Safety Impacts of Access Management

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Meet Your Instructors

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Course Objectives

- Define access management
- Describe the impacts of access management on crash rates / types
- Describe how to perform a safety evaluation of an access management treatment

Course Overview

1. What is access management?
2. What are typical safety considerations and findings?
3. How can you perform a safety study?
4. Resource materials / contact info

Session 1

What is Access Management?

What is Access Management?

"….the systematic control of the location, spacing, design, and operation of driveways, median openings, interchanges, and street connections to a roadway."

Transportation Research Board, Access Management Manual

What is Access Management?

- Balances access to land with traffic mobility needs
  - Works with functional classification hierarchy
- Set of tools to help protect public investments in roadways and improve safety

Why Use Access Management?

- Improve Public Safety
- Enhance Mobility
- Preserve Functional Classification Integrity
- Protect Infrastructure Investment

10 Principles of Access Management: Safety is Focus!

1. Ensure functional integrity
2. Limit direct access to major roadways
3. Promote intersection hierarchy
4. Locate signals to favor through movements
5. Preserve the functional area of intersections/interchanges

Source: TRB AM Manual, see supplement

10 Principles of Access Management: Safety is Focus!

6. Limit the number of conflict points
7. Separate conflict areas
8. Remove turning vehicles from through-traffic lanes
9. Use nontraversable medians to manage left-turn movements
10. Provide a supporting street and circulation system

Source: TRB AM Manual, see supplement

Session 2

What are Typical Safety Considerations and Findings?

Safety at the National Level

2011	US
Fatalities (motorists/nonmotorists)	32,367
Fatality Rate per 100M VMT	1.10
Injury Rate per 100M VMT	75

Source: National Highway Traffic Safety Administration

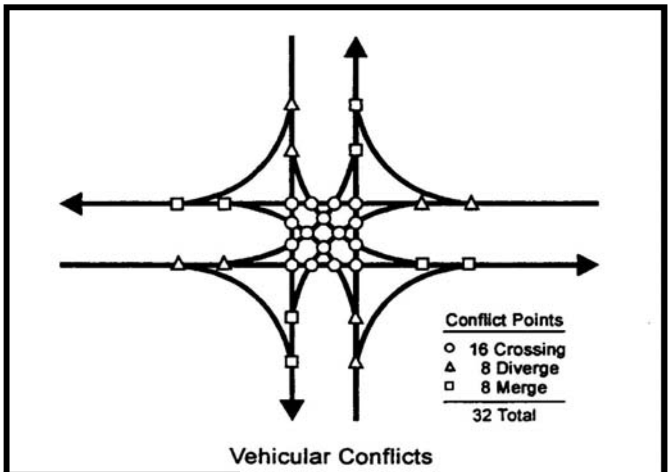
How Access Management Improves Safety

- Reduces Conflict Points at Intersections
  – Driveways are Intersections too!!
- Reduces Speed Differentials
- Increases Driver Expectations

Conflict Points

Locations where the path of a car can cross the path of another car, bike, or pedestrian.

4-Leg Intersection Conflict Points

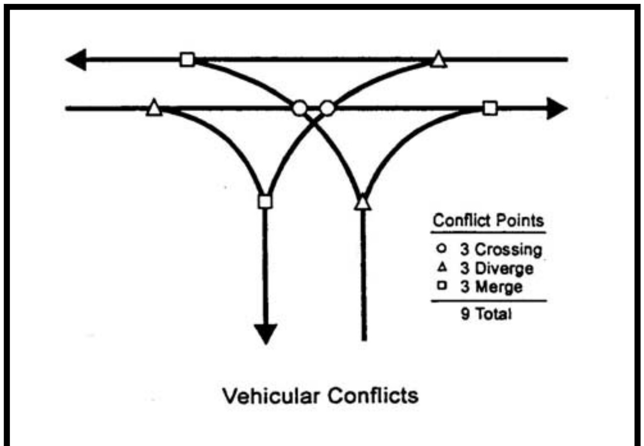


NHI Access Management Course

Conflict Points

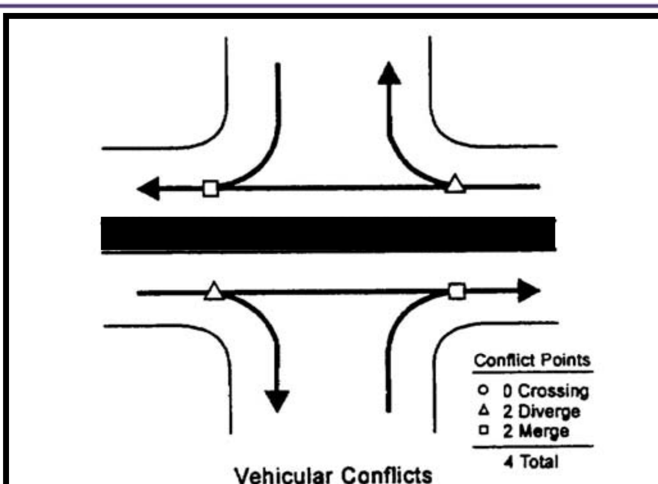
Source: Texas A&M Transportation Institute

3-Leg Intersection Conflict Points



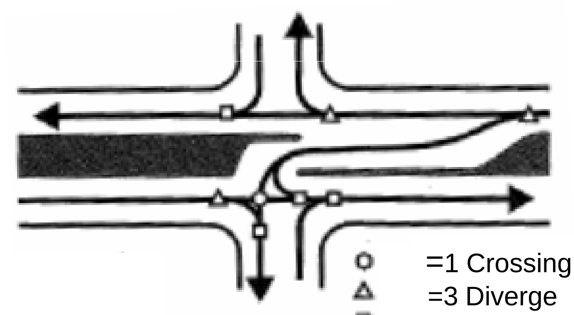
NHI Access Management Course

Conflict Points with Raised Median



NHI Access Management Course

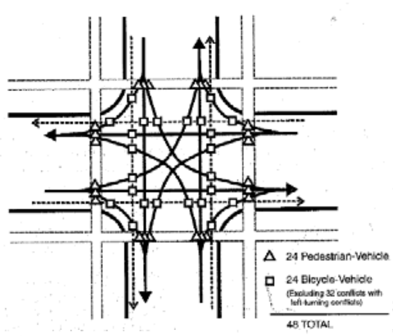
Conflict Points: Directional Raised Median

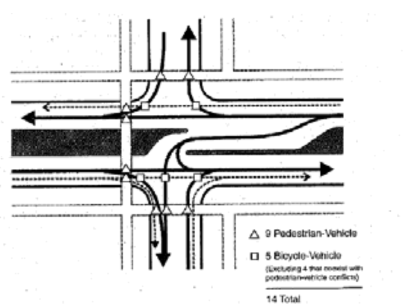


=1 Crossing
=3 Diverge
=4 Merge
8 Total

Source: TRB AM Manual

Conflict Points: Non-motorized





Source: TRB AM Manual

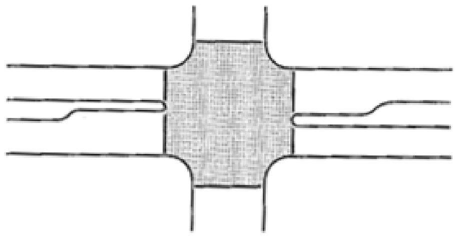
Safety Considerations

Access Spacing

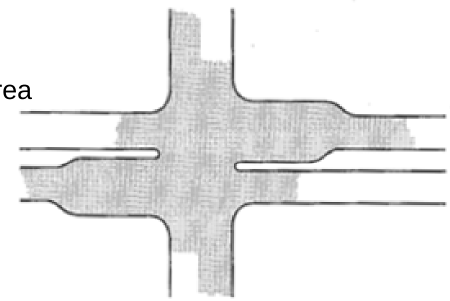
Unsignalized Access Spacing

- Some engineering considerations:
  - Functional intersection area
  - AASHTO guidance
  - Stopping sight distance
  - Intersection sight distance
  - Case-by-case
    - Not a cookbook process!

Functional Area of an Intersection (vs. Physical Area)



Defined by Physical Area



Defined by Functional Intersection

Inappropriate Median Opening

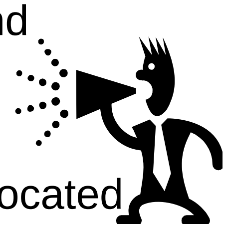
Source: Texas A&M Transportation Institute

Queuing Through Signal

Source: Texas A&M Transportation Institute

AASHTO Says

- Intersection functional areas extend beyond the physical boundaries



- “Ideally, driveways should not be located within the functional area of an intersection or in the influence area of an adjacent driveway”

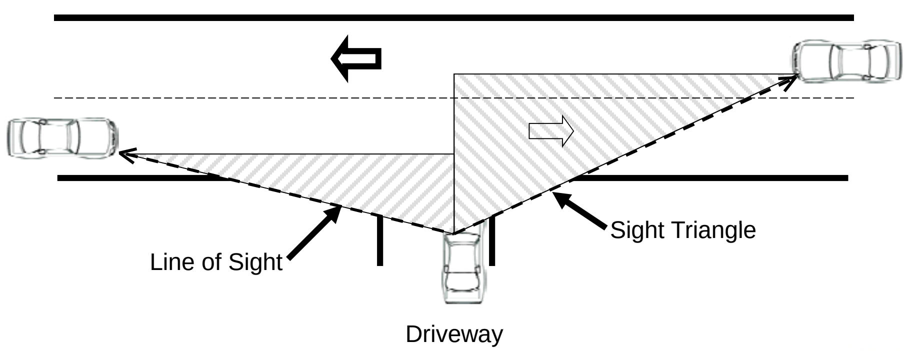
(AASHTO, 2011, “Green Book”, page 9-4)

More from AASHTO

- Driveway spacing should consider impacts that ingress and egress actions have on through traffic
- Impacts are measured by the distance at which through traffic slows or changes lanes due to a turning vehicle

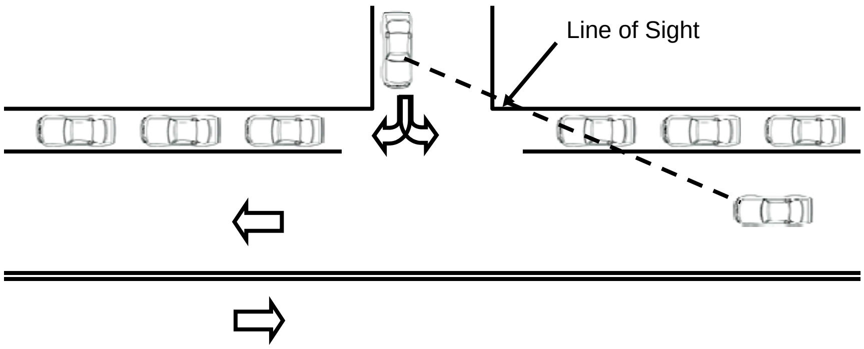
(AASHTO, 2004, Green Book, page 729)

Intersection Sight Distance (enter / cross roadway)



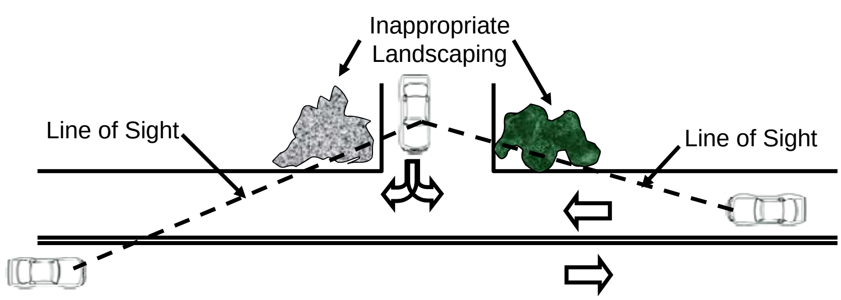
Source: TRB Access Management Manual, ITE Transportation and Land Development

On-street Parking Obstruction



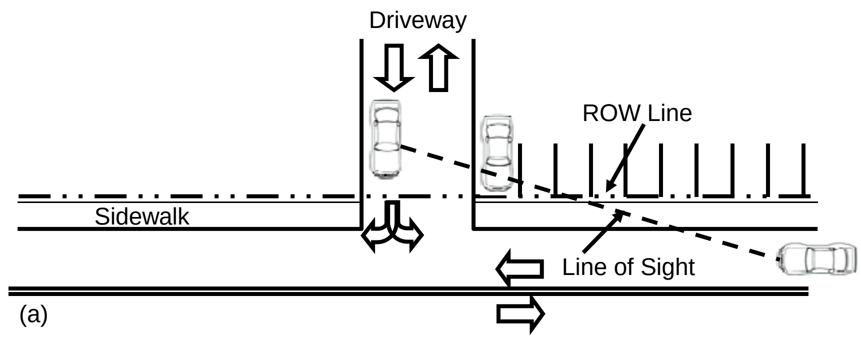
Source: TRB Access Management Manual, ITE Transportation and Land Development

Landscaping Obstruction



Source: TRB Access Management Manual, ITE Transportation and Land Development

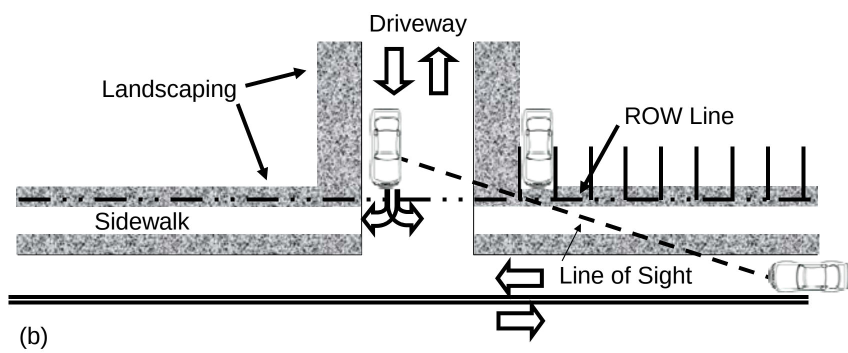
Close Proximity Parking (problem)



How do we fix this?

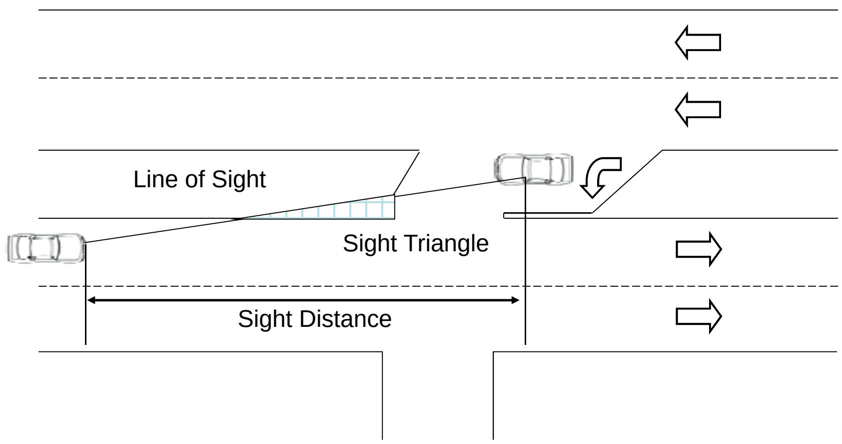
Source: TRB Access Management Manual, ITE Transportation and Land Development

Close Proximity Parking (solution)



Source: TRB Access Management Manual, ITE Transportation and Land Development

Intersection Sight Distance (left turn from roadway)



Source: TRB Access Management Manual, ITE Transportation and Land Development

Driveway Geometric Design Considerations

- Adequate lighting
- Driveway entry speed
  - Speed differential and crash potential
  - Function of driveway radius
  - Functional of vertical curve
- Design vehicle
- Throat width and length
- Driveway profile considering drainage

Source: ITE Transportation and Land Development

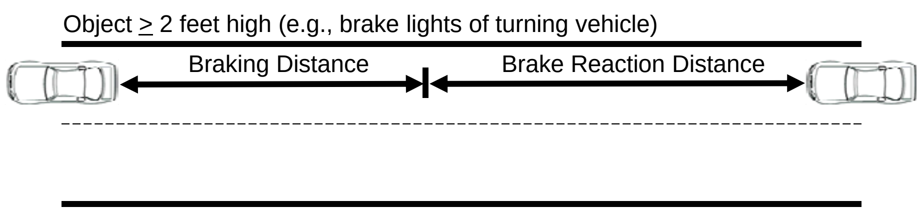
Corner Clearance

- Where adequate space cannot be provided
  - May allow lesser spacing when shared access is allowed
  - Access may be allowed when no alternative exists, but at farthest location from intersection
  - Consideration given to right-in/right-out only operations
- Involvement in platting process earlier helps to mitigate

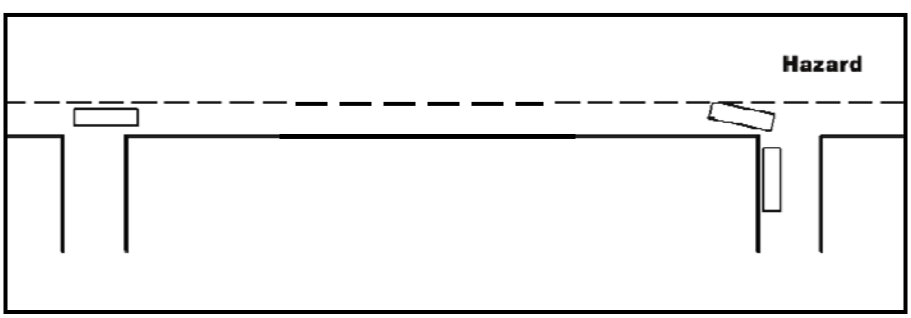
Good Corner Clearances

Source: Texas A&M Transportation Institute

Stopping Sight Distance



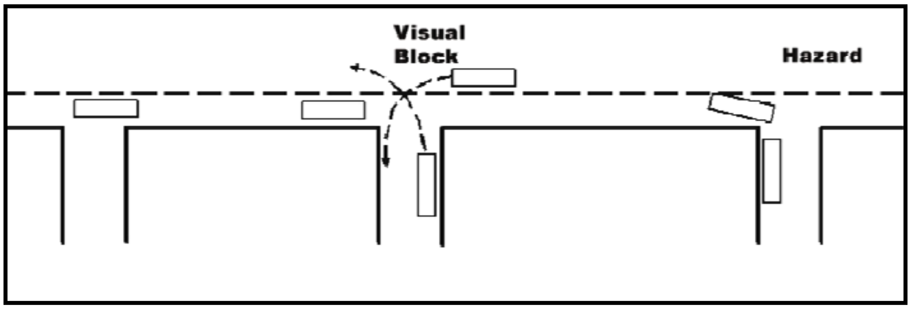
Application of Access Criteria



Stopping Sight Distance Example

(Discussion Paper #5C, Oregon DOT)

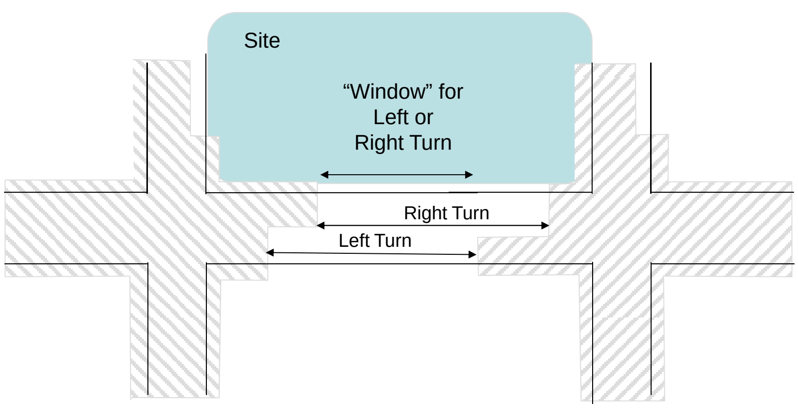
Application of Access Criteria



Stopping Sight Distance Example

(Discussion Paper #5C, Oregon DOT)

Access Window



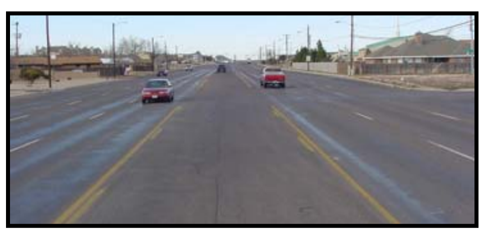
Source: ITE Transportation and Land Development

Safety Considerations

Raised Medians

TWLTL Appropriate

- Built out
- Low volume
- Low access density



Source: Texas A&M Transportation Institute

TWLTL Breaking Down

- Built out
- High volume
- High access density

Source: Texas A&M Transportation Institute

Why and When to Consider a Raised Median

- Play critical role of operations and safety of roadway
- Roadways where aesthetic considerations are a high priority
- Multilane roadways with a high level of pedestrian activity
- High crash locations or where it is desirable to limit left turns to improve safety
  - Clear safety benefit

Source: TRB AM Manual

Keep in Mind . . .

- Need adequate locations and width to handle U-turns
  - Can flare intersections or use loons
  - Alternative U-turn treatments
- Alternate routes to handle delivery truck traffic

Source: Texas A&M Transportation Institute

Poll Question

Do you have a 4-lane or 5-lane cross-section where a raised median would improve safety and/or mobility, but there is not adequate right-of-way to allow for U-turns?

a) Yes
b) No

Poll Question

Have you implemented flared intersections or similar midblock treatments to allow U-turns where there is limited right-of-way?

a) Yes
b) No

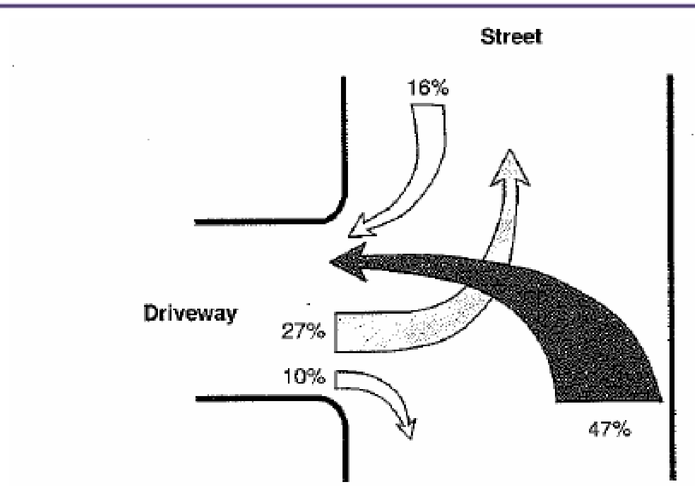
Safety Findings

Access Density

Safety

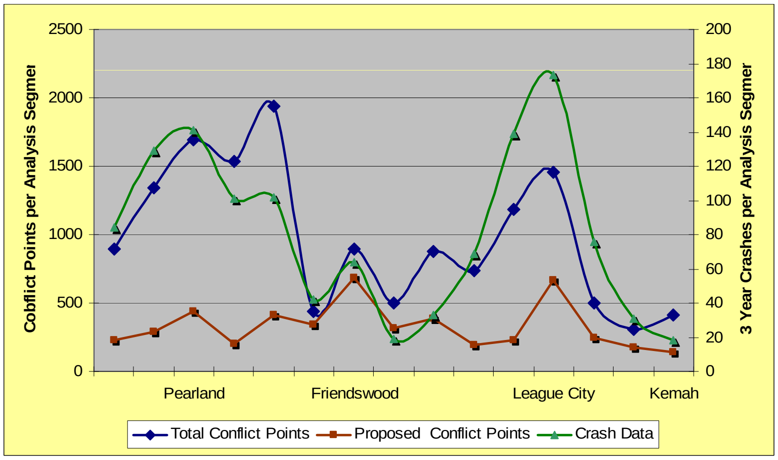
- Reducing conflict points reduces crash potential
- 50 to 55% related to intersections
  - 60% in urban areas
  - 40% in rural areas
- Remember, driveways are intersections too!

Percentage of Crashes by Movement



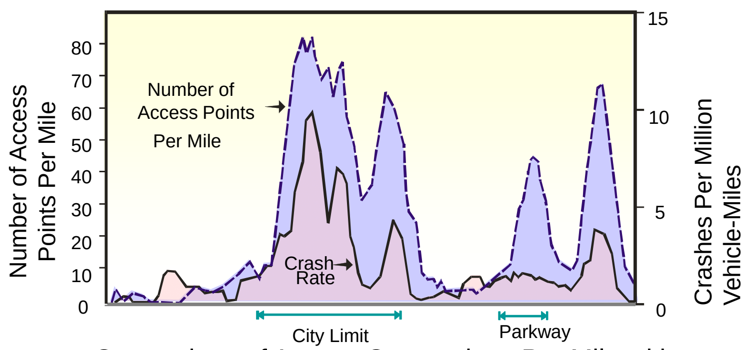
Source: TRB AM Manual

FM 518 Corridor Study



Source: H-GAC, FM 518 Corridor Access Management Plan

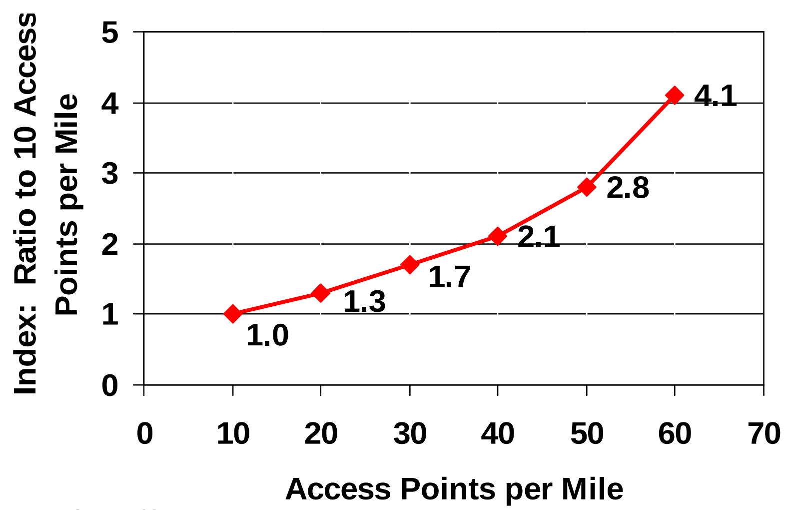
Oregon Case Study



Comparison of Access Connections Per Mile with Crashes per Mile on a Segment of US 101 in Oregon

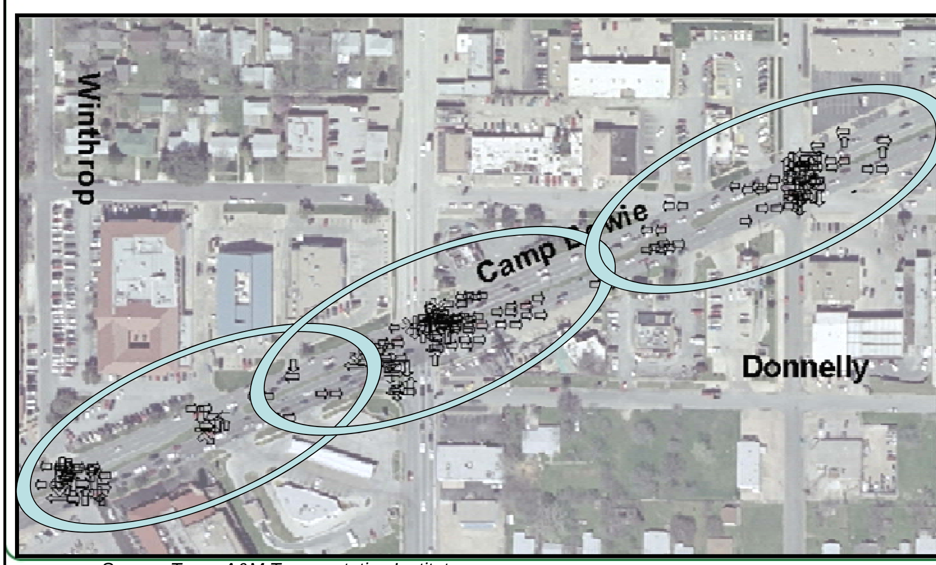
Source: TRB AM Manual, see supplement

Safety Effect



Source: NCHRP 420

High Access Density—Ft. Worth, TX



Source: Texas A&M Transportation Institute

Low Access Density—Same Street

Source: Texas A&M Transportation Institute

US 377 – Total Crashes

Year	Segment	Access Density (pts/mi)	Number of Crashes	Crashes / Million VMT
1993	East	110	28	9.59
	West	50	27	7.40
1994	East	110	27	9.25
	West	50	22	6.03
1995	East	110	29	9.46
	West	50	16	4.17
1996	East	110	24	7.83
	West	50	26	6.78

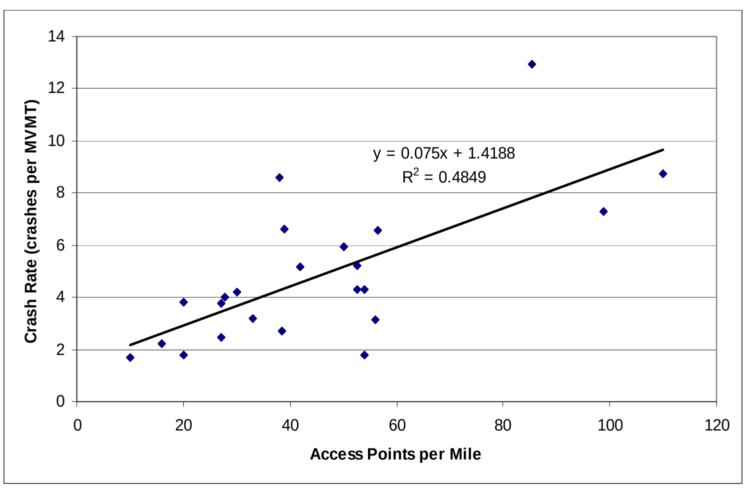
Source: TTI Research Report 0-4221-2

US 377 – Total Crashes

Year	Segment	Access Density (pts/mi)	Number of Crashes	Crashes / Million VMT
1997	East	110	24	8.52
	West	50	25	7.10
1998	East	110	17	6.40
	West	50	14	4.21
1999	East	110	22	8.19
	West	50	26	7.74
2000	East	110	29	10.85
	West	50	13	3.89

Source: TTI Research Report 0-4221-2

Access Density and Crash Rates



Source: TTI Research Report 0-4221-2

Safety Findings

Raised Medians

Crash Rates

Representative Crash Rates (Crashes per Million VMT) by Type of Median – Urban and Suburban Areas			
	Median Type		
Total Access Points per Mile	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	8.3
Average Rate	***9.0***	***6.9***	***5.6***

Source: NCHRP 420

Case Study: Memorial Drive - Atlanta

- Memorial Drive Before Median Installation
  - 4.3-mile section
  - 6 lanes with TWLTL
  - densely commercial
  - ADT: 28,300 - 47,700
  - driveways per mile: 59
  - speed limit: 45 mph

Source: TRB AM Manual; Parsonson, 2000

Professional

Memorial Drive: One Year After Completion

- 37% reduction in total crashes
  - Preventing about 300 crashes
- 48% drop in injury rate
  - Preventing about 150 injuries
- Left-turn crashes between intersections were virtually eliminated
- No fatalities (15 in previous 10 years)

Source: TRB AM Manual; Parsonson, 2000

Professional

Reasons for Crash Reduction

- Conflict points reduced in number
- Conflict areas reduced in size
- Pedestrians found refuge while crossing
- No mid-block left-turns
- Left-turns eliminated at 7 public roads
- All 14 median crossovers were signalized

Source: TRB AM Manual; Parsonson, 2000

Memorial Drive: Eight Years Later

- Still no fatalities
- Crash reduction not as dramatic: 17% vs. 37%
- Injury reduction not as dramatic: 10% vs. 38%
    - Police believe this reduction in improvements is mainly due to increased driver carelessness

Source: TRB AM Manual; Parsonson, 2000

Memorial Drive Conclusions

- Low access point densities typically correlate with lower crash rates
- The presence of raised medians on arterial streets typically means that there will be:
  - Lower crash rates
  - Less severe crashes
  - Better safety for pedestrians crossing the street

Source: TRB AM Manual; Parsonson, 2000

Ft. Lauderdale, FL, Oakland Park Blvd.

Roadway Characteristics

	Before Improvements	After Improvements
Type of corridor	6-land divided	6-land divided
Vehicles per day (daytime)[a]	34,670	36,580
No. of signalized intersections	4	4
No. of unsignalized intersections	33	16 (15 with left ingress and U-turn only and 1 with left egress)
Street lighting	None	Yes

[a] A reduction of crashes at night can also be attributed to the additional lighting that was installed during reconstruction. Therefore, to determine the success of the median plan, the study concentrated on daytime use only.

Reconstruction of raised median, closed several openings

Source: TRB AM Manual, see supplement

Ft. Lauderdale, FL, Oakland Park Blvd

Results

Type	Average Number of Crashes Per Year: Before[b]	After[c]	% Change	Crash Rate[a]: Before[b]	After[c]	% Change
Total	238	185	-22.3	7.73	5.69	-26.4
Injury	85	82	-3.7	2.67	2.62	0.0
Property damage	156	97	-37.8	5.07	2.97	-4.14

[a] Crashes per million vehicle miles.
[b] Before: January 1984-April 1985.
[c] After: August 1986-June 1988.

Source: TRB AM Manual, see supplement

Raised Median Installations

Corridor	ADT[1]	Before Median Type	Crash Rate: Pre	Post	Abs. Diff	% Diff	Access Dens
Bus SH 6	41,000	TWLTL	4.3	1.8	-2.5	***-58***	54
Loop 281	23,500	TWLTL	5.2	4.3	-0.9	***-17***	53
71st West	30,500	Undiv	3.8	2.5	-1.3	***-34***	27
71st WC	29,500	Undiv	3.8	1.8	-2.0	***-53***	20
US 385	10,600	Undiv	19.6	15.4	-4.2	***-21***	50
Others[2]	30,600	Varies	7.0	4.8	-2.2	***-31***	49

[1]ADT is the traffic volume in the “after” condition that has the raised median present.
[2]This is a comparison of the average crash rate for all the corridors “before” and “after” the raised median was installed. Note that the “before” condition was typically a TWLTL

Source: TTI Research Report 0-4221-2

Loop 281 – Longview

Source: Texas A&M Transportation Institute

Loop 281 – Injuries (Before and After Raised Median)

	‘92	**‘93**	**’94**	**’95**	***’96***	**’97**	**’98**	**‘99**
None	112	125	186	155	***80***	114	119	85
Possible	28	54	51	50	***45***	45	64	52
Non-incapac	0	4	8	18	***15***	7	12	11
Incapac	1	1	0	3	***0***	0	0	1
Fatality	0	0	0	1	***0***	0	0	0

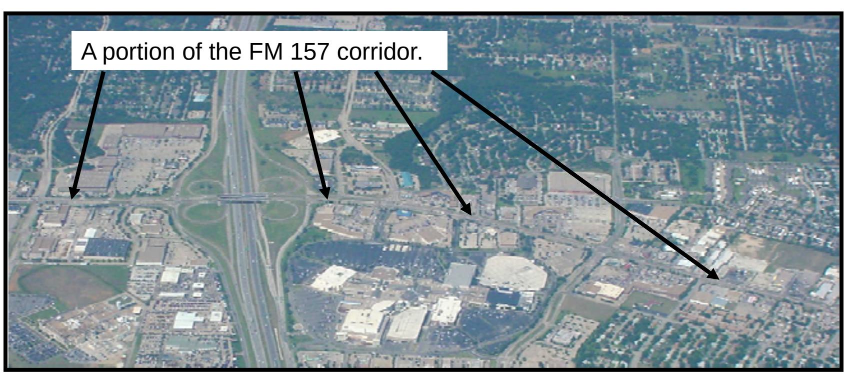
Source: TTI Research Report 0-4221-2

Loop 281 – Crash Types

	'92	'93	'94	'95	'96	'97	'98	'99
Rear-End	16	31	27	20	***18***	21	23	17
Side-Impact	10	22	27	44	***18***	15	30	25
Side-Swipe	9	8	11	4	***3***	1	2	0
Single	0	0	0	2	***1***	1	2	0
Head-On	9	1	1	1	***2***	0	0	0

Source: TTI Research Report 0-4221-2

FM 157 (Cooper St.) Case Study



Source: Texas A&M Transportation Institute

FM 157 Characteristics

- 7-lane cross section
  - 2007 raised median installed
- 2004 ADT range of 26,000 (at US 287) to 58,000 (at IH 20)
- Crash rates (2004)
  - at least 3.76-4.47 per million vehicle miles traveled (MVMT) – between Pleasant Ridge and Arkansas
  - at least 5.3 per MVMT between Arbrook and Medlin

FM 157 Characteristics

- Driveway density of at least 60.9/mile
  - between Pleasant Ridge and Arkansas
- Heavy retail corridor (particularly in Arlington)

FM 157 (Cooper St.) - Arlington, Texas
Before Raised Medians

Offset driveways and absence of raised medians cause drivers to move cars into oncoming travel lanes while waiting to turn, as well as moving upstream against traffic while turning.

Source: Texas A&M Transportation Institute

FM 157 (Cooper St.) - Arlington, Texas
Before Raised Medians

Absence of raised medians allows drivers to enter and exit TWLTL at any point, including in close proximity to major intersection; drivers often end up facing each other trying access frequent driveways.

Source: Texas A&M Transportation Institute

FM 157 (Cooper St.) - Arlington, Texas
Before Raised Medians

The white car in these pictures traveled several hundred feet, while accelerating in the TWLTL and finding an acceptable gap. This is a hazardous maneuver, in that a vehicle may enter the TWLTL in the opposite direction, resulting in a head-on crash.

Source: Texas A&M Transportation Institute

FM 157 (Cooper St.) - Arlington, Texas
Before Raised Medians

The red truck in this photo had to brake hard, while using the TWLTL as an acceleration lane, to avoid a rear-end crash with the silver car in front of it, which stopped and was using the TWLTL to perform a left-turn.

Source: Texas A&M Transportation Institute

FM 157 (Cooper St.) - Arlington, Texas
With Raised Medians

The design of some left-turn bays physically allowed a driver to perform a left- or U-turn from a through-lane. Some drivers actually stopped in the through-lanes while waiting to perform a turn. In these situations, special signs were installed indicating that left- *and* U-turns are prohibited.

Source: Texas A&M Transportation Institute

FM 157 (Cooper St.) - Arlington, Texas
With Raised Medians

Raised medians separate left-turn maneuvers and minimize the likelihood of opposing traffic in a left-turn lane. The raised medians also separate a potentially dangerous left-turn maneuver on a high-volume road into two simpler maneuvers – a right-turn and a U-turn.

Source: Texas A&M Transportation Institute

FM 157 (Cooper St.) - Arlington, Texas
With Raised Medians

In some locations, the raised medians are difficult for a driver to see, due to lack of vertical features and color similar to pavement. At problem spots, yellow striping (see picture) and signage helps drivers see the raised medians.

Source: Texas A&M Transportation Institute

FM 157 (Cooper St.) - Arlington, Texas
With Raised Medians

Where necessary, the raised medians were constructed to allow drainage through the medians.

Source: Texas A&M Transportation Institute

FM 157 (Cooper St.) - Arlington, Texas
With Raised Medians

It was necessary to modify one median opening to properly align with a driveway.

Source: Texas A&M Transportation Institute

FM 157 (Cooper St.) - Arlington, Texas
With Raised Medians

In one location, an adjacent property owner requested that a left-turn lane for a major intersection be shortened and an additional median opening be installed to provide access to the property. TxDOT was able to demonstrate that mobility (queuing at the major intersection) and safety issues would not allow the additional opening.

Source: Texas A&M Transportation Institute

FM 157 Findings

- Preliminary investigation indicates:
  - Crash frequency decreasing
  - Fewer crashes involving left-turns
  - No migration of crashes to intersections
  - Very few U-turn crashes
  - Crash severity decreasing
- Investigation continues to obtain additional data prior to and after raised median installation

Loop 323 – Tyler, Texas

- Analyzed 3 Years of pre-raised median crash data and 1.5 years of with-raised median crash data
- Basic findings:
  - Crash rate did not substantially change
  - Mid-block, side-impact crashes decreased dramatically
  - Rear-end crashes increased, particularly in red light queues

Loop 323 – Tyler, Texas

- Performed traffic counts to verify TxDOT counts
- Used crash data from City of Tyler and Texas Department of Public Safety
  - Both were necessary to compile a complete set of crash reports
- Developed crash rates for specific segments, due to variations in traffic volumes (36,000 to 59,000)

Loop 323 – Tyler, Texas

Analyzing all aspects of the crash data

- Sorted the crashes by impact type by year
- But, that doesn't always tell the entire story

		2000	2001	2002	2003	2004	2005
REAR END		110	136	172	130	177	172
SIDE IMPACT		49	79	50	57	52	66
OTHER		28	54	78	60	53	32
	TOTAL	187	269	300	247	282	270

Conversion year = 2003

Source: Texas A&M Transportation Institute

Loop 323 – Tyler, Texas

Analyzing all aspects of the crash data

- Side impact crashes were of primary concern
- Calculated as percentage of all crashes

Number of events						
	2000	2001	2002	2003	2004	2005
TOTAL	187	269	300	247	282	270
SIDE IMPACT	49	79	50	57	52	66
% SIM	26%	29%	17%	23%	18%	24%

Conversion year = 2003

Source: Texas A&M Transportation Institute

Loop 323 – Tyler, Texas

Analyzing all aspects of the crash data

- Looking at side-impact, mid-block crashes
- Calculated another percentage
- Side-impact crashes as a percentage of all mid-block crashes decreased substantially with the raised median

	2000	2001	2002	2003	2004	2005
TOTAL	137	188	197	145	196	125
SIDE IMPACT	29	37	21	7	9	13
% SIM	21%	20%	11%	5%	5%	10%

Conversion year = 2003

Source: Texas A&M Transportation Institute

Loop 323 – Tyler, Texas

Analyzing all aspects of the crash data

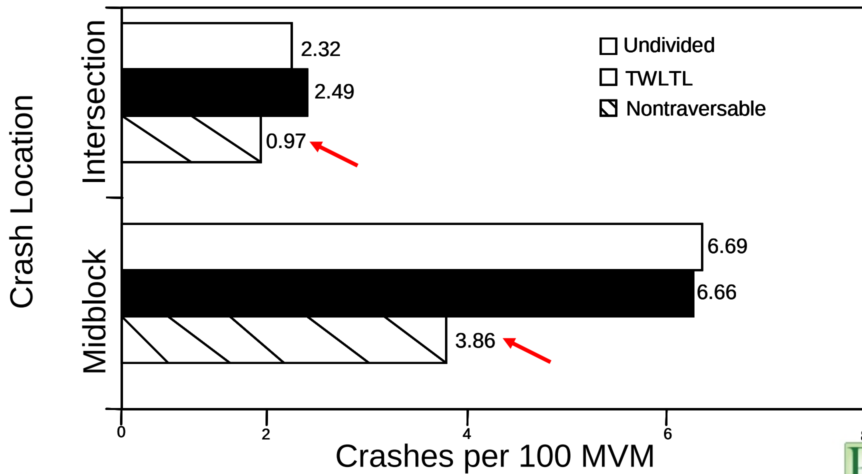
- Directional split of crashes and injuries
  - Found that were more incapacitating injuries in the eastbound direction than westbound
- Volumes also varied by direction in one small segment
  - Influenced by adjacent land use (regional mall)

Loop 323 – Tyler, Texas

Analyzing all aspects of the crash data

- Determined that others issues could be analyzed
  - Red-light running
  - Rear-end crashes at intersection queues
  - Adjacent land uses/access points
  - Signal timing?

Pedestrian Crash Rates



Source: TRB AM Manual

Summary of Safety Findings

1. As access density increases, crash rates increase
2. Roadways with nontraversable medians are safer than undivided roadways or those with continuous two-way left-turn lanes
3. U-turns are generally safer than direct left turns
4. Medians improve pedestrian safety

Source: TRB AM Manual, see supplement

Session 3

How Can You Perform a Safety Study?

Poll Question

Have you ever performed a safety study using crash reports?

a) Yes
b) No

Experiences and Lessons Learned

- Based on unique experiences, situations
- Experiences and lessons learned are applicable to safety studies anywhere

Methodology

- Compare corridors before and after treatment presence
  - Compare high, medium, and low access point density corridors and segments
  - Raised median installation
  - Other
- Investigate crashes per million VMT and crash frequency

Data Sources

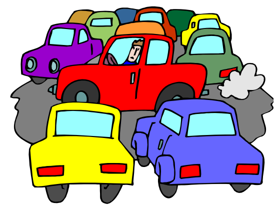
- Enforcement agencies
- State DOTs
- Cities, counties
- Other jurisdictions
- Information sorces
  - News media
  - EMS

Crash Data Considerations

- Reporting errors
- Crash records (hard cop reports) provide most detail
  - Typically not more than 10 years available
- Investigate crash data collection and data reduction processes

Traffic Volumes Considerations

- Sources
  - State DOT
  - Cities, counties, townships
  - Metropolitan Planning Organization
  - Other jurisdiction



- Interpolation for missing years

Aerial Photos/Maps—Considerations

- Sources
  - State DOT
  - Cities
  - Metropolitan Planning Organizations
  - Councils of Governments
  - Internet sites
- Varying resolution and quality

Summary Lessons Learned

- Ensure sample is representative of different conditions
- Prefer 3-5 years before/after the roadway change
- Get crash reports and volume data
  - Understand coding error possibilities
- Variety of sources for reports or volume data
- Care in truthfully presenting results

Additional ITE Guidance

- Fatalities generally known to within 5%
- Number of injuries/hospitalization is underreported by about 20%
- Only about half of all injuries in crashes are reported
- Motorists report fewer than half of all PDO crashes

Therefore:

- Analysts should note “reported collisions” rather than just “collisions”

Source: ITE Manual of Transportation Engineering Studies, 2nd Edition, 2010

Resources

- TRB, *Access Management Manual*
- ITE, *Transportation and Land Development, 2nd Edition*
- ITE, *Manual of Transportation Engineering Studies*
- AASHTO, Green Book
- FHWA, *Manual on Uniform Traffic Control Devices*
- NCHRP Report 420, *Impacts of Access Management*
- NCHRP Report 395, *Capacity and Operational Effects of Mid-block Left Turns*

Resources

- TRB Access Management Committee Internet Site
  - http://www.accessmanagement.info
    - TRB AM Manual ordering, NCHRP reports, conferences, presentations, etc
- Texas Transportation Institute
  - http://tti.tamu.edu
- The Student Supplement
  - TRB AM Manual, selected pages
  - ITE *Manual of Engineering Studies*, selected pages
  - NHTSA, latest Traffic Safety Facts
  - TTI report 0-4221-2 PDF link

Resources: Supplement

- Case studies from TRB *Access Management Manual*
- ITE *Manual of Transportation Engineering Studies*
- NHTSA "Traffic Safety Facts," 2011 Data
- "Access window" and sight distance
- Link to TTI report 0-4221-2

Resources

- TRB Access Management Committee Internet Site
  - http://www.accessmanagement.info
- TRB, *Access Management Manual*
- AASHTO, Green Book
- NCHRP Report 420, *Impacts of Access Management*
- NCHRP Report 659*, Guide for the Geometric Design of Driveways*

ITE Resources

- *Transportation and Land Development, 2nd Edition*
- *Manual of Transportation Engineering Studies, 2nd Edition*
- *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach*
- *Promoting Sustainable Transportation Through Site Design*
- *Urban Street Geometric Design Handbook (Chapter 3)*
- *Informational Report on Separated Bikeways*
- *Accommodating Pedestrians and Bicyclists at Interchanges* (Draft Recommended Practice)

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