis of 'policy'. Intuitively, such a driveway would appear to be no more hazardous than one not in such a recessed lane and perhaps even safer. At least one study found a lower accident frequency with such a driveway than the average for other driveways of the same land use category. Clearly, more research is needed to settle this issue.

The AASHTO Design Guide[14] includes the statement that "Driveways should not be situated within the functional boundary of at-grade intersections. This boundary would include the longitudinal limits of auxiliary lanes." While the AASHTO did not present guidelines as to the size of this functional area, the TRB Committee on Access Management chose to do so in Circular 456, Driveway and Street Intersection Spacing.[18] They concluded that the desirable functional area, excluding length of storage lanes, ranged from 100 meters at 50 km/hr approach speed to 190 to 230 meters at 70-80 km/hr.

Typical urban and suburban block limits in the mid and western U.S.A. are 100 meters (short) and 200 meters (long). These traditional values are the 1/16th and 1/8th mile spacings used in city layout. It is obvious that following the AASHTO admonition and the Access Committee's conclusions would eliminate most driveways and negate the second function of a major traffic route --to provide access to abutting property. Hopefully, most governmental agencies will continue to ignore such unrealistic and impractical proposals

ADDED ACCESS ON MAJOR ROUTE MAY REDUCE CONFLICTS



A = intercept driveway, right-in only.
B = primary access.
C = relief driveway, right-out only.
S = traffic signal control.

FIGURE 3

The ITE Driveway Guidelines include the statement: "It should be stressed that these design values are guidelines. The dimensions should be adjusted by the driveway permit engineer as required to handle expected traffic conditions."

It is the author's firm conviction that no driveway regulation should be cast in stone. Permit engineers should have the authority to approve rational departures from the basic guidelines, and should have the common senseneeded to exercise appropriate engineering judgment.

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Overview of NCHRP Project 3-52
Impacts of Access Management Techniques

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DISCLAIMER

ABSTRACT

This paper presents an overview of NCHRP Project 3-52 – Impacts of Access Management Techniques. The project classified access management techniques, identified the "priority" techniques, and suggested safety, operation, and economic impact measures. The impacts and benefits of "priority" techniques were quantified based upon an extensive literature review, case studies of good and poor practice, and special field studies. In addition, the salient planning and policy implications were set forth.

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State, local, and other agencies were very helpful by providing information on their access management practices and procedures. In particular, the support of the following state departments of transportation in providing accident information is acknowledged: Delaware, Illinois, Michigan, Oregon, New Jersey, Texas, Virginia, and Wisconsin.

The insights, guidance, and suggestions of the NCHRP Project 3-52 panel are greatly appreciated. Panel members included Mr. Arthur Eisdorfer (Chair), New Jersey Department of Transportation (DOT); Mr. Gary Coburn, Ohio DOT; Mr. Ronald Giguere, Federal Highway Administration; Mr. Del Huntington, Oregon DOT; Ms. Denise Kors, British Columbia Ministry of Transportation and Highways; Mr. Kenneth Lazar, Illinois DOT; Dr. William McShane, Polytechnic University; and Mr. Michael Tako, Florida DOT. The support and assistance from Mr. Ray Derr of the National Cooperative Highway Research Program are gratefully acknowledged.

INTRODUCTION

The research objective of NCHRP 3-52 was "to develop methods of predicting and analyzing the traffic-operation and safety impacts of selected access management techniques for different land use, roadway variables, and traffic volumes. The methods to be developed are for use by state departments of transportation, city and county traffic departments, transportation-planning agencies, and private developers." A two-phase research approach was designed to achieve these objectives and to produce practical guidelines for the application, analysis, and selection of various access management techniques.

The first phase identified the various techniques that are available; showed how they can be classified in terms of functional objectives, roadway elements, and likely impacts; and suggested "priority" techniques for further analysis. Likely impacts were extracted based on a literature review, the Research Team's experience, and selected agency surveys. The need for further data collection was identified. First phase efforts concluded with the design of data collection plans that addressed the data voids for the priority techniques.

The second phase_focused on the further analysis of priority techniques that included signalized and unsignalized access spacing, median treatments, left turns, separation distances at interchanges, and frontage roads. It involved collecting, analyzing, and synthesizing information obtained from secondary sources to develop methods for estimating impacts; preparing case studies that identified good and poor practices; and performing primary data collection. Findings are contained in a final report and are detailed in a series of technical memoranda.

A. Techniques and Impacts

More than 100 individual access management techniques were identified. These, in turn, were grouped according to policy and roadway design features as shown in Table 1. This system keys techniques to the type of improvements normally applied along highways and access driveways. It is simple to use and understand.

A series of "priority" techniques was identified for detailed analysis. These techniques (1) apply over a large portion of the roadway system, (2) can improve safety, speeds, and emissions, and (3) are generally amenable to measurement. These priority techniques are listed in Table 2. The research effort focused on techniques whose impacts can be measured. Where impacts could not be quantified, case studies identified good and poor practice.

A wide range of possible impacts was identified. These impacts were grouped into four broad categories: traffic operations, traffic safety, environmental, and economics. In reviewing these groups, it became apparent that many impacts are interrelated. For example, emissions largely depend upon traffic volume and speed of travel. Therefore, subsequent analysis for the specific techniques focused on traffic operations (travel times, speeds, capacities) and safety (accident rates). However, economic impacts were also identified where relevant.

Table 1
Recommended Classification System
for Access Management Techniques

I. Policy - Management

a. Access Codes/Spacing
b. Zoning/Subdivision Regulations
c. Purchase of Access Rights
d. Establish setbacks from interchanges and intersections

II. Design - Operations (by roadway features)

a. Interchanges
b. Frontage Roads
c. Medians - Left Turns
d. Right Turns
e. Access/Driveway Location - (Mainly Retrofit -- consolidation, reorientation, relocation)
f. Traffic Controls
g. Access/Driveway Design

Table 2
Priority Techniques Analyzed

1a	Establish Traffic Signal Spacing Criteria
1b	Establish Spacing for Unsignalized Access
1c	Establish Corner Clearance Criteria
1d	Establish Access Separation Distances at Interchanges
2a	Install Physical (Restrictive) Continuous Median on Undivided Highway
2b	Replace Continuous Two-Way Left-Turn Lane with Restrictive Median
3a	Install Left-Turn Deceleration Lanes
3c	Install Continuous Two-Way Left-Turn Lane
3d	Install U-Turns as Alternative to Direct Left-Turns
3e	Install Jug-Handle and Eliminate Left Turns
6a	Install Frontage Road to Provide Access to Individual Parcels
6b	Locate/Relocate the Intersection of a Parallel Frontage Road and Cross Road Further from the Arterial Cross Road Intersection

B. Traffic Signal Spacing (Technique 1a)

The spacing of traffic signals, in terms of their frequency and uniformity, governs the performance of urban and suburban highways. It is one of the most important access management techniques. This is why Colorado, Florida, and New Jersey require long signal spacings (e.g. ½ mile) or minimum through band widths (e.g. 50 percent) along principal arterial roads.

Safety

Several studies have reported that accident rates (accidents per million VMT) rise as traffic signal density increases. An increase from two to four traffic signals per mile resulted in about a 40 percent increase in accidents along highways in Georgia and about a 150 percent increase along US 41 in Lee County, Florida. However, the safety impacts may be obscured in part by differing traffic volumes on intersecting roadways and by the use of vehicle-miles of travel for computing rates, rather than the accidents per million entering vehicles.

Travel Times

Each traffic signal per mile added to a roadway reduces speed about two to three mph. Using two traffic signals per mile as a base results in the following percentage increases in travel times as signal density increases. For example, travel time on a segment with four signals per mile would be about 16 percent greater than on a segment with two signals per mile.

Signals Per Mile	Percent Increase in Travel Times (Compared to 2 Signals Per Mile)
2.0	0
3.0	9
4.0	16
5.0	23
6.0	29
7.0	34
8.0	39

C. Unsignalized Access Spacing (Technique 1b)

Access points introduce conflicts and friction into the traffic stream. As stated in the 1994 AASHTO *Policy on Geometric Design of Highways and Streets*, "Driveways are, in effect, at-grade intersections .... The number of accidents is disproportionately higher at driveways than at other intersections; thus, their design and location merit special consideration."

It is increasingly recognized that spacing standards for unsignalized access points should complement those for signalized access. Potentially high-volume unsignalized access points should be placed where they conform to traffic signal progression requirements. On strategic and primary arterials, there is a basic policy decision of whether or not access should be provided entirely from other roads.

Safety

Many studies over the past 40 years have shown that accident rates rise with greater frequency of driveways and intersections. Each additional driveway increases accident potential. This finding was confirmed by a comprehensive safety analysis of accident information obtained from Delaware, Illinois, Michigan, New Jersey, Oregon, Texas, Virginia, and Wisconsin.

About 240 roadway segments, involving more than 37,500 accidents, were analyzed in detail. Accident rates were derived for various spacings and median types. The accident rate indices shown below were derived using 10 access points per mile as a base. (Access density is a measure of the total number of access points in both travel directions.) For example, a segment with 60 access points per mile would be expected to have an accident rate that is three times higher than a segment with 10 access points per mile. In general, each additional access point per mile increases the accident rate by about 4 percent.

Total Access Points Per Mile (Both Direction)	Accident Rate Index
10	1.0
20	1.4
30	1.8
40	2.1
50	2.5
60	3.0
70	3.5

Representative accident rates by access frequency, median type and traffic signal density are summarized in Table 3 for urban and suburban areas. Tables 4 and 5 show how accident rates rise as the total access points per mile (both signalized and unsignalized) increases in urban and rural areas, respectively, as a function of the median treatment. In urban and suburban areas, each access point (or driveway) added would increase the annual accident rate by 0.11 to 0.18 on undivided highways and by 0.09 to 0.13 on highways with TWLTLs or non-traversable medians. In rural areas, each point (or driveway) added would increase the annual accident rate by 0.07 on undivided highways and 0.02 on highways with TWLTLs or non-traversable medians.

Travel Times

Travel times along unsignalized multi-lane divided highways can be estimated using procedures set forth in the *1994 Highway Capacity Manual* (HCM). Speeds are estimated to be reduced by 0.25 mph for every access point up to a 10 mph reduction for 40 access points per mile. The HCM procedure is keyed to access points on one side of a highway, but access points on the opposite side of a highway may be included where they have a significant effect on traffic flow.

Table 3

Representative Accident Rates
(Accidents Per Million VMT)
By Access Density
Urban and Suburban Areas

Unsignalized Access Points Per Mile	Signalized Access Points Per Mile			
	# 2	2.01-4.00	4.01-6.00	> 6
# 20	2.6	3.9	4.8	6.0
20.01-40	3.0	5.6	6.9	8.1
40.01-60	3.4	6.9	8.2	9.1
>60	3.8	8.2	8.7	9.5
All	3.1	6.5	7.5	8.9

Table 4

Representative Accident Rates
(Accidents Per Million VMT)
By Type of Median - Urban and Suburban Areas

Total Access Points Per Mile (1)	Median Type		
	Undivided	Two-Way Left-Turn Lane	Non Traversable Median
# 20	3.8	3.4	2.9
20.01-40	7.3	5.9	5.1
40.01-60	9.4	7.9	6.8
>60	10.6	9.2	8.2
All	9.0	6.9	5.6

(1) Includes both signalized and unsignalized access points.

Table 5

Representative Accident Rates
(Accidents Per Million VMT)
By Type of Median - Rural Areas

Total Access Points Per Mile (1)	Median Type		
	Undivided	Two-Way Left-Turn Lane	Non Traversable Median
# 15	2.5	1.0	0.9
15.01-30	3.6	1.3	1.2
> 30	4.6	1.7	1.5
All	3.0	1.4	1.2

(1) Includes both signalized and unsignalized access points.

Curb Lane Impacts

Detailed analyses were made to estimate curb-lane impacts on through traffic resulting from cars turning right into driveways at 22 unsignalized locations in Connecticut, Illinois, New Jersey, and New York.

Impacted Vehicles. The percentage of through vehicles in the right (curb) lane that would be impacted at a single driveway increases as right-turn volumes increase as shown below.

Right-Turn Volume Entering Driveway (Vehicles Per Hour)	Percent of Through Vehicles Impacted
Less than or equal to 30	2.4
31 to 60	7.5
61 to 90	12.2
Over 90	21.8

Influence Distances. The influence distances were calculated adding driver perception-reaction distances and car lengths to the impact lengths. The percentages of right-lane through vehicles that would be influenced to or beyond an upstream driveway in a quarter-mile section were estimated for various right-turn volumes, driveway spacings, and posted speeds. The likely percentages of impacted vehicles that would extend to or beyond at least one driveway (upstream) per quarter mile (i.e., "spillback") for a 45 mph speed were as follows:

Right-Turn Volume Per Driveway (vph)	Unsignalized Access Spacing (Feet)				
	100	200	300	400	500
Less than or equal to 30	27.3	14.6	7.8	2.6	0.9
31-60	64.2	40.0	23.0	8.0	2.9
61-90	82.1	57.5	35.3	12.9	4.7
Over 90	96.1	80.1	55.5	22.1	8.3

This information may be used to identify the cumulative impact of decisions concerning driveway locations and unsignalized access spacing.

Right-Turn Lanes

Right-turn deceleration lanes should be provided wherever it is desired to keep the proportion of right-lane through vehicles impacted to a specified minimum. For arterial right-lane volumes of 250 to 800 vph, the percentage of through vehicles impacted was about 0.18 times the right-turn volume.

This results in the following impacts that may provide a basis for decisions regarding provision of right-turn deceleration lanes:

Percent Right-Lane Through Vehicles Impacted	Right-Turn in Volume (vph)
0	0
2	10
5	30
10	60
15	85
20	110

Criteria of 2 percent and 5 percent impacted suggest minimum right turn volumes of 10 vph and 30 vph, respectively. This range may be applicable in certain rural settings. Criteria of 15 percent and 20 percent impacted suggest a minimum of 85 vph and 110 vph, respectively. This range may be applicable in certain urban areas. The length of the deceleration lane is a function of the impact length and storage requirements.

Access Separation

Three factors influence the desired access separation distances -- safety, operations, and roadway access classification. Direct property access along strategic and principal arterials should be discouraged. However, where access must be provided, adequate spacing should be established to maintain safety and preserve movement.

"Spillback" is defined as a right-lane through vehicle that is influenced to or beyond the driveway upstream of the analysis driveway. It occurs when the influence length is greater than the driveway spacing minus the driveway width. The spillback rate represents the percentage of right-lane through vehicles that experience this occurrence.

The spillback rate should be kept to a level that is consistent with an arterial's function and desired safety and operations. Table 6 provides suggested access separation distances for spillback rates of 5, 10, 15, and 20 percent. For the lower speeds of 30 and 35 mph, access separation distances shown are based on the safety implications of driveway density. For roadways with a primary function of mobility, there should not be more than 20 to 30 connections per mile (both directions).

D. Corner Clearance (Technique 1c)

Corner clearances represent the minimum distances that should be required between intersections and driveways along arterial and collector streets. As stated in the AASHTO *Policy on Geometric Design of Highways and Streets*: "Driveways should not be situated within the functional boundary of at-grade intersections. This boundary would include the longitudinal limits of auxiliary lanes."

Table 6

Access Separation Distances (Feet) Based on Spillback Rate*

Posted Speed (mph)	Spillback Rate**			
	5%	10%	15%	20%
30	335	265 [(a)]	210 [(b)]	175 [(c)]
35	355	265 [(a)]	210 [(b)]	175 [(c)]
40	400	340	305	285
45	450	380	340	315
50	520	425	380	345
55	590	480	420	380

(a) Based on 20 driveways per mile.
(b) Based on 25 driveways per mile.
(c) Based on 30 driveways per mile.

* Based on an average of 30 to 60 right runs per driveway.
** Spillback occurs when a right-lane through vehicle is influenced to or beyond a driveway upstream of the analysis driveway.
The spillback rate represents the percentage of right-lane through vehicles experiencing this occurrence.

Corner clearance criteria assembled from various state, county, and city agencies showed values ranging from 16 to 325 feet.

Eight case studies of corner clearances were reviewed to illustrate current practices, problems and opportunities. These case studies indicated that (1) definition of corner clearance distances varied among locations; (2) distances ranged from two to 250 feet; (3) queuing or spillback across driveways was perceived as the most pervasive problem, making it difficult to turn left into or out of a driveway; (4) roadway widening to increase capacity sometimes reduces corner clearances; (5) placing driveways too close to intersections correlates with higher accident frequencies — sometimes up to half of all accidents involved are driveway-related; (6) corner clearances are limited by the property frontage available; (7) improving or retrofitting minimum corner driveway distances is not always practical, especially in built up areas.

The analyses suggested that adequate corner clearances can best be achieved where they are established before land subdivision and site development approval. Corrective actions include: (1) requiring property access from secondary roads; (2) locating driveways at the farthest edge of the property line away from the intersection; (3) consolidating driveways with adjacent properties; and (4) installing a raised median barrier on approaches to intersections to prevent left-turn movements.

E. Median Alternatives (Techniques 2a, 2b & 3c)

The basic choices for designing the roadway median are whether to install a continuous two-way left-turn lane or a non-traversable median on an undivided roadway, or to replace a two-way left-turn lane with a non-traversable median. These treatments improve traffic safety and operations by removing left turns from through travel lanes. Two-way left-turn lanes provide more ubiquitous access and maximize operational flexibility. Medians physically separate opposing traffic, limit access, clearly define conflicts, and provide better pedestrian refuge; their design requires adequate provision for left and U-turns to avoid concentrating movements at signalized intersections.

An extensive review of safety and operational experience and models provided guidelines for impact assessment.

Safety

The safety benefits reported in studies conducted since 1970 were as follows:

- Highway facilities with two-way left-turn lanes had accident rates that were overall about 38 percent less than experienced on undivided facilities (13 studies).

- Highway facilities with non-traversable medians had an overall accident rate of 3.3 per million VMT compared to about 5.6 per million VMT on undivided facilities (10 studies).

- Highway facilities with non-traversable medians had an overall accident rate of 5.2 per million VMT compared to 7.3 per million VMT on facilities with two-way left-turn lanes (11 studies).
- The estimated total accidents per mile per year -- based on an average of seven accident prediction models -- were as follows:

ADT	Accidents Per Mile Per Year		
	Undivided Highway	**Two-Way Left-Turn Lane**	**Non-traversable Median**
10,000	48	39	32
20,000	126	60	55
30,000	190	92	78
40,000	253	112	85

Operations

Several operations studies have indicated that removing left-turning vehicles from the through traffic lanes reduces delays whenever the number of through travel lanes is not reduced. Some 11 operations models developed over the past 15 years confirmed these findings.

Economic Impacts

The economic impacts of various median alternatives depend upon the extent that access is improved, restricted, or denied. The impacts to specific establishments also depend on the type of activity involved and on background economic conditions.

Where direct left turns are prohibited, some motorists will change their driving or shopping patterns to continue patronizing specific establishments. Some repetitive pass-by traffic will use well designed or conveniently located U-turn facilities. Impacts also will be reduced at locations where direct left-turn access is available. In some cases, retail sales may increase as overall mobility improves.

The maximum impacts resulting from median closures can be estimated by multiplying the number of left turns entering an establishment by the proportion of these turns that represents pass-by traffic. Typical proportions of this pass-by traffic are as follows:

!	Service Station-Convenience Market	55%
!	Small Retail (<50,000 sq. ft.)	55
!	Fast Food Restaurant with Drive Through Window	45
!	Shopping Center (250,000 - 500,000 sq. ft.)	30
!	Shopping Center (Over 500,000 sq. ft.)	20

Selecting a Median

Selecting a median alternative depends upon factors related to policy, land use, and traffic. These factors include: (1) the access management policy for and access class of the roadway under consideration; (2) the types and intensities of the adjacent land use; (3) the supporting street system and the opportunities for rerouting left turns; (4) existing driveway spacings; (5) existing geometric design and traffic control features (e.g. proximity of traffic signals and provisions for left turns); (6) traffic volumes, speeds, and accidents; and (7) costs associated with roadway widening and reconstruction.

F. Left-Turn Lanes (Technique 3a)

The treatment of left-turns is a major access management concern. Left turns at driveways and street intersections may be accommodated, prohibited, diverted, or separated depending upon specific circumstances.

Safety

A synthesis of safety experience indicates that the removal of left turns from through traffic lanes reduced accident rates about 50 percent (range was 18 to 77 percent).

Operations

Left turns in shared lanes may block through vehicles. The proportion of through vehicles blocked on approaches to signalized intersections is a function of the number of left turns per traffic signal cycle as shown below:

Left Turns Per Cycle	Proportion of Through Vehicles Blocked
1	0.25
2	0.40
3	0.60

The capacity of a shared lane might be 40 to 60 percent of that for a through lane under typical urban and suburban conditions. Thus, provision of left-turn lanes along a four-lane arterial would increase the number of effective travel lanes from about 1.5 to 2.0 lanes in each direction — a 33 percent gain in capacity.

Application of the *1994 Highway Capacity Manual* gives the following illustrative capacities for two- and four-lane roads at signalized intersections:

Condition	Capacity - Vehicles Per Hour Per Approach	
	Two-Lane Road	**Four-Lane Road**
No Left Turns	840	1,600
Shared Lane (50 to 150 Left Turns/Hour)	425-650	900 - 1,000
Exclusive Left-Turn Lanes	750-960	1,100 - 1,460

G. U-Turns as Alternatives to Direct Left Turns (Technique 3d)
U-turns reduce conflicts and improve safety. They make it possible to prohibit left-turns from driveway connections onto multi-lane highways and to eliminate traffic signals that would not fit into time-space (progression) patterns along arterial roads. When incorporated into intersection designs, they enable direct left-turns to be rerouted and signal phasing to be simplified.

Safety
U-turns result in a 20 percent accident rate reduction by eliminating direct left-turns from driveways and a 35 percent reduction when the U-turns are signalized. Roadways with wide medians and "directional" U-turn crossovers have about half of the accident rates of roads with TWLTLs.

Operations
U-turns, coupled with two-phase traffic signal control, result in about a 15 to 20 percent gain in capacity over conventional intersections with dual left-turn lanes and multi-phase traffic signal control.

A right-turn from a driveway followed by a U-turn can result in less travel time along heavily traveled roads than a direct left-turn exit when there is up to half a mile of additional travel.

Indirect U-turns may require a median width of 40 to 60 feet at intersections depending upon the types of vehicles involved. Narrower cross sections may be sufficient when there are few large trucks.

H. Access Separation at Interchanges (Technique 1d)
Freeway interchanges have become focal points of activity and have stimulated much roadside development in their environs. Although access is controlled within the freeway interchange area, there generally is little access control along the interchanging arterial roadways.

Separation distances reported by state agencies ranged from 100 to 700 feet in urban areas and 300 to 1000 feet in rural areas. Case studies reported separation distances of 120 to 1,050 feet. These distances are usually less than the access spacing needed to ensure good traffic signal progression and to provide adequate weaving and storage for left turns.

Desired access separation distances for free-flowing right turns from exit ramps should include the following components:

!	Perception-Reaction Distance	100-150 feet
!	Lane Transition	150-250 feet

!	Left-Turn Storage	50 feet per left-turn per cycle
!	Weaving Distance	800 feet, 2-lane arterials 1200 feet, 4-lane arterials 1600 feet, 6-lane arterials
!	Distance to Centerline of Cross Street	40-50 feet

I. Frontage Roads (Techniques 6a and 6b)

Frontage roads reduce the frequency and severity of conflicts along the main travel lanes and permit direct access to abutting property. Along freeways and expressways, they can be integrated with interchange and ramping systems to alleviate congestion and to improve access. Frontage roads along arterials should be carefully designed to avoid increasing conflicts at intersections. Reverse frontage or "backage" roads with developments along each side may be desirable in developing areas. In all cases, arterial frontage roads must be carefully designed and located to protect arterial and cross road operations.

J. Policy Considerations

Several planning and policy implications emerged from the research. Some key findings follow:

! Comprehensive access management codes should indicate where access is allowed or denied for various classes of roads, specify allowable spacings for signalized and unsignalized connections, and set forth permit procedures and requirements. Codes may define or limit the application of specific techniques and establish procedures for an administering agency to use in removing access.

! There should be a sufficient network of supporting local and collector streets that provide direct access to adjacent developments. These secondary streets should connect to arterial streets at appropriate and well-spaced locations. They make it possible to minimize direct property access on major arterials.

! Access should be provided from strategic and primary arterials only when reasonable access cannot be provided from other roadways. In such cases, access should be limited to right turns wherever possible.

! Left-turn and cross egress should be well separated and placed at locations that fit into overall signal coordination patterns with high efficiency.

! Advance purchase of right-of-way and access rights is desirable. Access spacing standards (including corner clearance requirements) should be established in advance of actual development.

! Coordination of land use and transportation planning is essential. Zoning, subdivision, and access spacing requirements should be consistent. Better coordination of land use, interchange geometry, and arterial street operations are necessary to avoid "double loading" arterials and to minimize weaving movements and traffic congestion. Strategically placed supporting streets and frontage roads may play a major role in this effort.

! Wide medians that allow indirect U-turns in lieu of direct left turns should be considered for new arterials where space permits, since these medians improve safety and simplify intersection operations and signal timing/coordination.

! Any access control or management plan must be done on a route or system-wide basis to avoid transferring problems to upstream or downstream intersections.

Session 24

Closing Session

Moderator: Gary Sokolow, Florida Department of Transportation

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