# Texas Access Management Outreach Materials



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Texas Transportation Institute

Texas Department of Transportation

## INSTRUCTIONS FOR USING
## TEXAS ACCESS MANAGEMENT RECOURCE CENTER CD

1. Insert the CD into your computer.

2. The main menu should open automatically – if not, go to the directory for your CD drive and find the "Autorun.exe" file and click on it.

3. You may need to click on a message bar above the main menu to allow blocked content. This may need to be repeated when opening the main video or video clips.

4. Click on any of the five button bars to open additional button bars that will link you to specific presentations, videos, or other materials. Roll the cursor over the button bar and the number of slides in that presentation will appear.

5. To advance slides or animated bullets within slides, use the "Page Up" and "Page Down" Keys on your keyboard.

6. When you are finished with a presentation, close it by clicking on the "X" in the upper right-hand corner of the screen. You will be automatically returned to the previous menu.

7. To return to the main menu from any sub-menu, click on the "Texas Access Management Resource Center" in the top-center portion of the menu.

## GUIDE TO VIDEO CLIPS

### "RT Lane Benefits"

The first part of this video shows how having a right-turn lane allows turning vehicles to decelerate out of the through-lane and the traffic in the through-lane does not have to brake for the turning vehicles. The second part shows how the absence of a right-turn lane causes all vehicles traveling behind the turning vehicle to brake for the decelerating, turning vehicle.

### "Avoid Driveway Blocked by Queue"

The camera follows a silver car (with a small spoiler on the trunk lid) from a Chik-Fil-A parking lot, through a shopping center parking lot, to a driveway that is several hundred feet away, upstream along the frontage road. It is important to note here that the driver does not use the Chik-Fil-A driveway, nor another main driveway for the shopping center – the driver is willing to travel all the way to the upstream driveway to be able to safely get to the turnaround at the interchange, which is very close to the Chik-Fil-A driveway he avoided.

### "Driveway Retrofit"

The first part of this clip is a still shot of a McDonalds in Corpus Christi – note the driveways at the tip of the property, near the intersection. The video that follows shows how they modified the driveways.

### "Ramp Gore Issues"

Note how vehicles exiting the freeway cross the solid white line in order to access a driveway that is located near the ramp, or get in the right-turn lane for the intersection. Also note how vehicles already on the frontage road cross the solid white line to get into the turnaround lane. The point here is that the ramp is too close to the intersection and turnaround, and some driveways are too close to the ramp. There are plans to change the interchanges along this freeway to X-interchanges from the existing diamond-interchanges.

### "LT in 2 Moves"

This intersection requires the white vehicle to make a left-turn in two moves, minimizing the load on the driver. The driver on has to be concerned with traffic from the right at first, can then get into a left-turn lane, then make a U-turn in a separate maneuver, once oncoming traffic is clear.

### "LT Cars Bail Out"

The two cars facing the camera in the left-turn lane have already been waiting to make a turn for a little while. Traffic queues up beyond their turn lane and they bail out and access the same property at a driveway further down the street.

**“LT – X-Access Would Help”**
Two cars make left turns out of a mall parking lot, the second one making some dangerous maneuvers, to access the next driveway down the street. If cross-access were provided, neither of these vehicles would have had to get on the street.

**“LT Thru Queue – Near T-bone”**
The vehicle making a left-turn, after waiting a while, finally makes the turn through traffic queued up and is almost hit by a car in the far right lane. The driver should have used a different access point to make a safer maneuver.

**“LT Long Wait – TWLTL as Haven”**
The driver waits a long time to make a left-turn out of the parking lot, then has to sit in the two-way-left-turn-lane (TWLTL) until he finds and acceptable gap in the through-lanes.

**“TWLTL Acceleration”**
The white minivan makes a left-turn out of the parking lot, then uses the TWLTL as an acceleration lane – something we are trying to prohibit to avoid potential head-on crashes.

# ANSWERING FREQUENTLY ASKED QUESTIONS

1. Why can't I have more driveways, or driveways closer to each other (with less spacing)?

   Answer: Use Findings/Safety/Key Points, 6th slide – explain that the driveway spacing guidance is based on stopping-sight distance for the posted speed on the street. Use the two driveways at each end of the graphic as examples of proper spacing, stating that a driver passing the first one has time to react to something blocking the other one and time to stop in time to avoid a crash. Add that if the center driveway does not meet the spacing guidance, the driver does not have enough time to react and stop for something blocking it; or actual speeds on the street will decrease to accommodate the lesser spacing.

2. Why should I not have a raised median opening for a corner lot too close to a street intersection?

   Answer: Use "Why Should We Do Access Management?" long presentation, slide 27. It shows a picture of traffic queued up back through a signalized intersection (for which the light has turned red), blocking the cross street traffic because the lead vehicle is waiting to make a left-turn across the TWLTL and the through lanes into a corner lot. The driver could have made a left-turn at the signalized intersection, followed by a right-turn into the corner lot business.

3. Why does the business down the street have more driveways than I am allowed to have?

   Answer: This is most likely due to TxDOT's current access management program (effective January 1, 2004) that may not have been in effect when the other business obtained its driveway permits. There is no slide that addresses this issue.

4. What are conflict points and why are they important?

   Answer: Use Findings/Safety/Key Points, 2nd–4th slides – explain that every time two vehicle paths cross, a conflict point exists where a potential crash can occur. The first of these slides shows a simple, four-leg intersection that has 32 conflict points. The following slides show how the number of conflict points decreases as left-turn opportunities are removed.

5. Won't a raised median on this street kill my business?

   Answer: Go through the Economic Impacts short presentation, emphasizing the findings that show how business owners stated that they believe their customers place more importance on product price, product quality, and customer service than on accessibility when choosing which business of a certain type to patronize.

6. How can access management improve my business?
   Answer: Use "Why Should We Do Access Management?" long presentation, slide 18. It shows how the market area of a business can increase when travel speeds increase, as typically happens when access management treatments are implemented.

7. What if there is not enough pavement width to make a U-turn, but the street needs a raised median?
   Answer: Go to Mobility Photographs, slide 77, "Two-stage Loon." This treatment can be used at mid-block locations, requiring limited amounts of additional right-of-way along the corridor. It allows the driver to make left-turn into the loon (or jughandle) and then, in a separate maneuver, merge into the through-lanes.

8. When should a raised median be considered?
   Answer: Go to treatments, Raised Medians, slide 7. Raised medians are typically useful as the functionality of TWLTLs deteriorates due to high volumes and high access point densities.

## ACCESS MANAGEMENT RESOURCE CENTER
## TABLE OF CONTENTS

## What is Access Management?

- Set of Tools to Help Improve Safety, Improve Mobility, and Promote Economic Development
- Balances Access to Developed Land with Traffic Mobility Needs
- Works with Functional Classification Hierarchy

Emphasize safety as the primary aspect of AM;

Balancing access to developed land with mobility shows that TxDOT acknowledges adjacent properties must have some level of access

As we move up functional classification hierarchy (from locals to freeways), access becomes less important and mobility more important – this will be discussed more detail in a later slide (11)

## What is Access Management?

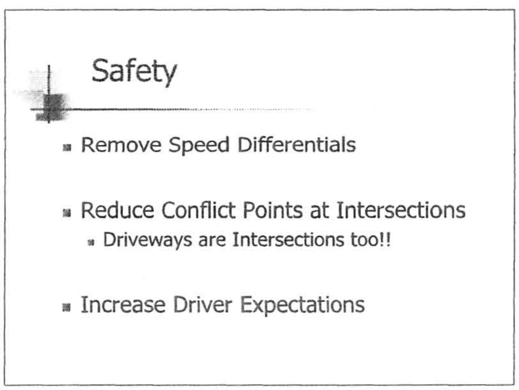
- ***NOT*** One-Size-Fits-All

What works on one corridor in one city will not work on another corridor in the same or another city

Appropriate AM techniques vary among corridors, based on their characteristics and surroundings


Some people need to be physically limited as to where they can go!

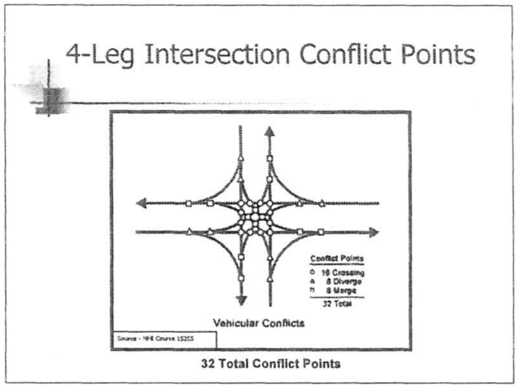
Self-explanatory bullets – Protecting infrastructure investment refers to maintaining or recapturing capacity on roads by using appropriate AM techinques



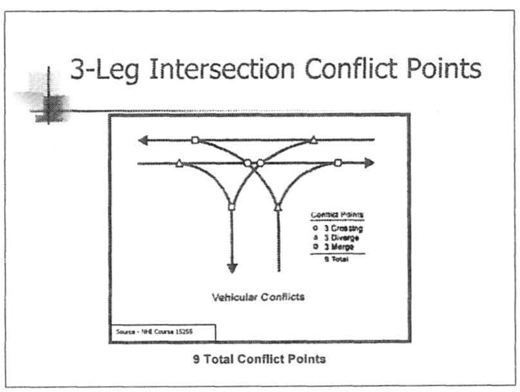

Speed differentials are differences in speeds of two vehicles, one following the other; when the lead vehicle slows down to turn while remaining in a through-lane, the difference between its new speed and the speed of the trailing vehicle is the speed differential; turn lanes reduce speed differentials by allowing the slower-moving, turning vehicle to leave the through-lane

Conflict points are the locations in intersections where vehicle paths cross and can result in crashes – this is explained in the next few slides

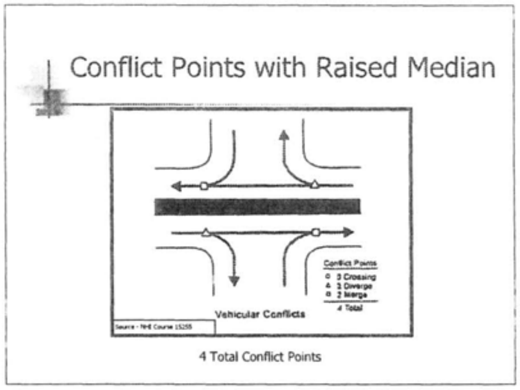
As the driver moves along a road, he or she must process everything that is happening and could happen at each intersection; the further that intersections are from each other, the less work load there is for the driver



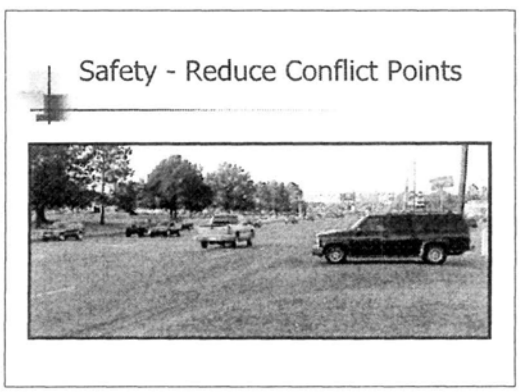

At a typical four-leg intersection, counting only one lane in each direction, there are 32 conflict points, or opportunities for vehicle paths to cross and result in crashes.




When you remove one of the legs from the intersection, you now have only 9 conflict points – and only 3 of them are relatively dangerous type of crashes (side impact)

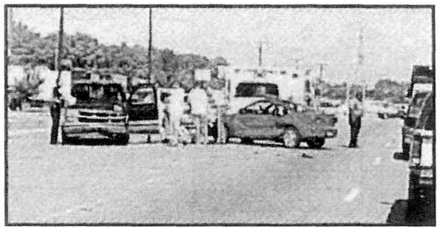



When you have four legs, but have a non-traversable median, you really have 2 three-leg intersections with only 2 minor type conflict points each, for a total of 4 conflict points.




This photograph illustrates a driver having to watch for traffic in a total of 7 lanes (including the two-way-left-turn-lane) while trying to turn left out of a driveway

## Safety - Reduce Crashes

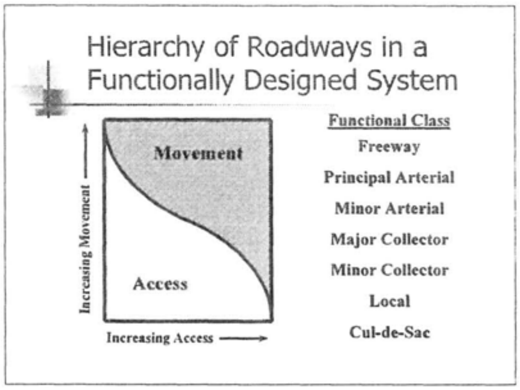


This photograph was taken on the same street at another location; it shows how conflicting uses of a TWLTL can result in crashes.

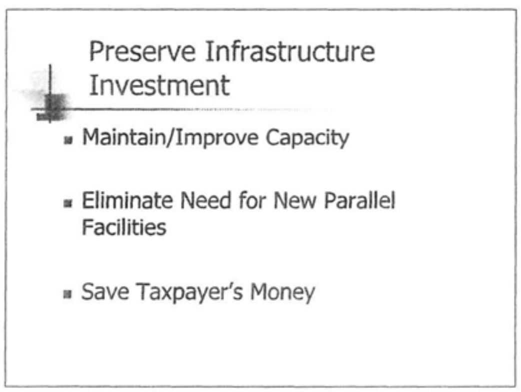
## Increase Mobility

- Less Stop and Go Traffic
- Reduce Travel Delay
- Increase/Preserve Road Capacity
- Reduce Fuel Consumption

AM, including the use of turn lanes, increases mobility on roads by requiring less braking and hard accelerating, which reduces stop and go traffic, travel delay, and fuel consumption while preserving or increasing (recapturing) road capacity




This "text book" chart shows how movement of traffic is the greater purpose of roads like freeways and arterials, while access is the greater purpose of locals and collectors.




By reducing the need for road improvements or new roads, we can save tax payer

## Let's Open the Tool Box!

We will now look at some of the AM techniques that are available

## Basic Access Management Techniques

- Traffic Signal Spacing Criteria
- Unsignalized Access Spacing Criteria
- Corner Clearance Criteria
- Median Alternatives (Directional vs. Full)

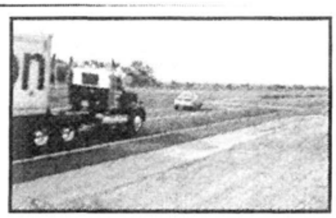
Here are four of the commonly used techniques

## Basic Access Management Techniques

- Auxiliary Lanes
- Alternative Left Turn Treatment
- Access Separation at Interchanges
- Frontage Roads

Here are four more

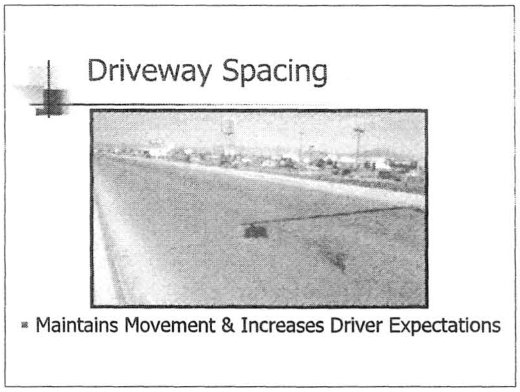
## Turn Lanes



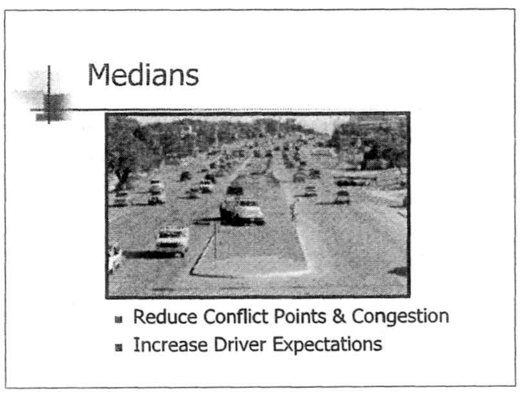
- Separate Speeds and Create Safe Havens

This photo illustrates the benefit of providing a separate lane for the turning car, so it is out of the way of the truck (through-traffic)

The truck doesn't have to slow (as much) – less braking and hard accelerating




This photo shows a development with no direct access to the arterial; all access is from side streets and internal circulation




This median, on SH 16 in San Antonio, prevents left-turns between two signalized intersections.

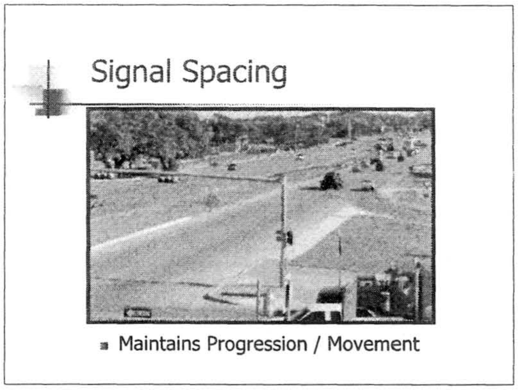
## Signage for Raised Median Turn Bays

- Provides Direction to Adjacent Businesses

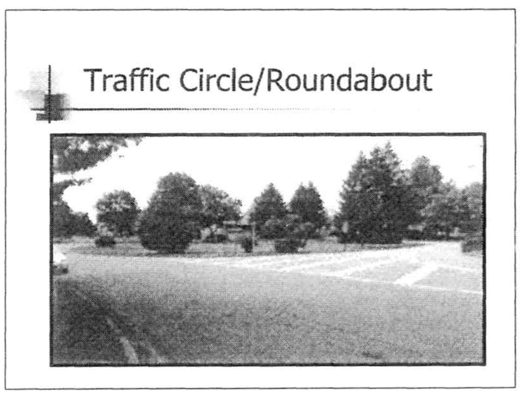
When U-turns are going to be an important aspect of a raised median treatment, it can be helpful to have signs that inform the motorists where how to access specific businesses or shopping centers

## Raised Median at Close Intersection Spacing

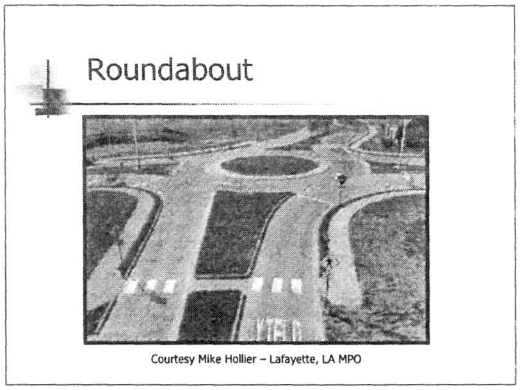
This raised median, while quite narrow, prevents unsafe left-turns where many crashes were occurring, due to the close proximity of two intersections and weaving traffic.



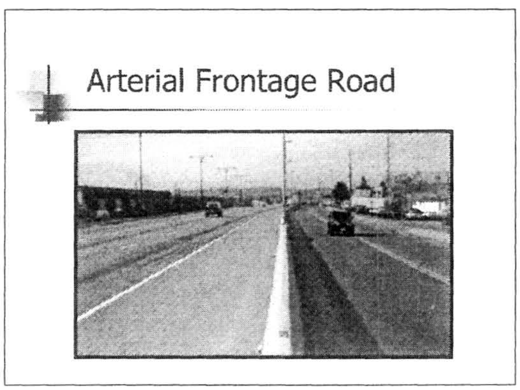

Proper signal spacing benefits mobility by allowing for "progression" along a corridor. Remember, anytime you have a full median opening, you are potentially inviting a future signalized intersection.




This roundabout is actually helps a nearby jughandle intersection operate efficiently.

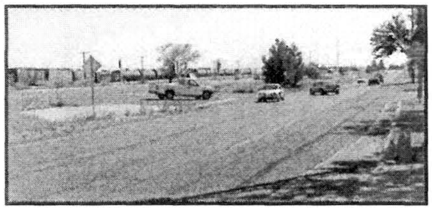



This is a roundabout in a new development in Lafayette, Louisiana. The development is filling up very rapidly.




Frontage roads can maintain access to development along arterial corridors when limiting direct access to the through-lanes, but care needs to be given then developing intersections, as shown in the next slide.

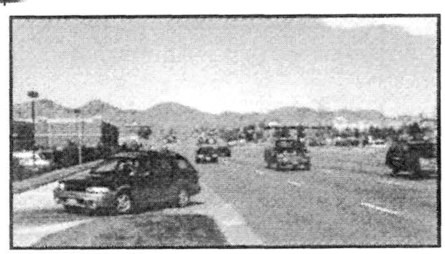
## Arterial Frontage Road



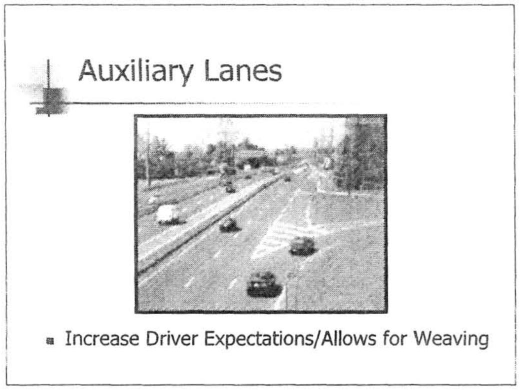
Intersection Spacing

The intersections of the frontage road and the main lanes with the connector overlap and can cause traffic to back up into the frontage road or main lanes. Ideally, the frontage road would be further away from the main lanes at intersections of this nature.

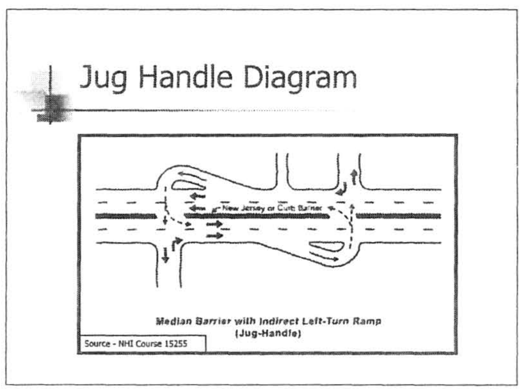
## Auxiliary Lanes



The outside lane is actually an auxiliary lane between two signalized intersections, providing for continuous deceleration, acceleration, and turning movements. This treatment provides for better mobility in the through-lanes.

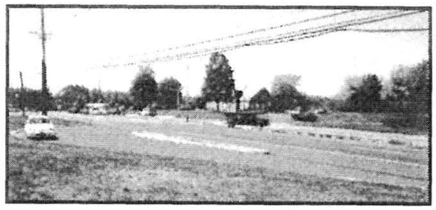



The auxiliary lanes in this photograph provide opportunities for deceleration, acceleration, turning, and weaving at a grade-separated intersection of two arterials.




This diagram shows how jughandles remove left-turns from the arterial street, eliminating the need for left-turn lanes where ROW is limited. Yet, left-turn and U-turn maneuvers are still possible with the jughandle treatments.

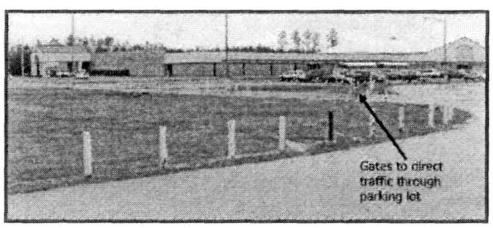
## U-Turn Jug Handle



- Left-turn, then Merge with Traffic

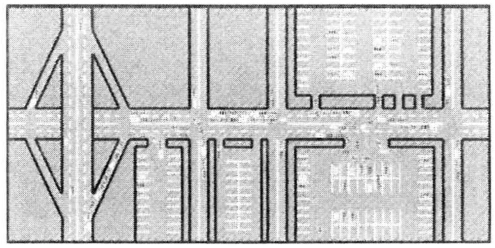
This type of jughandle provides for U-turns on arterials where there are only 2 through-lanes in each direction and there is not enough ROW available throughout the corridor to add a third through-lane, but a raised median is necessary.

## On-Site Queuing




This middle school in Lumberton (near Beaumont) added gates that can be closed during peak student drop-off and pick-up times to make traffic queue through the parking lot, instead of the adjacent two-lane arterial road. Traffic had been backing up on the adjacent road, causing safety and mobility problems. This was an innovative way to improve the problem.

## Arterial Case Study
## Example of Poor Access Management



This graphic displays various AM problems – how many can you identify?

## Application of AM Techniques

- Short Term Projects & TSM Improvements
  - Signal Coordination
  - Turn Lane Development
- Retrofit & Widening Projects
  - Development of Raised Medians
  - Driveway Consolidation
- New Location Projects
  - All Techniques Applicable
  - Strict Land Planning Through Local Entities

Access management techniques can be applied in a variety of situations. Traffic signal coordination (timing) and turn lane installation can provide relatively inexpensive solutions to problems on a small scale.

## What is Access Management?

- Set of Tools to Help Improve Safety and Protect Public Investments in Roadways
- Balances Access to Developed Land with Traffic Mobility Needs
- Works with Functional Classification Hierarchy
- NOT One-Size-Fits-All

This is an important question to answer up front, so that we are all on the same page from the beginning.

Access management includes a wide variety of techniques that can be applied in many ways to suit the needs of a specific location or corridor.

There must be some amount of access to and from the streets and highways, otherwise nobody could ever get to where they are going. Access management provides a balance between the mobility purpose a road serves and the need (note, this is need, not desire) of access to adjacent businesses.

The purposes different roads serve is based on their functional classification – whether they are collectors, arterials (minor and principle) or freeways.

Given all of these points, access management is not one-size-fits-all – what works on one segment of one street may not work on another segment of another street in another city. It is vital to keep in mind the specific characteristics of a certain location or corridor when applying access management techniques.

## Why Use Access Management?

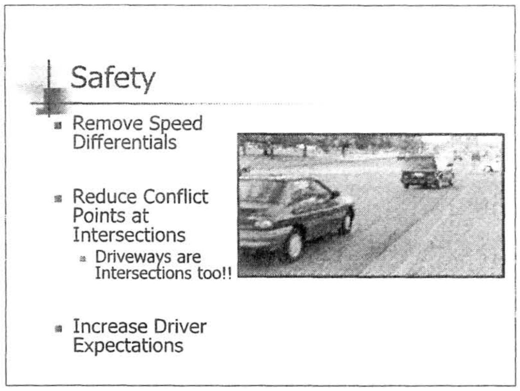
- Improve Public Safety
- Enhance Mobility
- Preserve Functional Classification Integrity
- Protect Infrastructure Investment

The number one, most important reason to use access management is to improve safety. Every crash that is prevented is money saved and potentially injuries and fatalities prevented.

The next most important reason to apply access management techniques is to improve mobility – the movement of vehicles along the roadway.

One of the best ways to enhance mobility is by preserving the integrity of functional classification categories. This means allowing arterials to serve their primary purpose of moving large volumes of vehicles, while accommodating appropriate levels of access to adjacent businesses and land uses.

Finally, by applying access management techniques, we can save tax dollars. When applying access management techniques, such as turn lanes and limited driveways, it is typically easier for a street to operate at or near its designed capacity. This means that fewer additional travel lanes or parallel facilities would have to be constructed.

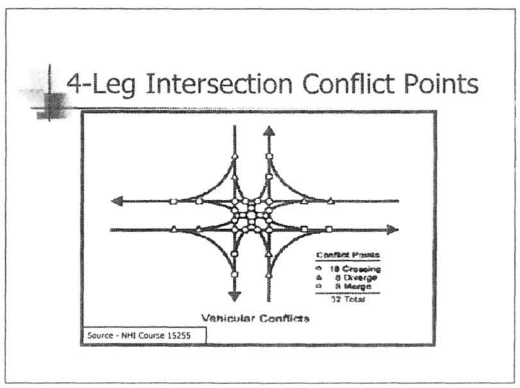



There are several ways access management techniques can improve safety.

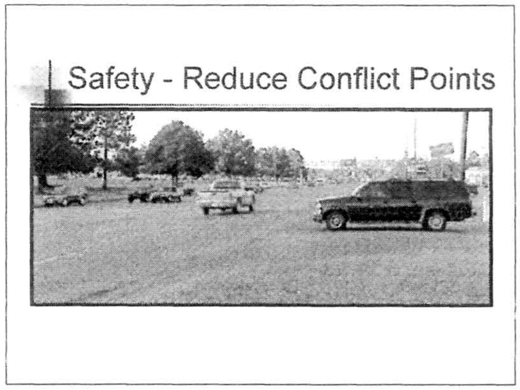
More than half of all crashes are intersection related – this includes driveways, which are intersections. If the turning vehicles can decelerate and make their turning movements in a turn lane, there is much less chance of it being rear-ended by a faster moving, through vehicle.

The reason there are so many crashes at intersections is due to the number of conflict points, or opportunities for vehicle paths to cross, at intersections. By physically reducing the number of possible turning movements at an intersection, we reduce the number of conflict points, thus reducing the opportunities for crashes to occur.

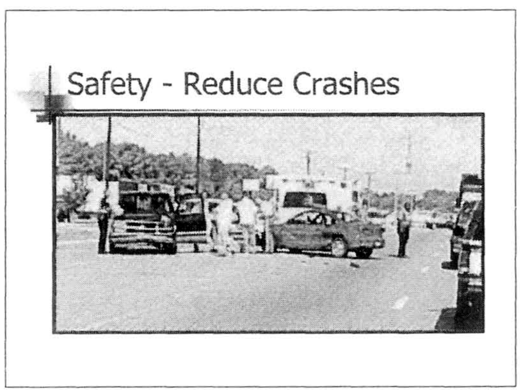
By moving turning vehicles out of the through lanes, reducing the number of driveways along streets, and reducing the number of conflict points at intersections, drivers are more likely to have better expectations of what to expect while driving on the corridor. They can better anticipate when and where vehicles will make turning movements that may conflict with their travel path.



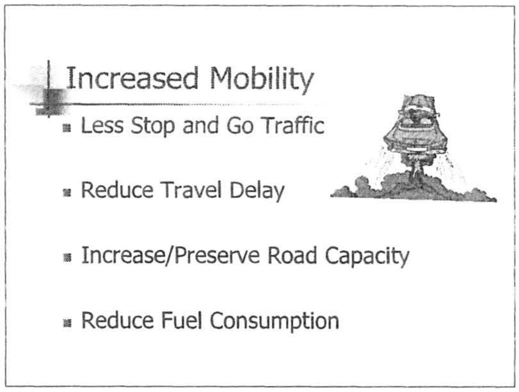

This slide shows that there are 32 conflict points when two roads that each have two lanes intersect. Half of the conflict points include head-on, near head-on, and side-impact conflicts that can cause the most severe injuries and property damage.




Notice how the driver waiting to exit the driveway by turning left must identify potential conflict points in three lanes in two directions, plus be ready for what may occur if entering the two-way-left-turn lane, where other conflicts may occur.




This is what can happen when volumes on the arterial street are high (above the mid-20,000 range) and the function of the two-way-left-turn lane breaks down.

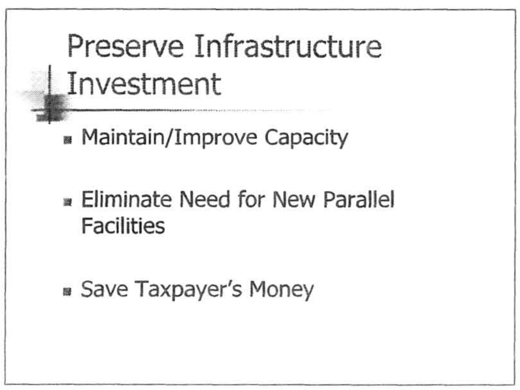



When there are fewer opportunities to make turns on to or from the arterial street, there are fewer times the through traffic will have to slow down and re-accelerate because of vehicles turning in front of them.

By reducing the number of times through vehicles must decelerate and re-accelerate, travel time on the corridor can be reduced.

When mobility is improved, the road will be have a better chance of operating at or near its designed capacity.

Another benefit of less decelerating and accelerating is a reduction in fuel consumption, which can also lead to better air quality due to fewer hard accelerations.




By allowing arterial streets to operate as close to their designed capacity as possible, there should be fewer needs to build additional travel lanes or parallel facilities. This practice will ultimately save tax money that we all pay.

## Basic Access Management Techniques

- Median Alternatives (Directional vs. Full)
- Traffic Signal Spacing Criteria
- Unsignalized Access Spacing Criteria
- Corner Clearance Criteria

The next two slides show examples of some basic access management techniques.

One of the more common set of treatments is median alternatives, which can include raised medians, two-way-left-turn lanes, and depressed medians. An important factor to consider when determining the number and location of median openings (when you have a non-traversable median) is that every full opening is a candidate location for a future traffic signal.

That leads us to traffic signal spacing criteria. You want to have spacings that allow for progression to occur along a corridor. You also want to make sure that signalized intersections are not so close to each other that they begin to negatively impact each other.

Another common technique is providing adequate spacing between driveways and the nearest intersecting street. These distances are typically based on stopping sight distances.

## Basic Access Management Techniques

- Auxiliary Lanes
- Access Control at Exit/Entrance Ramp Junctions with Frontage Roads
- Frontage Roads
- Alternative Left Turn Treatment

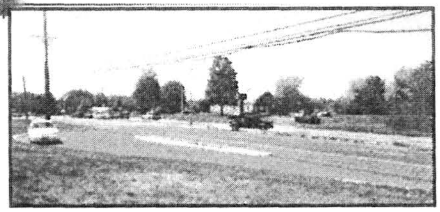
Auxiliary lanes are typically longer than turning lanes, sometimes extending the entire distance between two signalized intersections. They can be effective where there are numerous driveways that cause great amounts of decelerating and accelerating.

On and off ramps should be located sufficient distances from the intersecting roads so that traffic on the freeway main lanes and the frontage roads is not negatively impacted. This also includes locating driveways along frontage roads at appropriate distances from turnarounds and on and off ramps. Driveways should not be located directly across from flush ramp gores.

Frontage roads can provide necessary access to adjacent businesses and land uses that should not be allowed to main lanes of freeways and, in some cases, arterial streets.

In addition to the typical two-way-left-turn lane and left-turn bays in raised median segments, there are other ways, such as jug handles and Michigan left turns, to allow left turns that can minimize the impacts of left turns on through traffic. These treatments can also provide greater levels of safety for the corridors.

## U-Turn Jug Handle



- Left-turn, then Merge with Traffic

This slide depicts a jug handle that allows a driver to complete a u-turn in two movements. The first movement is a left turn across the opposing travel lanes; the second movement is merging into the through traffic. Jug handles can accommodate u-turns on streets where a raised median is necessary, but there is limited right-of-way to allow for enough lanes that would accommodate u-turn movements.

## Application of AM Techniques

- Short Term Projects & TSM Improvements
  - Signal Coordination
  - Turn Lane Development
- Retrofit & Widening Projects
  - Development of Raised Medians
  - Driveway Consolidation
- New Location Projects
  - All Techniques Applicable
  - Strict Land Planning Through Local Entities

Access management technique's can be applied in a variety of situations. Traffic signal coordination (timing) and turn lane installation can provide relatively inexpensive solutions to problems on a small scale.

When a corridor is to be widened, it is typically a good opportunity to retrofit the corridor with a raised median (if applicable, considering volumes and driveway densities) and consolidation of driveways. Driveway consolidation is possibly the most delicate access management issue and be the most difficult to implement. It can, however, lead to some of the best mobility improvements on a corridor.

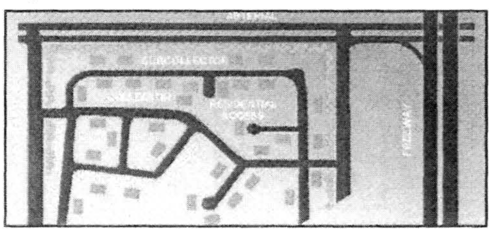
The best time to implement access management techniques is when a new location road is being built. Any type of technique can be included with the least likelihood of problems from adjacent property owners. Through which ever process access management techniques are implemented, it is vital that the city responsible for development regulations be dedicated to adopting and enforcing regulations that support the purposes and integrity of access management principles.

## Why Should We Do Access Management?

- Relationship to Functional Classification
- Guiding Principles for Texas
- What are We Trying to Fix/Avoid?
  - Common Problems on Roadways

Guiding principles based on themes – result of research – other states expressed importance of themes in program/elements

## Roadway Functional Classification



This is the "text book" description of functional classification.

The local streets (denoted here as "residential access") provide unlimited access to the homes on these streets.

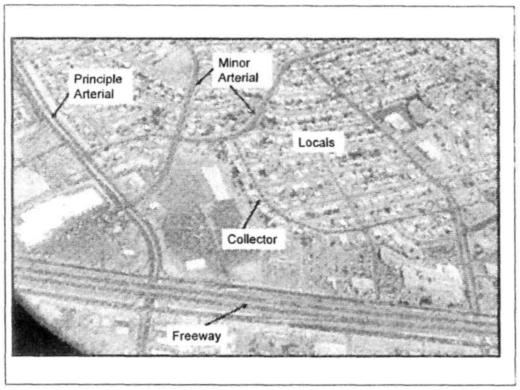
The collectors bring local street traffic to the minor arterial, as well as having some access as well.

The minor arterial is wider, with less direct access and well-spaced street intersections.

The principle arterial in this case is divided, with a greater spacing of street intersections and feeds traffic to the freeway. The arterials also have limited numbers of driveways.

The freeway has grade-separated intersections, with no direct access to the main lanes.

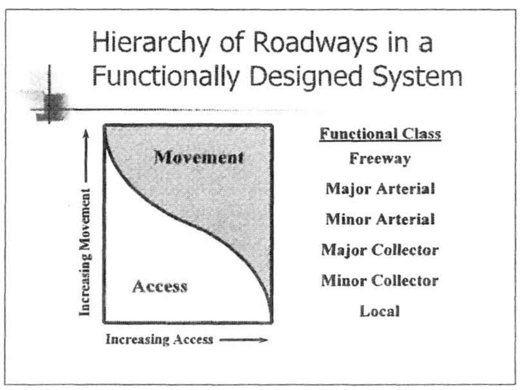
Remember, these are the ideal descriptions of the purposes of these functional classifications – reality often varies from this!




Here is an aerial photo from El Paso that pretty closely mimics the "text book" description from the previous slide.

The photo includes a freeway segment, as well as a divided principle arterial. Note how the principle arterial has very few private driveways, as well as very good street intersection spacing.

Please note that these "example" functional classifications may differ from the actual, approved functional classification map for the El Paso area. This graphic is presented primarily to show how reality can imitate the "ideal, textbook" scenario.




This is a classic, textbook diagram that shows that the primary purpose of freeways is to move traffic, not provide access. The importance of providing access increases as the functional classification moves down to the local street. Arterials, at least in theory, should be serving the purpose of moving traffic more than providing access.

## Access Management Guiding Principles for Texas

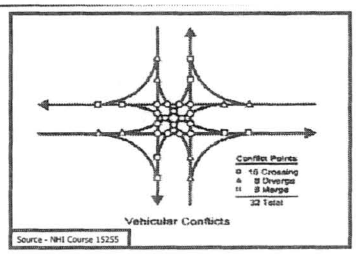
- "SAFETY and MOBILITY"
  - Safety
    - Reducing Conflict Points Reduces Crash Potential
    - ~ 50% of all Crashes are Intersection-Related
      - Driveways are intersections, too!
    - More than 3500 People Die in Texas Crashes Each Year

When developing the access management program, TxDOT informally adopted some access management guiding principles. One of those is safety and mobility.

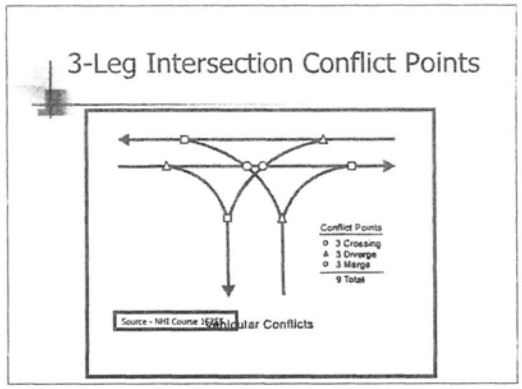
Above all else, safety of the motoring public is the vital consideration.

It is important that safety and mobility be considered together

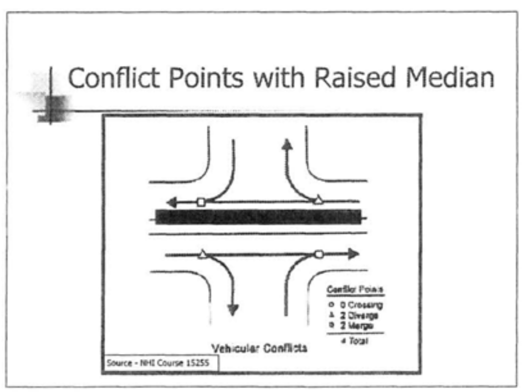
## 4-Leg Intersection Conflict Points



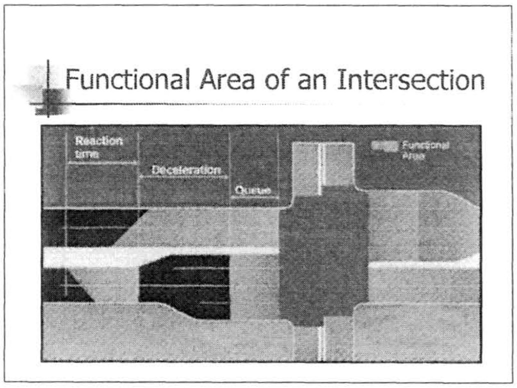

This slide shows that there are 32 conflict points when two roads that each have two lanes intersect. Half of the conflict points include head-on, near head-on, and side-impact conflicts that can cause the most severe injuries and property damage.




A three-leg intersection has only 9 conflict points, quite a reduction from the 32 seen in the four-leg intersection.




When there are two opposing three-leg intersections, due to a non-traversable median, there are only two conflict points in each intersection. Also, they are likely to cause the least serious injuries and amount of property damage.



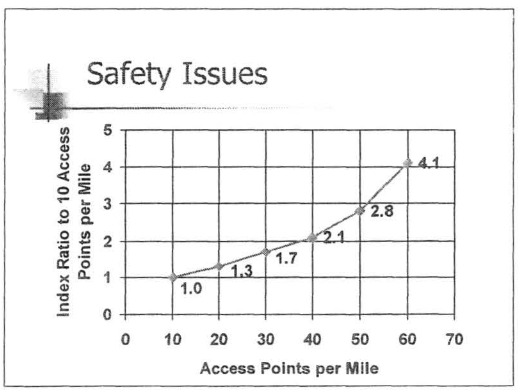

This slide shows the different elements of an intersection's functional area. The Reaction time area is that in which the driver realizes that traffic is stopped at the intersection ahead and begins to take action.

The deceleration area is that in which the driver begins to slow the vehicle.

The queue is the line of cars waiting at the intersection.

Finally, the red area depicts the physical area of the intersection.

The length of these areas varies among different intersections, and can even vary between peak and off-peak hours at a single intersection.




This chart illustrates that as a corridor's access point density per mile increases, crash rates increase as well. As access point densities increase, driver expectancies decrease, because there are so many opportunities for conflict points due to other vehicles potentially turning.

## Accident Rates

**Representative Accident Rates (Crashes per Million VMT) by Type of Median – Urban and Suburban Areas**

| Total Access Points per Mile (1) | Median Type: Undivided | Median Type: Two-Way Left-Turn Lane | Median Type: 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 |

(1) Includes both signalized and unsignalized access points.

This chart, the result of a national study that analyzed thousands of crashes on numerous corridors, illustrates that the safest type of arterial street is that with less than 20 access points per mile and a non-traversable median. The most dangerous corridors have above 60 access points per mile and are undivided.

## Safety Impacts – Texas

- Texas Avenue – College Station
  - Crashes reduced by 50-67%
  - Severity of crashes decreased (evidenced by injuries)

(Research Project 0-4221)

A case study was performed on a segment of Texas Avenue (Business SH 6) in College Station where a raised median was installed. In the first year after the median was installed, the crash rate dropped by ½ to 2/3, depending on which specific part of the corridor you are looking at – some particular sections or locations along the corridor may have had very high crash rates before median installation, due to turning movements and the turning movements have now been made physically impossible. In addition, fewer severe crashes occurred, based on the number of injuries reported.

## Access Management Guiding Principles for Texas

- "SAFETY and MOBILITY"
  - Mobility
    - Allow Through-Traffic to Move More Efficiently
    - Separate Speed Differentials
    - Less Braking and Hard Acceleration

In addition to trying to improve safety on the roadways, TxDOT also wants to gain the mobility improvements that access management techniques can yield. These include allowing through traffic to move through a corridor more efficiently by moving the turning vehicles to turn and auxiliary lanes. These improvements reduce the amount of slowing and speeding up that vehicles must do.

## Access Points and Free Flow Speed

**Access Points and Free Flow Speed**

| Access points per mile | Reduction in free flow speed, mph |
|---|---|
| 0 | 0.0 |
| 10 | 2.5 |
| 20 | 5.0 |
| 30 | 7.5 |
| 40 or more | 10 |

This chart illustrates that as driveway density increases, traffic free flow decreases. This follows the concept in the previous slide – if you have more opportunities to turn, there are more opportunities to have to slow down; therefore, it will take longer to drive through a corridor.

## Travel Time and Signal Density

| Percentage Increase in Travel Times as Signalized Density Increases | |
|---|---|
| Signals per Mile | Percent Increase in Travel Times (compared with 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 |

Likewise, as signal density increases, travel time on a corridor increases. The closer signals are to each other, the harder it becomes to attain a good progression that would allow platoons of vehicles to move through a corridor with minimal stops.

## Economic Effects

- Access management techniques, in general, are not directly related to retail sales
- Poorly designed access treatments can present traffic hazards and congestion that create a negative image of a center (Urban Land Institute (ULI) Shopping Center Development Handbook)

The biggest concerns expressed when a raised median project is announced is that it will negatively affect businesses along the corridor. Research in Texas and around the country has shown that when raised medians are installed, there is not a correlation to businesses suffering. The retail sales on studied corridors, typically follow the same trends of the entire cities in which they are located, or even do better.

The Urban Land Institute has a statement in its Shopping Center Development Handbook saying that poor access to a retail center can actually have a negative affect on whether people decide to shop there.

## Economic Effects

- Research in Texas - raised medians have no direct impact on retail sales in general
- Issues that businesses can control are more vital to success
  1. Price
  2. Quality
  3. Service
  4. Access
  5. Distance
  6. Hours

(Research Project 7-3904)

A four-year research project performed in Texas showed that the installation of raised medians had no long-term negative affects on adjacent businesses. If the project includes widening the roadway and occurs over a relatively long period of time, businesses can experience decreases in sales during the construction phase. However, almost all businesses return to at least pre-construction sales levels, with many actually exceeding those levels some time after the construction is complete.

Part of that project included asking business owners and managers to consider these six issues from the perspective of their customers and rank them in the order of importance they believe their customers would. With great consistency, the businesses representatives said the customers likely rank them in this order, with access coming in fourth. The main point here is that the main issues that drive a business's success are those things that the business itself can control – price, product quality, and customer service.

## Economic Effects

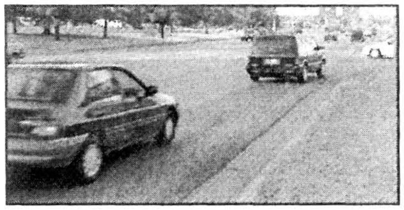
- Market area is important to business success
  - Reduction of travel speeds means smaller market areas

Graphic from *Transportation and Land Development* - Stover and Koepke

How do you answer the question, "how far is it from your house to the grocery store?" Do you answer in terms of distance or time – miles or minutes?

Travel time is more important to a business when determining the market area it serves. If a business locates at the center of this diagram, you can see the different market area it will serve, depending on the speeds at which motorists are able to drive. If arterial streets have good access management, resulting in less decelerating and accelerating, motorists can drive greater distances in less time than on streets that don't have good access management. Access management can actually increase the market area a business serves.

## What Are We Trying to Fix/Avoid?



- Speed Differentials

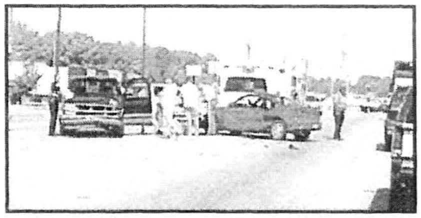
The brake lights on the car in this photo illustrate how through traffic must slow for vehicles making right turns when no turn lane is present. Additionally, the curb return radius of the driveway dictates how slowly the turning vehicle must be going when executing the turn maneuver, and, therefore, how much the through vehicle must slow. A right-turn lane would reduce how much the through vehicle must slow (and accelerate).

## What Are We Trying to Fix/Avoid?

- TWLTL Conflicting Uses

The minivan in this picture has exited a driveway and is entering the left-turn lane to use it as a haven while it looks for an acceptable gap in the traffic it wants to merge into. The pick-up truck has entered the left-turn lane from the opposite direction, preparing to make a left-turn. These conflicting uses are setting up a potential crash, as the minivan driver is likely looking over his shoulder.

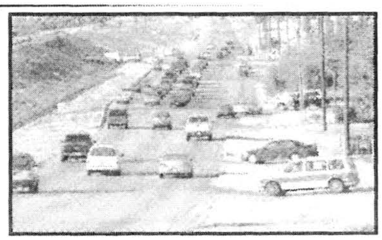
## What Are We Trying to Fix/Avoid?



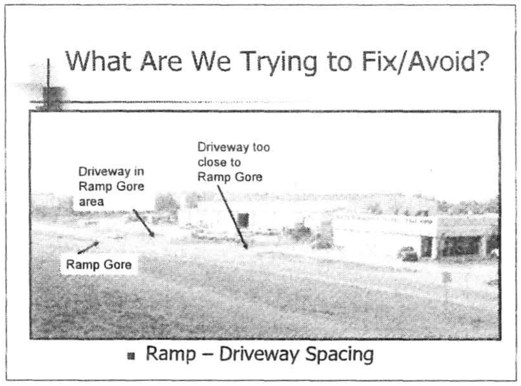
- Conflict Points

This crash is what can result from a TWLTL's original purpose being degraded due to large volumes on the arterial street and conflicting uses in the TWLTL.

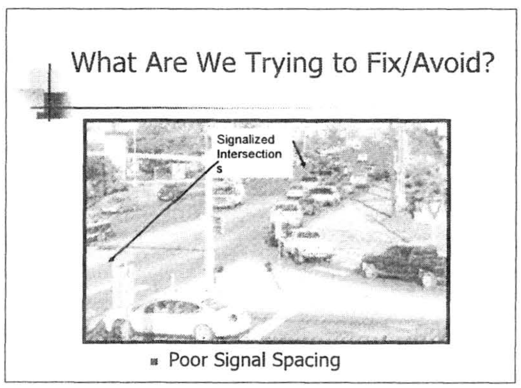
## What Are We Trying to Fix/Avoid?



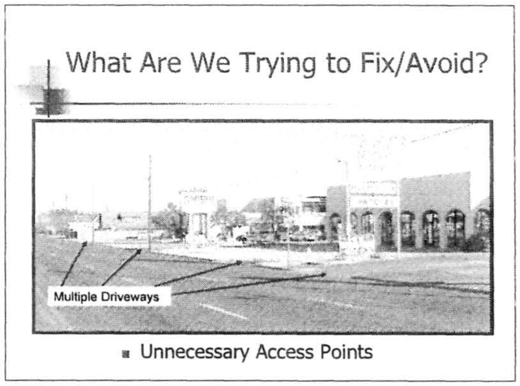
- Multiple Conflict Opportunities



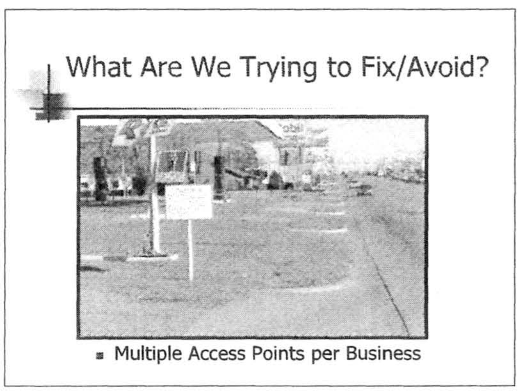

Driveways within, or too close to, the ramp gore can encourage unsafe maneuvers by vehicles exiting those driveways. The higher the traffic volumes on the frontage roads, the more dangerous the maneuvers can be by vehicles wanting to access the entrance ramp to the mainlanes. The driveways need to be a sufficient distance from the ramp gore that will allow the vehicle exiting the driveway to complete a right-turn and then enter the area influenced by the ramp gore.




These two signalized intersections are so close together that traffic queued up at one is backed up into the previous one, affecting traffic on its intersecting street.

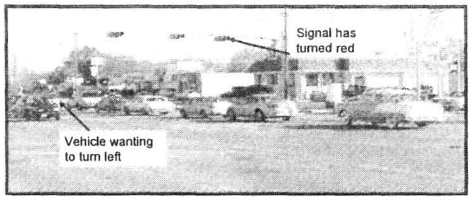



When shared access is possible and accepted by the businesses, unnecessary driveways can be eliminated. Access point spacing guidance can indicate how many driveways may be appropriate for a development, given its amount of frontage on the arterial street.




This gasoline station has four driveways – note how small the sections of curb are, as well as how close the next business's driveway is.

## What Are We Trying to Fix/Avoid?



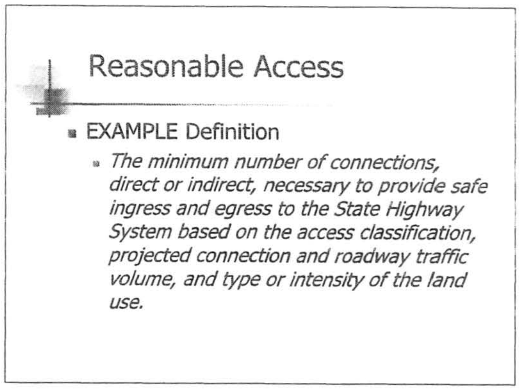

- Mobility Problems

The lead vehicle is stopped, waiting to make a left-turn, across the opposing TWLTL and through lanes. Meanwhile, traffic in that lane is backed up through the signalized intersection, after their signal has turned red. A raised median would prevent this problem, requiring the vehicle that is wanting to turn left to proceed further and make a U-turn, or turn left at the signalized intersection and access the business from the intersecting street.

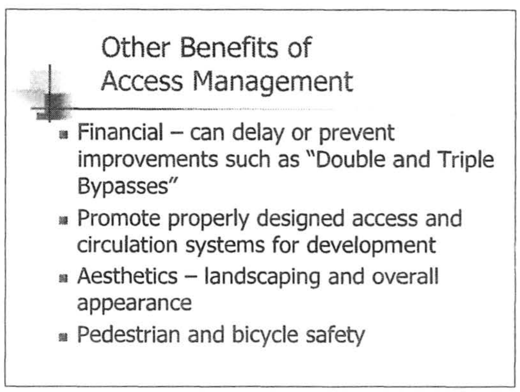
## Access Management Guiding Principles for Texas

- "ACCESS MANAGEMENT CAN PROVIDE REASONABLE ACCESS TO DEVELOPMENTS"
  - Transportation and Land Development Must Exist Together

The difficult challenge is to actually define what reasonable access is.




This is a compilation of how other states have officially defined reasonable access – it is NOT TxDOT's definition, but something to give and idea of what should be considered when discussing reasonable access.




Access Management is a comprehensive approach to solving corridor problems. Implementing access management techniques can maintain or improve capacity on a road, eliminating the need for construction of expensive, parallel facilities.

Raised medians can include landscaping and pavement treatments that improve a corridor's aesthetics. Keep in mind that vegetation in a median should not interfere with sight distance at openings.

Well-designed access and on-site circulation systems for developments can actually enhance their attractiveness to potential customers. Since at least part of these attributes are included outside of TxDOT's ROW and not at the intersection of access, it is up to the local agencies and the developer to properly design and implement these attributes.

## Access Management Guiding Principles for Texas

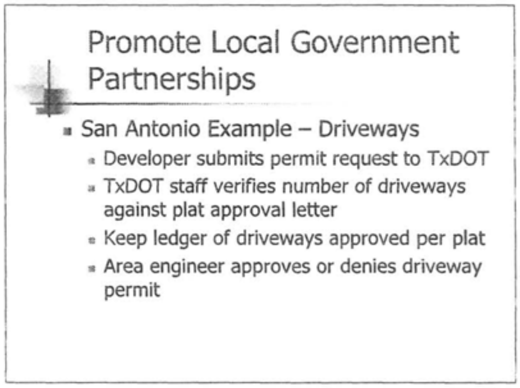
- "Promote Local Government Partnerships"
  - TxDOT Desires to Coordinate and Cooperate in Development and Access Review
  - Ensures Both Agencies are "On The Same Page"
  - Engineering Should be Coordinated with Local Agencies
    - Geometrics, Hydrology, Etc
  - Statewide Implementation Consistency

TxDOT realizes that a key element of successfully implementing access management is developing partnerships with local governments. These partnerships include cooperative review of plats and site plans for developments that front TxDOT facilities. There are numerous issues that need to be addressed, including geometrics of the access points, spacing, and drainage. In-depth cooperation is particularly necessary for local governments that do not have their own engineering staff to review plats and site plans.

## Promote Local Government Partnerships

- San Antonio Example - Plats
  - Developer submits plats to TxDOT
  - Developer and TxDOT work out issues
  - TxDOT keeps track of number of allowed driveways per plat
  - TxDOT provides comments to city
  - City includes comments on final plat

The City of San Antonio and the San Antonio District have one of the best cooperative systems in the state for reviewing plats for access issues. After the developer and TxDOT have worked out an agreement for the number of acceptable access points, TxDOT provides comments to the City. The City can then include those comments as its conditions for approval of the plat. TxDOT keeps track of the number of access points allowed at the development, and reviews that file each time an access point is requested to ensure that the agree upon number of access points is not exceeded.




More details on how the SAT District monitors the number of access points for a given development.

## Why Should We Do Access Management?

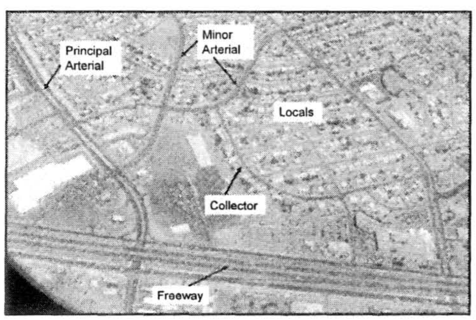
- Relationship to Functional Classification
- Guiding Principles for Texas
- What are We Trying to Fix/Avoid?
  - Common Problems on Roadways

Guiding principles based on themes – result of research – other states expressed importance of themes in program/elements

AM helps maintain the integrity of roadway functional classification, relative to the traffic movement and access purposes as discussed later

TxDOT developed three guiding principles for developing and implementing an AM program – they will be discussed later

AM can fix certain problems on existing roads and prevent them on new or rebuilt roads

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Please note that these "example" functional classifications may differ from the actual, approved functional classification map for the El Paso area. This graphic is presented primarily to show how reality can imitate the "ideal, textbook" scenario. Local streets typically provide virtually unlimited access to driveways for adjacent residential or other developments – access is the primary purpose. Collectors typically collect traffic from local streets and take it to arterials; likewise the distribute traffic from arterials to locals; typically fewer access points/intersections that locals.

Minor arterials should have even fewer access points that collectors; traffic movement becomes more important than access. Principal arterials have even fewer access points that arterials; usually are muliti-lane (particularly in urban areas) and are often divided; traffic movement is the primary purpose. Freeways have very limited access at on and off-ramps; no direct access from driveways to main lanes; primary purpose is to carry large volumes of traffic long distances. The primary purpose of freeways is to move traffic, not provide access. The importance of providing access increases as the functional classification moves down to the local street. Arterials, at least in theory, should be serving the purpose of moving traffic more than providing access.

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- "SAFETY and MOBILITY"
  - **Safety**
    - Reducing Conflict Points Reduces Crash Potential
    - ~ 50% of all Crashes are Intersection-Related
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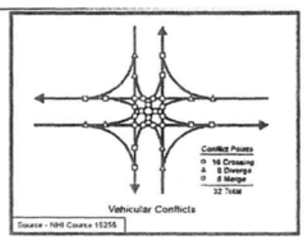
## 4-Leg Intersection Conflict Points

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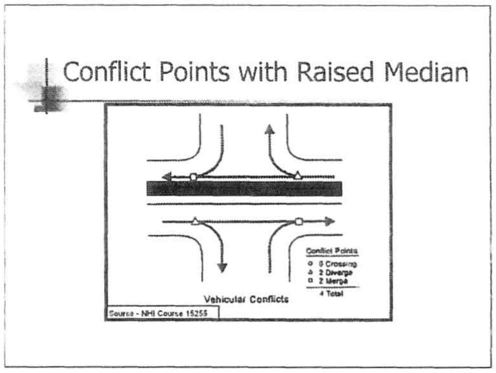


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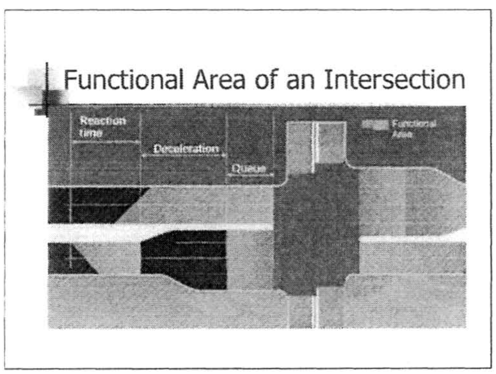


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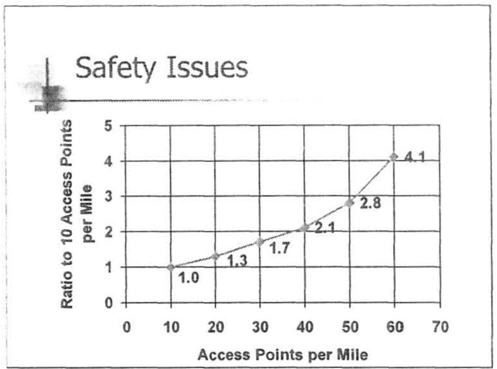


This chart illustrates that as a corridor's access point density per mile increases, crash rates increase as well. As access point densities increase, driver expectancies decrease, because there are so many opportunities for conflict points due to other vehicles potentially turning.

For example, the chart shows that as access point per mile density increases from 10 to 20, the expectancy of crashes increase 30%; it doubles when access density increases from 10 to 40 access points per mile, and so on.

Table 1-1. Accident Rates

**Representative Accident Rates (Crashes 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 |
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| Average Rate | 9.0 | 6.9 | 5.6 |

(1) Includes both signalized and unsignalized access points.

This chart, the result of a national study that analyzed thousands of crashes on numerous corridors, illustrates that the safest type of arterial street is that with less than 20 access points per mile and a non-traversable median. The most dangerous corridors have above 60 access points per mile and are undivided.

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    - Separate Speed Differentials
    - Less Braking and Hard Acceleration

In addition to trying to improve safety on the roadways, TxDOT also wants to gain the mobility improvements that access management techniques can yield. These include allowing through traffic to move through a corridor more efficiently by moving the turning vehicles to turn and auxiliary lanes. These improvements reduce the amount of slowing and speeding up that vehicles must do.

## Table 1-2. Access Points and Free Flow Speed

| **Access Points and Free Flow Speed** | |
|---|---|
| Access points per mile | Reduction in free flow speed, mph |
| 0 | 0.0 |
| 10 | 2.5 |
| 20 | 5.0 |
| 30 | 7.5 |
| 40 or more | 10 |

This chart illustrates that as driveway density increases, traffic free flow decreases. This follows the concept in the previous slide – if you have more opportunities to turn, there are more opportunities to have to slow down; therefore, it will take longer to drive through a corridor.

## Economic Effects

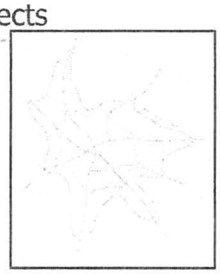
- Access management techniques, in general, are not directly related to retail sales
- Poorly designed access treatments can present traffic hazards and congestion that create a negative image of a center (Urban Land Institute (ULI) Shopping Center Development Handbook)

The biggest concerns expressed when a raised median project is announced is that it will negatively affect businesses along the corridor. Research in Texas and around the country has shown that when raised medians are installed, there is not a correlation to businesses suffering. The retail sales on studied corridors, typically follow the same trends of the entire cities in which they are located, or even do better.

The Urban Land Institute has a statement in its Shopping Center Development Handbook saying that poor access to a retail center can actually have a negative affect on whether people decide to shop there.

## Economic Effects

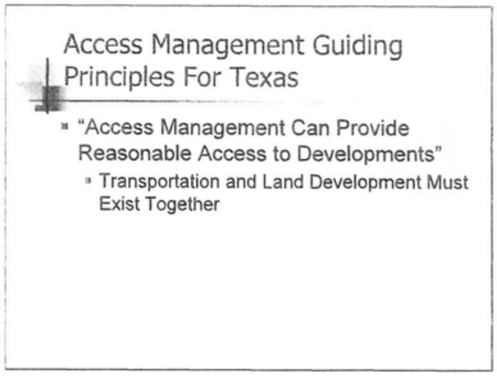
- Market area is important to business success
  - Reduction of travel speeds means smaller market areas



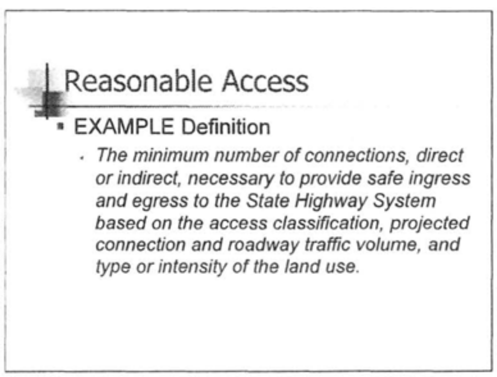
Graphic from *Transportation and Land Development* – Stover and Koepke

How do you answer the question, "how far is it from your house to the grocery store?" Do you answer in terms of distance or time – miles or minutes?

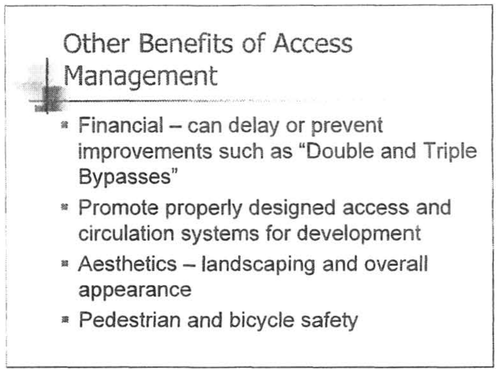
Travel time is more important to a business when determining the market area it serves. If a business locates at the center of this diagram, you can see the different market area it will serve, depending on the speeds at which motorists are able to drive. If arterial streets have good access management, resulting in less decelerating and accelerating, motorists can drive greater distances in less time than on streets that don't have good access management. Access management can actually increase the market area a business serves.




The difficult challenge is to actually define what reasonable access is.



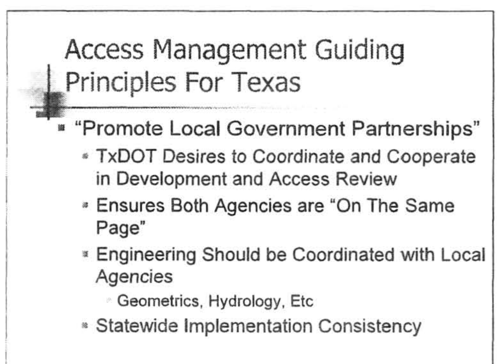

This is a compilation of how other states have officially defined reasonable access – it is NOT TxDOT's definition, but something to give an idea of what should be considered when discussing reasonable access.



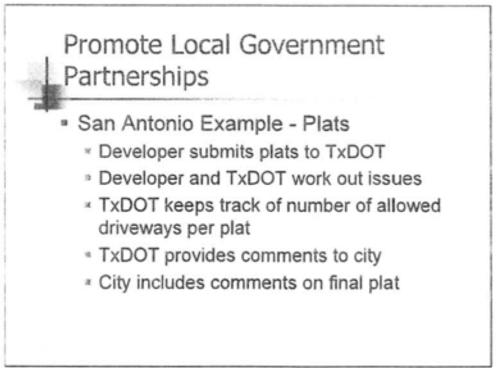

Access Management is a comprehensive approach to solving corridor problems. Implementing access management techniques can maintain or improve capacity on a road, eliminating the need for construction of expensive, parallel facilities.

Raised medians can include landscaping and pavement treatments that improve a corridor's aesthetics. Keep in mind that vegetation in a median should not interfere with sight distance at openings.

Well-designed access and on-site circulation systems for developments can actually enhance their attractiveness to potential customers. Since at least part of these attributes are included outside of TxDOT's ROW and not at the intersection of access, it is up to the local agencies and the developer to properly design and implement these attributes.




TxDOT realizes that a key element of successfully implementing access management is developing partnerships with local governments. These partnerships include cooperative review of plats and site plans for developments that front TxDOT facilities. There are numerous issues that need to be addressed, including geometrics of the access points, spacing, and drainage. In-depth cooperation is particularly necessary for local governments that do not have their own engineering staff to review plats and site plans.

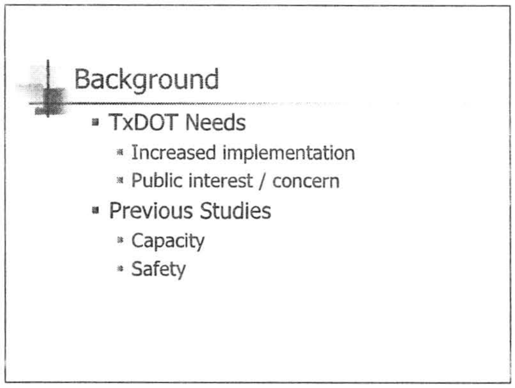



The City of San Antonio and the San Antonio District have one of the best cooperative systems in the state for reviewing plats for access issues. After the developer and TxDOT have worked out an agreement for the number of acceptable access points, TxDOT provides comments to the City. The City can then include those comments as its conditions for approval of the plat. TxDOT keeps track of the number of access points allowed at the development, and reviews that file each time an access point is requested to ensure that the agree upon number of access points is not exceeded.

## Business and Property Value Impacts of Raised Medians

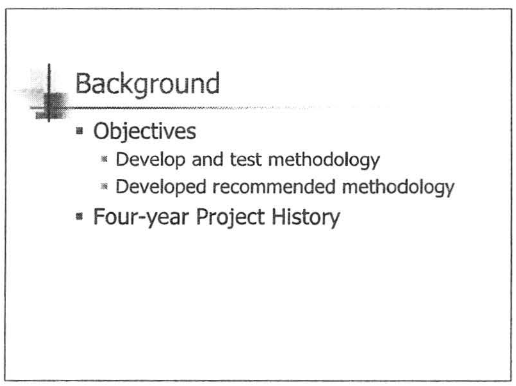
## Presentation Outline

- Background
- Recommended Methodology
- Analysis and Findings
- Conclusions

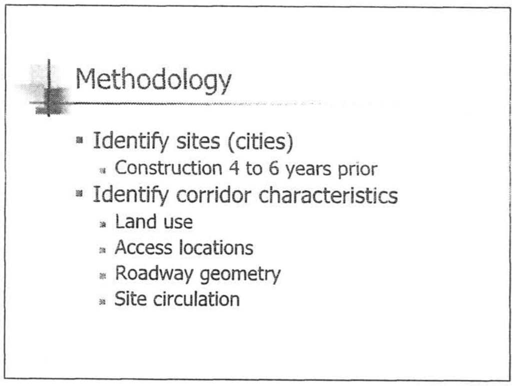



The economic impacts research was performed to satisfy TxDOT's needs to be able to effectively communicate what is really happening in Texas when raised medians are installed. Of course, the first thing business owners and managers will say when a raised median project is proposed is that their business will suffer. When research from other states showed that is not typically the case, the response was generally, "Great, now what about here in Texas."

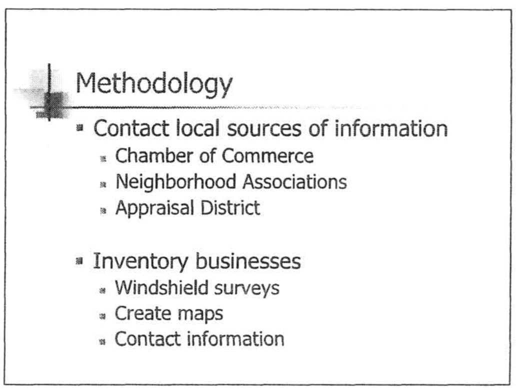
Most of the past research in Texas related to access management had to do with capacity and safety, and those were somewhat dated at the time this research was performed.



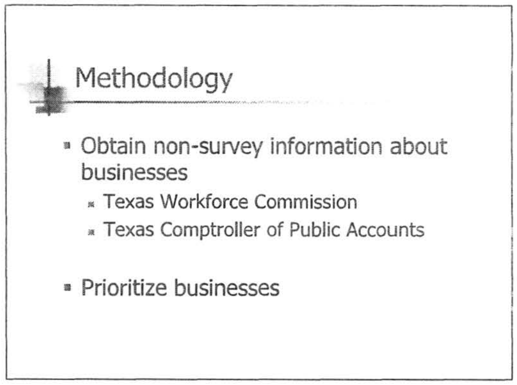

The original intent of the research was to develop and test a methodology to obtain information related to economic impacts of raised medians on adjacent businesses. It started as a one-year project and was extended to four years, in order to obtain more data and refine the methodology.




The research team identified several candidate corridors to study. Ideally, there would be a raised median in existence for approximately 4-6 years, in order to obtain adequate "before" and "after" data. Other considerations included the adjacent land uses – the more built out the corridor was, the better for getting the most retail sales data possible.




The research team contacted the local chambers of commerce and, where applicable, neighborhood/business associations, in the cities where case study corridors were located to get their support for performing the research. The chambers and/or associations sent letters to the businesses on the corridors stating that they supported the research and encouraged the businesses to cooperate with surveys/interviews. In addition, researchers contacted appraisal districts to obtain property value information. In many cases, appraisal districts now have that information available via the Internet – at least for current and some recent years. The research team then inventoried the corridors by performing windshield surveys of the corridors, followed by creating land use maps and contact information databases.

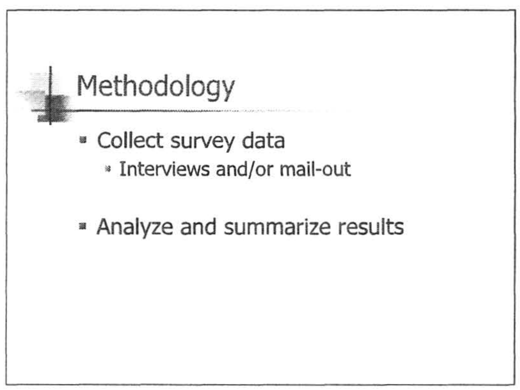



The Texas Workforce Commission provided employment rates for cities and counties where the case study corridors were located. The Comptroller's office provided sales tax information for the cities.

The research team prioritized the businesses by order in which they would be interviewed, given the limited resources of the project and the inability to interview every business.

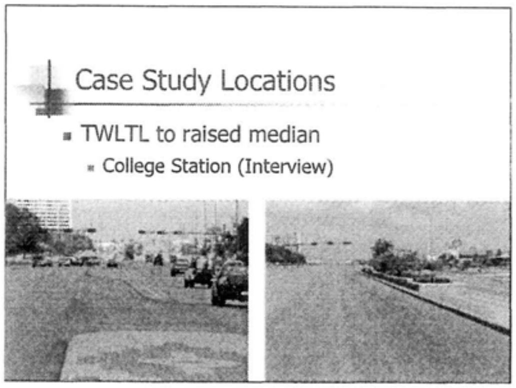
Next, they collected the survey data, primarily by in-person interviews, with some mail-out surveys. The mail-out surveys had a very typical, very low response rate of about 10%, while about 60% of the businesses contacted for interviews participated.

Finally, the researchers analyzed and summarized the survey/interview data results.

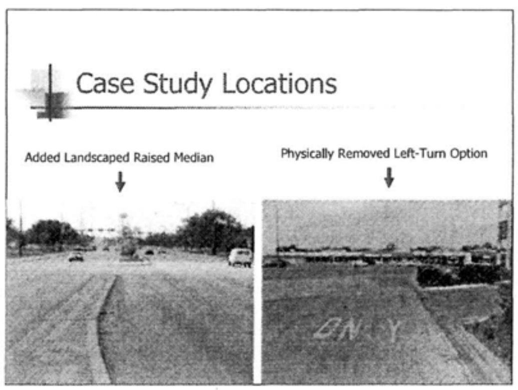



The next step was to collect business data through interviews and mail-out surveys. Again, the interviews provided the best information.

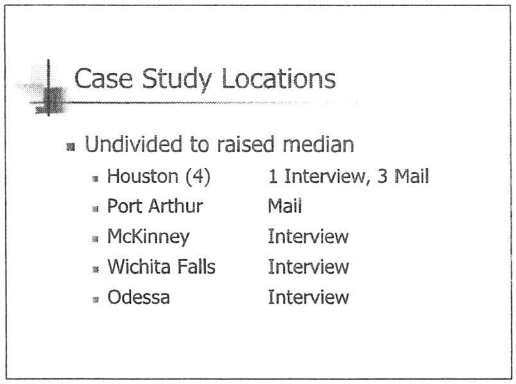
This step was followed by data analysis and summary preparation.



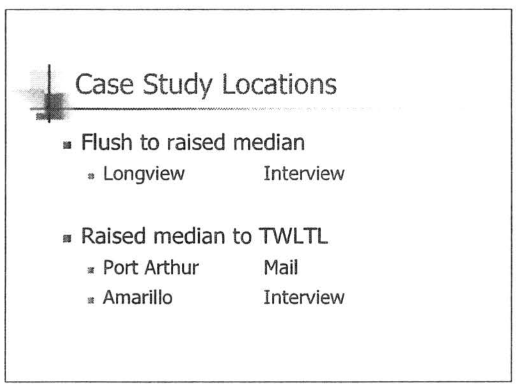

These two slides show examples of the raised medians that were installed on Texas Avenue (SH Business 6) in College Station as part of a project that included adding two lanes.




The photo on the right was taken from Dominik Dr, where left-turns became physically prohibited, at Texas Avenue. In previous years, left-turns were allowed, but were later prohibited, with signage and flexible pylons being placed at the intersection. Some drivers continued to make the left-turn; the raised median makes harder to execute this left-turn.




This slide gives a list of the corridors studied where roads went from being undivided (not even a TWLTL) to having a raised median.




The Loop 281 corridor in Longview went from being a flush median (conventional TWLTL in part and very wide space in other parts) to a raised median.

The corridors in Port Arthur and Amarillo had raised medians removed and converted to TWLTLs.

## Case Study Locations

- Land use mix, primarily retail
- Half-mile to 2.5 miles
- Interview and mail-out surveys
  - Business surveys
  - Undeveloped land surveys

In general, the adjacent land uses were primarily retail, with some office and multi-family on certain cooridors.

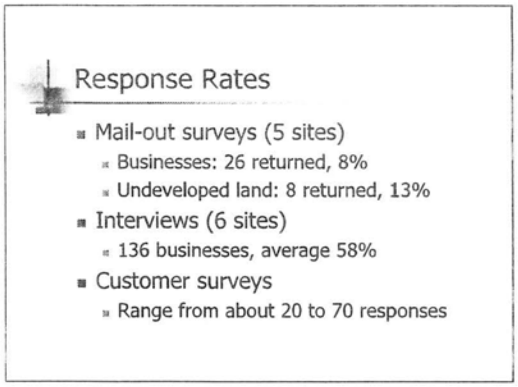
The corridors ranged in length from 1/2 mile to 2.5 miles, so there is a variety of corridor types represented.

As stated before, there was a mix of interview and mail-out surveys, with the interviews providing greater amounts of and more reliable data. There were also attempts to reach owners of undeveloped land, with poor results. Property values have been identified as a better measure of impacts on vacant land.

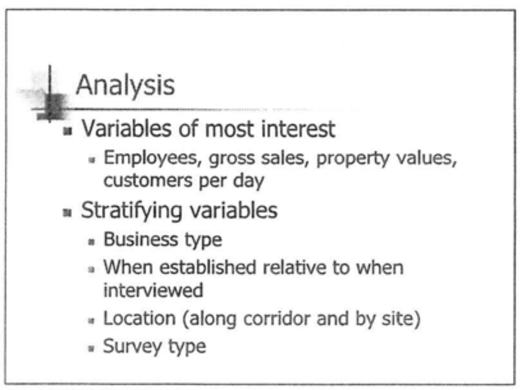
## Case Study Locations

- Customer surveys (5 sites)
  - College Station corridor
  - 2 sit-down restaurants
  - 1 fast-food restaurant
  - 2 gas stations

Customers were interviewed at five sites on the Texas Avenue corridor in College Station at the types of businesses shown here.




This slide presents the actual response/participation rates of the surveys and interviews. Again, the in-person interviews proved to be far more beneficial.




The researchers identified the types of data that were of most interest and the most useful ways to sort the data, according to various attributes.

## Findings

- Most businesses increased in gross sales
- Gas stations / Auto repair indicated perceived decreases in gross sales
- Generally followed city and county trends
- Similar pattern with customers per day
- Property values increased for all businesses

There were some pretty consistent findings:

•Most businesses experienced increased gross sales in the years after the median was installed

•Gas stations and auto repair businesses were the only types that consistently showed decreases

  •It is very important to note that there were very few samples of these businesses, though; having more of these business types may or may not have yielded different resutls

•The retail sales along the corridor generally followed the trends of sales tax receipts for the cities and counties in which they were located

•The numbers of customers per day, according to the business representatives, were very consistent with their reports of retail sales patterns

•Property values increased for all types of businesses where those data were available

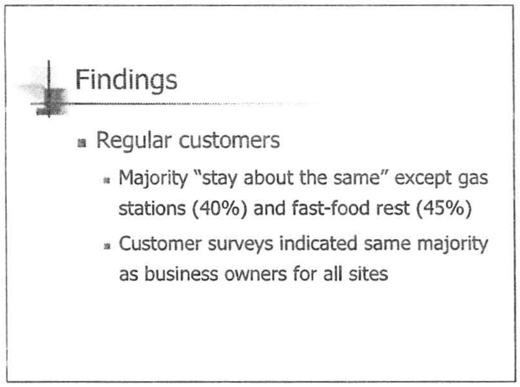
## Findings

- All but gas stations / "other services" indicated no affect on full-time emp.
- Decreases in sales were common during construction
- GOOD Communication with business owners is vital

All business types, except for gas stations and "other services", again with small sample sizes, showed patterns of no overall affect on full-time employment along the corridors.

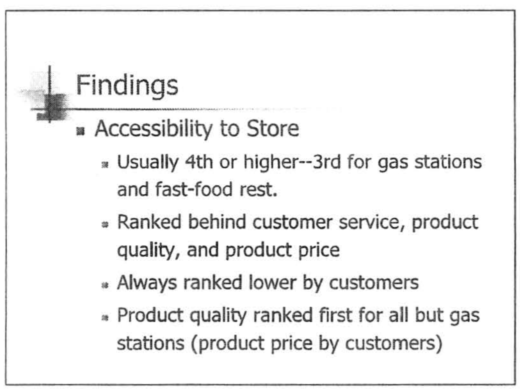
It was common to hear about businesses experiencing decreases in retail sales during the years when construction activities were occurring.

The research also found that GOOD communications is vital to the business owners in all phases of the projects, from planning to end of construction. They want to know what is happening, when, and what to expect, including any changes to what they last heard.




The vast majority of customers who were interviewed stated that they were at least as likely or more likely to continue patronizing businesses after a raised median is installed, with the exceptions of gas stations and fast food restaurants. These findings indicated that consumers are somewhat less "brand loyal" when it comes to buying gasoline and fast food

The customers' responses are in line with the responses from business representatives when asked what attributes they thought were most important to their customers. We will see those results in the following slides.




The business owners and managers consistently said that they thought accessibility to the business was less important to their customers than customer service, product quality, and product price – all things that the businesses themselves can control. The other attributes that ranked after accessibility were distance to travel and hours of operation.

## Findings

- Customers:
  - Indicated that access had generally declined
  - Customer service remained the same or improved

Interviewed customers stated that while accessibility had declined, customer service at businesses along the corridor had remained the same or improved.

## Conclusions

- In general, no significant negative economic impacts
  - Some businesses affected more
- General loyalty to employees
- Many economic factors
- Public involvement "low" for 62% of respondents
- Good communications is vital

Major points from the research:

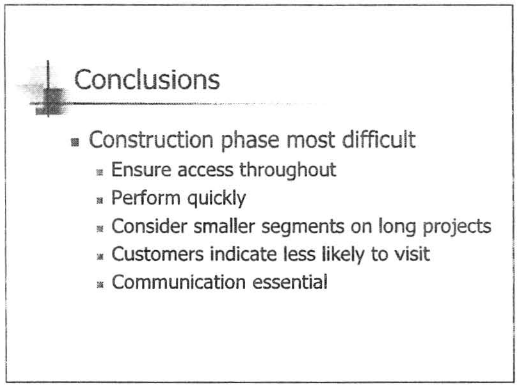
•there were no overall significant negative economic impacts along the corridors, though some individual businesses were affected more than others

•Businesses were generally very loyal to their employees during the construction phases when sales decreased

•There are many other economic factors that contribute to a business's success other than accessibility

•62% of the business representatives said that public involvement had been at a low (not good) level on their corridors

•It is vital to have constant, good communications with the businesses during all phases of the project




Some ideas of how to address the negative impacts during construction:

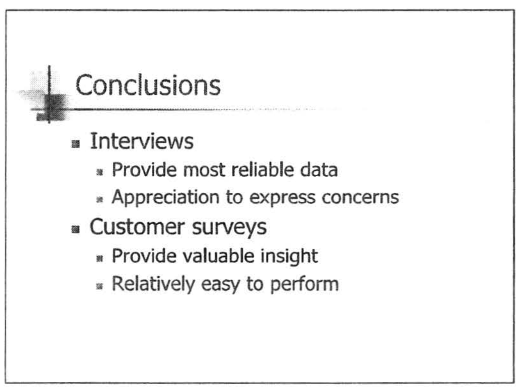
•Ensure access to all businesses throughout the project

•Perform each construction segment as quickly as possible

•Consider smaller/shorter segments on very long projects, particularly if it will involve tearing up the street

•Customers indicated that they are less likely to visit businesses along a corridor when construction activities are occurring

•Again, communications with the businesses and the public are essential




Interviews provided more reliable and greater amounts of data than mail-out surveys. Some businesses representatives expressed their appreciation to express concerns about the projects.

Customer surveys provided valuable insight that yielded findings consistent with business representatives' ideas about what customers think is important when selecting a business to patronize.

## Economic Impacts - National

- States with studies
  - Florida
  - Iowa
  - Kansas

- Found no significant economic impacts

Studies in Florida, Iowa, and Kansas have shown that there is no correlation between the installation of raised medians and retail sales on the corridors where raised medians have been installed. While there is typically some decrease in sales during a major construction phase, such as a project that involves the street being torn up for widening, sales typically get back to pre-construction levels within a couple of years. Sales then follow the previous trends or, in some cases, increase.


A four-year research project in Texas found similar results. Eleven corridors were studied in 8 cities, yielding results similar to the studies in other states. In the before and after raised median installation cases, there were no major overall decreases in retail sales. Likewise, in cases where raised medians were removed, there was no sudden surge in retail activity. Because these studies were primarily performed with in-person interviews, there was an extremely high 60% participation rate.

## Economic Impacts of Raised Medians Study in Texas

- Surveyed Customers
- Interviewed Business Owners/Managers
- Actual Revenues/Percent Changes per Year
- Customer Decisions

The overall methodology for this research involved surveying business owners and managers to obtain their perspectives, as well as annual changes in retail sales. Some businesses would share actual sales numbers per year, while others provided estimates of percent changes by year. The researchers also asked business representatives about what influences their customers' decisions about which stores to patronize. Customers were surveyed on one corridor.

## Findings on Business Impacts - Texas

- Construction phase is critical
- Loyalty to employees
- Specialty retail, fast food, and sit-down restaurants; sales up after construction
- Auto repair sales down after construction (very small sample size)

The research found that the construction phase is the most critical to businesses – that is when businesses are most likely to see negative impacts. This is particularly true if the street is completely torn up for any time.

Businesses were typically found to be loyal to employees, by not laying off large numbers (none in most cases) of workers during the construction phase related decreases in sales. The business owners and managers tended to realize that the construction impacts would be temporary.

The only types of businesses that showed an overall decrease in years after the medians were installed were auto repairs and gasoline stations. There were very small samples of these types of businesses in the research, though. Most of the other types of businesses showed increases in sales after the medians were installed.

## Findings on Business Impacts - Texas

- Regular customers not impacted
- No significant economic impacts
- Many other economic factors
  - National/Local Economy
  - Business Management

The general findings from the research were that regular customers still continued to patronize the businesses that went to prior to median installations and that there were no significant economic impacts on retail sales in the corridors where raised medians were installed.

Business representatives generally stated that there are many other factors, such as management skills, customer service, prices, and the general economy, that influence the success of their businesses besides the presence of a raised median.

## Findings on Business Impacts - Texas

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## Perceptions of Customer Preferences

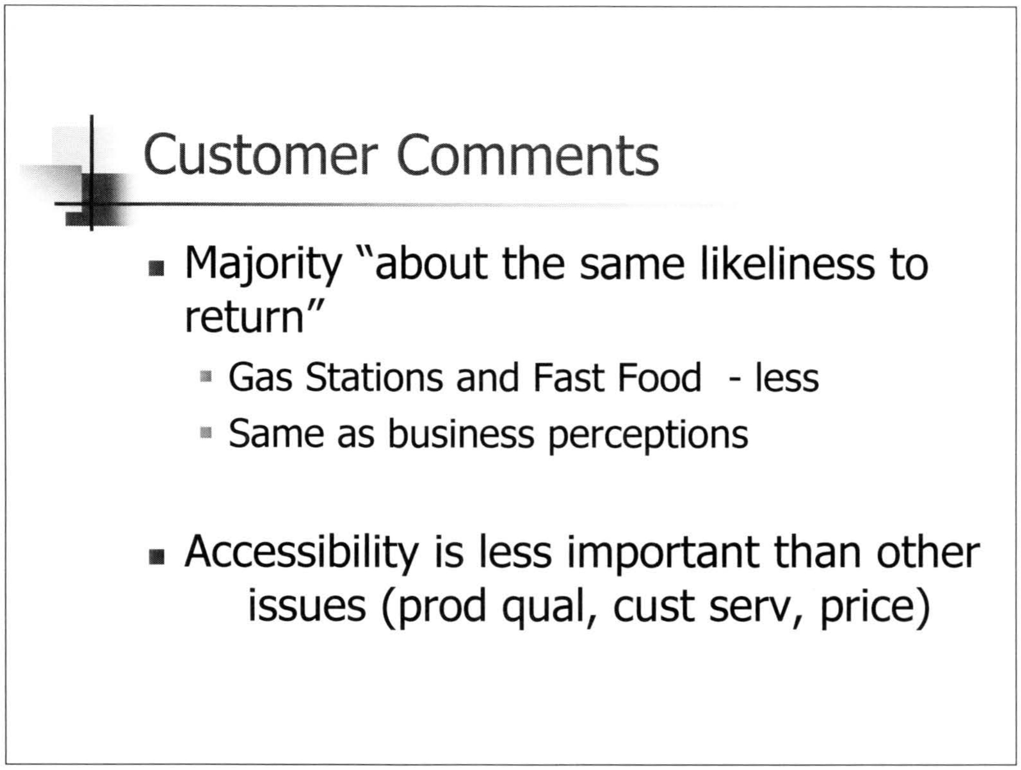
1. Customer Service
2. Product Quality
3. Product Price
4. Accessibility to Store
5. Distance to Travel
6. Hours of Operation

The survey asked business representatives to rank six characteristics that their customers consider then deciding which businesses to patronize. The overall results of about 200 responses were very consistent – business representatives typically believe that customers value customer service, product quality, and product price before access to the store.


As a result of talking to the business representatives, the study found that they desire to play a greater role in determining which access options are the best. They also desire smaller and faster construction phases that would result in shorter periods of disruption to businesses. There is also a need to increase communications, from the planning phases of the projects all the way to the construction phases, so the business representatives can know what to expect.

The agency implementing the access management techniques need to explain the benefits of doing so to help the businesses better understand why the project is being undertaken.

Business representatives also expressed concerns about what would happen with future access and the diversion of traffic to side streets. Again, some education/outreach would likely help with these concerns.




When customers were asked about continuing to patronize businesses where a raised median was installed, the vast majority said that they were at least as likely to return to the stores they had previously patronized. This is similar to the business representatives' perspective that access isn't as important to customers as the attributes that businesses themselves control.

## Conclusions

- In general, no significant negative economic impacts
  - Some businesses affected more
- General loyalty to employees
- Many economic factors
- Public involvement "low" for 62% of respondents
- Good communications is vital

Major points from the research:

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•Businesses were generally very loyal to their employees during the construction phases when sales decreased

•There are many other economic factors that contribute to a business's success other than accessibility

•62% of the business representatives said that public involvement had been at a low (not good) level on their corridors

•It is vital to have constant, good communications with the businesses during all phases of the project

## Conclusions

- Construction phase most difficult
  - Ensure access throughout
  - Perform quickly
  - Consider smaller segments on long projects
  - Customers indicate less likely to visit
  - Communication essential

Some ideas of how to address the negative impacts during construction:

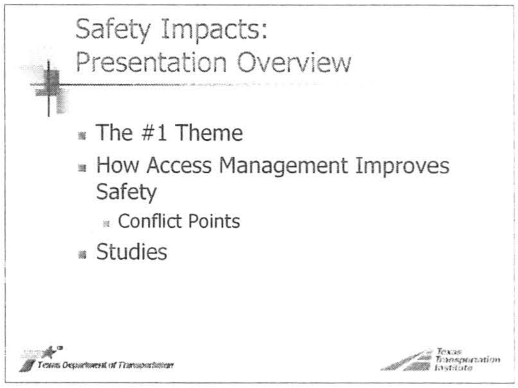
•Ensure access to all businesses throughout the project

•Perform each construction segment as quickly as possible

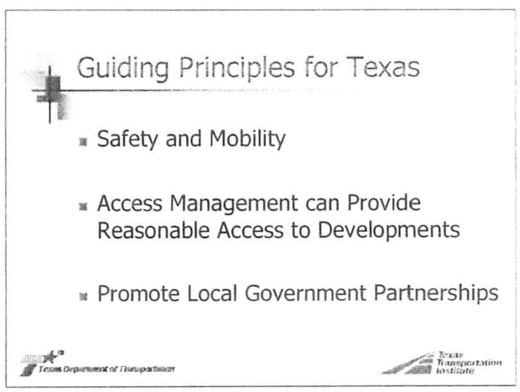
•Consider smaller/shorter segments on very long projects, particularly if it will involve tearing up the street

•Customers indicated that they are less likely to visit businesses along a corridor when construction activities are occurring

•Again, communications with the businesses and the public are essential

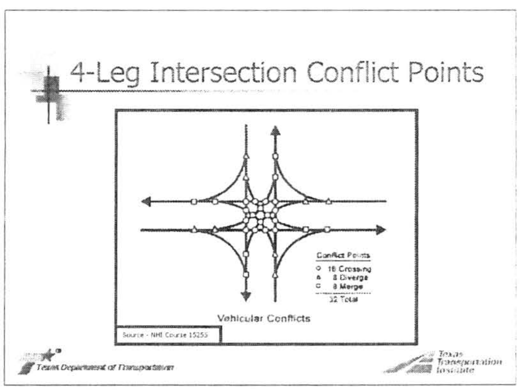



Throughout this presentation, I will discuss how safety can be improved by implementing access management treatments. Safety is often the #1 theme for implementing access management treatments. Access management treatments inherently reduce the number of conflict points, which improves safety. This presentation will conclude with the results of studies where access management treatments have been implemented.

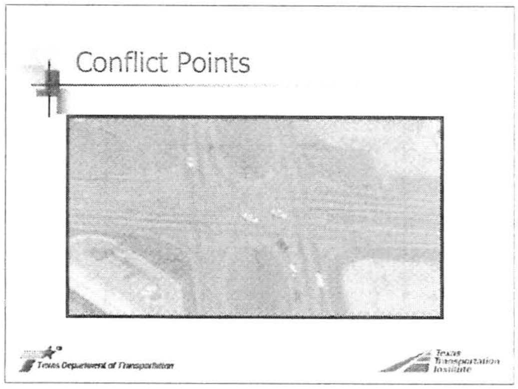



This slide lists the three primary guiding principles that form the basis of why TxDOT is pursuing access management implementation. The first guiding principle is that access management improves safety and mobility. Secondly, properly implementing access management treatments can provide reasonable access to developments. Finally, TxDOT wishes to promote local government partnerships by implementing access management. Cooperation between local agencies (cities, counties) and TxDOT facilitates access management implementation and success.

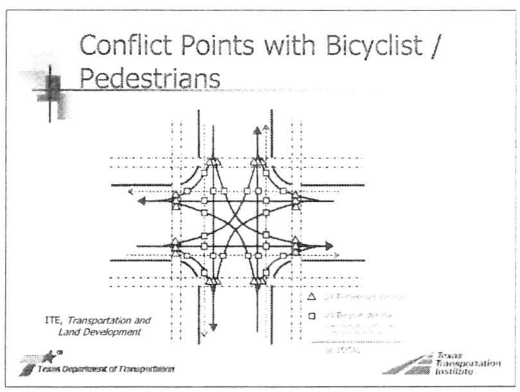

Access management improves safety by reducing conflict points, reducing speed differentials between turning and through traffic, and increasing driver expectations by reducing the number of locations where turning maneuvers are allowed. As shown in the first bullet, it should be noted that driveways are intersections too because they introduce conflict points along a roadway.



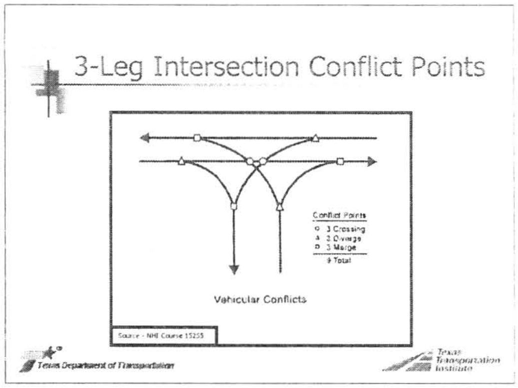

As you can see in this figure, there are 32 conflict points in one intersection that has only one lane in each direction. This means there are 32 locations where vehicle paths either cross, diverge, or merge. Obviously, the number of conflict points increases at intersections with more than one lane in each direction. Further, this graphic only includes vehicle conflicts. The presence of bicyclists and/or pedestrians yield even more conflict opportunity with vehicular traffic.



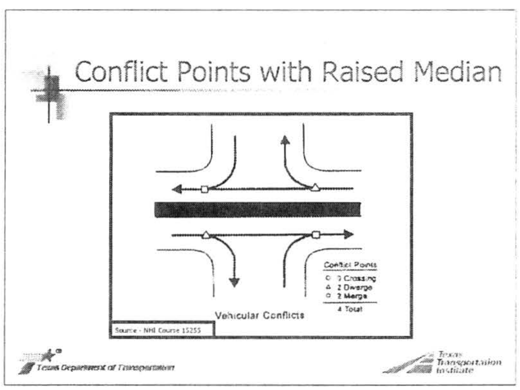

This aerial photograph shows where the paths of vehicles cross as evidenced by pavement discoloration from tire tmarkings and engine fluid dripping on the pavement.



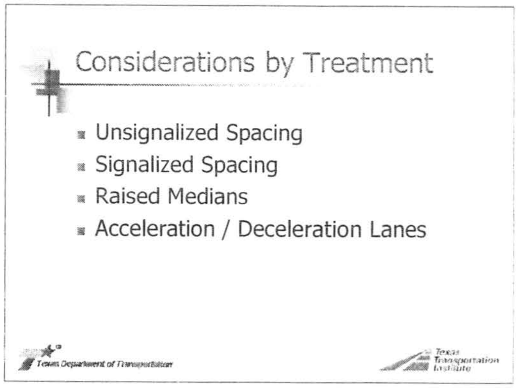

This graphic illustrates the additional conflict points encountered with the addition of a bicycle lane (dashed line) and sidewalk. With only one lane in each direction, this intersection yields an additional 24 pedestrian-vehicle conflict points and an additional 24 bicycle-vehicle conflict points. Note that bicycle-pedestrian conflict points are not included though they also exist.



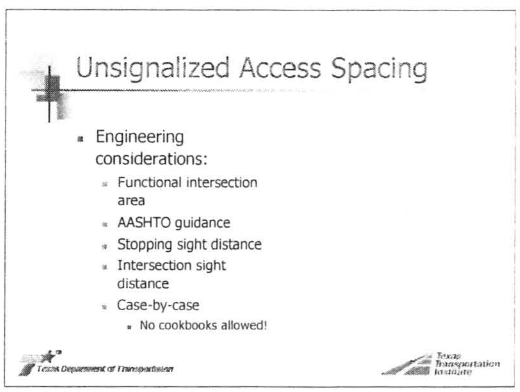

A three-leg intersection has only 9 conflict points, comparing to the previously mentioned 32 conflict points for a four-leg intersection.




If a raised median is constructed at a four-leg intersection, the number of conflict points reduces from 32 to 4 points. This can also be considered for a driveway, not just a cross-street, which yields two conflict points per driveway with a raised median.

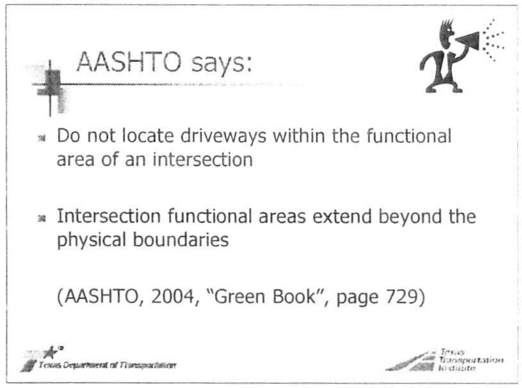



There are numerous access management treatments. The four most common treatments are listed on this slide. These include unsignalized or signalized spacing, raised medians, and acceleration or deceleration lanes. One method, or a combination of methods, can be used.




There are several engineering considerations when spacing unsignalized access points. These considerations include the functional area of the intersection, guidance from the American Association of State Highway and Transportation Officials (AASHTO), stopping sight distance, and intersection sight distance.

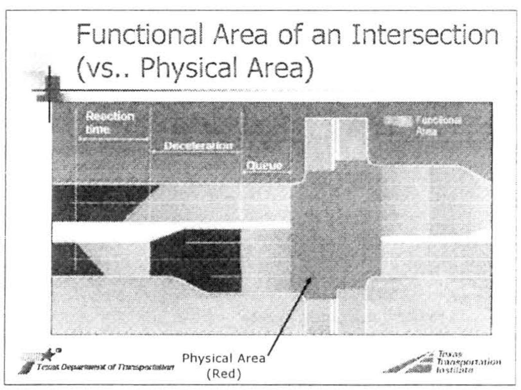
Access management treatment implementation is not a cookbook process. Each corridor must be evaluated on a case-by-case basis as different treatments and techniques may require additional considerations from corridor to corridor or region to region. For example, prior to installing raised medians, truck traffic and deliveries must be evaluated to ensure there are adequate alternate routes to handle truck deliveries. This will be discussed further in a later section of this presentation.



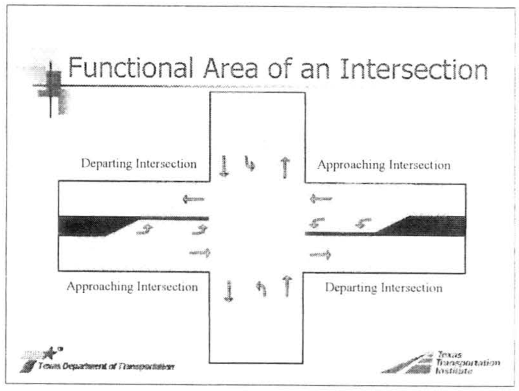

According to the 2004 AASHTO "Green Book" (*A Policy on the Geometric Design of Highways and Streets*), driveways should not be located within the functional area of an intersection. Further, the 2004 "Green Book" indicates that functional areas extend beyond the physical boundaries of the intersection and include the longitudinal limits of auxiliary lanes.

For reference, the following text is directly from the 2004 AASHTO "Green Book" (page 729):

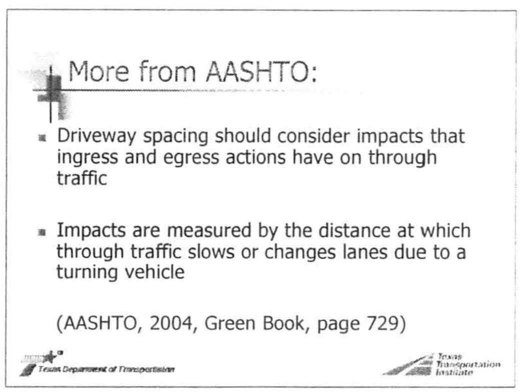
"Ideally, driveways should not be located within the functional area of an intersection or in the influence area of an adjacent driveway. The functional area extends both upstream and downstream from the physical intersection area and includes the longitudinal limits of auxiliary lanes. The influence area associated with a driveway includes (1) the impact length (the distance back from a driveway that cars begin to be affected), (2) the perception-reaction distance, and (3) the car length."




This figure illustrates the difference between the physical area (shown in red) and the larger functional area of the intersection. This graphic shows the detail of what the functional area of the intersection includes along one leg of the intersection—namely, the queue (storage) length, deceleration length and perception-reaction time length.



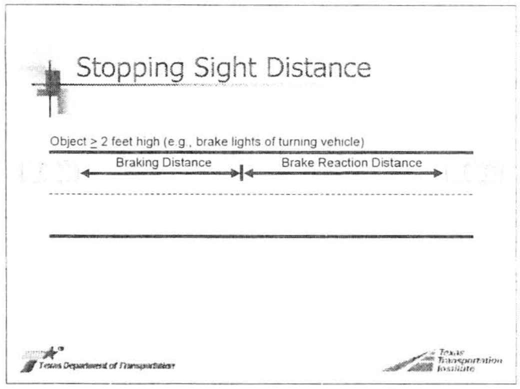

This graphic shows the functional area of the intersection along all legs of the intersection—both approaching and departing the intersection. It is imperative to preserve access in the entire yellow (functional) area of the intersection. Driveways allowed within the "yellow area" will be negatively influenced by the traffic operations (queues, sight distances) of the primary intersection.




The 2004 AASHTO "Green Book" indicates that driveway spacing should consider the impacts that ingress and egress movements have on through traffic. Impacts are measures by the distance at which through traffic slows or changes lanes due to a turning vehicle.

For reference, the following text is directly from the 2004 AASHTO "Green Book" (page 729):

"The spacing of driveways should reflect the impact lengths and influence areas associated with motorists entering or leaving a driveway. The impact length represents the distance upstream when the brake lights of through vehicles are activated or there is a lane change due to a turning vehicle."



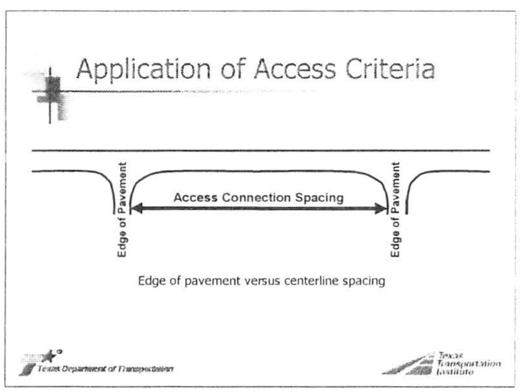

This slide visually illustrates the concept of stopping sight distance.

Per the 2004 AASHTO "Green Book" (page 110):

"Sight distance is the length of the roadway ahead that is visible to the driver. The available sight distance on a roadway should be sufficiently long to enable a vehicle traveling at or near the design speed to stop before reaching a stationary object in its path. Although greater lengths of visible roadway are desirable, the sight distance at every point along a roadway should be at least that needed for a below-average driver or vehicle to stop."

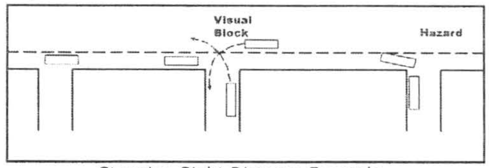
"Stopping sight distance is the sum of two distances: (1) the distance traversed by the vehicle from the instant the driver sights an object necessitating a stop to the instant the brakes are applied; and (2) the distance needed to stop the vehicle from the instant brake application begins. These are referred to as brake reaction distance and braking distance, respectively."

It should be noted that stopping sight distance calculations in the 2004 AASHTO "Green Book" assume an object height of two feet, a driver's eye height of 3.5 feet, and a deceleration rate of 11.2 ft/s$^2$.




TxDOT access spacing between streets or driveways is measured from the two innermost edges of pavement, not from the driveway centerlines.

## Application of Access Criteria




Stopping Sight Distance Example

(Discussion Paper #5C, Oregon DOT)

TxDOT bases minimum access spacing on AASHTO stopping sight distance. This graphic illustrates the use of AASHTO stopping sight distance for access spacing. This concept was first presented in the following manner by Robert Layton of Oregon State University in the development of Oregon DOT's spacing standards.

Imagine that the middle driveway does not exist, and that only the first and third driveways are present. Assume that these remaining driveways are spaced according to stopping sight distance for the speed of the roadway. Therefore, vehicles approaching the right-most driveway (after they pass the first driveway) have plenty of time to perceive, react, and brake when faced with a potential hazard at the right-most driveway. The hazard could include vehicles queuing out into the street (as shown). Therefore, drivers would be reacting to the vehicle's brake lights, which represent the 2-foot object per AASHTO stopping sight distance. Because the driveways are spaced at stopping sight distance, upstream drivers have no problem seeing, reacting to, and braking for the queue at the downstream driveway.

Now imagine there is a second (middle) driveway inserted between the two driveways. Now the driveways are not spaced per stopping sight distance. Turning maneuvers at the middle driveway can cause a visual block as turning vehicles cross the sight line of upstream vehicles. In the event of a queue into the street at the third driveway, vehicles passing the first driveway would not have enough time to react and brake for such a queue at the third driveway if there is a visual block at the second (middle) driveway.

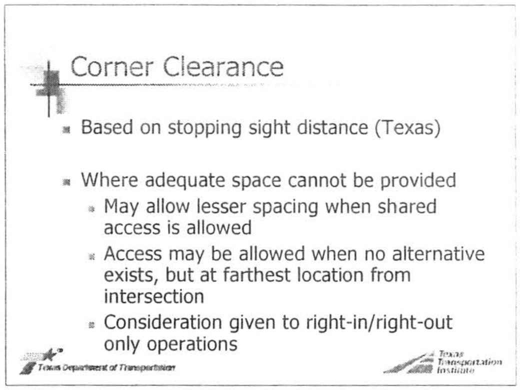
## Unsignalized Spacing Criteria (Texas)

**Other State Highways Minimum Connection Spacing**

| Posted Speed (mph) | Distance (ft) |
|---|---|
| ≤ 30 | 200 |
| 35 | 250 |
| 40 | 305 |
| 45 | 360 |
| ≥50 | 425 |

Distances are for passenger cars on level grade. These distances may be adjusted for downgrades and/or significant truck traffic.
When these values are not attainable, refer to the deviation process

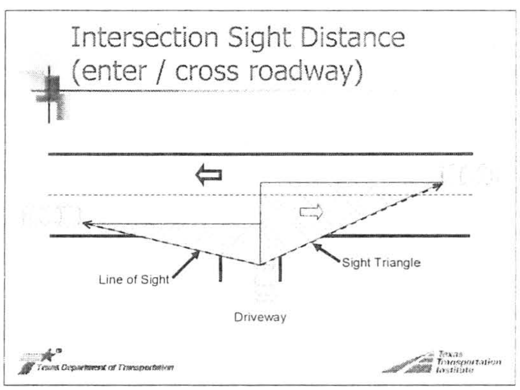
This is a table from TxDOT's *Access Management Manual* that illustrates the minimum spacing values for a given posted speed. It should be noted that these values are "minimums." They assume passenger cars on level grade. When a grade is present and/or a significant truck traffic, these values should be adjusted accordingly.



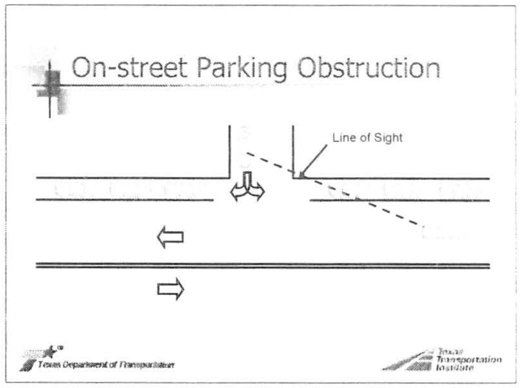

We are all familiar with small corner parcels (e.g., gas station, convenience stores) that do not have enough frontage to satisfy access spacing criteria. "Corner clearance" is the distance from the primary intersection to the corner parcel's first driveway. As noted in the TxDOT *Access Management Manual*, corner clearance is subject to AASHTO stopping sight distance.

However, when adequate spacing can not be provided at the corner parcel, a couple practical suggestions can be made to mitigate the operational impacts of allowing access on the major street. Ideally, access would only be allowed on the minor street; however, this is not always possible.

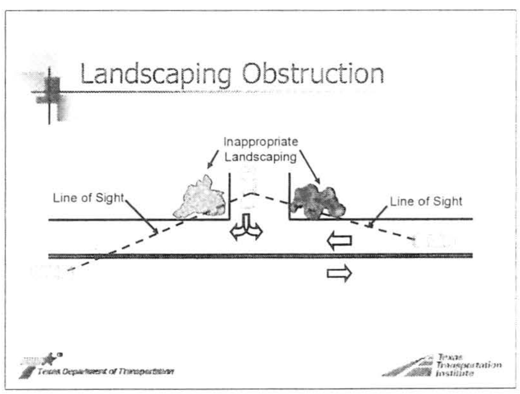
Other practical suggestions include allowing a lesser spacing when shared access is allowed with an adjacent business in an effort to reduce the number of driveways; allowing the access, but at the farthest location from the intersection (i.e., the far edge of the property line); or giving consideration to right-in/right-out only operations, which is best facilitated with the presence of a raised median along the roadway.



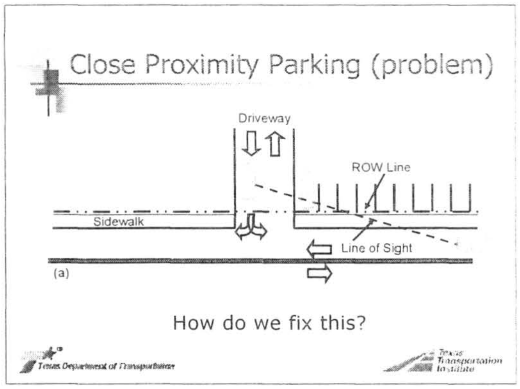

We have discussed stopping sight distance as it relates to driveway spacing along the primary roadway. Intersection sight distance (ISD) for entering and crossing a roadway is also important. TxDOT has limited control over ISD as the proper consideration of ISD goes beyond the right-of-way of the state roadway. Therefore, local agencies (cities) have better opportunity to regulate ISD through ordinances that require and enforce ISD. This typically includes ensuring a proper line of sight and sight triangle at access locations that are free of signing, landscaping and other elements. Of course, TxDOT can ensure line of site and sight triangles within the state right-of-way. An example would be ensuring a raised median treatment that includes landscaping satisfies ISD.




On-street parking can also provide an obstruction to the line of site. When on-street parking is allowed, it should be removed in the vicinity of the intersection to ensure the line of sight is preserved.

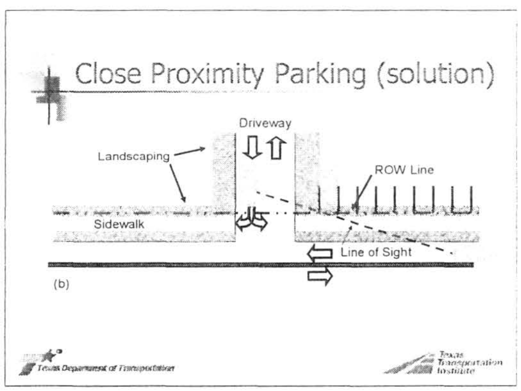



Landscaping can also provide a visual obstruction. Landscaping must not be in the line of sight and regular maintenance should be scheduled to keep sight lines unobstructed.



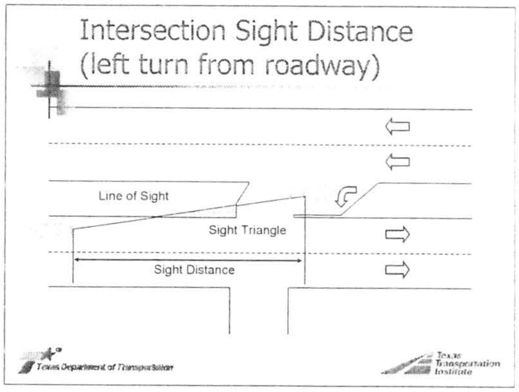

Allowing on-site parking that is directly on the right-of-way line can block the sight line.

How can this problem be fixed or avoided?

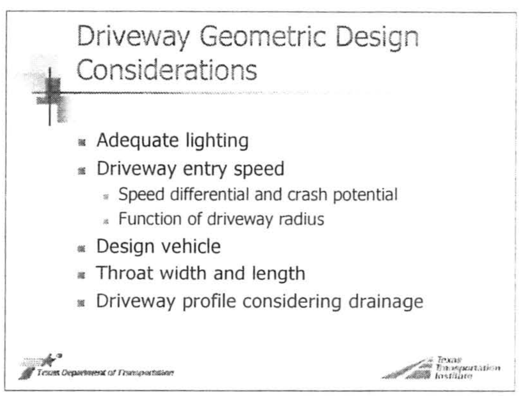



The solution is to add some landscaping between the driveway and the parking. This will allow for an unobstructed line of sight.

As mentioned previously, because the landscaping and parking issues are beyond the right-of-way line of the state facility, they can not be regulated by the state. They must be addressed in local agency ordinances. They would likely be included in a city's development ordinances. This example illustrates the importance of the needed coordination between local and state agencies to ensure safe driveway design.




Because the design of raised medians is within the right-of-way lines of the state facility, TxDOT can ensure appropriate intersection sight distance at the raised median treatments for left-turning maneuvers from the roadway.




There are numerous geometric design considerations for driveways. Prior slides have discussed the concepts of stopping sight distance and intersection sight distance. There are additional factors that relate to the specific operation of the driveway. These considerations include:

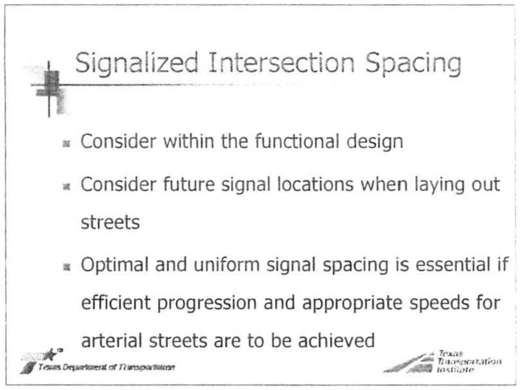
•Adequate lighting to ensure drivers can see the driveway and any pedestrians crossing it at night.

•Proper radius to ensure appropriate driveway entry speed. Removing turning vehicle's deceleration from the through lanes is desired. Ideally, a deceleration lane (or right-turn lane) can remove some of the deceleration from the through lanes and improve safety. The shorter the driveway radius, the slower vehicles must be traveling to turn into the driveway.

•Appropriate design vehicle consideration for the driveway operation.

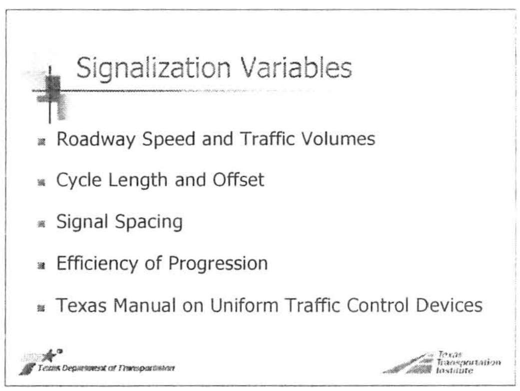
•Appropriate throat width and length. The width of the driveway must be appropriate to handle the operation of the driveway, and the driveway must be long enough to queue vehicles on-site to ensure traffic queues do not overflow into the street.

•Adequate drainage consideration to ensure the roadway does not take on additional drainage from the development.




The spacing of signalized intersections require additional considerations beyond unsignalized streets and driveways. Specifically, these considerations include:

- •Functional design should still be considered. Ensuring the appropriate amount of access (signalized or unsignalized) given the functional classification of the roadway.
- •Future signal locations should be considered when streets are planned. Consider where future signals may be warranted. Consider future signal locations when locating openings for raised medians also.
- •Efficient signal progression is crucial to minimize corridor delay; therefore, optimal and uniform signal spacing is desired.

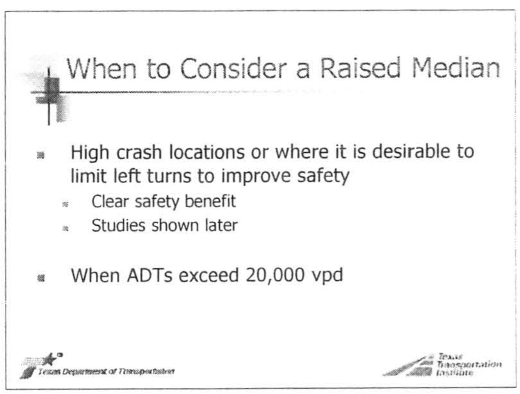



The ideal signalization along a roadway is a function of:

- •Roadway speed, traffic volumes and turning movements;
- •Signal cycle length and signal offset;
- •Signal spacing; and
- •The efficiency of progression.

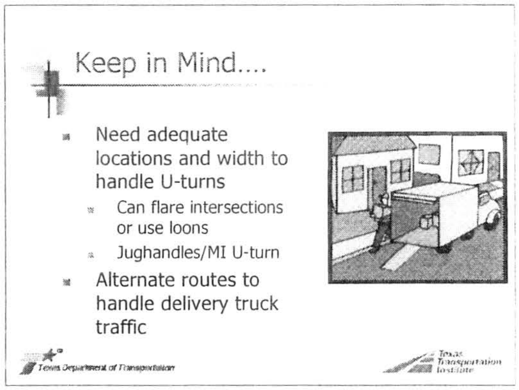
The *Texas Manual on Uniform Traffic Control Devices* provides more detail on when signals are warranted.


Raised medians were previously introduced as an access management treatment. Raised medians positively separate opposite traffic flows along a roadway, and they play a critical role in the operations and safety of roadways. Raised medians also provide the opportunity to incorporate aesthetic considerations (landscaping) into the roadway, and they provide a refuge for pedestrians.



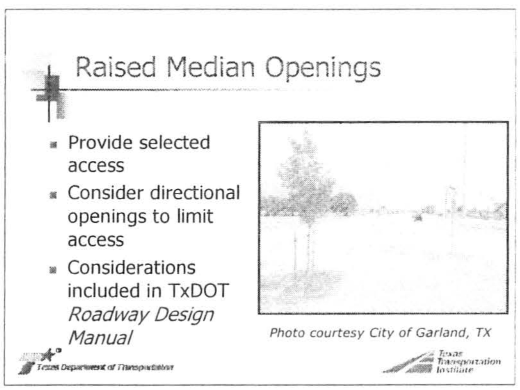

The safety benefit of raised medians is clearly demonstrated in national research and in Texas studies. These studies will be presented later in this presentation. Limiting left turns reduces conflict opportunities along the roadway, which equates to reduced crashes.

TxDOT's *Roadway Design Manual* indicates that raised medians should be considered when the average daily traffic (ADT) exceeds 20,000 vehicles per day.



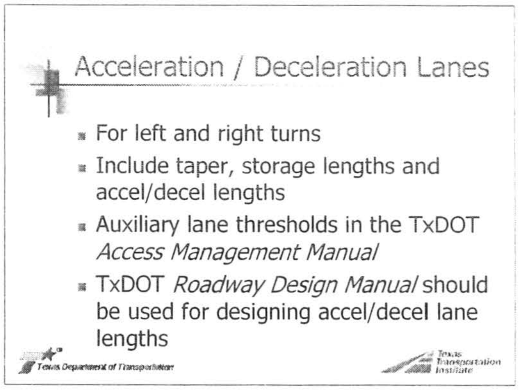

It is important to consider where and how U-turns will be handled with the installation of a raised median. Raised medians restrict left-turn opportunities; therefore, U-turn movements must be considered in the design. Typically, three lanes of travel in each direction are needed to provide adequate space for U-turning vehicles. Alternatively, intersections can be flared to provide adequate space. Some states have developed unique treatments for successfully handling U-turns at mid-block locations. Subsequent slides present these methods in more detail.

Trucks and delivery vehicles are another important consideration when installing raised medians. Alternate routes must exist for deliveries as large trucks may have difficulty negotiating U-turn locations.



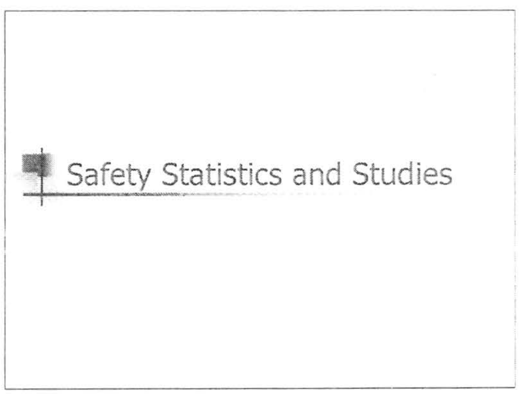

Raised median openings provide selected left-turn maneuvers to/from adjacent properties. Full median openings allow for all ingress/egress maneuvers, while directional median openings allow selected maneuvers. The photograph on this slide shows a median opening which allows only left turns into the site, but does not allow left turns out of the site.

TxDOT's *Roadway Design Manual* provides additional discussion on considerations related to raised median openings.

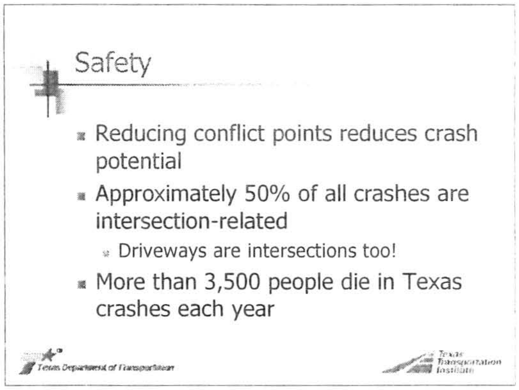



Acceleration and deceleration lanes provide a refuge for left or right turning traffic. They allow for minimal disruption of through vehicles by turning vehicles. The lanes include the necessary taper, storage lengths and acceleration and deceleration lengths.

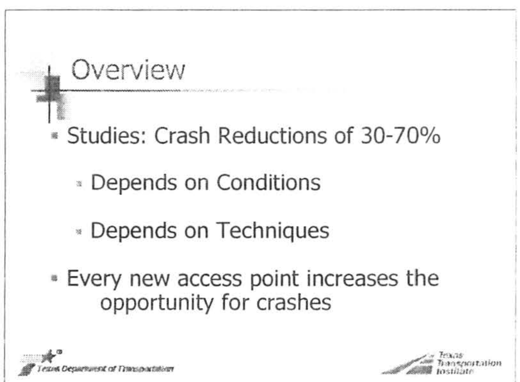
The TxDOT *Access Management Manual* provides thresholds based upon speed and volume to identify when an acceleration or deceleration lane should be considered. The TxDOT *Roadway Design Manual* provides design guidance for constructing acceleration and deceleration lanes.



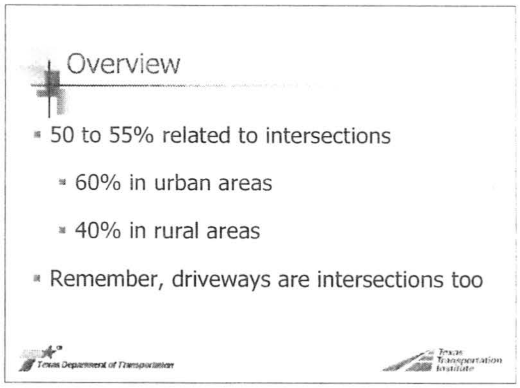

The following sections provide some basic safety statistics, and also provide safety-related benefits from access management studies.



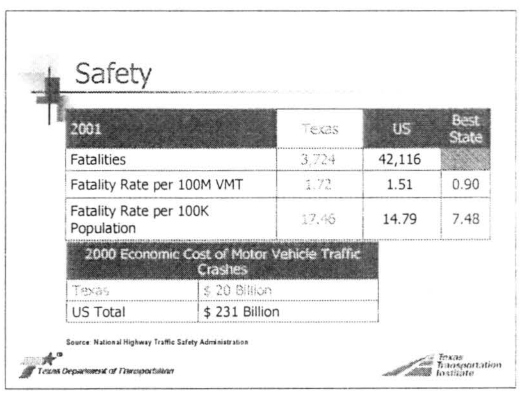

Safety is the primary benefit to implementing access management treatments. Access management treatments reduce conflict points, which reduces crash potential. Approximately half of all crashes occur at intersections, so reducing intersections with a raised median should reduce crashes. More than 3,500 people die in crashes each year in Texas.




Studies show that access management treatments reduce crashes from 30 to 70 percent. The variability depends upon the conditions and techniques implemented. It is important to keep in mind that every new access point added to a roadway increases crash potential; therefore, the reduction of these access points has a beneficial affect.




About half of all crashes are related to intersections. In urban areas it is 60%, and in rural areas it is 40%. As always, keep in mind that driveways are intersections too!

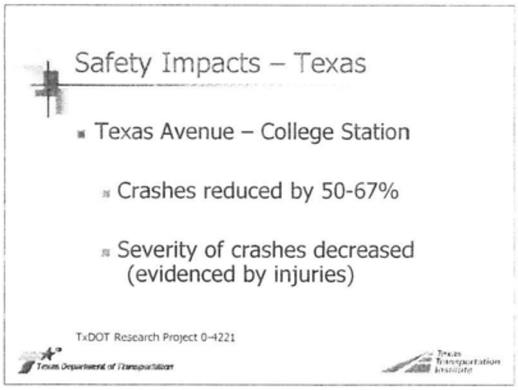



| 2001 | Texas | US | Best State |
|---|---|---|---|
| Fatalities | 3,724 | 42,116 | |
| Fatality Rate per 100M VMT | 1.72 | 1.51 | 0.90 |
| Fatality Rate per 100K Population | 17.46 | 14.79 | 7.48 |

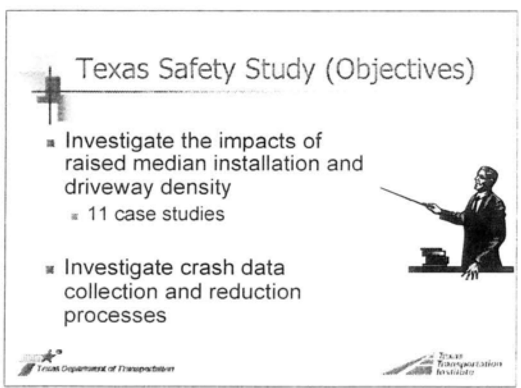
| 2000 Economic Cost of Motor Vehicle Traffic Crashes | |
|---|---|
| Texas | $ 20 Billion |
| US Total | $ 231 Billion |

This slide provides specific information for the years 2000 and 2001 that relate to the number of crashes and economic costs. These data are provided by the National Highway Traffic Safety Administration (NHTSA).

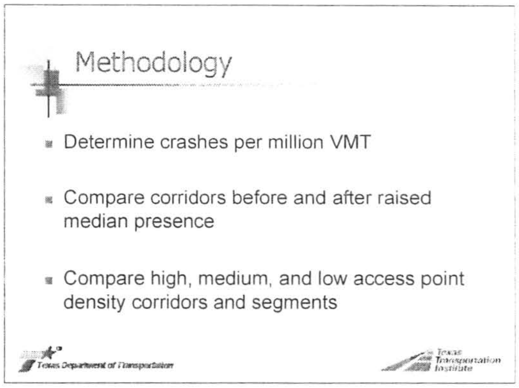
In 2001, there were over 3,700 fatalities in Texas due to crashes. Texas has a higher fatality rate based on travel and population (shown in red) than the national average (shown in black). The cost to Texas of these crashes was approximately $20 Billion in 2000.



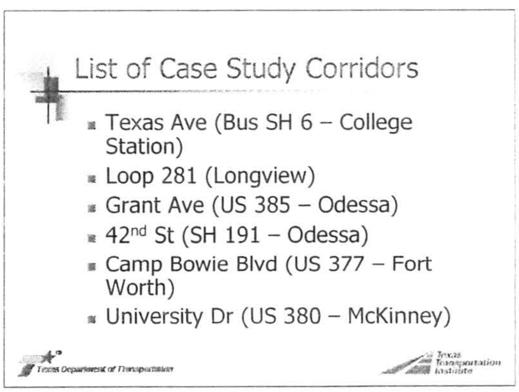

Along Texas Avenue in College Station, crashes were reduced by 50-67% with the installation of a raised median. The severity of the crashes also decreased. This study is described in TxDOT Research Project 0-4221.




The research performed by the Texas Transportation Institute and sponsored by the Texas Department of Transportation investigated the impacts of raised median installation and driveway density at 11 case studies. The study also investigated the process of collecting and reducing crash data.

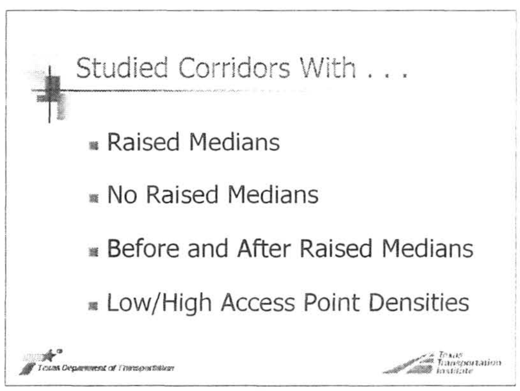



The project determined crashes per million vehicle-miles of travel (VMT) and subsequently compared corridors before and after the installation of a raised median. Locations with high, medium and low access point density were also compared.

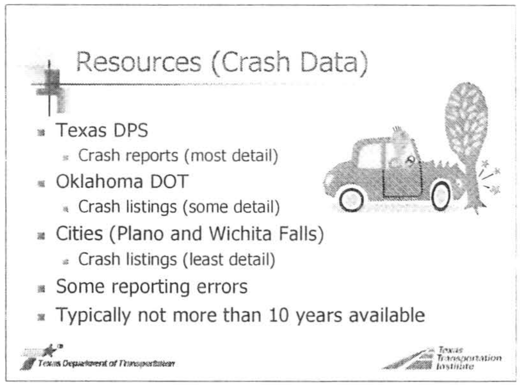



For reference, here is a list of the corridors used in this case study.

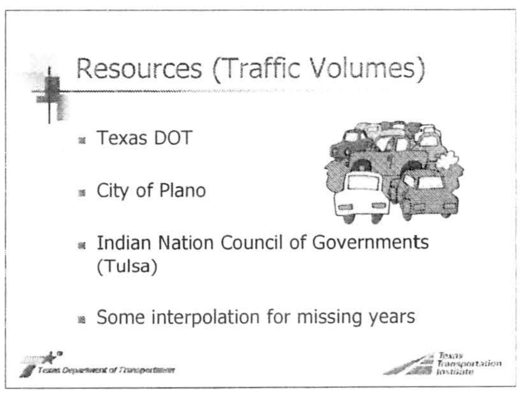

This is the remainder of the corridors used in this research project.



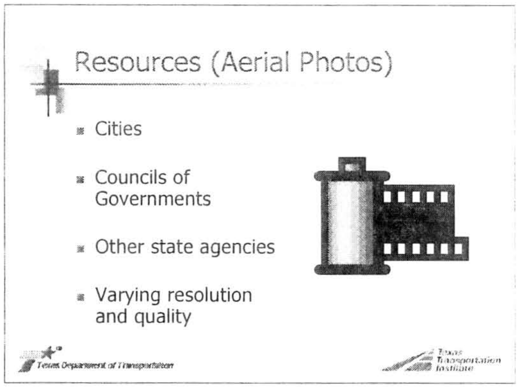

The project studied corridors with or without raised medians, before and after raised medians, and a range of access point densities.



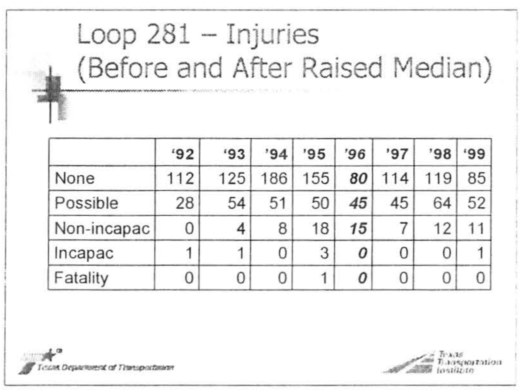

The crash data came from crash reports from Texas Department of Public Safety (DPS) and crash listings from Oklahoma DOT and cities. Some reporting errors were identified as the research team looked at individual crash reports whenever possible. Typically not more than 10 years of historical data was available.




Traffic volume data were collected from TxDOT, the City of Plano, and the Indian Nation Council of Governments in Tulsa. In some cases, traffic volumes were missing for some years; therefore, interpolation was necessary.




Aerial photographs were obtained from cities, councils of governments, and other state agencies. The resolution and quality of the photographs varied.




| | '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 |

This graphic shows that incapacitating injuries were reduced after the installation of a raised median on Loop 281 in Longview.

You have to be careful about some statistics – while fatalities went from 1 before the median was built to 0 after, that fatality was due to a heart attack that caused a single-vehicle crash. Therefore, the raised median had no apparent impact on fatalities (though there were still none after the median was installed).

## Loop 281 – Crash Types

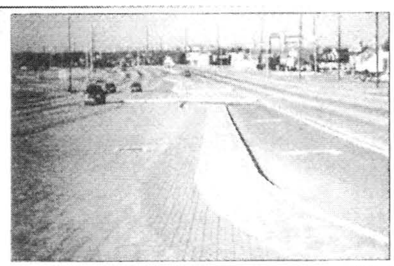
| | '92 | '93 | '94 | '95 | '96 | '97 | '98 | '99 |
|---|---|---|---|---|---|---|---|---|
| Rear-End | 16 | 31 | 27 | 20 | ***18*** | 21 | 23 | 17 |
| Side-Impact | 10 | 22 | 27 | 44 | ***18*** | 15 | 30 | 25 |
| Side-Swipe | 9 | 8 | 11 | 4 | ***3*** | 1 | 2 | 0 |
| Single | 0 | 0 | 0 | 2 | ***1*** |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

Texas Department of Transportation

Texas Transportation Institute

This slide shows how head-on crashes (typically the most sever type) were eliminated in the years after the raised median was installed. In addition, sideswipe crashes were reduced.

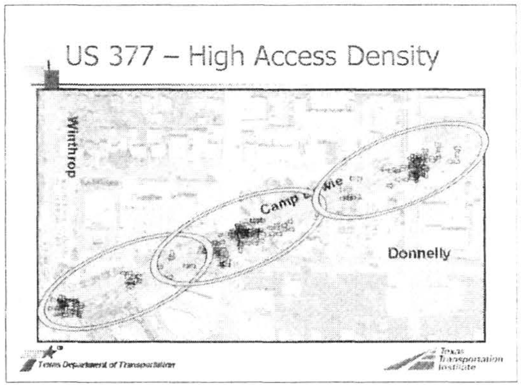
## Loop 281 – Longview



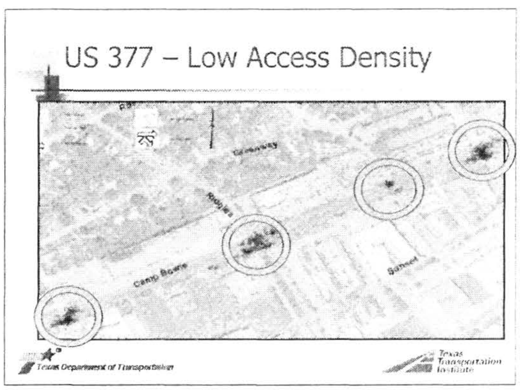
Texas Department of Transportation

Texas Transportation Institute

This graphic shows the raised median that was installed on Loop 281 in Longview, Texas. This raised median is rather wide, and prior to installation the previous two-way left-turn lane (TWLTL) was a "no-man's land" of erratic maneuvers because of the wide median.




This graphic illustrates the number, location and type of crashes along US 377 (Camp Bowie Boulevard) in Ft. Worth, Texas. This segment of US 377 is just south of I-30, and one can see there is a relatively high density and the major streets intersect US 377 at skewed angles. This results in crashes located across the corridor at major intersections and at mid-block locations. This is in contrast to the next slide.




This slide shows US 377 further south of the segment shown in the prior slide. Here the major intersections have been aligned at right angles to US 377, and access density is much lower than the prior slide.

## 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 |

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This table, and the table on the next slide, illustrate that the crash rate is lower on the west segment that has a lower access density than the east segment of US 377.

## 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 |

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## Corridor Summaries

| Corridor Segment | ADT Range | Access Points/Mile | Median Type | Avg. Crash Rate |
|---|---|---|---|---|
| SH 289 | 44-53K | 30.0 | Raised | 4.21 |
| Park Blvd (west) | 28-37K | 10.0 | Raised | 1.71 |
| Park Blvd (central) | 33-36K | 38.9 | Raised | 6.59 |
| Park Blvd (east) | 34-35K | 16.0 | Raised | 2.23 |
| 71st Street (west) | 20-24K | 27.0 | Undivided (Before) | 3.76 |
| 71st Street (west) | 28-33K | 27.0 | Raised (After) | 2.48 |
| 71st Street (west-central) | 20-21K | 20.0 | Undivided (Before) | 3.82 |
| 71st Street (west-central) | 22-37K | 20.0 | Raised (After) | 1.78 |
| 71st Street (east-central) | 27-47K | 33.0 | Raised | 3.20 |
| 71st Street (east) | 25-51K | 42.0 | Raised | 5.17 |
| US 380 (west) | 14-29K | 56.0 | Raised | 3.12 |
| US 380 (east) | 13-24K | 98.8 | Raised | 7.29 |

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The next two slides show the names, average daily traffic (ADT) ranges, access points per mile, median type, and average crash rate.

## Corridor Summaries

| Corridor Segment | ADT Range | Access Points/Mile | Median Type | Avg. Crash Rate |
|---|---|---|---|---|
| US 377 (west) | 18-21K | 50.0 | Raised | 5.92 |
| US 377 (east) | 18-21K | 110.0 | Raised | 8.76 |
| FM 1741 | 26-31K | 38.5 | TWLTL | 2.71 |
| Loop 281 | 20-27K | 52.5 | TWLTL (Before) | 5.21 |
| Loop 281 | 20-17K | 52.5 | Raised (After) | 4.29 |
| US 69 (north) | 30-39K | 38.1 | TWLTL | 8.60 |
| US 69 (south) | 27-40K | 85.4 | TWLTL | 12.92 |
| US 385 | 9-12K | 50.0 | Undivided (Before) | 19.57 |
| US 385 | 9-12K | 50.0 | Raised (After) | 15.39 |
| SH 191 (west) | 29-36K | 56.4 | TWLTL | 6.55 |
| SH 191 (east) | 16-24K | 27.7 | TWLTL | 4.00 |

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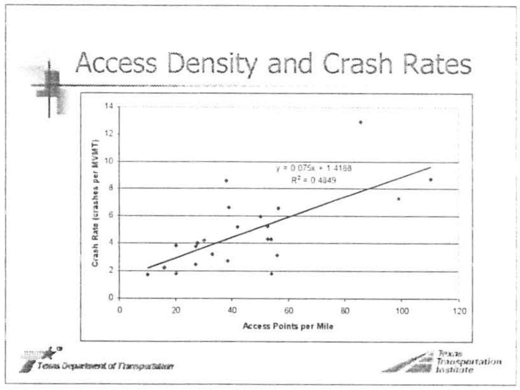


From all of the data from on the prior two slides, a trend was derived to illustrate the relationship between access density and crash rate. Clearly, crash rate increases as access points per mile increase.

## Raised Median Installations

| Corridor | ADT[1] | Before Median Type | Crash Rate | | | | Access Dens |
|---|---|---|---|---|---|---|---|
| | | | Pre | Post | Abs. Diff | % Diff | |
| 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

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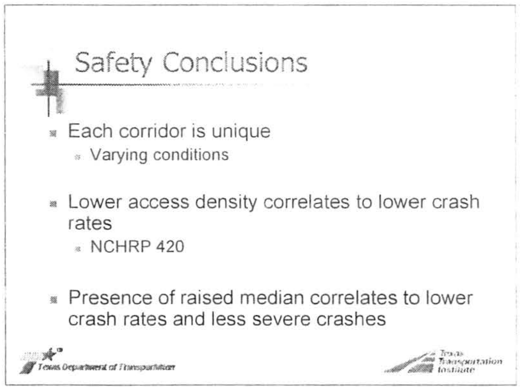
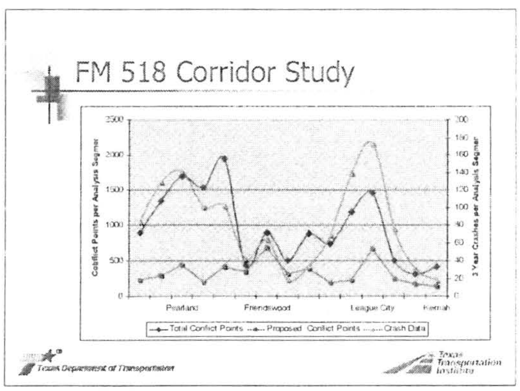
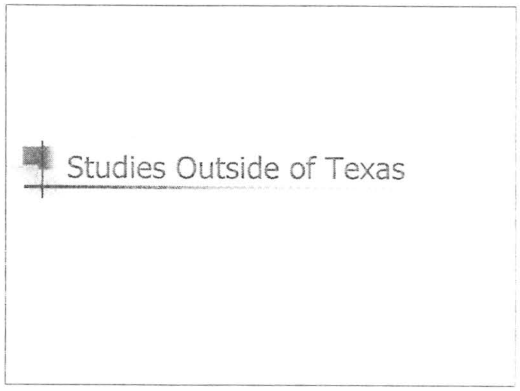
This graphic shows crash rate information before and after a raised median was installed. The table also shows the corridor, ADT, the absolute difference in crash rates, the percent difference in crash rates, and the access density. The results indicate that a raised median resulted in between a 17 and 58 percent reduction in the crash rate.



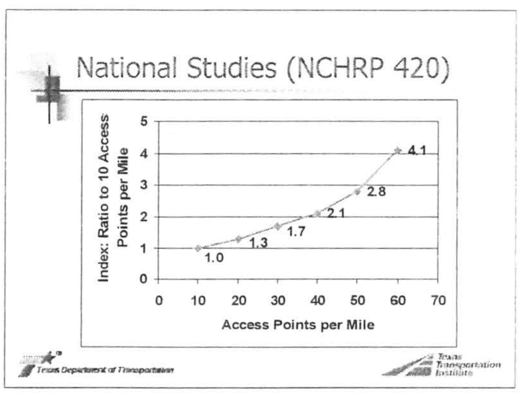

There were many key conclusions to this research project. Clearly, each corridor is unique and has varying traffic conditions. Lower access density does correlate to lower crash rates. This result was also found in National Cooperative Highway Research Program (NCHRP) Report 420 *Impacts of Access Management*. Finally, the presence of a raised median correlates to a lower crash and less sever crashes. This result has also been found in national research including NCHRP Report 420 and NCHRP Report 395 *Capacity and Operational Effects of Midblock Left-turn Lanes*.




This graphic also shows a study from Texas that illustrates how conflict points are correlated with higher crash rates. This graphic is from a *Corridor Access Management Plan of FM 518*, which was lead by the Houston-Galveston Area Council (H-GAC).




Similar studies of the safety impacts of access management treatments have been performed outside of Texas as well. The next few slides highlight some of these studies.




This graphic is from NCHRP Report 420 mentioned previously. This graphic was developed from an extensive dataset of 240 roadway segments with more than 37,500 crashes from throughout the United States and Canada. The graphic clearly indicates that as access points per mile increase, the ratio of crashes to 10 access points per mile increases. As an example, if access points increase from 10 to 30, there is a 70% increase in the crash rate.

## Crash Rates

| Representative Crash Rates (Crashes per Million VMT) by Type of Median – Urban and Suburban Areas | | | |
|---|---|---|---|
| | Median Type | | |
| Total Access Points per Mile (1) | 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 |

(1) Includes both signalized and unsignalized access points.

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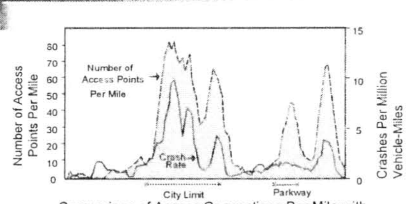
This graphic is also from NCHRP 420. It illustrates that the non-traversable median (raised median) has a lower crash rate than both undivided roadway segments and two-way left-turn lane (TWLTL) segments, irrespective of access points per mile.

## Oregon Case Study




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

Source: Lall, et al, 1996

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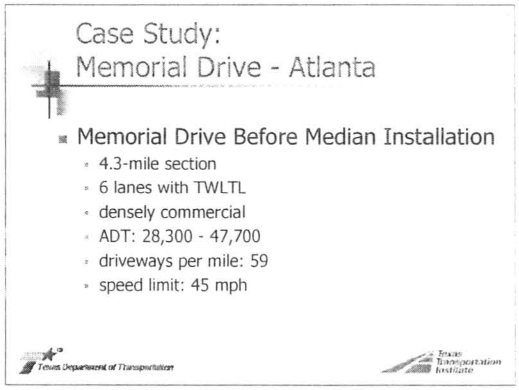
In Oregon, the crashes per million vehicle-miles of travel (MVMT) and access points per mile were measured along US 101. One can readily see that as the access points per mile increase, the crash rate tends to increase.



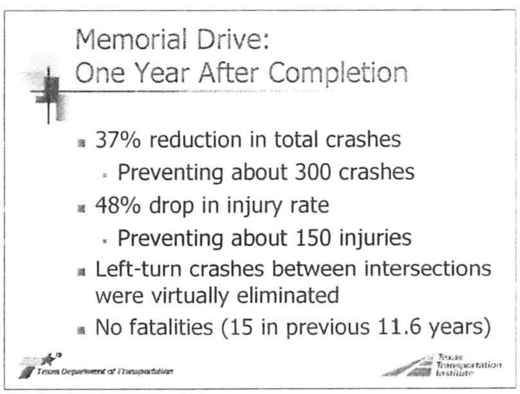

Memorial Drive in Atlanta, Georgia is an often-cited before and after raised median installation project. The 4.3-mile section of Memorial Drive had the following characteristics in the "before" condition:

•6 lanes with a TWLTL.

•Densely commercial with 59 driveways (access points) per mile.

•Speed limit was 45 mph.

•Average daily traffic (ADT) of 28,300 to 47,700.



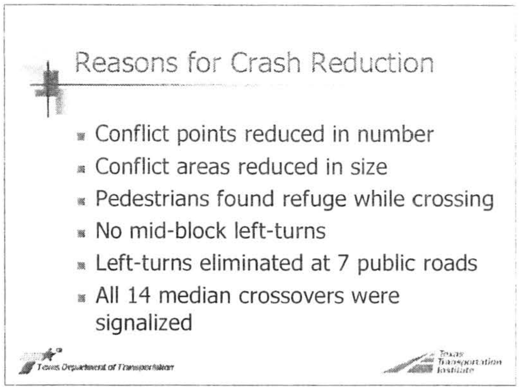

One year after a raised median was installed:

•There was a 37% reduction in total crashes (~300 crashes).

•About 150 injuries were prevented, which is a drop of 48%.

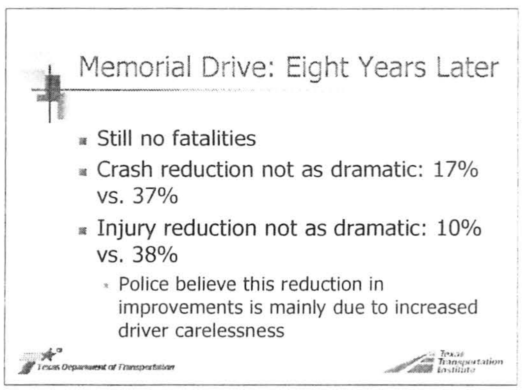
•Left-turn crashes between controlled intersections were virtually eliminated.

•No fatalities where there had been 15 in the previous 11.6 years.




The reasons for the crash reductions were:

- •The conflict points reduced in number
- •The conflict areas reduced in size
- •Pedestrians found refuge in medians when crossing street
- •No mid-block and 7 public road left-turns were eliminated
- •All 14 median crossovers were signalized.




It is now 8 years later and there still are no fatalities. The crash reduction is not as dramatic (17% vs. 37%). The injury reduction is not as dramatic (10% vs. 38%). These two numbers are believed to be attributed to drivers becoming more comfortable with their surroundings, thus being a little more careless (e.g., cellular telephone use).

## 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

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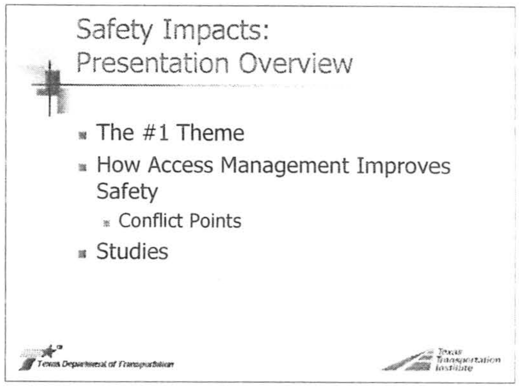
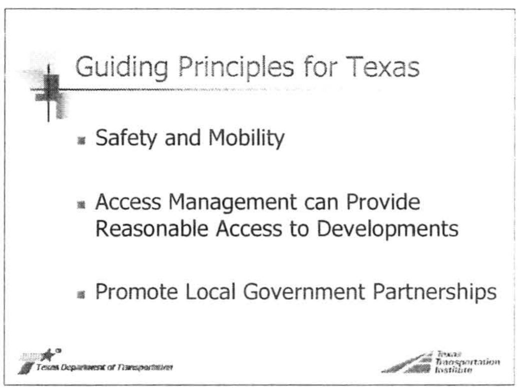
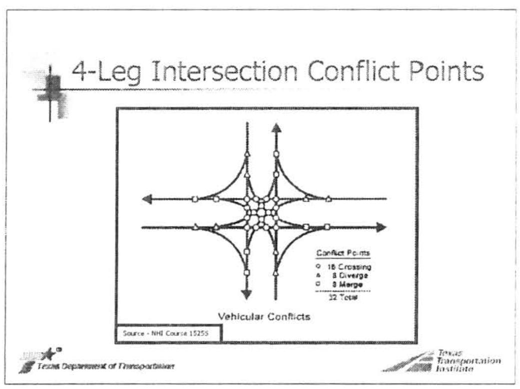



Throughout this presentation, I will discuss how safety can be improved by implementing access management treatments. Safety is often the #1 theme for implementing access management treatments. Access management treatments inherently reduce the number of conflict points, which improves safety. This presentation will conclude with the results of studies where access management treatments have been implemented.

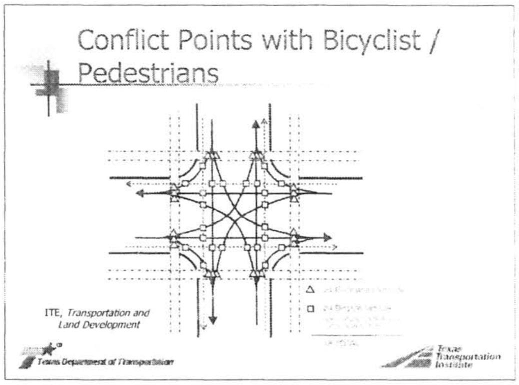



This slide lists the three primary guiding principles that form the basis of why TxDOT is pursuing access management implementation. The first guiding principle is that access management improves safety and mobility. Secondly, properly implementing access management treatments can provide reasonable access to developments. Finally, TxDOT wishes to promote local government partnerships by implementing access management. Cooperation between local agencies (cities, counties) and TxDOT facilitates access management implementation and success.

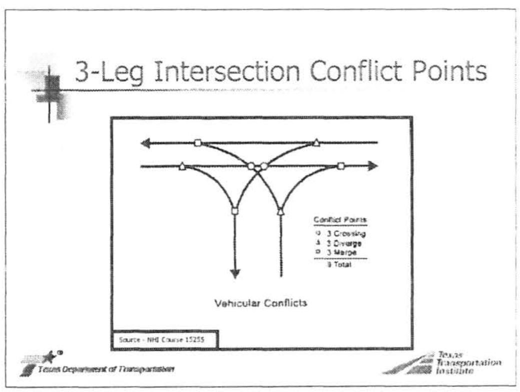

Access management improves safety by reducing conflict points, reducing speed differentials between turning and through traffic, and increasing driver expectations by reducing the number of locations where turning maneuvers are allowed. As shown in the first bullet, it should be noted that driveways are intersections too because they introduce conflict points along a roadway.



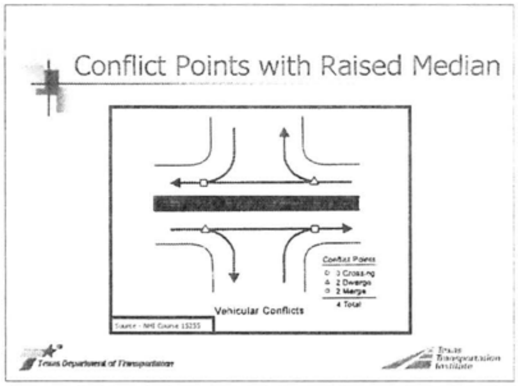

As you can see in this figure, there are 32 conflict points in one intersection that has only one lane in each direction. This means there are 32 locations where vehicle paths either cross, diverge, or merge. Obviously, the number of conflict points increases at intersections with more than one lane in each direction. Further, this graphic only includes vehicle conflicts. The presence of bicyclists and/or pedestrians yield even more conflict opportunity with vehicular traffic.



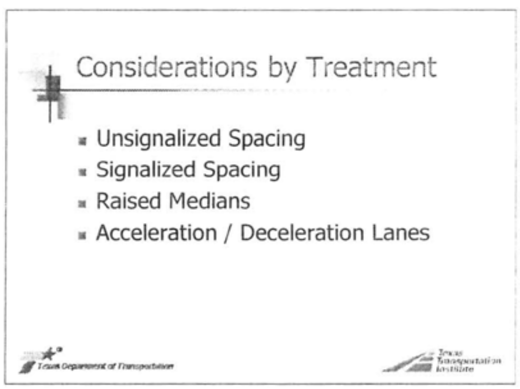

This graphic illustrates the additional conflict points encountered with the addition of a bicycle lane (dashed line) and sidewalk. With only one lane in each direction, this intersection yields an additional 24 pedestrian-vehicle conflict points and an additional 24 bicycle-vehicle conflict points. Note that bicycle-pedestrian conflict points are not included though they also exist.



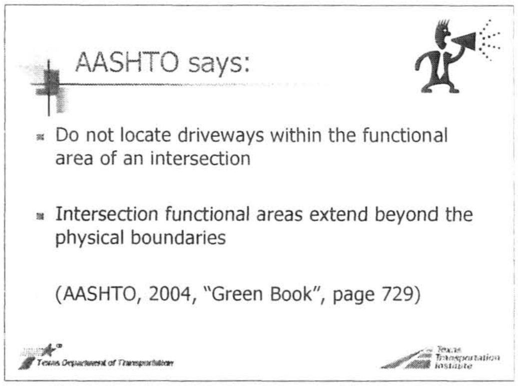

A three-leg intersection has only 9 conflict points, comparing to the previously mentioned 32 conflict points for a four-leg intersection.




If a raised median is constructed at a four-leg intersection, the number of conflict points reduces from 32 to 4 points. This can also be considered for a driveway, not just a cross-street, which yields two conflict points per driveway with a raised median.



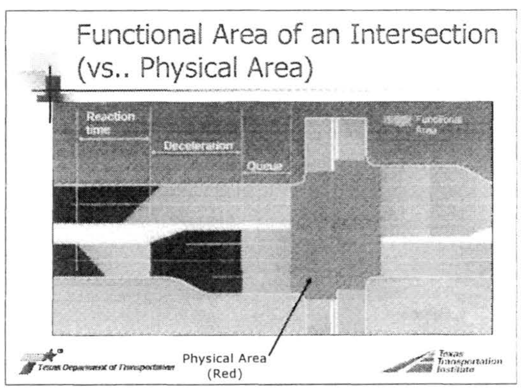

There are numerous access management treatments. The four most common treatments are listed on this slide. These include unsignalized or signalized spacing, raised medians, and acceleration or deceleration lanes. One method, or a combination of methods, can be used.



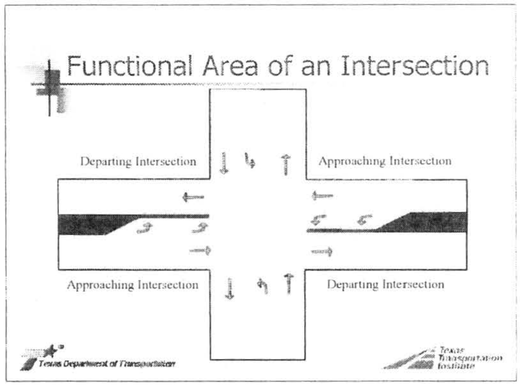

According to the 2004 AASHTO "Green Book" (*A Policy on the Geometric Design of Highways and Streets*), driveways should not be located within the functional area of an intersection. Further, the 2004 "Green Book" indicates that functional areas extend beyond the physical boundaries of the intersection and include the longitudinal limits of auxiliary lanes.

For reference, the following text is directly from the 2004 AASHTO "Green Book" (page 729):

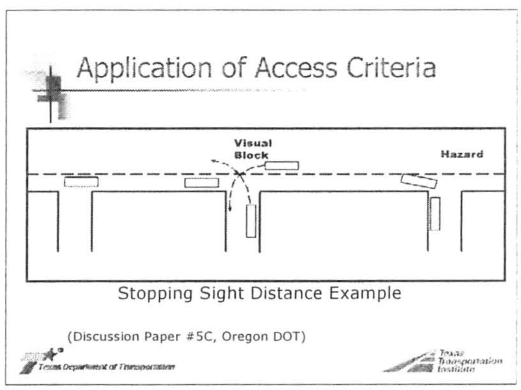
"Ideally, driveways should not be located within the functional area of an intersection or in the influence area of an adjacent driveway. The functional area extends both upstream and downstream from the physical intersection area and includes the longitudinal limits of auxiliary lanes. The influence area associated with a driveway includes (1) the impact length (the distance back from a driveway that cars begin to be affected), (2) the perception-reaction distance, and (3) the car length."




This figure illustrates the difference between the physical area (shown in red) and the larger functional area of the intersection. This graphic shows the detail of what the functional area of the intersection includes along one leg of the intersection—namely, the queue (storage) length, deceleration length and perception-reaction time length.



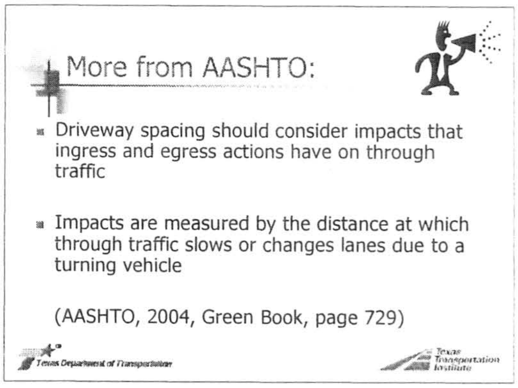

This graphic shows the functional area of the intersection along all legs of the intersection—both approaching and departing the intersection. It is imperative to preserve access in the entire yellow (functional) area of the intersection. Driveways allowed within the "yellow area" will be negatively influenced by the traffic operations (queues, sight distances) of the primary intersection.




TxDOT bases minimum access spacing on AASHTO stopping sight distance. This graphic illustrates the use of AASHTO stopping sight distance for access spacing. This concept was first presented in the following manner by Robert Layton of Oregon State University in the development of Oregon DOT's spacing standards.

Imagine that the middle driveway does not exist, and that only the first and third driveways are present. Assume that these remaining driveways are spaced according to stopping sight distance for the speed of the roadway. Therefore, vehicles approaching the right-most driveway (after they pass the first driveway) have plenty of time to perceive, react, and brake when faced with a potential hazard at the right-most driveway. The hazard could include vehicles queuing out into the street (as shown). Therefore, drivers would be reacting to the vehicle's brake lights, which represent the 2-foot object per AASHTO stopping sight distance. Because the driveways are spaced at stopping sight distance, upstream drivers have no problem seeing, reacting to, and braking for the queue at the downstream driveway.

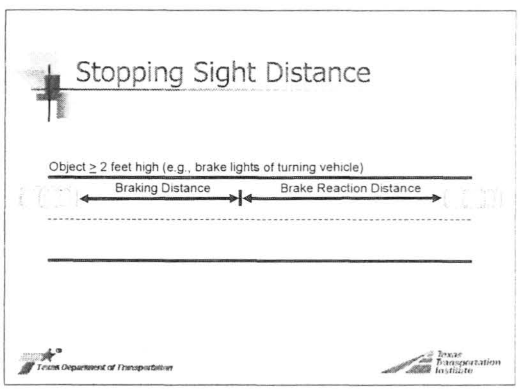
Now imagine there is a second (middle) driveway inserted between the two driveways. Now the driveways are not spaced per stopping sight distance. Turning maneuvers at the middle driveway can cause a visual block as turning vehicles cross the sight line of upstream vehicles. In the event of a queue into the street at the third driveway, vehicles passing the first driveway would not have enough time to react and brake for such a queue at the third driveway if there is a visual block at the second (middle) driveway.




The 2004 AASHTO "Green Book" indicates that driveway spacing should consider the impacts that ingress and egress movements have on through traffic. Impacts are measures by the distance at which through traffic slows or changes lanes due to a turning vehicle.

For reference, the following text is directly from the 2004 AASHTO "Green Book" (page 729):

"The spacing of driveways should reflect the impact lengths and influence areas associated with motorists entering or leaving a driveway. The impact length represents the distance upstream when the brake lights of through vehicles are activated or there is a lane change due to a turning vehicle."




This slide visually illustrates the concept of stopping sight distance.

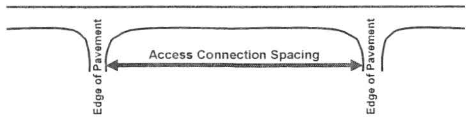
Per the 2004 AASHTO "Green Book" (page 110):

"Sight distance is the length of the roadway ahead that is visible to the driver. The available sight distance on a roadway should be sufficiently long to enable a vehicle traveling at or near the design speed to stop before reaching a stationary object in its path. Although greater lengths of visible roadway are desirable, the sight distance at every point along a roadway should be at least that needed for a below-average driver or vehicle to stop."

"Stopping sight distance is the sum of two distances: (1) the distance traversed by the vehicle from the instant the driver sights an object necessitating a stop to the instant the brakes are applied; and (2) the distance needed to stop the vehicle from the instant brake application begins. These are referred to as brake reaction distance and braking distance, respectively."

It should be noted that stopping sight distance calculations in the 2004 AASHTO "Green Book" assume an object height of two feet, a driver's eye height of 3.5 feet, and a deceleration rate of 11.2 $ft/s^2$.

## Application of Access Criteria




Edge of pavement versus centerline spacing



TxDOT access spacing between streets or driveways is measured from the two innermost edges of pavement, not from the driveway centerlines.

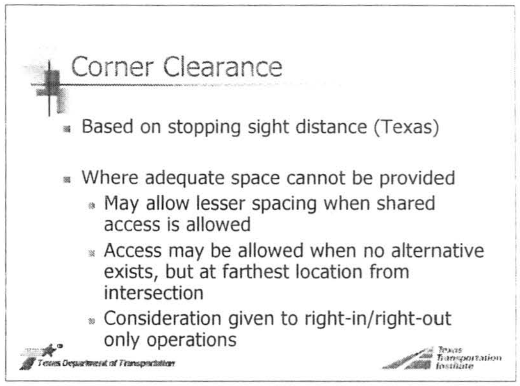
## Unsignalized Spacing Criteria (Texas)

| Other State Highways Minimum Connection Spacing | |
|---|---|
| Posted Speed (mph) | Distance (ft) |
| ≤ 30 | 200 |
| 35 | 250 |
| 40 | 305 |
| 45 | 360 |
| ≥50 | 425 |

Distances are for passenger cars on level grade. These distances may be adjusted for downgrades and/or significant truck traffic.
When these values are not attainable, refer to the deviation process



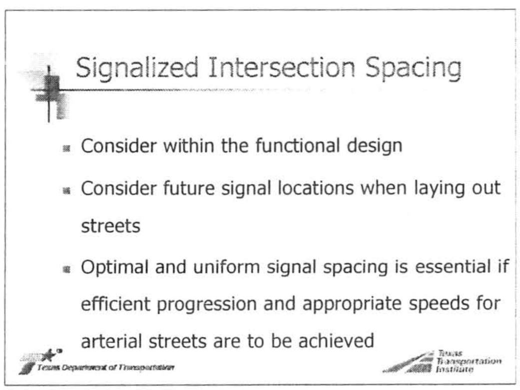
This is a table from TxDOT's *Access Management Manual* that illustrates the minimum spacing values for a given posted speed. It should be noted that these values are "minimums." They assume passenger cars on level grade. When a grade is present and/or a significant truck traffic, these values should be adjusted accordingly.




We are all familiar with small corner parcels (e.g., gas station, convenience stores) that do not have enough frontage to satisfy access spacing criteria. "Corner clearance" is the distance from the primary intersection to the corner parcel's first driveway. As noted in the TxDOT *Access Management Manual*, corner clearance is subject to AASHTO stopping sight distance.

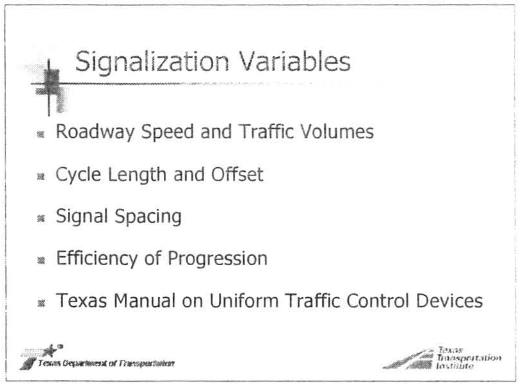
However, when adequate spacing can not be provided at the corner parcel, a couple of practical suggestions can be made to mitigate the operational impacts of allowing access on the major street. Ideally, access would only be allowed on the minor street; however, this is not always possible.

Other practical suggestions include allowing a lesser spacing when shared access is allowed with an adjacent business in an effort to reduce the number of driveways; allowing the access, but at the farthest location from the intersection (i.e., the far edge of the property line); or giving consideration to right-in/right-out only operations, which is best facilitated with the presence of a raised median along the roadway.




The spacing of signalized intersections require additional considerations beyond unsignalized streets and driveways. Specifically, these considerations include:

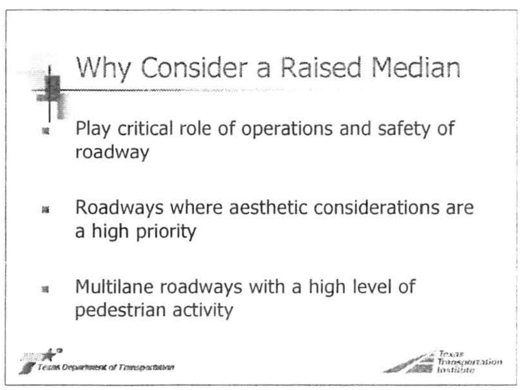
- •Functional design should still be considered. Ensuring the appropriate amount of access (signalized or unsignalized) given the functional classification of the roadway.
- •Future signal locations should be considered when streets are planned. Consider where future signals may be warranted. Consider future signal locations when locating openings for raised medians also.
- •Efficient signal progression is crucial to minimize corridor delay; therefore, optimal and uniform signal spacing is desired.




The ideal signalization along a roadway is a function of:

- •Roadway speed, traffic volumes and turning movements;
- •Signal cycle length and signal offset;
- •Signal spacing; and
- •The efficiency of progression.

The Texas Manual on Uniform Traffic Control Devices provides more detail on when signals are warranted.




Raised medians were previously introduced as an access management treatment. Raised medians positively separate opposite traffic flows along a roadway, and they play a critical role in the operations and safety of roadways. Raised medians also provide the opportunity to incorporate aesthetic considerations (landscaping) into the roadway, and they provide a refuge for pedestrians.

## When to Consider a Raised Median

- High crash locations or where it is desirable to limit left turns to improve safety
  - Clear safety benefit
  - Studies shown later
- When ADTs exceed 20,000 vpd

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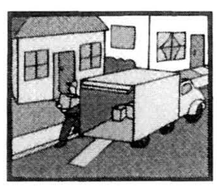
The safety benefit of raised medians is clearly demonstrated in national research and in Texas studies. These studies will be presented later in this presentation. Limiting left turns reduces conflict opportunities along the roadway, which equates to reduced crashes.

TxDOT's *Roadway Design Manual* indicates that raised medians should be considered when the average daily traffic (ADT) exceeds 20,000 vehicles per day.

## Keep in Mind....

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



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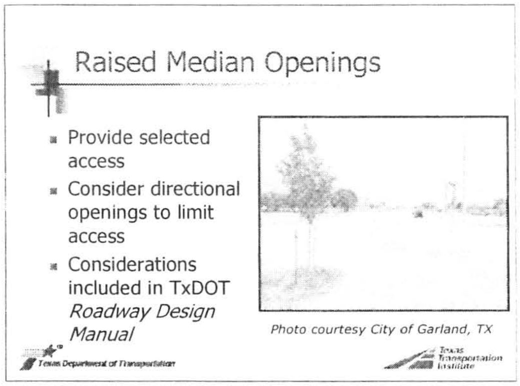
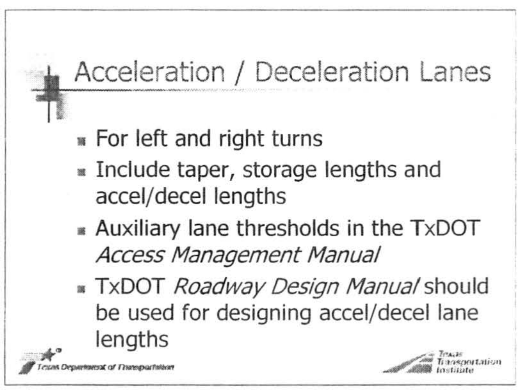
It is important to consider where and how U-turns will be handled with the installation of a raised median. Raised medians restrict left-turn opportunities; therefore, U-turn movements must be considered in the design. Typically, three lanes of travel in each direction are needed to provide adequate space for U-turning vehicles. Alternatively, intersections can be flared to provide adequate space. Some states have developed unique treatments for successfully handling U-turns at mid-block locations.

Trucks and delivery vehicles are another important consideration when installing raised medians. Alternate routes must exist for deliveries as large trucks may have difficulty negotiating U-turn locations.




Raised median openings provide selected left-turn maneuvers to/from adjacent properties. Full median openings allow for all ingress/egress maneuvers, while directional median openings allow selected maneuvers. The photograph on this slide shows a median opening which allows only left turns into the site, but does not allow left turns out of the site.

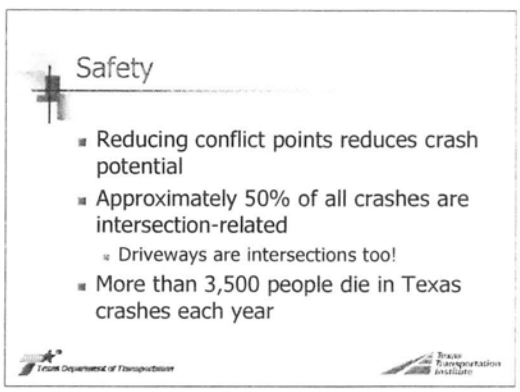
TxDOT's *Roadway Design Manual* provides additional discussion on considerations related to raised median openings.



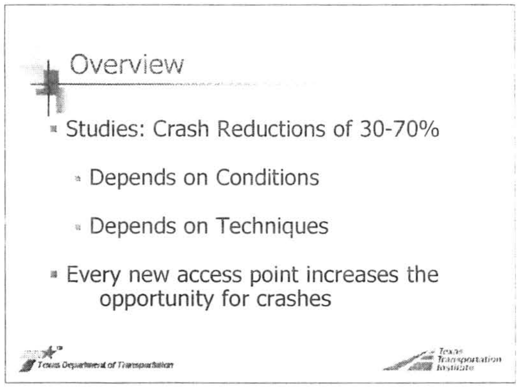

Acceleration and deceleration lanes provide a refuge for left or right turning traffic. They allow for minimal disruption of through vehicles by turning vehicles. The lanes include the necessary taper, storage lengths and acceleration and deceleration lengths.

The TxDOT *Access Management Manual* provides thresholds based upon speed and volume to identify when an acceleration or deceleration lane should be considered. The TxDOT *Roadway Design Manual* provides design guidance for constructing acceleration and deceleration lanes.

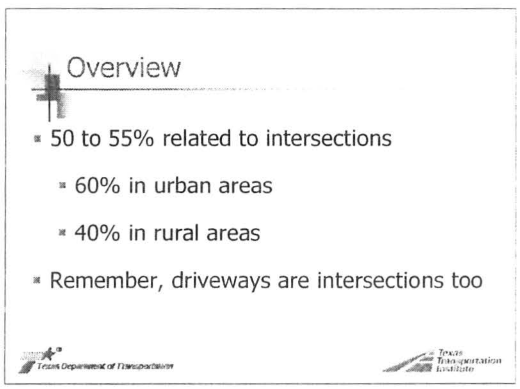

The following sections provide some basic safety statistics, and also provide safety-related benefits from access management studies.



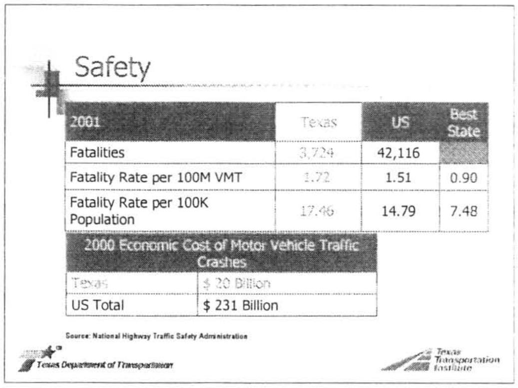

Safety is the primary benefit to implementing access management treatments. Access management treatments reduce conflict points, which reduces crash potential. Approximately half of all crashes occur at intersections, so reducing intersections with a raised median should reduce crashes. More than 3,500 people die in crashes each year in Texas.




Studies show that access management treatments reduce crashes from 30 to 70 percent. The variability depends upon the conditions and techniques implemented. It is important to keep in mind that every new access point added to a roadway increases crash potential; therefore, the reduction of these access points has a beneficial affect.

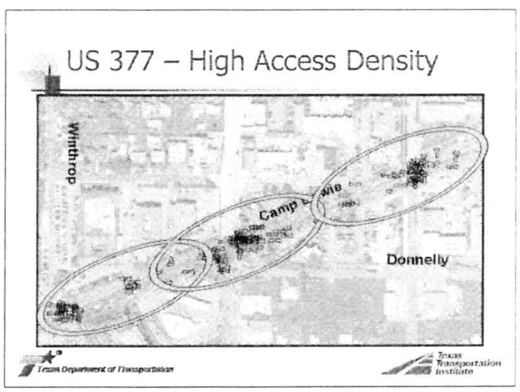



About half of all crashes are related to intersections. In urban areas it is 60%, and in rural areas it is 40%. As always, keep in mind that driveways are intersections too!

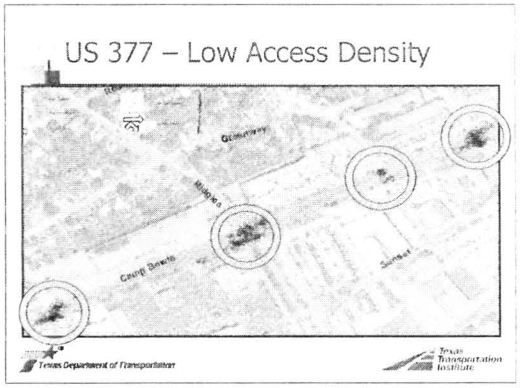



This slide provides specific information for the years 2000 and 2001 that relate to the number of crashes and economic costs. These data are provided by the National Highway Traffic Safety Administration (NHTSA).

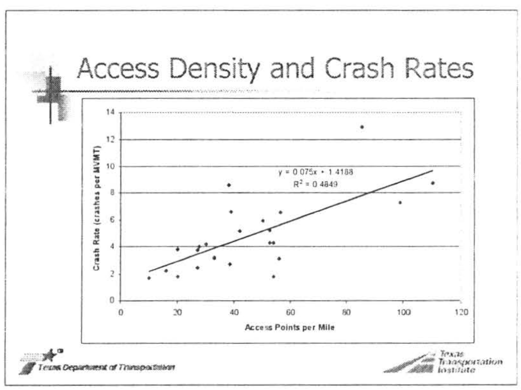
In 2001, there were over 3,700 fatalities in Texas due to crashes. Texas has a higher fatality rate based on travel and population (shown in red) than the national average (shown in black). The cost to Texas of these crashes was approximately $20 Billion in 2000.




This graphic illustrates the number, location and type of crashes along US 377 (Camp Bowie Boulevard) in Ft. Worth, Texas. This segment of US 377 is just south of I-30, and one can see there is a relatively high density and the major streets intersect US 377 at skewed angles. This results in crashes located across the corridor at major intersections and at mid-block locations. This is in contrast to the next slide.




This slide shows US 377 further south of the segment shown in the prior slide. Here the major intersections have been aligned at right angles to US 377, and access density is much lower than the prior slide.




A trend was derived to illustrate the relationship between access density and crash rate. Clearly, crash rate increases as access points per mile increase.

## Raised Median Installations

| Corridor | ADT[1] | Before Median Type | Crash Rate Pre | Crash Rate Post | Crash Rate Abs. Diff | Crash Rate % 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.

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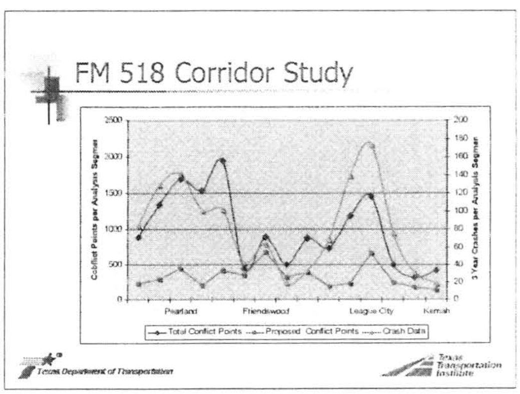
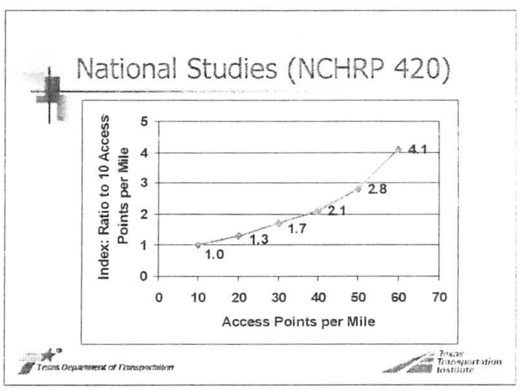
This graphic shows crash rate information before and after a raised median was installed. The table also shows the corridor, ADT, the absolute difference in crash rates, the percent difference in crash rates, and the access density. The results indicate that a raised median resulted in between a 17 and 58 percent reduction in the crash rate.




This graphic also shows a study from Texas that illustrates how conflict points are correlated with higher crash rates. This graphic is from a *Corridor Access Management Plan of FM 518*, which was lead by the Houston-Galveston Area Council (H-GAC).

## Studies Outside of Texas

Similar studies of the safety impacts of access management treatments have been performed outside of Texas as well. The next few slides highlight some of these studies.




This graphic is from NCHRP Report 420 mentioned previously. This graphic was developed from an extensive dataset of 240 roadway segments with more than 37,500 crashes from throughout the United States and Canada. The graphic clearly indicates that as access points per mile increase, the ratio of crashes to 10 access points per mile increases. As an example, if access points increase from 10 to 30, there is a 70% increase in the crash rate.

## Crash Rates

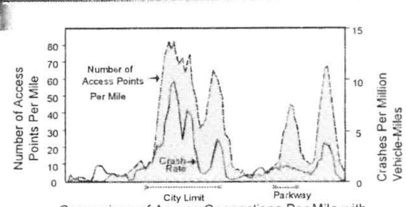
| Representative Crash Rates (Crashes per Million VMT) by Type of Median – Urban and Suburban Areas | | | |
|---|---|---|---|
| | Median Type | | |
| Total Access Points per Mile (1) | Undivided | Two-Way Left-Turn Lane | Non Traversable Median |
| <20 | 3.8 | 3.4 | 2.9 |
| 20.01-40 | 7.3 | 5.9 | 5.1 |
| 40.01-60 | 9.4 | 7.9 | 6.8 |
| >60 | 10.6 | 9.2 | 8.3 |
| Average Rate | 9.0 | 6.9 | 5.6 |

(1) Includes both signalized and unsignalized access points.

Texas Department of Transportation — Texas Transportation Institute

This graphic is also from NCHRP 420. It illustrates that the non-traversable median (raised median) has a lower crash rate than both undivided roadway segments and two-way left-turn lane (TWLTL) segments, irrespective of access points per mile.

## Oregon Case Study




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

Source: Lall, et al, 1996

Texas Department of Transportation — Texas Transportation Institute

In Oregon, the crashes per million vehicle-miles of travel (MVMT) and access points per mile were measured along US 101. One can readily see that as the access points per mile increase, the crash rate tends to increase.

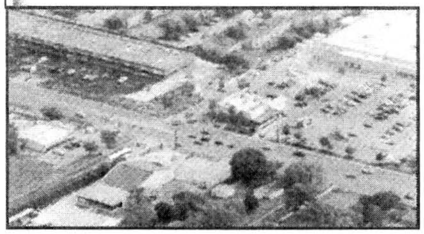
## Safety Photos: Presentation Overview

- Driveway Spacing and/or Consolidation
- Corner Clearance
- Signal Spacing
- Median Treatments
- Acceleration and Deceleration Lanes
- Auxiliary Lanes
- Freeway Frontage Roads
- Arterial Frontage Roads
- Summary



## Driveway Spacing and/or Consolidation

## Cross Access



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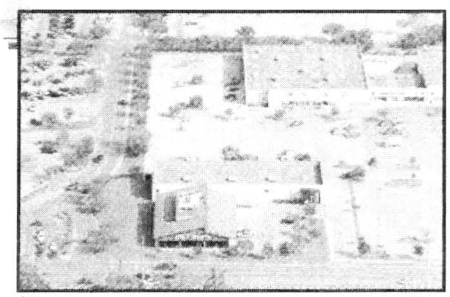
## Cross Access Desired



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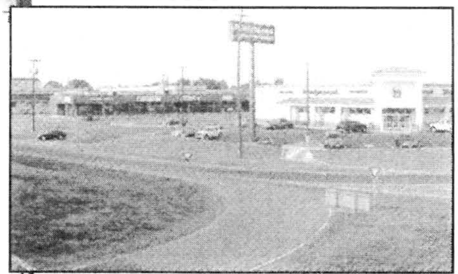
## Cross Access



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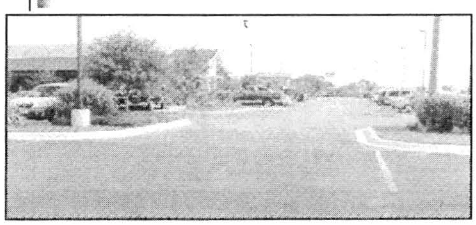
## Cross Access



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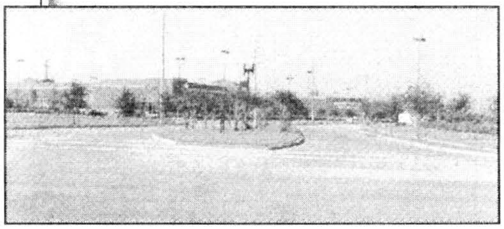
## Major Shared Access Point for Big Box



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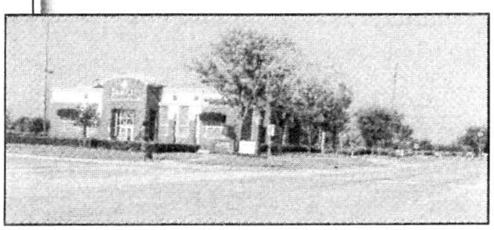
## Major and Minor Access Points for Big Box and Monument Sign



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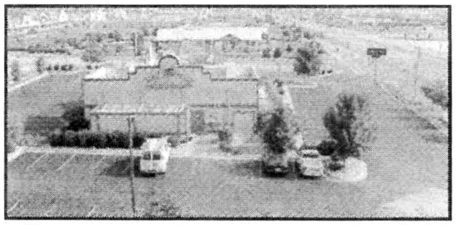
## Cross Access



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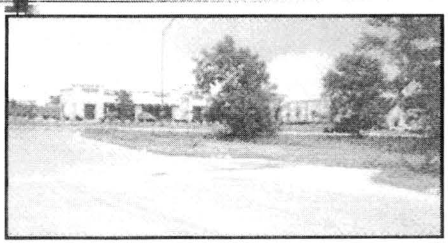
## Cross Access



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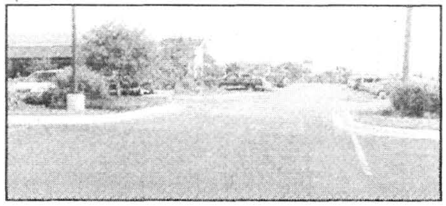
## Shared Access Retrofit



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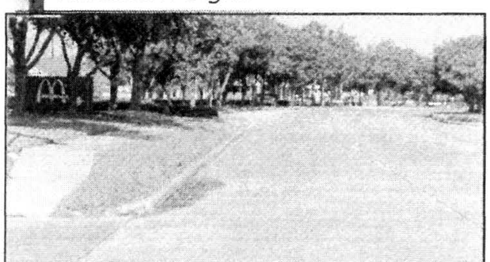
## Limited Driveways and Monument Signs



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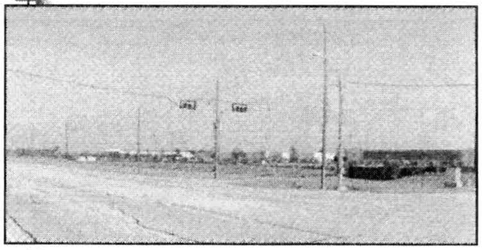
Texas Transportation Institute

## Big Box with Limited Access



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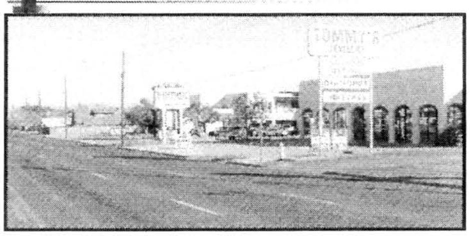
## Potential Drive Consolidation / Cross Access



- SH 191/42nd St – Odessa

Texas Department of Transportation

Texas Transportation Institute

## No Direct Access Big Box Retail

- SH 191/42nd St – Odessa

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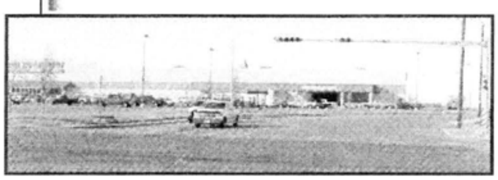
## Side Access for Big Box Retail



- SH 191/42nd St @ Preston Smith Rd - Odessa

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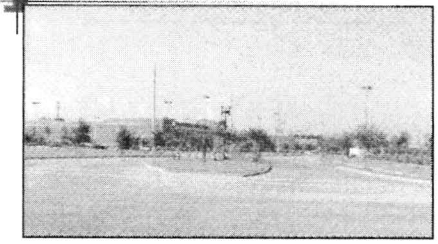
## Major Shared Access Point



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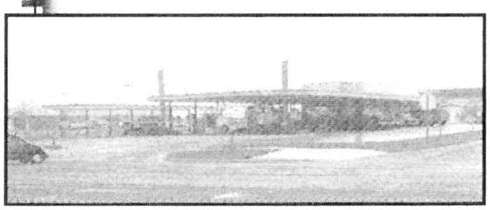
## Single Driveway Access for Fast Food



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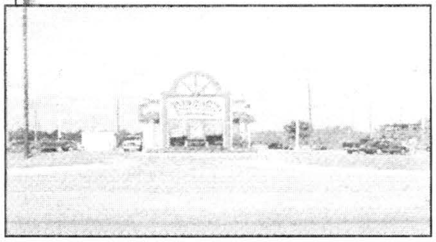
## Fast Food – Single Access Point



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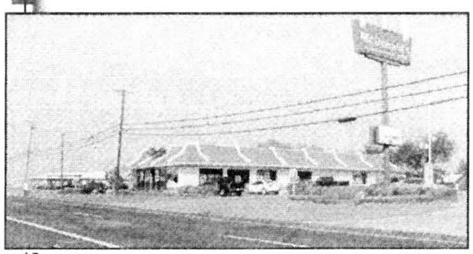
## Fast Food with 3 Access Points



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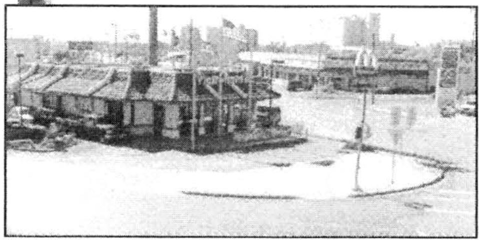
## Undesirable Spacing



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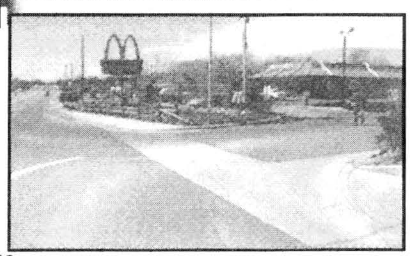
## Build It and They Will Still Come!



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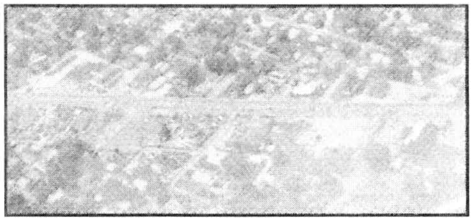
## Poor Driveway Spacing



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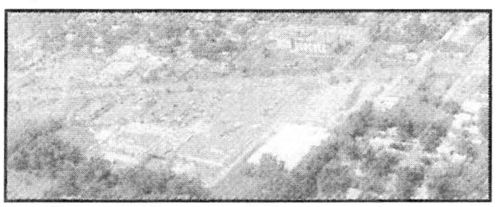
## Better Driveway Spacing



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## What Are We Trying to Fix/Avoid?

- Multiple Access Points per Business

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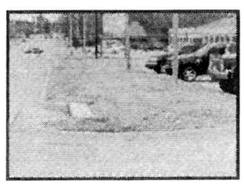
## What Are We Trying to Fix/Avoid?



- Reduce Conflict Points
- Increase Driveway Spacing

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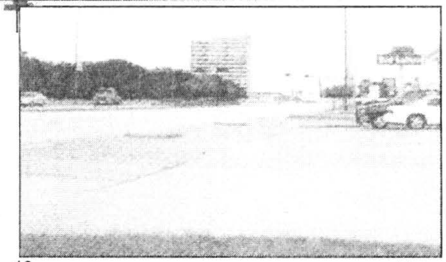
## Undesirable Driveway Spacing



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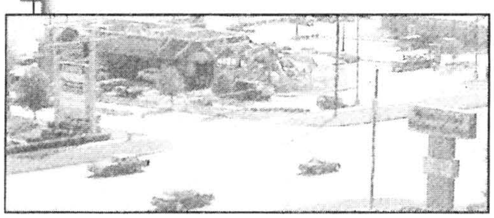
## Fast Food Restaurant With Limited Access



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# Corner Clearance

# Corner Clearance

Texas Department of Transportation

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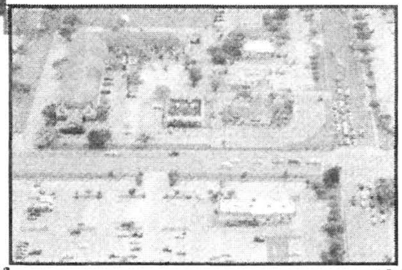
## Corner Clearance



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## Corner Clearance

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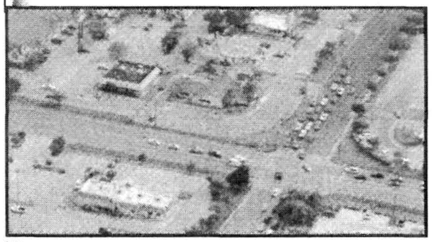
## Corner Clearance



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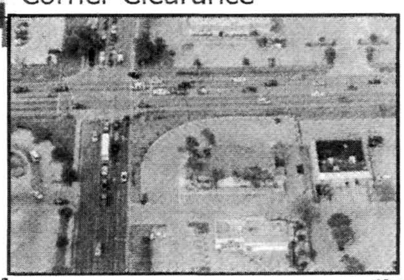
## Corner Clearance



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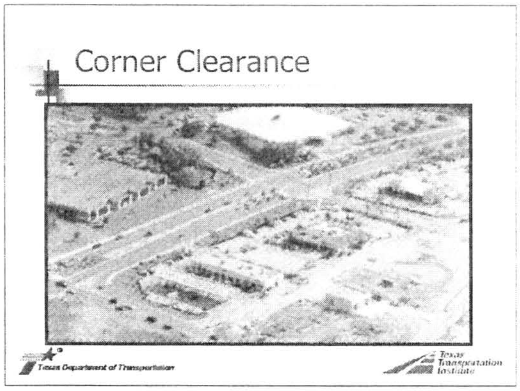
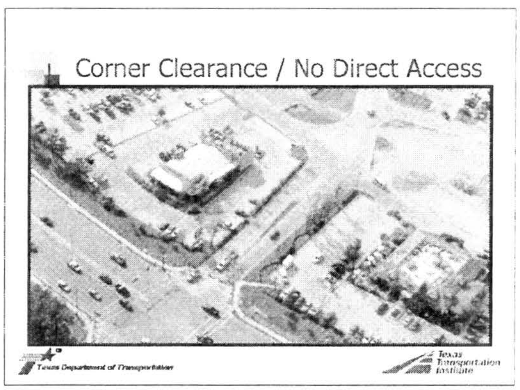

Corner Clearance
Texas Department of Transportation
Texas Transportation Institute

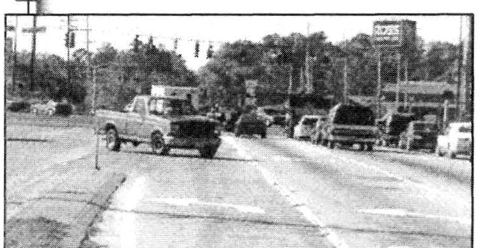

Corner Clearance / No Direct Access
Texas Department of Transportation
Texas Transportation Institute

## Downstream Left-Turn Queue Backing Up Into Intersection

Texas Department of Transportation

Texas Transportation Institute

## TWLTL Conflicting Uses/ Inappropriate Median Cut



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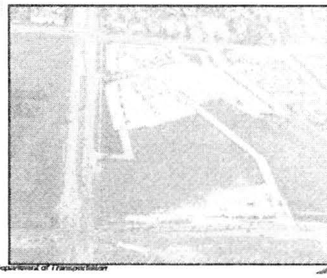
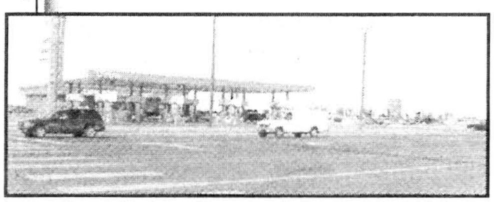
# Corner Clearance



Texas Department of Transportation

Texas Transportation Institute

# Corner Clearance



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## Corner Clearance / Raised Median

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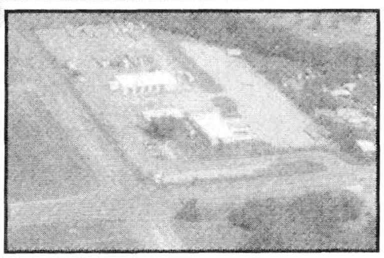
## Corner Clearance



Texas Department of Transportation

Texas Transportation Institute

## What Are We Trying to Fix/Avoid?

- Closed Access Points
- Increase Driveway Spacing

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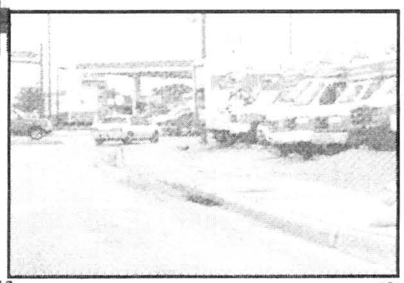
## Closed Access



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## Signal Spacing

## Signal Spacing and Directional Intersection

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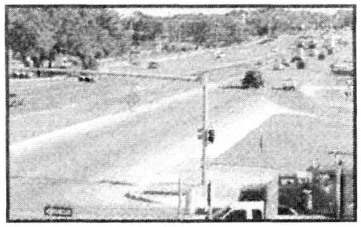
## Signal Spacing



- Maintains Progression / Movement

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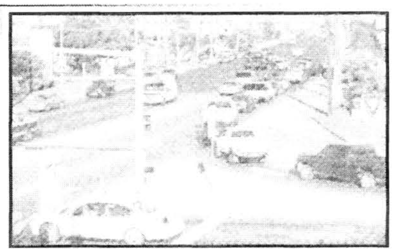
## What Are We Trying to Fix/Avoid?



- Poor Signal Spacing

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## Median Treatments

## Raised Median

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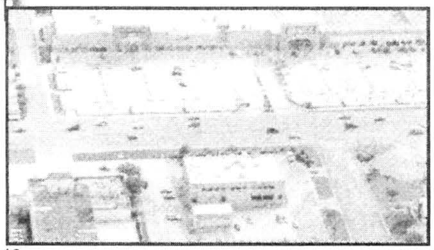
## Raised Median



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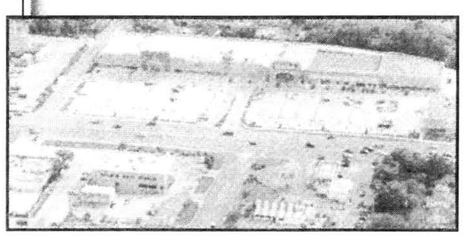
## Raised Median



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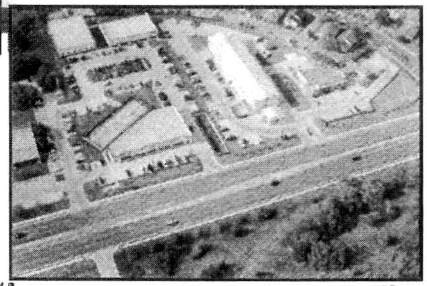
## Raised Median / Cross Access



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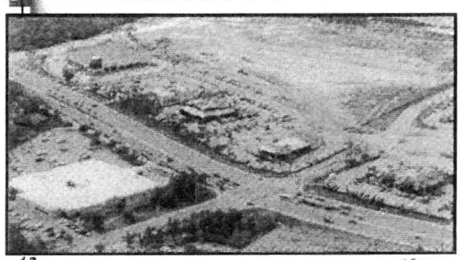
## Raised Median / Cross Access



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## Raised Median / Cross Access

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## Raised Median / Cross Access

Texas Department of Transportation

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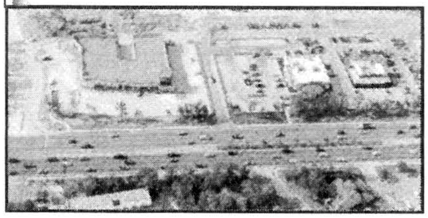
# Raised Median / Cross Access



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# Raised Median / Cross Access

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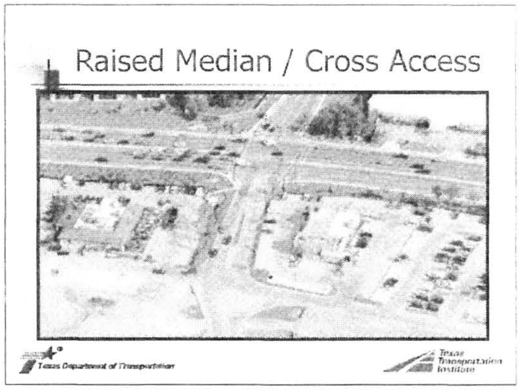
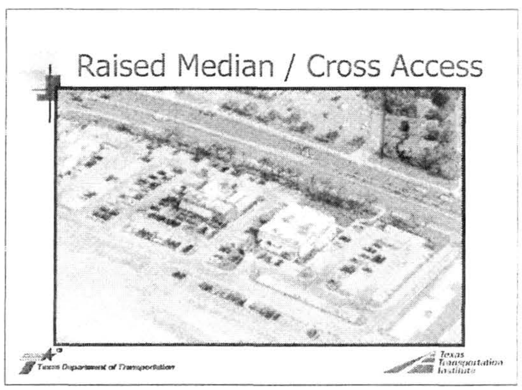
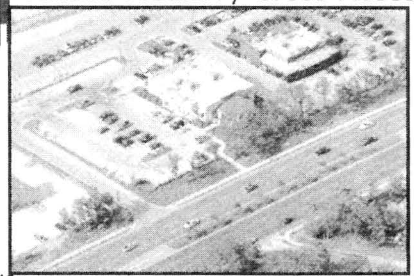

Raised Median / Cross Access
Texas Department of Transportation
Texas Transportation Institute


Raised Median / Cross Access
Texas Department of Transportation
Texas Transportation Institute

## Raised Median / Cross Access



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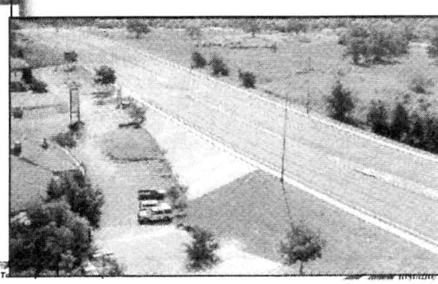
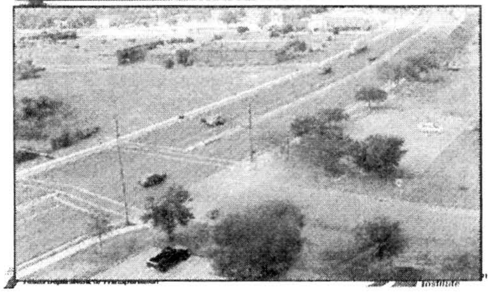
## Raised Median in Advance of Development

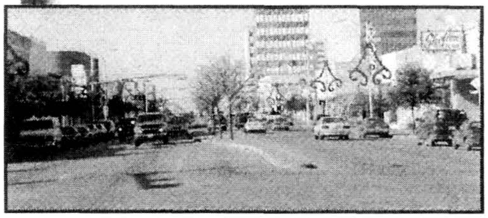


## Raised Median in Advance of Development



## Two-way Left-Turn Lane Conflicts

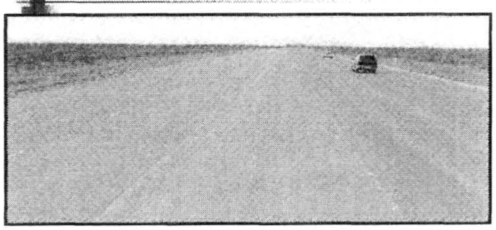
## Raised Median - CBD



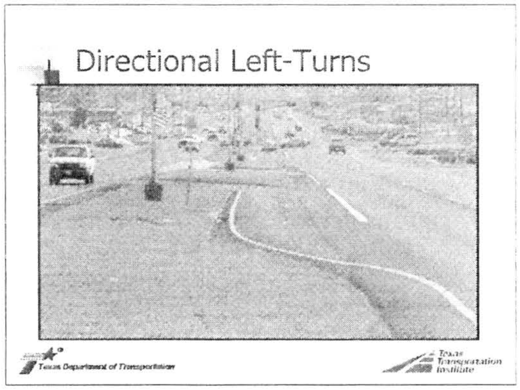
- US 385/Grant Ave – Odessa



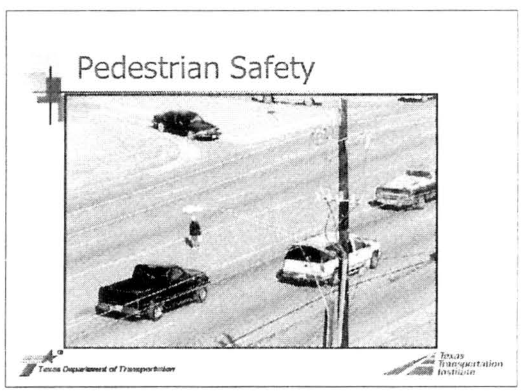
## Potential Access Management Undeveloped Land



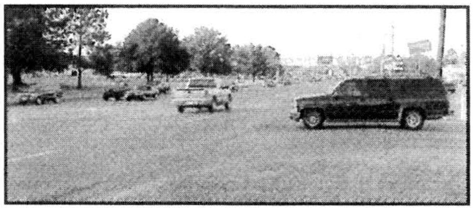
- Grandview Ave – Odessa




Eckerds paid to install the concrete directional left turn.



## Safety – Reduce Conflict Points



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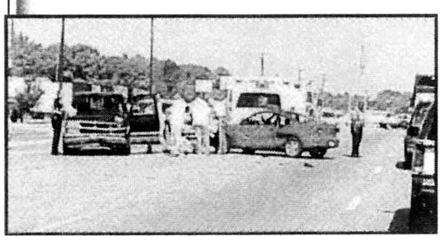
## Safety - Reduce Crashes



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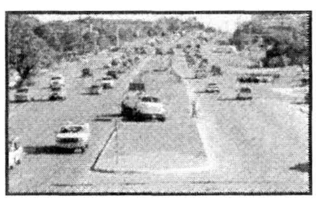
## What Are We Trying to Fix/Avoid?

- TWLTL Conflicting Uses

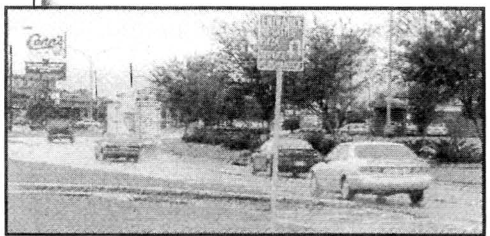


## Medians



- Reduce Conflict Points & Congestion
- Increase Driver Expectations

## Signage for Raised Median Openings



- Provides Direction to Adjacent Businesses

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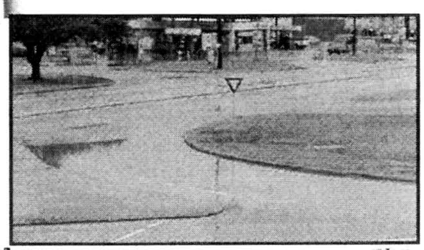
## Raised Median at Close Intersection Spacing



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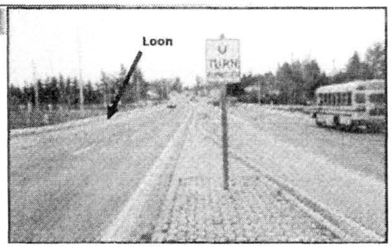
## Word for the Day: "Loon"




Sometimes wider for two-stage turning maneuver (Salem, OR)

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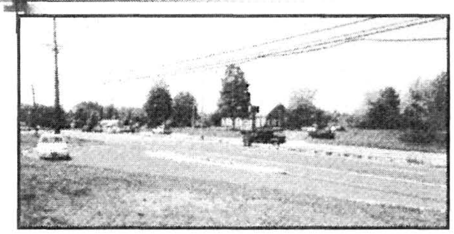
## "Two-stage" Loon



Left-turn and then merge with traffic (New Jersey)

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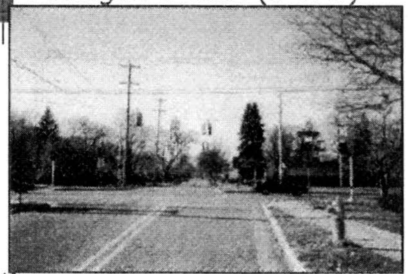
## Michigan U-turn (1 of 3)



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## Michigan U-turn (2 of 3)

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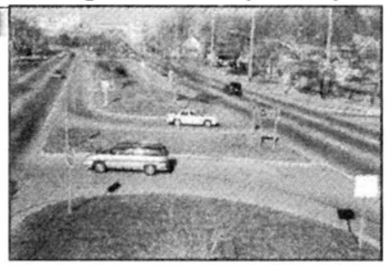
## Michigan U-turn (3 of 3)



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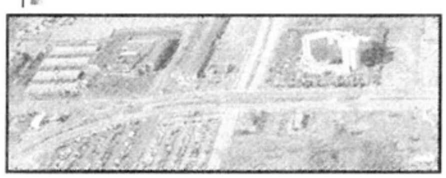
## Michigan U-turn



- Detroit, MI

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## Michigan U-turn

- Detroit, MI

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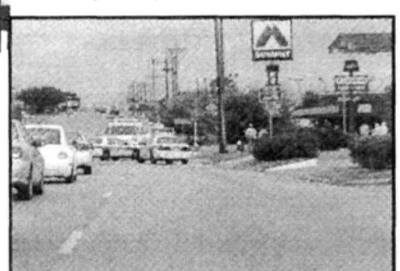
## Safety Impacts



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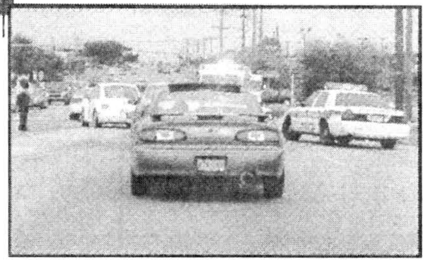
## Safety Impacts



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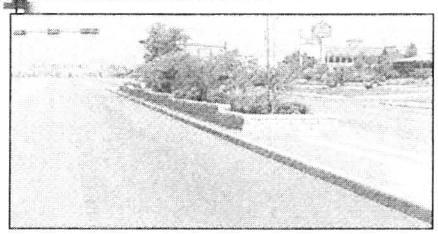
## Landscaping and Pavers



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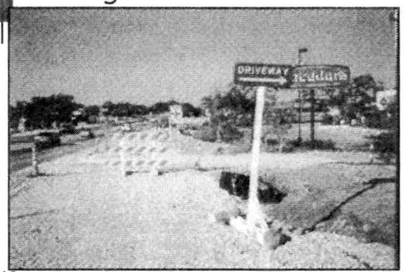
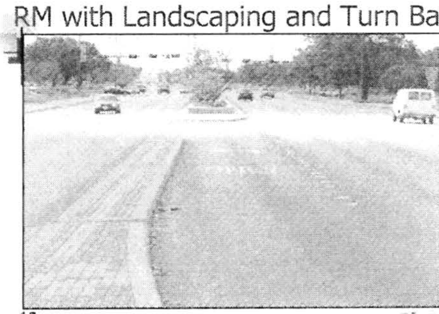
## Maintaining Driveway Access During Construction






## RM with Landscaping and Turn Bays

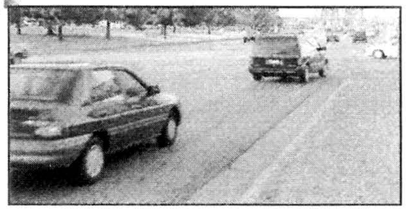


# Acceleration and Deceleration Lanes

# Turn Lanes

- Separate Speeds and Create Safe Havens

## What Are We Trying to Fix/Avoid?



- Speed Differentials

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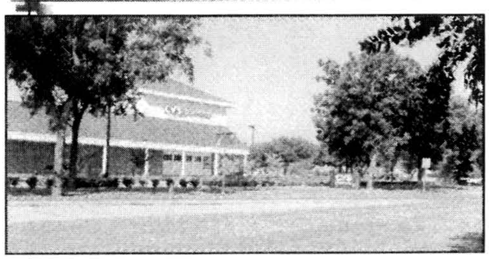
## Decel Lane and Architectural Standards



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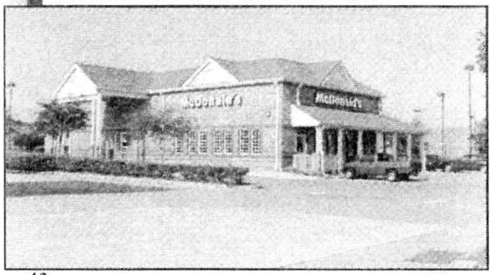
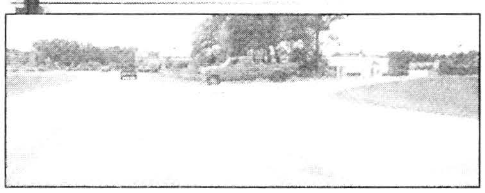
## Architectural Standards

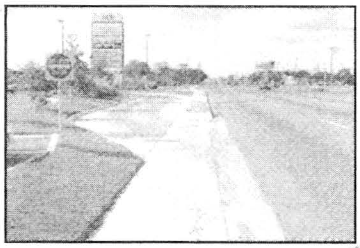





## Deceleration Lane



## Right-In / Right-Out with Queue Storage



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## Limited Length Deceleration Lane

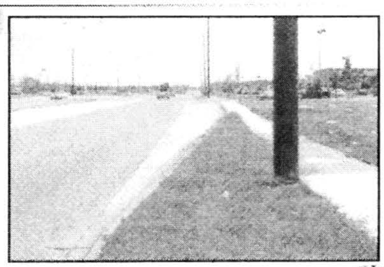

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*Photo courtesy City of Garland*

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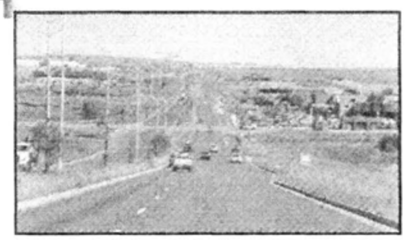
## Decel / Accel Lanes



- Colorado Springs, CO

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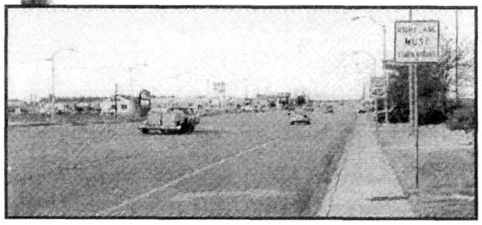
## Auxiliary Lanes

## Auxiliary Lane



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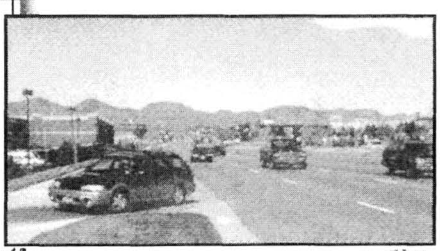
## Auxiliary Lane



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## Freeway Frontage Roads

## Driveways and Ramp

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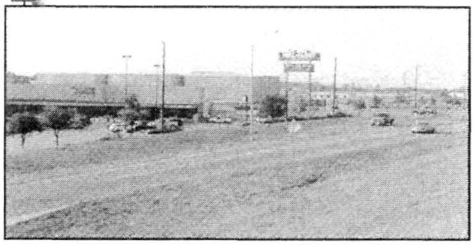
## Driveway – Ramp Spacing



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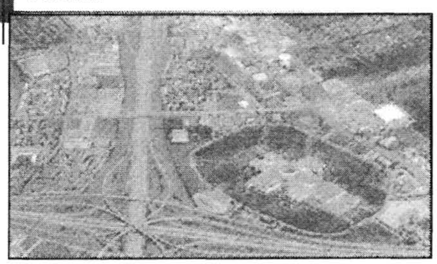
## Development Without Frontage Roads



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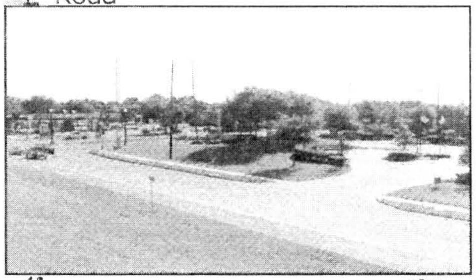
## Corner Clearance on Frontage Road



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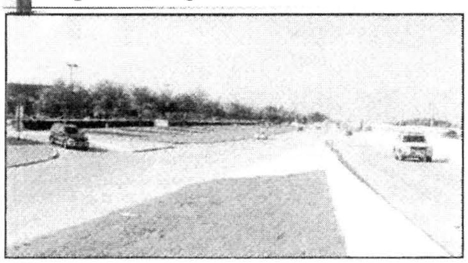
## Driveway/Ramp Spacing and Right-In/Right Out



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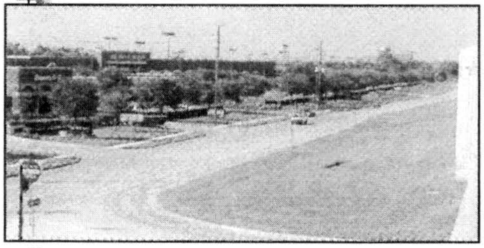
## Access Spacing on Frontage Road and Home Depot Architecture



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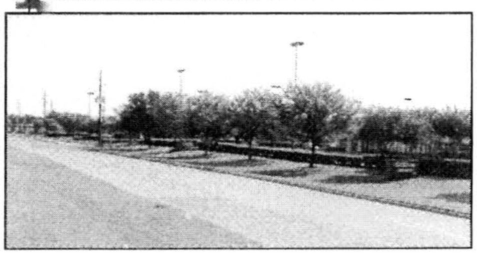
## Limited Access on Frontage Road



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## Freeway Auxiliary Lane Transition

- Loop 250 – Midland

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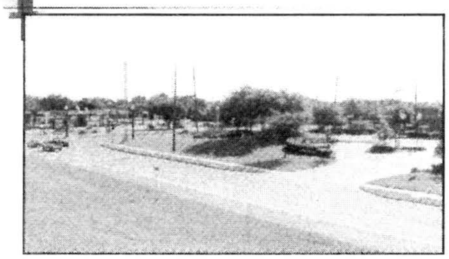
## Corner Clearance on Frontage Road



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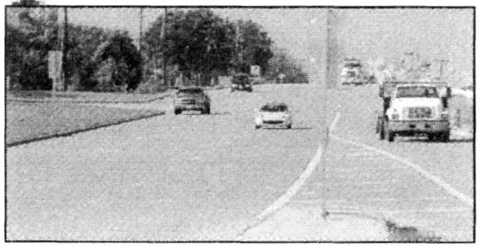
## Driveway/Ramp Spacing



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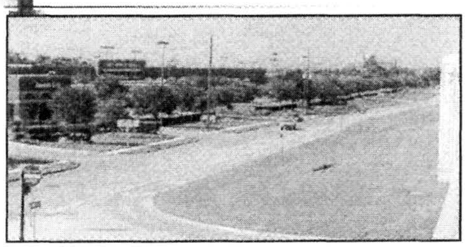
## Access Spacing on Frontage Road



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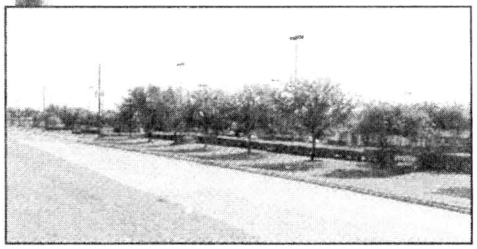
## Limited Access on Frontage Road



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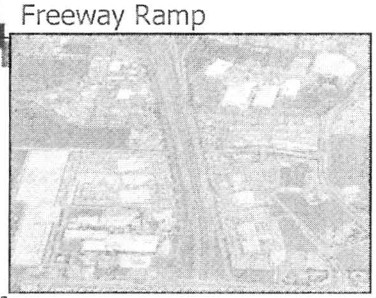
## Mall Entrance – Proximity to Freeway Ramp



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## Mall Entrance – Proximity to Freeway Ramp

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## Mall Ingress and Egress on Frontage Road

Texas Department of Transportation

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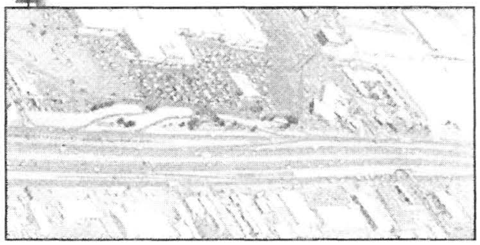
## Mall Ingress and Egress on Frontage Road – Close Up



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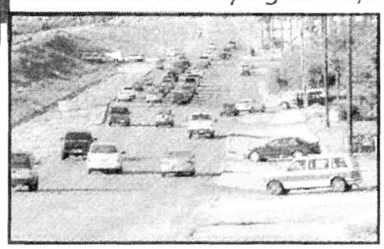
## What Are We Trying to Fix/Avoid?



- Multiple Conflict Opportunities

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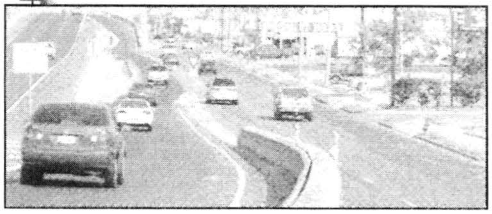
# Driveways at Ramp Gores



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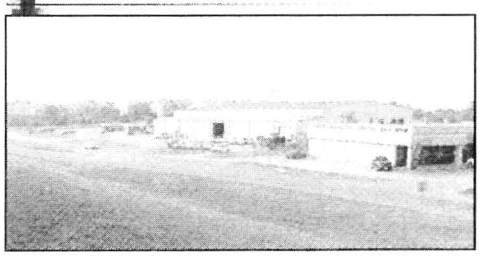
# What Are We Trying to Fix/Avoid?



- Ramp Gore – Driveway Spacing

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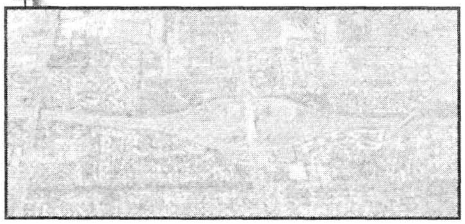
## No Frontage Roads – Access via City Streets



- Detroit, MI

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## No Frontage Roads – Access via City Streets



- Detroit, MI

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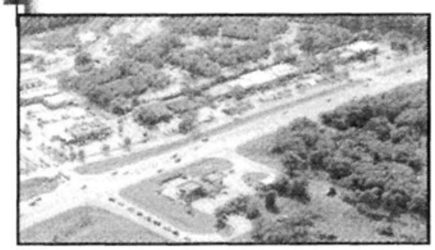
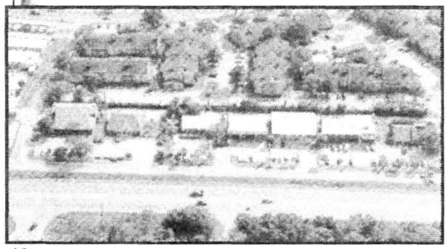
## Arterial Frontage Road

## Arterial Frontage Road



## Arterial Frontage Road



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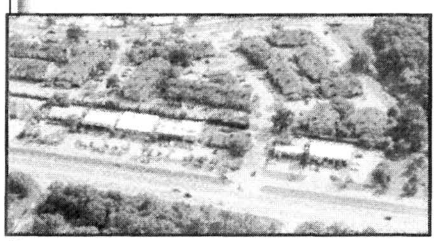
## Arterial Frontage Road



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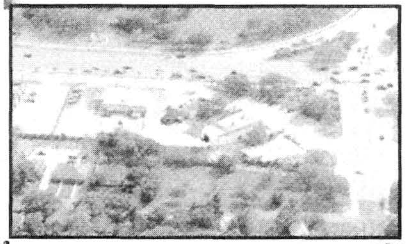
## Arterial Frontage Road



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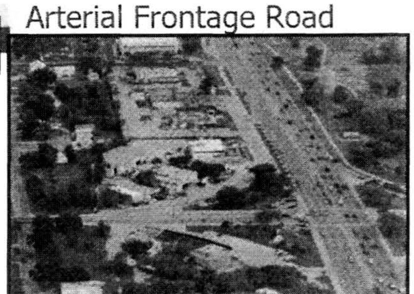
## Arterial Frontage Road



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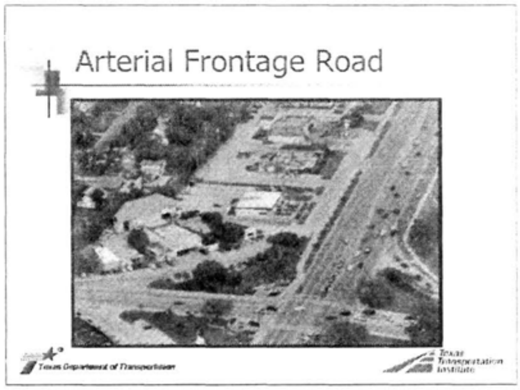
Arterial Frontage Road
Texas Department of Transportation
Texas Transportation Institute


Arterial Frontage Road / Raised Median
Texas Department of Transportation
Texas Transportation Institute

## Arterial Frontage Road / Cross Access

Texas Department of Transportation

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## Arterial Frontage Road / Cross Access

Texas Department of Transportation

Texas Transportation Institute

## Arterial Frontage Road

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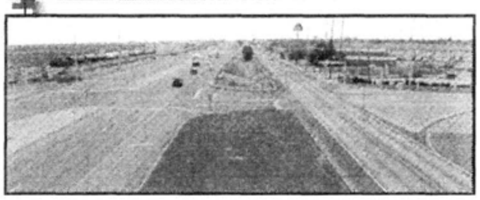
## Arterial Frontage Road



- Bus IH 20 – Odessa

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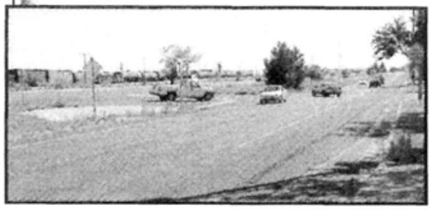
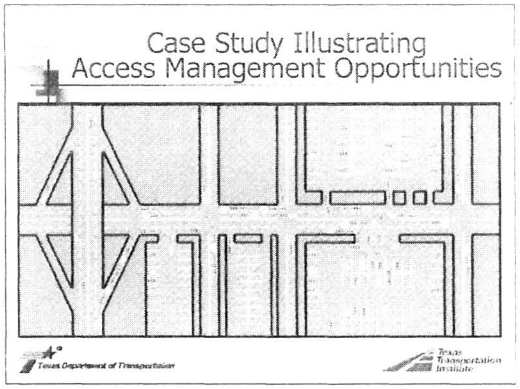
## Arterial Frontage Road

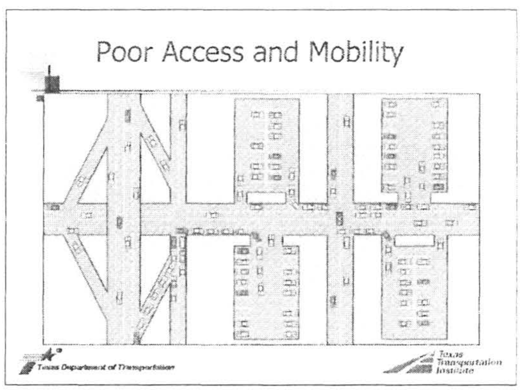


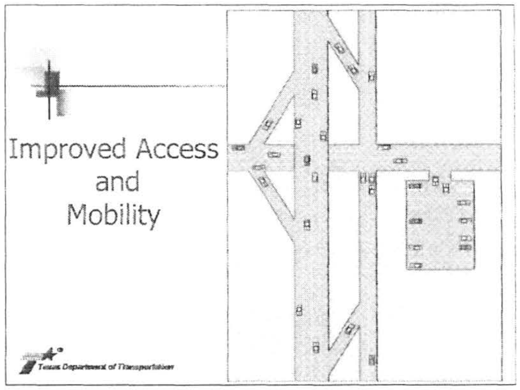
Intersection Spacing

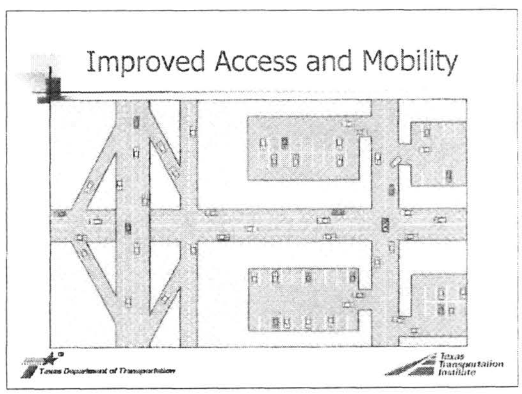


## Summary


Case Study Illustrating
Access Management Opportunities
Texas Department of Transportation
Texas Transportation Institute


Poor Access and Mobility
Texas Department of Transportation
Texas Transportation Institute


Improved Access and Mobility
Texas Department of Transportation


Improved Access and Mobility
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## Resources (TxDOT Manuals)

- TxDOT *Access Management Manual*
  - http://manuals.dot.state.tx.us/dynaweb/coldesig/acm
- TxDOT *Roadway Design Manual*
  - http://manuals.dot.state.tx.us/dynaweb/coldesig/rdw
- Texas Manual on Uniform Traffic Control Devices
  - http://www.dot.state.tx.us/TRF/mutcd.htm

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## Resources (TxDOT Research)


- Frawley, W.E., and W.L. Eisele. *Summary of Access Management Benefits.* Research Report 4221-S. Texas Transportation Institute. College Station, Texas. April 2004.
- Eisele, W.L, W.E. Frawley, and C.M. Toycen. *Estimating the Impacts of Access Management Techniques: Final Results.* Research Report 4221-2. Texas Transportation Institute. College Station, Texas. April 2004.
- Frawley, W.E. and W.L. Eisele. *Investigation of Access Point Density and Raised Medians: Crash Analysis and Micro-simulation.* Research Report 0-4221-P1. Texas Transportation Institute. College Station, Texas. October 2004.
- Frawley, W.E. and W.L. Eisele. *Access Management Guidebook for Texas.* Research Report 4141-P3. Texas Transportation Institute. College Station, Texas. May 2004.


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## Resources (National)


- *Access Management Manual.* National Research Council, Transportation Research Board, Washington, D.C., 2003.
- *Impacts of Access Management Techniques.* National Cooperative Highway Research Program Report 420, National Research Council, Washington, D.C., 1999.
- *Capacity and Operational Effects of Midblock Left-turn Lanes.* National Cooperative Highway Research Program Report 395, National Research Council, Washington, D.C., 1997.


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## Resources (National)


- *Access Management on Crossroads in the Vicinity of Interchanges.* National Cooperative Highway Research Program Synthesis 332, National Research Council, Washington, D.C., 2004.
- *Safety of U-turns at Unsignalized Median Openings.* National Cooperative Highway Research Program Report 524, National Research Council, Washington, D.C., 2004.
- *Geometric Design of Highways and Streets.* Fifth Edition. American Association of State Highway and Transportation Officials. Washington, D.C., 2004.


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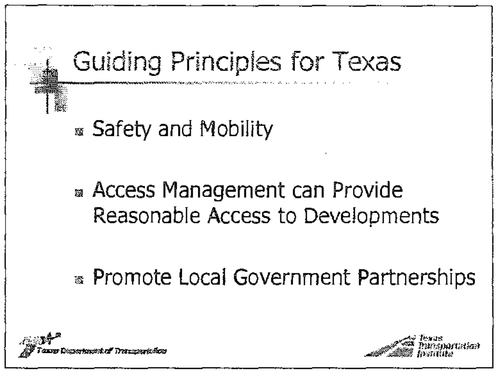
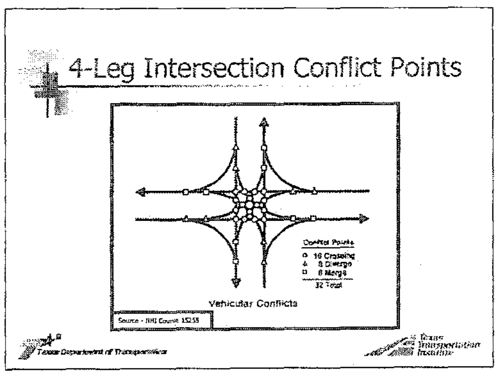
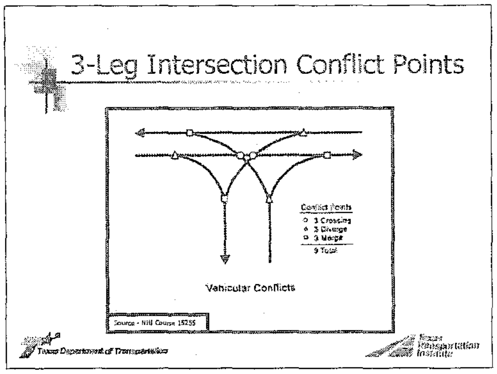


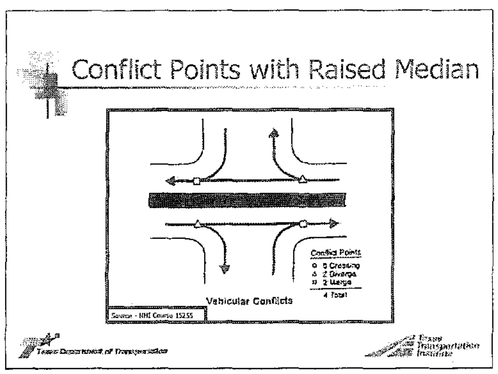

This slide lists the three primary guiding principles that form the basis of why TxDOT is pursuing access management implementation. The first guiding principle is that access management improves safety and mobility. Secondly, properly implementing access management treatments can provide reasonable access to developments. Finally, TxDOT wishes to promote local government partnerships by implementing access management. Cooperation between local agencies (cities, counties) and TxDOT facilitates access management implementation and success.



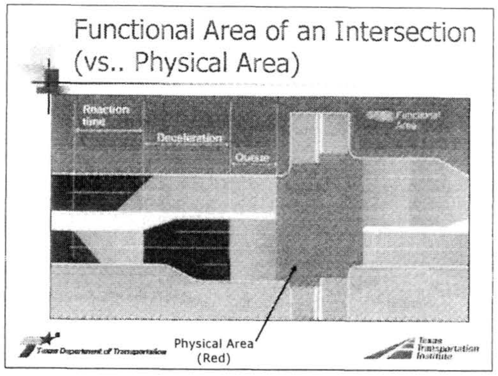

As you can see in this figure, there are 32 conflict points in one intersection that has only one lane in each direction. This means there are 32 locations where vehicle paths either cross, diverge, or merge. Obviously, the number of conflict points increases at intersections with more than one lane in each direction. Further, this graphic only includes vehicle conflicts. The presence of bicyclists and/or pedestrians yield even more conflict opportunity with vehicular traffic.




A three-leg intersection has only 9 conflict points, comparing to the previously mentioned 32 conflict points for a four-leg intersection.

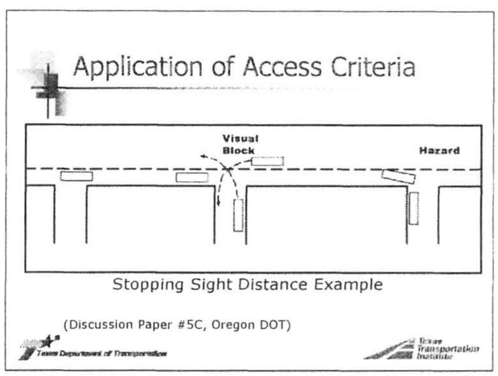



If a raised median is constructed at a four-leg intersection, the number of conflict points reduces from 32 to 4 points. This can also be considered for a driveway, not just a cross-street, which yields two conflict points per driveway with a raised median.




This figure illustrates the difference between the physical area (shown in red) and the larger functional area of the intersection. This graphic shows the detail of what the functional area of the intersection includes along one leg of the intersection—namely, the queue (storage) length, deceleration length and perception-reaction time length.

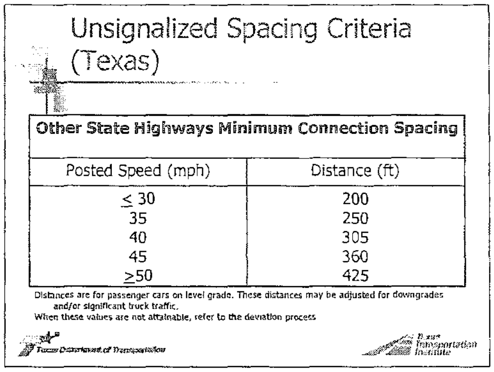
It is imperative to preserve access in the entire functional area of the intersection. Driveways allowed within the functional area will be negatively influenced by the traffic operations (queues, sight distances) of the primary intersection.




TxDOT bases minimum access spacing on AASHTO stopping sight distance. This graphic illustrates the use of AASHTO stopping sight distance for access spacing. This concept was first presented in the following manner by Robert Layton of Oregon State University in the development of Oregon DOT's spacing standards.

Imagine that the middle driveway does not exist, and that only the first and third driveways are present. Assume that these remaining driveways are spaced according to stopping sight distance for the speed of the roadway. Therefore, vehicles approaching the right-most driveway (after they pass the first driveway) have plenty of time to perceive, react, and brake when faced with a potential hazard at the right-most driveway. The hazard could include vehicles queuing out into the street (as shown). Therefore, drivers would be reacting to the vehicle's brake lights, which represent the 2-foot object per AASHTO stopping sight distance. Because the driveways are spaced at stopping sight distance, upstream drivers have no problem seeing, reacting to, and braking for the queue at the downstream driveway.

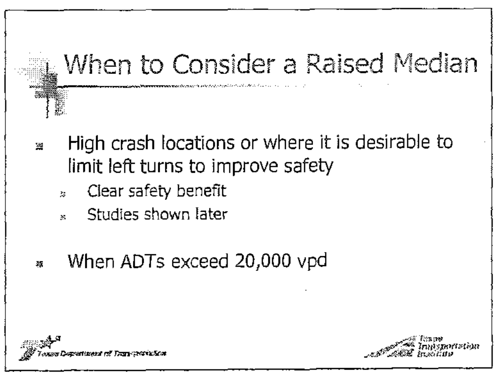
Now imagine there is a second (middle) driveway inserted between the two driveways. Now the driveways are not spaced per stopping sight distance. Turning maneuvers at the middle driveway can cause a visual block as turning vehicles cross the sight line of upstream vehicles. In the event of a queue into the street at the third driveway, vehicles passing the first driveway would not have enough time to react and brake for such a queue at the third driveway if there is a visual block at the second (middle) driveway.




| Other State Highways Minimum Connection Spacing | |
|---|---|
| Posted Speed (mph) | Distance (ft) |
| ≤ 30 | 200 |
| 35 | 250 |
| 40 | 305 |
| 45 | 360 |
| ≥50 | 425 |

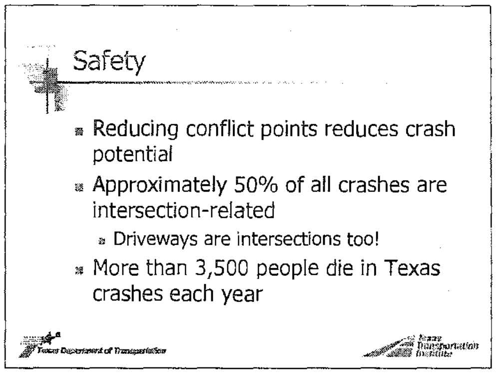


This is a table from TxDOT's *Access Management Manual* that illustrates the minimum spacing values for a given posted speed. It should be noted that these values are "minimums." They assume passenger cars on level grade. When a grade is present and/or a significant truck traffic, these values should be adjusted accordingly.

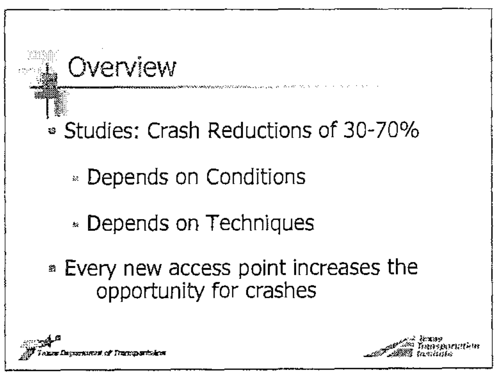



The safety benefit of raised medians is clearly demonstrated in national research and in Texas studies. These studies will be presented later in this presentation. Limiting left turns reduces conflict opportunities along the roadway, which equates to reduced crashes.

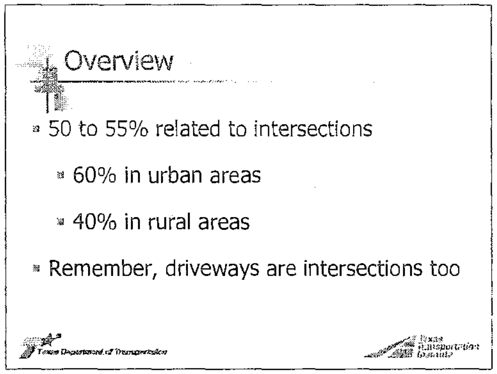
TxDOT's *Roadway Design Manual* indicates that raised medians should be considered when the average daily traffic (ADT) exceeds 20,000 vehicles per day.



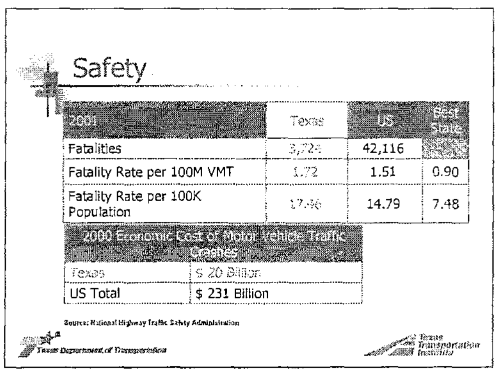

Safety is the primary benefit to implementing access management treatments. Access management treatments reduce conflict points, which reduces crash potential. Approximately half of all crashes occur at intersections, so reducing intersections with a raised median should reduce crashes. More than 3,500 people die in crashes each year in Texas.




Studies show that access management treatments reduce crashes from 30 to 70 percent. The variability depends upon the conditions and techniques implemented. It is important to keep in mind that every new access point added to a roadway increases crash potential; therefore, the reduction of these access points has a beneficial affect.




About half of all crashes are related to intersections. In urban areas it is 60%, and in rural areas it is 40%. As always, keep in mind that driveways are intersections too!




| 2001 | Texas | US | Best State |
|---|---|---|---|
| Fatalities | 3,724 | 42,116 | |
| Fatality Rate per 100M VMT | 1.72 | 1.51 | 0.90 |
| Fatality Rate per 100K Population | 17.46 | 14.79 | 7.48 |

| 2000 Economic Cost of Motor Vehicle Traffic Crashes | |
|---|---|
| Texas | $ 20 Billion |
| US Total | $ 231 Billion |

This slide provides specific information for the years 2000 and 2001 that relate to the number of crashes and economic costs. These data are provided by the National Highway Traffic Safety Administration (NHTSA).

In 2001, there were over 3,700 fatalities in Texas due to crashes. Texas has a higher fatality rate based on travel and population (shown in red) than the national average (shown in black). The cost to Texas of these crashes was approximately $20 Billion in 2000.

## Safety Impacts – Texas

- Texas Avenue – College Station
  - Crashes reduced by 50-67%
  - Severity of crashes decreased (evidenced by injuries)

TxDOT Research Project 0-4221

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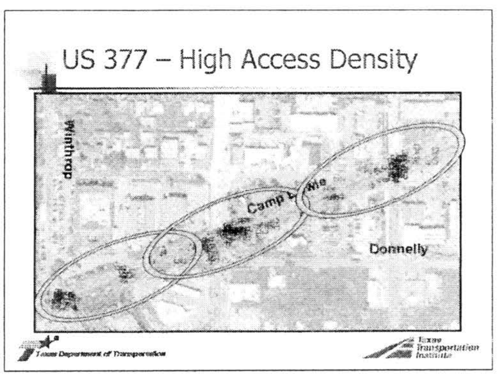
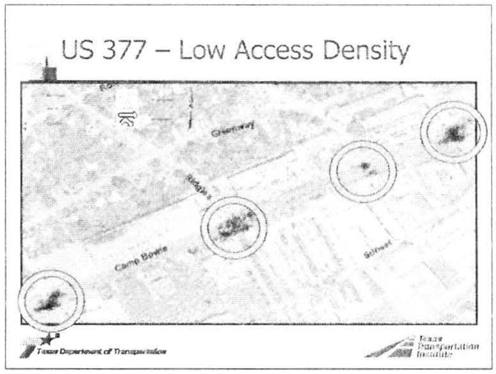
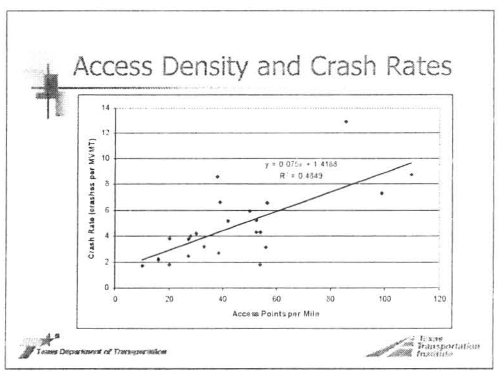
Along Texas Avenue in College Station, crashes were reduced by 50-67% with the installation of a raised median. The severity of the crashes also decreased. This study is described in TxDOT Research Project 0-4221.




This graphic illustrates the number, location and type of crashes along US 377 (Camp Bowie Boulevard) in Ft. Worth, Texas. This segment of US 377 is just south of I-30, and one can see there is a relatively high density and the major streets intersect US 377 at skewed angles. This results in crashes located across the corridor at major intersections and at mid-block locations. This is in contrast to the next slide.




This slide shows US 377 further south of the segment shown in the prior slide. Here the major intersections have been aligned at right angles to US 377, and access density is much lower than the prior slide.




A trend was derived to illustrate the relationship between access density and crash rate. Clearly, crash rate increases as access points per mile increase.

## 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.

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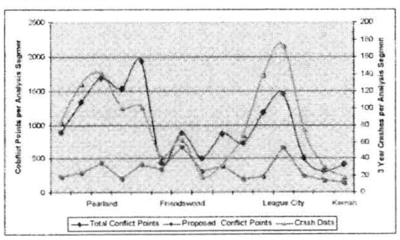
This graphic shows crash rate information before and after a raised median was installed. The table also shows the corridor, ADT, the absolute difference in crash rates, the percent difference in crash rates, and the access density. The results indicate that a raised median resulted in between a 17 and 58 percent reduction in the crash rate.

## FM 518 Corridor Study

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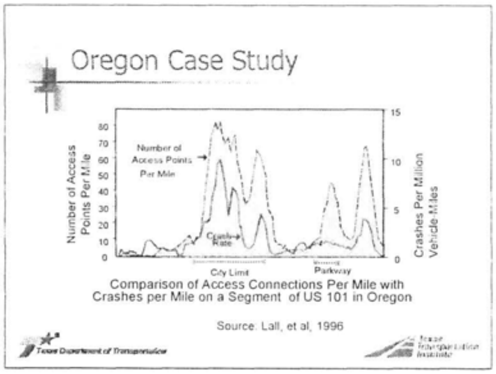
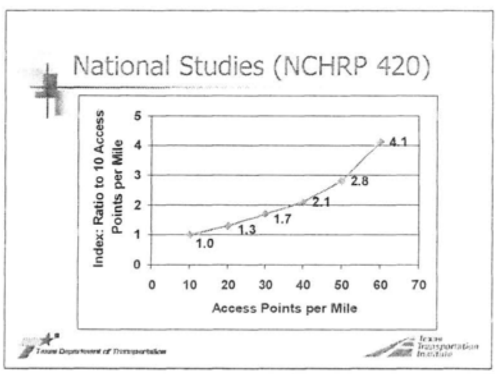
This graphic also shows a study from Texas that illustrates how conflict points are correlated with higher crash rates. This graphic is from a *Corridor Access Management Plan of FM 518*, which was lead by the Houston-Galveston Area Council (H-GAC).




In Oregon, the crashes per million vehicle-miles of travel (MVMT) and access points per mile were measured along US 101. One can readily see that as the access points per mile increase, the crash rate tends to increase.



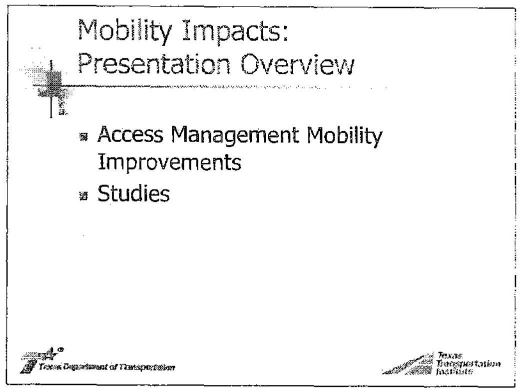

This graphic is from NCHRP Report 420, which was was developed from an extensive dataset of 240 roadway segments with more than 37,500 crashes from throughout the United States and Canada. The graphic clearly indicates that as access points per mile increase, the ratio of crashes to 10 access points per mile increases. As an example, if access points increase from 10 to 30, there is a 70% increase in the crash rate.

## Crash Rates

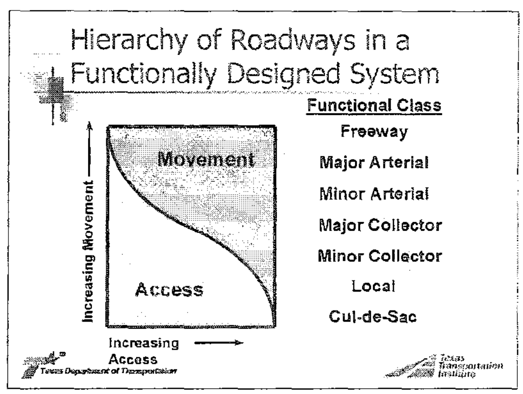
| Representative Crash Rates (Crashes per Million VMT) by Type of Median – Urban and Suburban Areas | | | |
|---|---|---|---|
| | Median Type | | |
| Total Access Points per Mile (1) | Undivided | Two-Way Left-Turn Lane | Non Traversable Median |
| <20 | 3.8 | 3.4 | 2.9 |
| 20.01-40 | 7.3 | 5.9 | 5.1 |
| 40.01-60 | 9.4 | 7.9 | 6.8 |
| >60 | 10.6 | 9.2 | 8.3 |
| Average Rate | 9.0 | 6.9 | 5.6 |

(1) Includes both signalized and unsignalized access points.

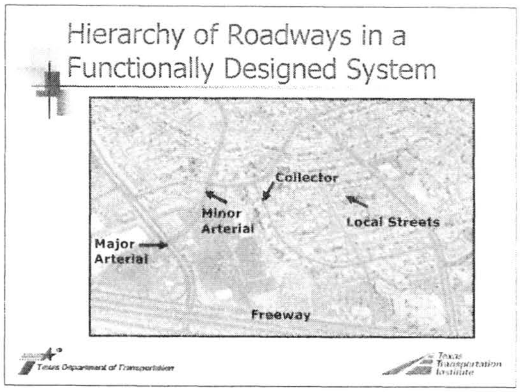
This graphic is also from NCHRP 420. It illustrates that the non-traversable median (raised median) has a lower crash rate than both undivided roadway segments and two-way left-turn lane (TWLTL) segments, irrespective of access points per mile.



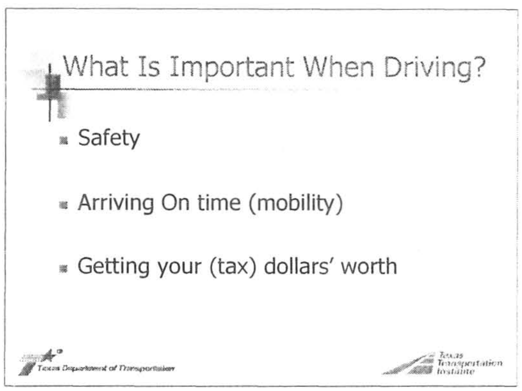

This presentation will focus on the mobility benefits of access management treatments. National and Texas studies are described as a part of this presentation.



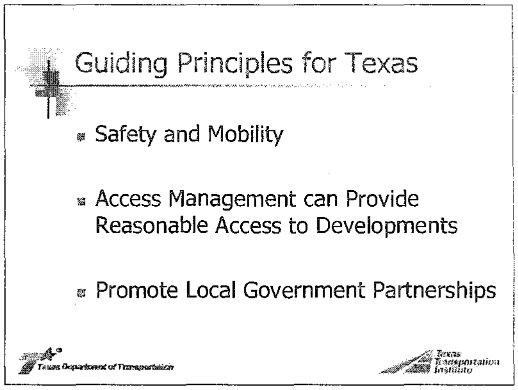

Roadways are planned, designed and built to serve a primary function. As this graphic shows, the function of freeways and arterials are to provide movement, whereas collectors and local streets primarily provide access. It is imperative that the primary function of the roadways be maintained when roadways are built. Allowing too much access on arterials, for example, will degrade their operation and not allow them to function as planned.



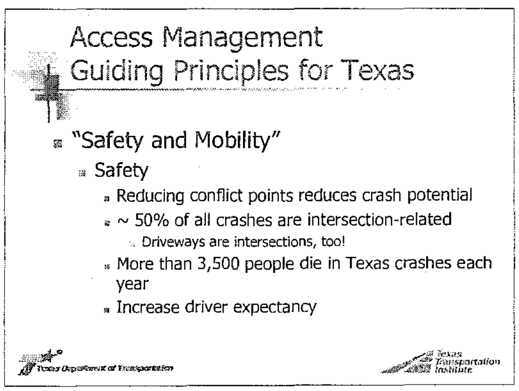

This photograph shows the hierarchy of roadways in a functionally designed system and how the roadways are connected to provide access and movement.




A good way to think about why we do access management is to think about what is important when driving. Arriving safely usually always tops the list, and the safety benefits of access management treatments are well documented. Mobility, or the ability to arrive to a destination on time, is important as well because users want to feel like the system is reliable. Access management treatments can improve mobility. Finally, motorists need to feel like they are getting their dollars' worth. If we allow our roadways to become too cluttered with multiple access points, they may not function as initially planned, and we will not be getting our tax dollars' worth.

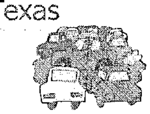



Thinking about the responses to the prior slide, TxDOT developed these three guiding principles for implementing access management in Texas. The first guiding principle is that access management improves safety and mobility. Secondly, properly implementing access management treatments can provide reasonable access to developments. Finally, TxDOT wishes to promote local government partnerships by implementing access management. Access Management is facilitated when there is a strong cooperative spirit between TxDOT and local agencies.




The first guiding principle is "safety and mobility." This slide discusses the "safety" aspects of this guiding principle. Access management treatments reduce the number of conflict points along a roadway, which, in turn, reduces crash potential. About half of all crashes are intersection-related, and about 3,500 people die in Texas crashes each year. Implementing access management treatments can improve the safety of our roadways.

## Access Management Guiding Principles for Texas



- "Safety and Mobility"
  - Mobility
    - Allow through traffic to move more efficiently (less "stop and go" traffic)
    - Preserve roadway capacity (reduced delay)
    - Separate speed differentials
    - Less braking and hard acceleration
    - Reduce fuel consumption/emissions

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On the "mobility" side of this guiding principle, it is important to note that access management treatments allow through traffic to move more efficiently (i.e., there is less "stop and go" traffic). We can preserve through-movement capacity with the construction of acceleration and deceleration lanes, which separate speed differentials. The smoother roadway operation created by access management treatments leads to less braking and hard acceleration and subsequently reduced fuel consumption/emissions.

## Access Points and Free-flow Speed

**Access Points and Free-flow Speed**

| Access points per mile | Reduction in free-flow speed, mph |
|---|---|
| 0 | 0.0 |
| 10 | 2.5 |
| 20 | 5.0 |
| 30 | 7.5 |
| 40 or more | 10 |

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National research in National Cooperative Highway Research Program (NCHRP) Report 420 *Impacts of Access Management* illustrates that as the access points (signalized and unsignalized) per mile increases, there is a reduction in the free-flow speed along a roadway.

## Travel Time and Signal Density

| Percentage Increase in Travel Times as Signal Density Increases | |
|---|---|
| Signals per Mile | Percent Increase in Travel Times (compared with 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 |

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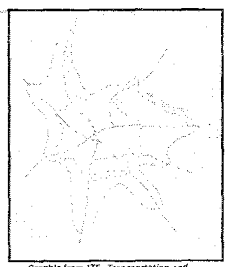
This table is also documentation from NCHRP Report 420. It indicates that as signal density increases, there is an increase in travel times. For example, going from 2 signals per mile to 4 signals per mile can cause a 16 percent increase in travel time.

## Mobility Provides Economic Impacts

- Market area is important to business success
  - Reduction of travel speeds means smaller market areas



Graphic from ITE, *Transportation and Land Development*

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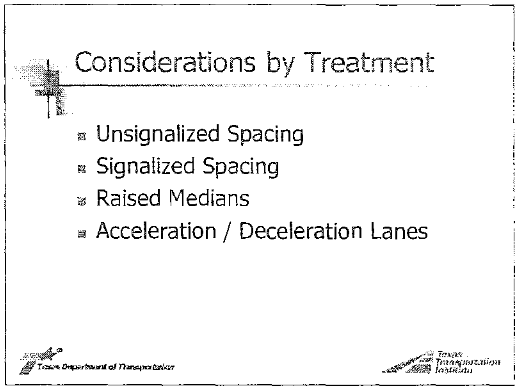
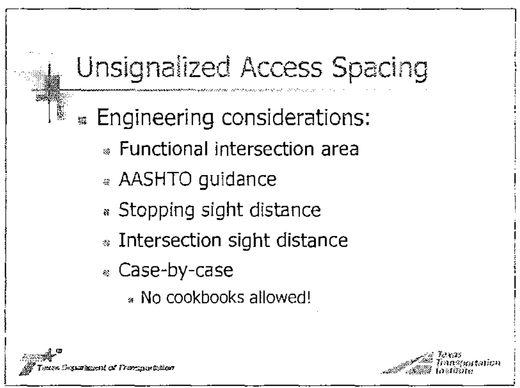
This slides illustrates the important connection between mobility and economic impacts. Imagine that the outer line represents the market share at 45 mph for a grocery store located in the middle of this urban area. If speeds are degraded along the corridors leading to the store to 30 mph, the market area shrinks to that shown by the dashed line. Speeds can be reduced by not practicing good access management.

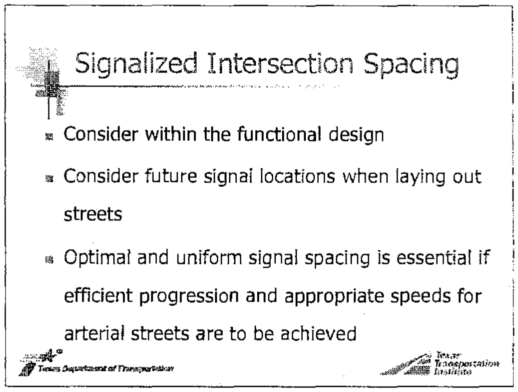



There are numerous access management treatments. The four most common treatments are listed on this slide. These include unsignalized or signalized spacing, raised medians, and acceleration or deceleration lanes. One method, or a combination of methods, can be used.



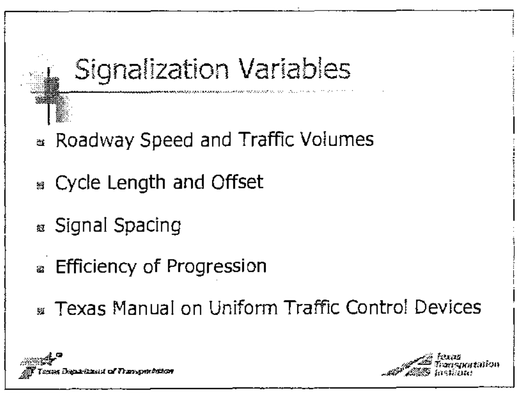

There are several engineering considerations when spacing unsignalized access points. These considerations include the functional area of the intersection, guidance from the American Association of State Highway and Transportation Officials (AASHTO), stopping sight distance, and intersection sight distance.

Access management treatment implementation is not a cookbook process. Each corridor must be evaluated on a case-by-case basis as different treatments and techniques may require additional considerations from corridor to corridor or region to region. For example, prior to installing raised medians, truck traffic and deliveries must be evaluated to ensure there are adequate alternate routes to handle truck deliveries. This will be discussed further in a later section of this presentation.




The spacing of signalized intersections require additional considerations beyond unsignalized streets and driveways. Specifically, these considerations include:

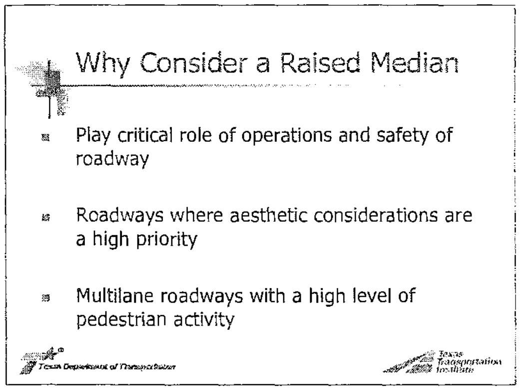
- Functional design should still be considered. Ensuring the appropriate amount of access (signalized or unsignalized) given the functional classification of the roadway.
- Future signal locations should be considered when streets are planned. Consider where future signals may be warranted. Consider future signal locations when locating openings for raised medians also.
- Efficient signal progression is crucial to minimize corridor delay; therefore, optimal and uniform signal spacing is desired.



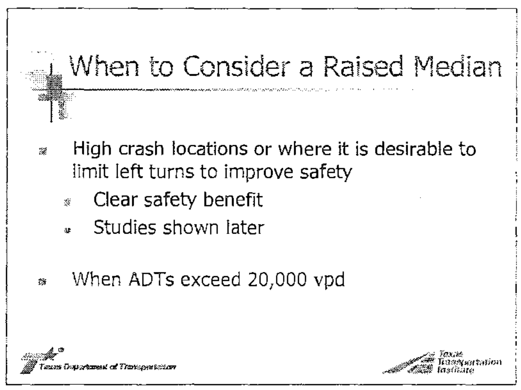

The ideal signalization along a roadway is a function of:

- Roadway speed, traffic volumes and turning movements;
- Signal cycle length and signal offset;
- Signal spacing; and
- The efficiency of progression.

The *Texas Manual on Uniform Traffic Control Devices* provides more detail on when signals are warranted.

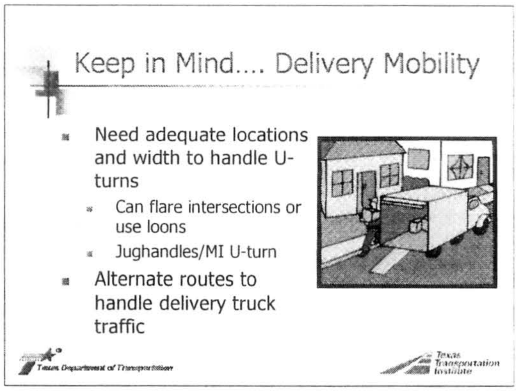



Raised medians were previously introduced as an access management treatment. Raised medians positively separate opposite traffic flows along a roadway, and they play a critical role in the operation and safety of roadways. Raised medians also provide the opportunity to incorporate aesthetic considerations (e.g., landscaping) into the roadway, and they provide a refuge for pedestrians.



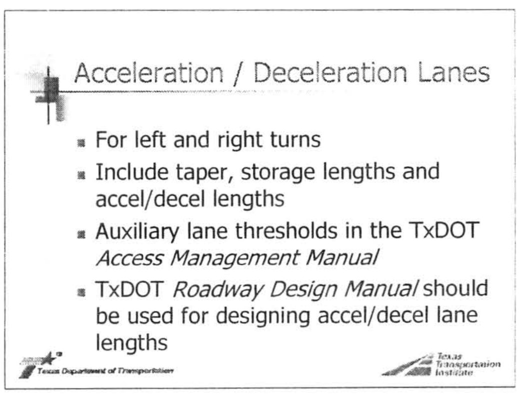

The safety benefit of raised medians is clearly demonstrated in national research and in Texas studies. Limiting left turns reduces conflict opportunities along the roadway, which equates to reduced crashes.

TxDOT's *Roadway Design Manual* indicates that raised medians should be considered when the average daily traffic (ADT) exceeds 20,000 vehicles per day.




It is important to consider where and how U-turns will be handled with the installation of a raised median. Raised medians restrict left-turn opportunities; therefore, U-turn movements must be considered in the design. Typically, three lanes of travel in each direction are needed to provide adequate space for U-turning vehicles. Alternatively, intersections can be flared to provide adequate space. Some states have developed unique treatments for successfully handling U-turns at mid-block locations. Subsequent slides present these methods in more detail.

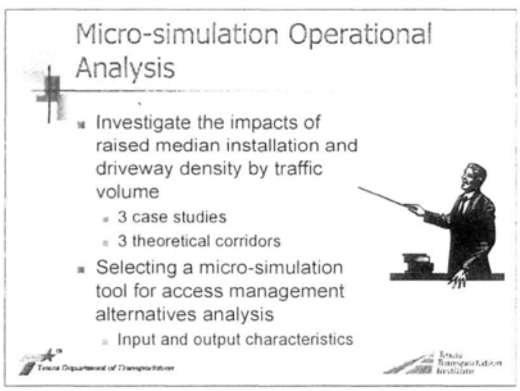
Trucks and delivery vehicles are another important consideration when installing raised medians. Alternate routes must exist for deliveries as large trucks may have difficulty negotiating U-turn locations.



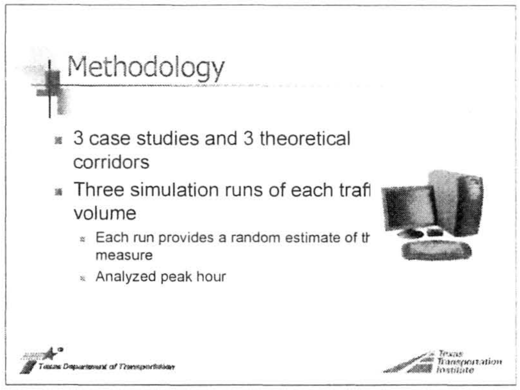

Acceleration and deceleration lanes provide a refuge for left or right turning traffic. They allow for minimal disruption of through vehicles by turning vehicles. The lanes include the necessary taper, storage lengths and acceleration and deceleration lengths.

The TxDOT *Access Management Manual* provides thresholds based upon speed and volume to identify when an acceleration or deceleration lane should be considered. The TxDOT *Roadway Design Manual* provides design guidance for constructing acceleration and deceleration lanes.


The following slides describe research findings that relate to the mobility aspects of access management treatments.

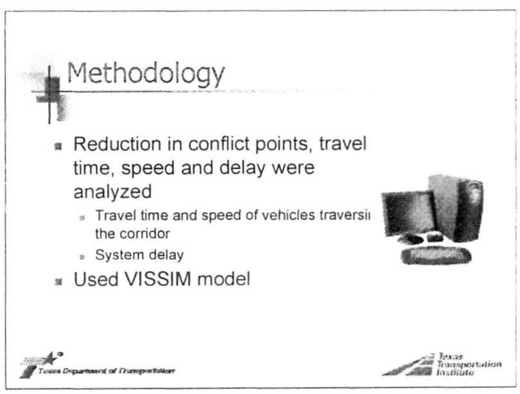



TxDOT sponsored a research project that investigated the impacts of raised median installation and driveway density by traffic volume along three case studies and three theoretical corridors. In addition, the research identified input and output characteristics an analyst should look for when selecting a micro-simulation tool for evaluating access management treatments.




Three case studies and three theoretical corridors were analyzed. Three simulation runs were performed for each traffic volume. The peak hour was analyzed, and it is important to note that each run of the micro-simulation represents a random estimate of the performance measures (e.g., travel time) investigated.

The reduction in conflict points, travel time, speed and delay were analyzed. Through vehicle travel time and speeds were measured along with system delay using the VISSIM micro-simulation model.




Three case studies and three theoretical corridors were analyzed. Three simulation runs were performed for each traffic volume. The peak hour was analyzed, and it is important to note that each run of the micro-simulation represents a random estimate of the performance measures (e.g., travel time) investigated.

The reduction in conflict points, travel time, speed and delay were analyzed. Through vehicle travel time and speeds were measured along with system delay using the VISSIM micro-simulation model.

## Three Case Studies (Characteristics)

| Location | Corridor Length (miles) | Signals per Mile / Access Points per Mile | Median Opening Spacing (feet) | Number of Lanes Each Direction |
|---|---|---|---|---|
| Bryan, Texas | 0.66 | 3.0 / 91 | 690 to 1,320 | 2 |
| Temple, Texas | 0.71 | 5.6 / 66 | 350 to 850 | 2 |
| Tyler, Texas | 1.47 | 4.1 / 46 | 500 to 1,500 | 3 |

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Texas Transportation Institute

This slide shows the key characteristics of the corridors studied. Each location has a two-way left-turn lane (TWLTL) in the existing condition.

## Texas Case Studies (Results)

| Location | Percent Difference in Conflict Points | Estimated Existing ADT | Estimated Future ADT | Future Percent Difference in Travel Time | Future Actual Difference in Speed (mph) |
|---|---|---|---|---|---|
| Bryan, Texas | -60 | | | | |
| Temple, Texas | -56 | | | | |
| Tyler, Texas | -60 | | | | |

- Large reduction in conflict points with raised median installation

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The research team initially investigated the absolute reduction in the number of conflict points along each corridor by installing a raised median. As shown here, it resulted in an approximately 60 percent reduction in conflict points for all corridors.

## Texas Case Studies (Results)

| Location | Percent Difference in Conflict Points | Estimated Existing ADT | Estimated Future ADT | Future Percent Difference in Travel Time | Future Actual Difference in Speed (mph) |
|---|---|---|---|---|---|
| Bryan, Texas | -60 | 18,200 | 21,800 | | |
| | | | 48,000 | | |
| Temple, Texas | -56 | 13,300 | 16,000 | | |
| Tyler, Texas | -60 | 24,400 | 29,300 | | |
| | | | 48,000 | | |

- Lower ADT is "existing +20%"
- Higher volume selected for further analysis

Texas Department of Transportation

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The research team investigated a 20% increase in the existing average daily traffic (ADT) values. For the Bryan and Tyler corridors, the research team also looked at a higher ADT level.

## Texas Case Studies (Results)

| Location | Percent Difference in Conflict Points | Estimated Existing ADT | Estimated Future ADT | Future Percent Difference in Travel Time | Future Actual Difference in Speed (mph) |
|---|---|---|---|---|---|
| Bryan, Texas | -60 | 18,200 | 21,800 | -11 | 2 (increase) |
| | | | 48,000 | -38 | 7 (increase) |
| Temple, Texas | -56 | 13,300 | 16,000 | 3 | 1 (decrease) |
| Tyler, Texas | -60 | 24,400 | 29,300 | 2 | <1 (decrease) |
| | | | 48,000 | 57 | 6 (decrease) |

- Case-specific results
- Function of traffic patterns, median opening locations, etc.

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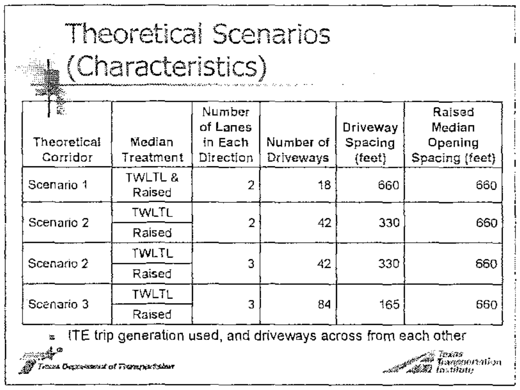
This slide clearly indicates that the results are case specific. The results were within 1 or 2 mph for the lower ADT level. At the higher ADT level in Bryan, there was a 7 mph increase in speed. At the higher ADT level in Tyler, there was a 6 mph decrease in speed. It is hypothesized that the 7 mile per hour difference in Tyler was due to the relatively long median opening spacing in some places (up to 1,500 feet).

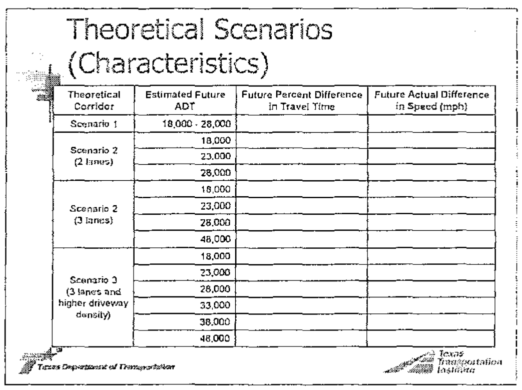
These results provide, at best, a cursory estimate of potential mobility impacts because of the limited number of runs and the limited number of geometric considerations investigated, particularly median opening spacings. While the simulation model was calibrated to existing corridor travel time conditions, evaluating future traffic patterns and operational impacts in the micro-simulation environment can be difficult, especially because these results are based upon nearly a doubling of the traffic levels. Traffic patterns, median opening locations, large trip generators, traffic demand, origin-destination patterns, etc. all affect the micro-simulation results and these elements can be difficult to estimate in a future environment.




| Theoretical Corridor | Median Treatment | Number of Lanes in Each Direction | Number of Driveways | Driveway Spacing (feet) | Raised Median Opening Spacing (feet) |
|---|---|---|---|---|---|
| Scenario 1 | TWLTL & Raised | 2 | 18 | 660 | 660 |
| Scenario 2 | TWLTL / Raised | 2 | 42 | 330 | 660 |
| Scenario 2 | TWLTL / Raised | 3 | 42 | 330 | 660 |
| Scenario 3 | TWLTL / Raised | 3 | 84 | 165 | 660 |

In addition to the "real" case studies from Tyler, Temple and Bryan, the research team also investigated three theoretical scenarios which varied the number of lanes in each direction, the number of driveways and driveway spacing from scenario to scenario. The raised median opening spacing was kept at 600 feet (1/8 of a mile).

The Institute of Transportation Engineers (ITE) *Trip Generation* manual was used to approximate typical land uses along the corridor, and driveways were placed directly across from each other.




| Theoretical Corridor | Estimated Future ADT | Future Percent Difference in Travel Time | Future Actual Difference in Speed (mph) |
|---|---|---|---|
| Scenario 1 | 18,000 - 28,000 | | |
| Scenario 2 (2 lanes) | 18,000 | | |
| | 23,000 | | |
| | 28,000 | | |
| Scenario 2 (3 lanes) | 18,000 | | |
| | 23,000 | | |
| | 28,000 | | |
| | 48,000 | | |
| Scenario 3 (3 lanes and higher driveway density) | 18,000 | | |
| | 23,000 | | |
| | 28,000 | | |
| | 33,000 | | |
| | 38,000 | | |
| | 48,000 | | |

This slide illustrates the range of ADT values that were investigated.

## Theoretical Scenarios (Characteristics)

| Theoretical Corridor | Estimated Future ADT | Future Percent Difference in Travel Time | Future Actual Difference in Speed (mph) |
|---|---|---|---|
| Scenario 1 | 18,000 - 28,000 | Not Applicable | Not Applicable |
| Scenario 2 (2 lanes) | 18,000 | 2 | <1 (decrease) |
| | 23,000 | 6 | 2 (decrease) |
| | 28,000 | 31 | 8 (decrease) |
| Scenario 2 (3 lanes) | 18,000 | 8 | 2 (decrease) |
| | 23,000 | 8 | 2 (decrease) |
| | 28,000 | 11 | 3 (decrease) |
| | 48,000 | 44 | 9 (decrease) |
| Scenario 3 (3 lanes and higher driveway density) | 18,000 | 6 | 2 (decrease) |
| | 23,000 | 1 | <1 (decrease) |
| | 28,000 | 2 | <1 (decrease) |
| | 33,000 | 7 | 2 (decrease) |
| | 38,000 | 22 | 6 (decrease) |
| | 48,000 | 10 | 3 (decrease) |

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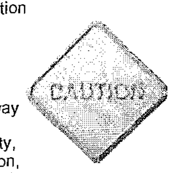
The results of the analysis showed that, on average, there was a 3 mph decrease in speeds for the corridors and scenarios investigated. As previously mentioned, this simulation provides a cursory estimate of anticipated impacts, subject to the numerous operational and geometric assumptions used in the micro-simulation models, and the limited number of micro-simulation runs performed.

## Concluding Thoughts

- Results from raised median installation are case-specific
- Caution should be used when generalizing access management impacts across corridors
- Function of: traffic volumes, driveway density, weaving (o-d patterns), median opening location and density, decel lane length, signal coordination, speed distribution, driver behavior, etc.
- Micro-simulation allows detailed corridor analysis

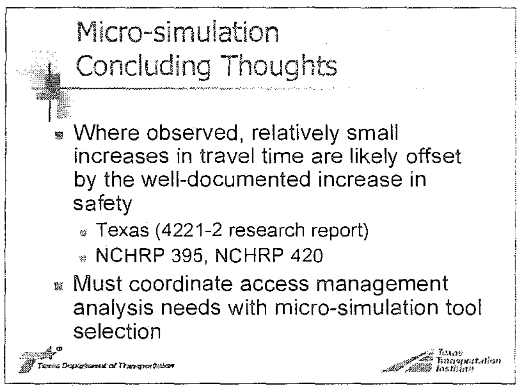



Texas Department of Transportation — Texas Transportation Institute

The results of the micro-simulation analysis are very corridor specific. Caution should be used when generalizing access management impacts across corridors because actual impacts will be a function of traffic volumes, driveway density, weaving, origin-destination (O-D) patterns of vehicles, median opening location and density, deceleration lane length, signal coordination, speed distribution, driver behavior, etc.

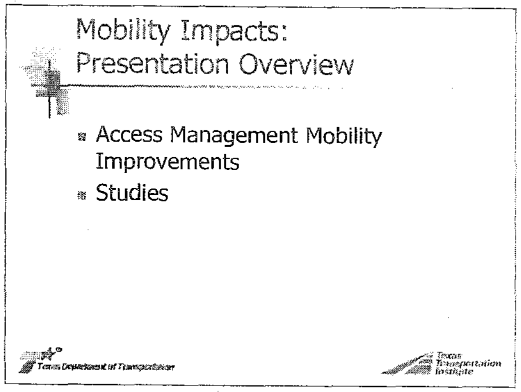
Micro-simulation allows a detailed corridor analysis, but the micro-simulation should be calibrated to field conditions, and it is time consuming to get complete input data to run a micro-simulation model.

While the results provide some mobility estimates, future work is needed that investigates a wider range of operational and geometric conditions with more micro-simulation runs. Analysts studying a specific corridor for improvement with access management treatments should ensure the range of operations and geometric conditions are represented, that an adequate number of runs are performed, and that the model is calibrated to field conditions.

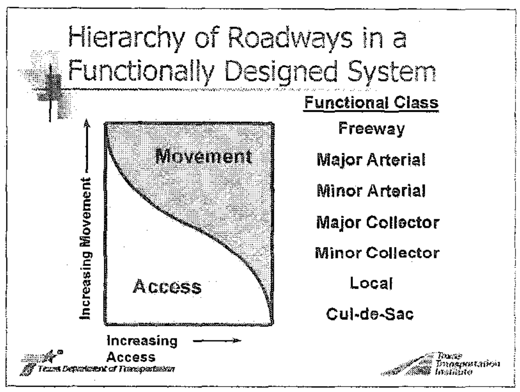



Where observed, the relatively small increases in travel time observed in this study are likely offset by the well-documented increase in safety when implementing access management treatments (particularly raised medians and driveway consolidation). This is evidenced in TxDOT research report 4221-2, which includes this micro-simulation analysis as well, and it is also well documented in NCHRP Report 420.

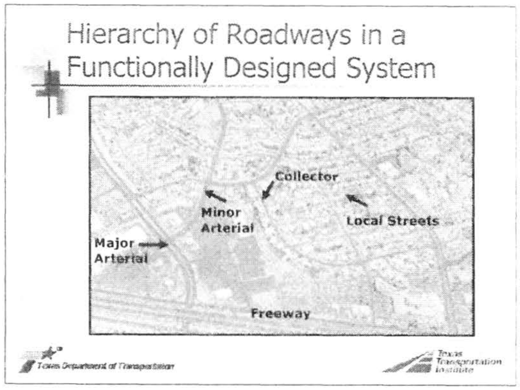
Finally, one must coordinate access management analysis needs with micro-simulation tool selection.




This presentation will focus on the mobility benefits of access management treatments. National and Texas studies are described as a part of this presentation.




Roadways are planned, designed and built to serve a primary function. As this graphic shows, the function of freeways and arterials are to provide movement, whereas collectors and local streets primarily provide access. It is imperative that the primary function of the roadways be maintained when roadways are built. Allowing too much access on arterials, for example, will degrade their operation and not allow them to function as planned.

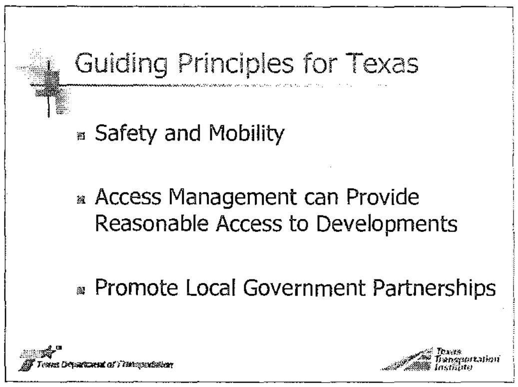



This photograph shows the hierarchy of roadways in a functionally designed system and how the roadways are connected to provide access and movement.

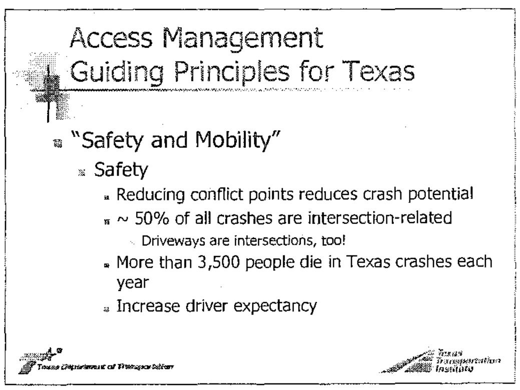
## What Is Important When Driving?

- Safety
- Arriving On time (mobility)
- Getting your (tax) dollars' worth

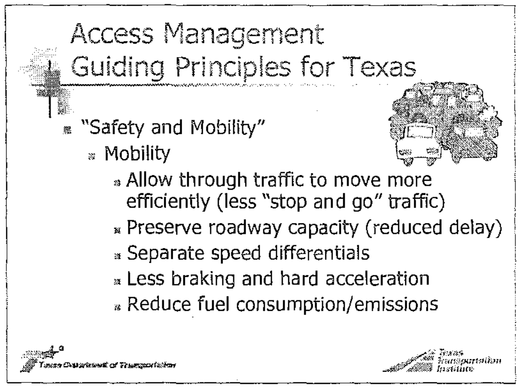
A good way to think about why we do access management is to think about what is important when driving. Arriving safely usually always tops the list, and the safety benefits of access management treatments are well documented. Mobility, or the ability to arrive to a destination on time, is important as well because users want to feel like the system is reliable. Access management treatments can improve mobility. Finally, motorists need to feel like they are getting their dollars' worth. If we allow our roadways to become too cluttered with multiple access points, they may not function as initially planned, and we will not be getting our tax dollars' worth.



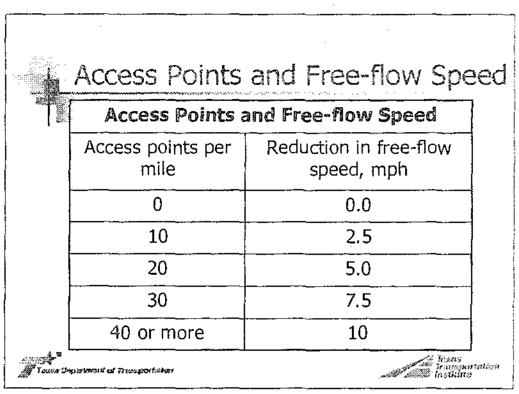

This slide lists the three primary guiding principles that form the basis of why TxDOT is pursuing access management implementation. The first guiding principle is that access management improves safety and mobility. Secondly, properly implementing access management treatments can provide reasonable access to developments. Finally, TxDOT wishes to promote local government partnerships by implementing access management. Cooperation between local agencies (cities, counties) and TxDOT facilitates access management implementation and success.




The first guiding principle is "safety and mobility." This slide discusses the "safety" aspects of this guiding principle. Access management treatments reduce the number of conflict points along a roadway, which, in turn, reduces crash potential. About half of all crashes are intersection-related, and about 3,500 people die in Texas crashes each year. Implementing access management treatments can improve the safety of our roadways.




On the "mobility" side of this guiding principle, it is important to note that access management treatments allow through traffic to move more efficiently (i.e., there is less "stop and go" traffic). We can preserve through-movement capacity with the construction of acceleration and deceleration lanes, which separate speed differentials. The smoother roadway operation created by access management treatments leads to less braking and hard acceleration and subsequently reduced fuel consumption/emissions.


Access Points and Free-flow Speed

**Access Points and Free-flow Speed**

| Access points per mile | Reduction in free-flow speed, mph |
|---|---|
| 0 | 0.0 |
| 10 | 2.5 |
| 20 | 5.0 |
| 30 | 7.5 |
| 40 or more | 10 |

National research in National Cooperative Highway Research Program (NCHRP) Report 420 *Impacts of Access Management* illustrates that as the access points (signalized and unsignalized) per mile increases, there is a reduction in the free-flow speed along a roadway.

## Travel Time and Signal Density

**Percentage Increase in Travel Times as Signal Density Increases**

| Signals per Mile | Percent Increase in Travel Times (compared with 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 |

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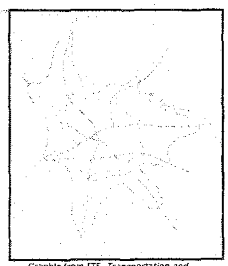
This table is also documentation from NCHRP Report 420. It indicates that as signal density increases, there is an increase in travel times. For example, going from 2 signals per mile to 4 signals per mile can cause a 16 percent increase in travel time.

## Mobility Provides Economic Impacts

- Market area is important to business success
  - Reduction of travel speeds means smaller market areas



Graphic from ITE, *Transportation and Land Development*

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This slides illustrates the important connection between mobility and economic impacts. Imagine that the outer line represents the market share at 45 mph for a grocery store located in the middle of this urban area. If speeds are degraded along the corridors leading to the store to 30 mph, the market area shrinks to that shown by the dashed line. Speeds can be reduced by not practicing good access management.

## Texas Studies

The following slides describe research findings that relate to the mobility aspects of access management treatments.

## Texas Case Studies (Results)

| Location | Percent Difference in Conflict Points. | Estimated Existing ADT | Estimated Future ADT | Future Percent Difference in Travel Time | Future Actual Difference in Speed (mph) |
|---|---|---|---|---|---|
| Bryan, Texas | -60 | 18,200 | 21,800 | -11 | 2 (increase) |
| | | | 48,000 | -38 | 7 (increase) |
| Temple, Texas | -56 | 13,300 | 16,000 | 3 | 1 (decrease) |
| Tyler, Texas | -60 | 24,400 | 29,300 | 2 | <1 (decrease) |
| | | | 48,000 | 57 | 6 (decrease) |

- Case-specific results
- Function of traffic patterns, median opening locations, etc.

This slide clearly indicates that the micro-simulation results are case specific. The results were within 1 or 2 mph for the lower ADT level. At the higher ADT level in Bryan, there was a 7 mph increase in speed. At the higher ADT level in Tyler, there was a 6 mph decrease in speed. It is hypothesized that the 7 mile per hour difference in Tyler was due to the relatively long median opening spacing in some places (up to 1,500 feet).

These results provide, at best, a cursory estimate of potential mobility impacts because of the limited number of runs and the limited number of geometric considerations investigated, particularly median opening spacings. While the simulation model was calibrated to existing corridor travel time conditions, evaluating future traffic patterns and operational impacts in the micro-simulation environment can be difficult, especially because these results are based upon nearly a doubling of the traffic levels. Traffic patterns, median opening locations, large trip generators, traffic demand, origin-destination patterns, etc. all affect the micro-simulation results and these elements can be difficult to estimate in a future environment.

## Theoretical Scenarios (Characteristics)

| Theoretical Corridor | Median Treatment | Number of Lanes in Each Direction | Number of Driveways | Driveway Spacing (feet) | Raised Median Opening Spacing (feet) |
|---|---|---|---|---|---|
| Scenario 1 | TWLTL & Raised | 2 | 18 | 660 | 660 |
| Scenario 2 | TWLTL / Raised | 2 | 42 | 330 | 660 |
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| Scenario 3 | TWLTL / Raised | 3 | 84 | 165 | 660 |

- ITE trip generation used, and driveways across from each other

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In addition to the "real" case studies from Tyler, Temple and Bryan, the research team also investigated three theoretical scenarios which varied the number of lanes in each direction, the number of driveways and driveway spacing from scenario to scenario. The raised median opening spacing was kept at 600 feet (1/8 of a mile).

The Institute of Transportation Engineers (ITE) *Trip Generation* manual was used to approximate typical land uses along the corridor, and driveways were placed directly across from each other.

## Theoretical Scenarios (Characteristics)

| Theoretical Corridor | Estimated Future ADT | Future Percent Difference in Travel Time | Future Actual Difference in Speed (mph) |
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| Scenario 1 | 18,000 - 28,000 | Not Applicable | Not Applicable |
| Scenario 2 (2 lanes) | 18,000 | 2 | <1 (decrease) |
| | 23,000 | 6 | 2 (decrease) |
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| Scenario 2 (3 lanes) | 18,000 | 8 | 2 (decrease) |
| | 23,000 | 8 | 2 (decrease) |
| | 28,000 | 11 | 3 (decrease) |
| | 48,000 | 44 | 9 (decrease) |
| Scenario 3 (3 lanes and higher driveway density) | 18,000 | 6 | 2 (decrease) |
| | 23,000 | 1 | <1 (decrease) |
| | 28,000 | 2 | <1 (decrease) |
| | 33,000 | 7 | 2 (decrease) |
| | 38,000 | 22 | 6 (decrease) |
| | 48,000 | 10 | 3 (decrease) |

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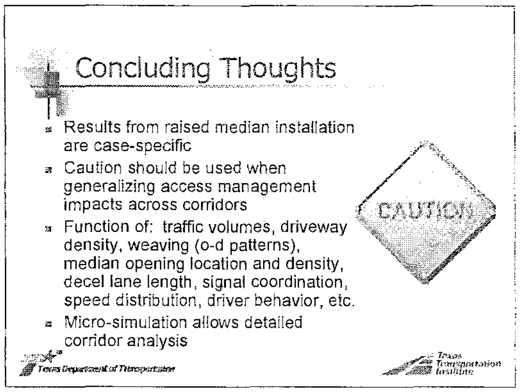
The results of the analysis showed that, on average, there was a 3 mph decrease in speeds for the corridors and scenarios investigated. As previously mentioned, this simulation provides a cursory estimate of anticipated impacts, subject to the numerous operational and geometric assumptions used in the micro-simulation models, and the limited number of micro-simulation runs performed.




The results of the micro-simulation analysis are very corridor specific. Caution should be used when generalizing access management impacts across corridors because actual impacts will be a function of traffic volumes, driveway density, weaving, origin-destination (O-D) patterns of vehicles, median opening location and density, deceleration lane length, signal coordination, speed distribution, driver behavior, etc.

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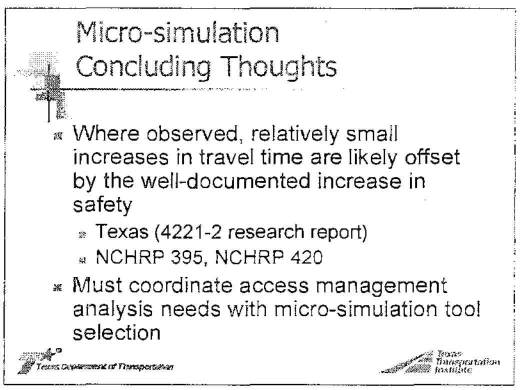


Where observed, the relatively small increases in travel time observed in this study are likely offset by the well-documented increase in safety when implementing access management treatments (particularly raised medians and driveway consolidation). This is evidenced in TxDOT research report 4221-2, which includes this micro-simulation analysis as well, and it is also well documented in NCHRP Report 420.

Finally, one must coordinate access management analysis needs with micro-simulation tool selection.

## Mobility Photos: Presentation Overview

- Driveway Spacing and/or Consolidation
- Corner Clearance
- Signal Spacing
- Median Treatments
- Acceleration and Deceleration Lanes
- Auxiliary Lanes
- Freeway Frontage Roads
- Arterial Frontage Roads
- Summary

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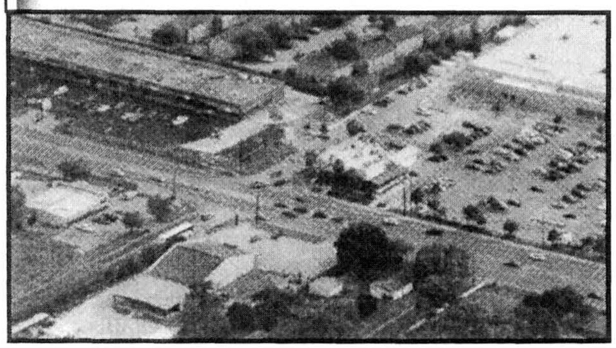
## Driveway Spacing and/or Consolidation

## Cross Access



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## Cross Access Desired

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## Cross Access

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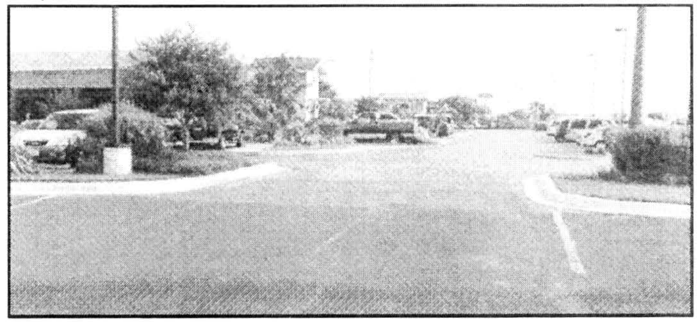
## Cross Access



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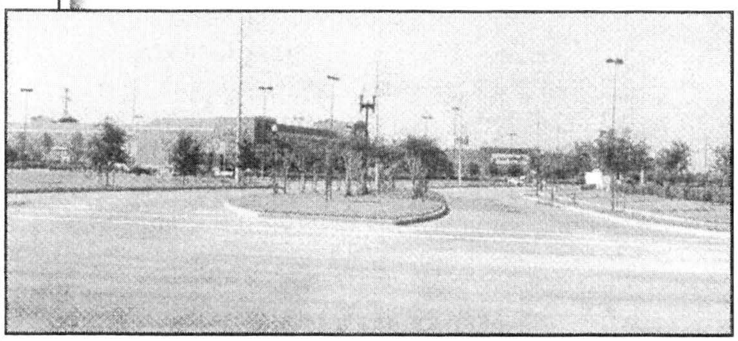
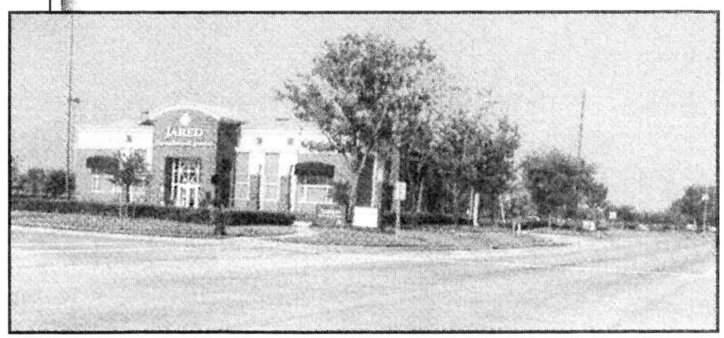
Texas Transportation Institute

## Major Shared Access Point for Big Box



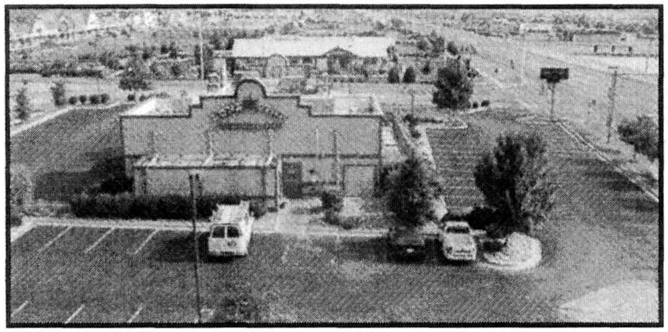
Texas Department of Transportation
Texas Transportation Institute

## Major and Minor Access Points for Big Box and Monument Sign



Texas Department of Transportation
Texas Transportation Institute

## Cross Access



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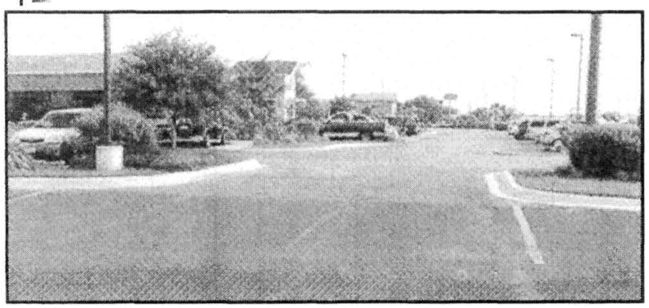
## Cross Access

Texas Department of Transportation

Texas Transportation Institute

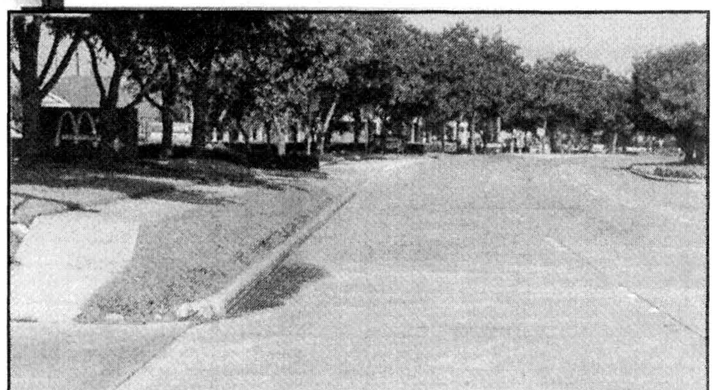
## Shared Access Retrofit



Texas Department of Transportation

Texas Transportation Institute

## Limited Driveways and Monument Signs



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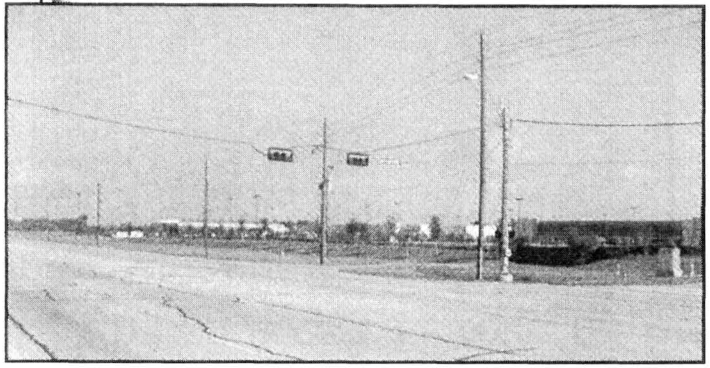
Texas Transportation Institute

## Big Box with Limited Access



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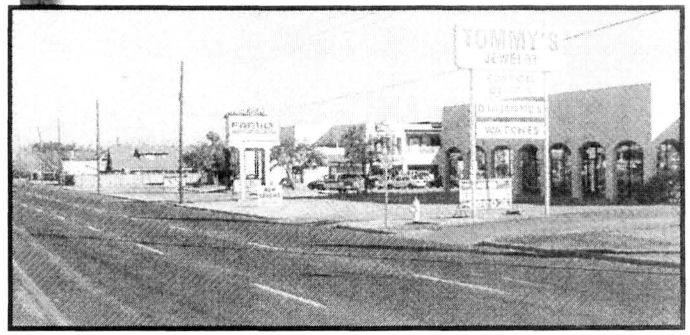
## Potential Drive Consolidation / Cross Access




- SH 191/42nd St – Odessa

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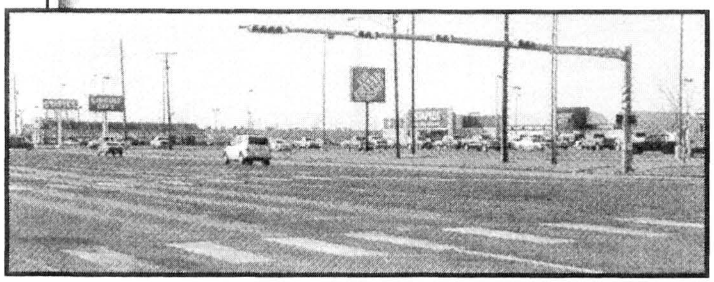
## No Direct Access Big Box Retail



- SH 191/42nd St – Odessa

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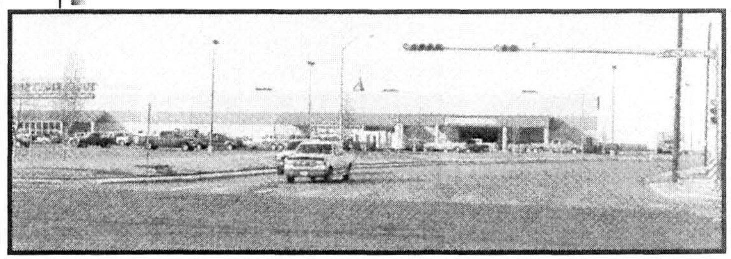
## Side Access for Big Box Retail



- SH 191/42nd St @ Preston Smith Rd - Odessa

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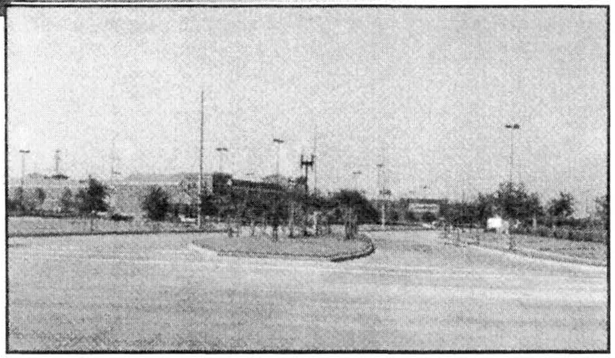
## Major Shared Access Point



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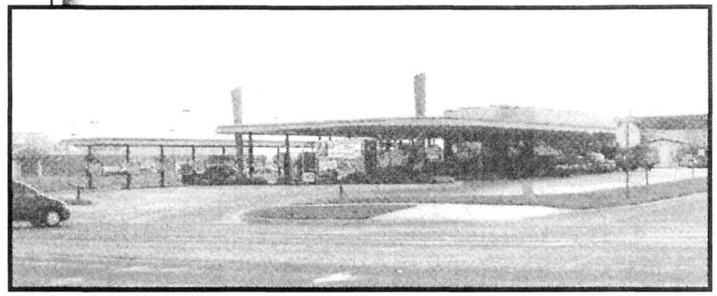
## Single Driveway Access for Fast Food



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## Fast Food – Single Access Point

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## Fast Food with 3 Access Points


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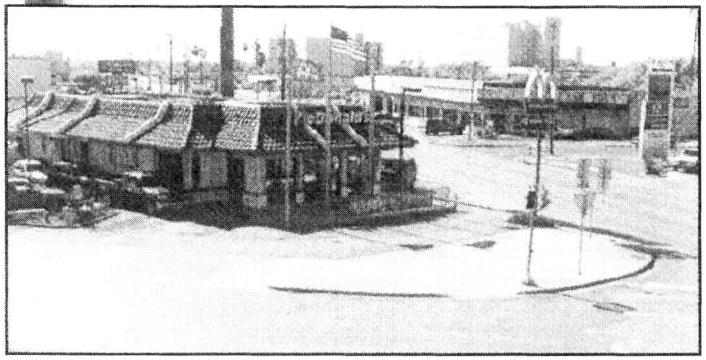
## Undesirable Spacing



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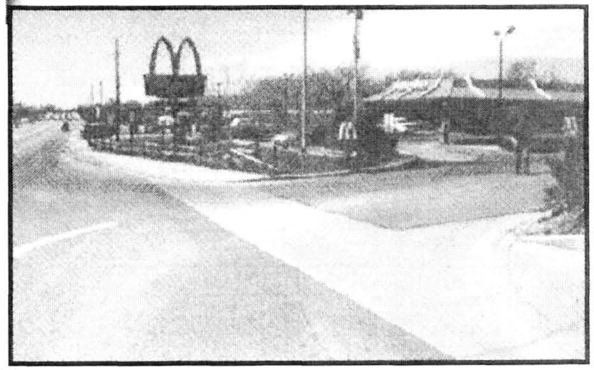
## Build It and They Will Still Come!



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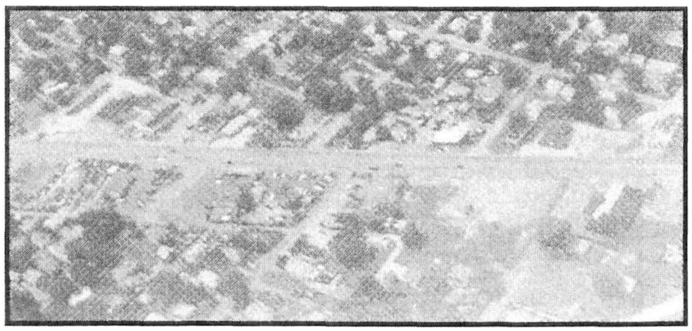
## Poor Driveway Spacing



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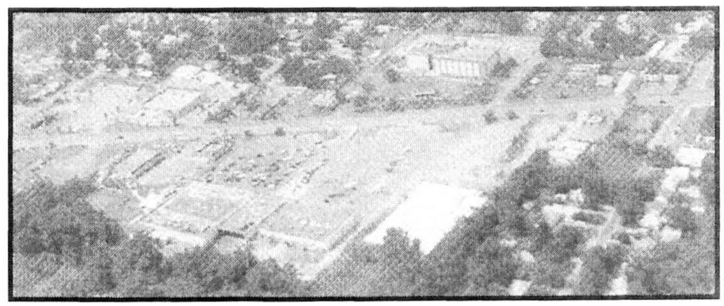
## Better Driveway Spacing



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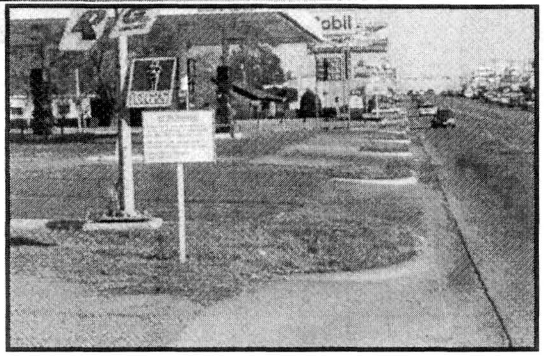
## What Are We Trying to Fix/Avoid?

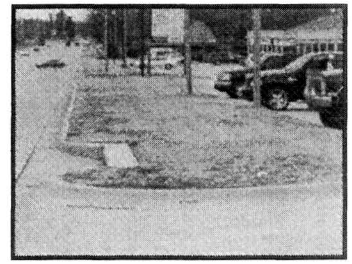


- Multiple Access Points per Business



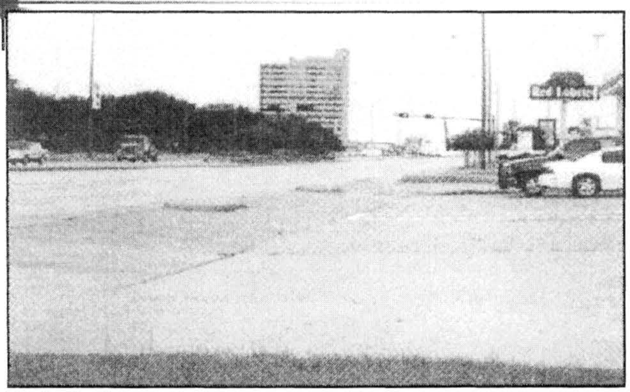
## What Are We Trying to Fix/Avoid?

- Reduce Conflict Points
- Increase Driveway Spacing





## Undesirable Driveway Spacing

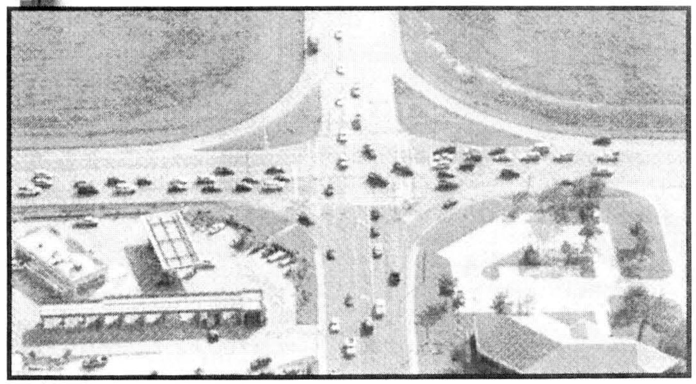




## Fast Food Restaurant With Limited Access

## Corner Clearance

## Corner Clearance



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## Corner Clearance

Texas Department of Transportation

Texas Transportation Institute

## Corner Clearance

Texas Department of Transportation

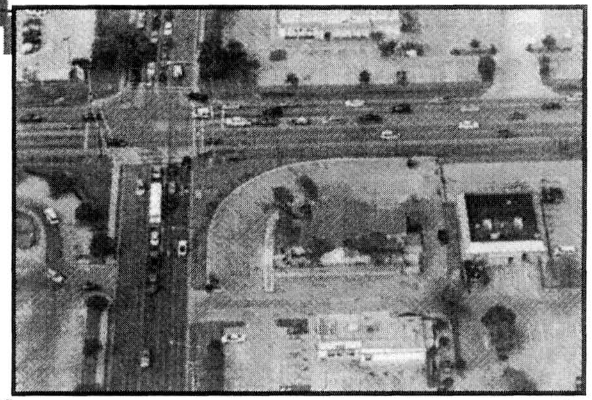
Texas Transportation Institute

## Corner Clearance

Texas Department of Transportation

Texas Transportation Institute

## Corner Clearance



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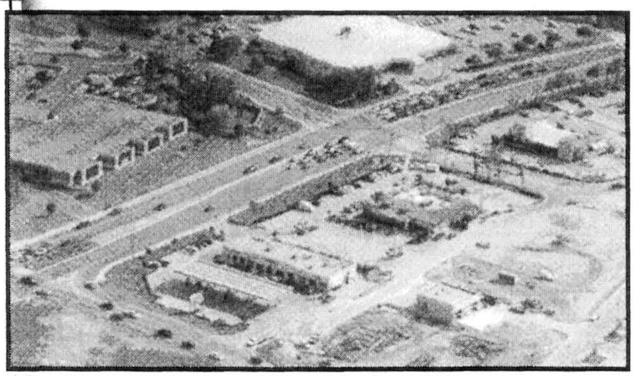
## Corner Clearance



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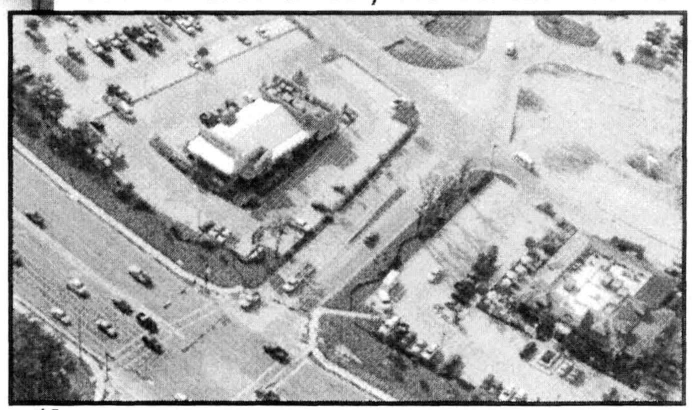
## Corner Clearance / No Direct Access



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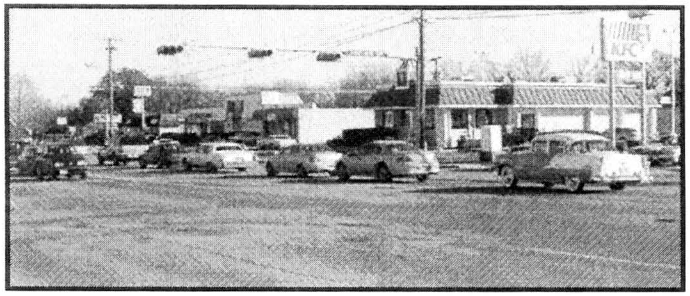
## Downstream Left-Turn Queue Backing Up Into Intersection

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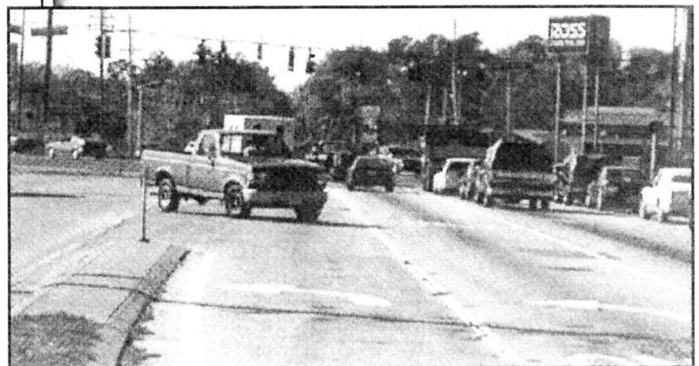
## TWLTL Conflicting Uses/ Inappropriate Median Cut

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## Corner Clearances

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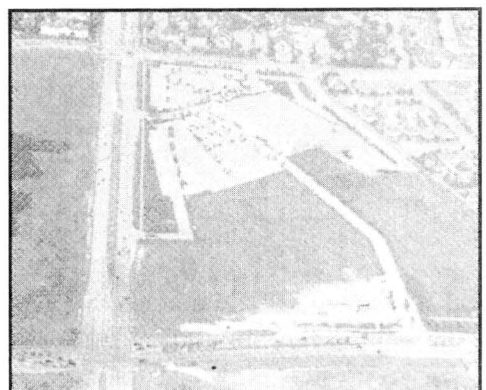
## Corner Clearance



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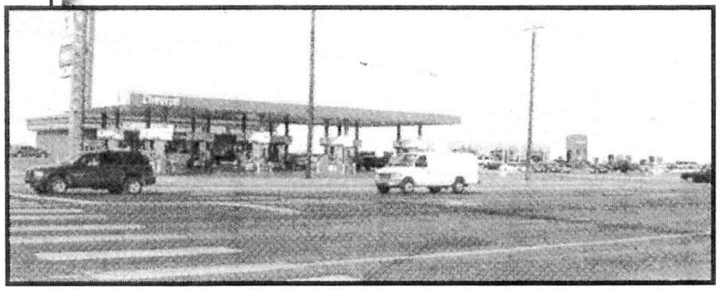
## Corner Clearance



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## Corner Clearance / Raised Median

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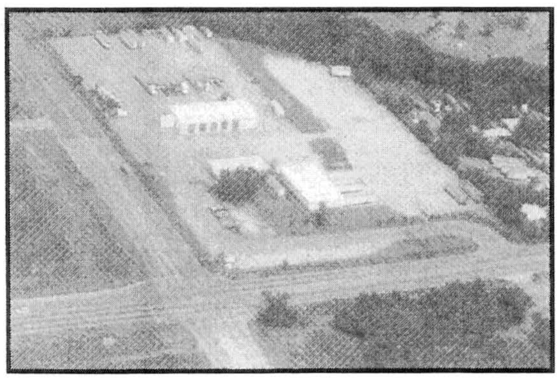
## Corner Clearance



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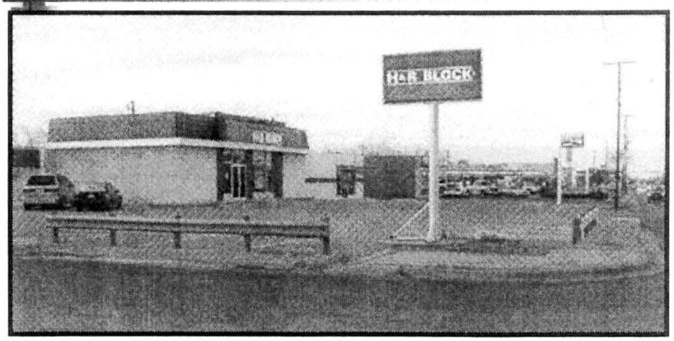
## What Are We Trying to Fix/Avoid?




- Closed Access Points
- Increase Driveway Spacing

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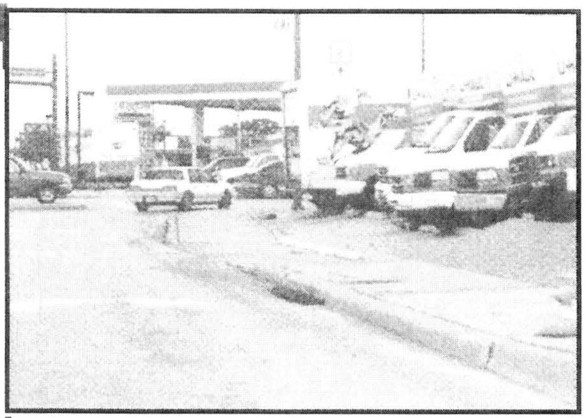
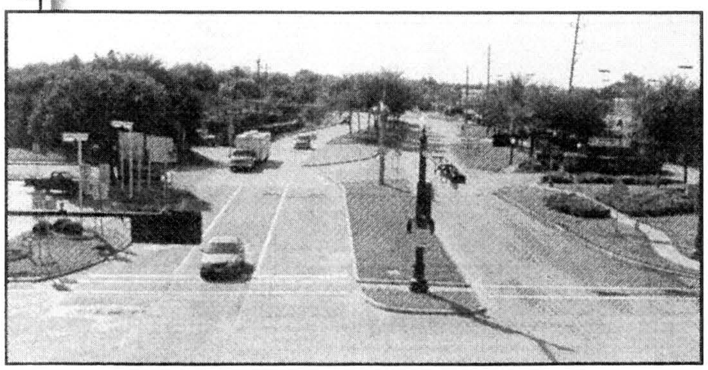
## Closed Access





## Signal Spacing

## Signal Spacing and Directional Intersection



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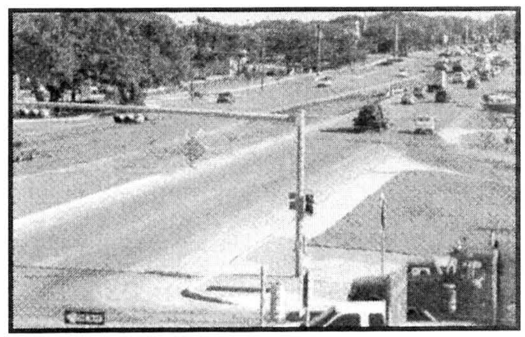
## Signal Spacing



- Maintains Progression / Movement

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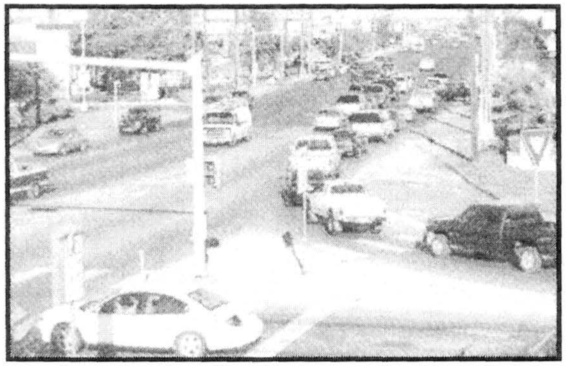
## What Are We Trying to Fix/Avoid?



- Poor Signal Spacing

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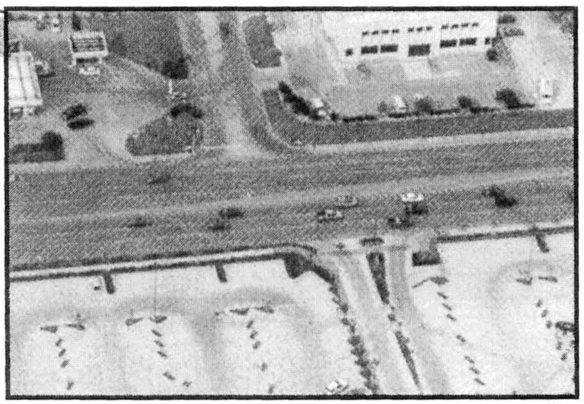
## Median Treatments

## Raised Median



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## Raised Median

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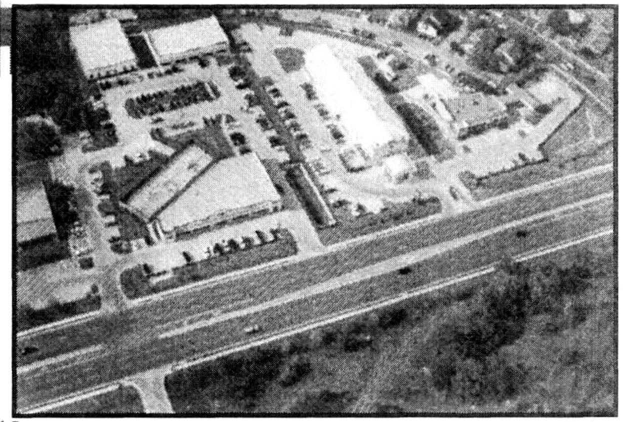
# Raised Median

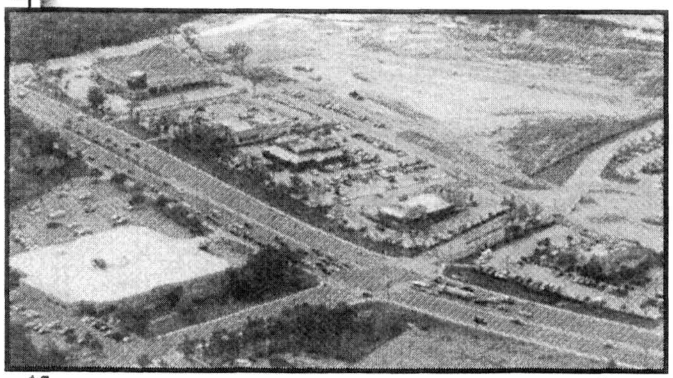


# Raised Median / Cross Access



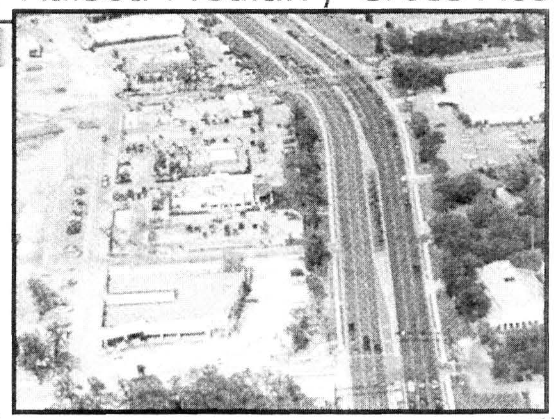


# Raised Median / Cross Access

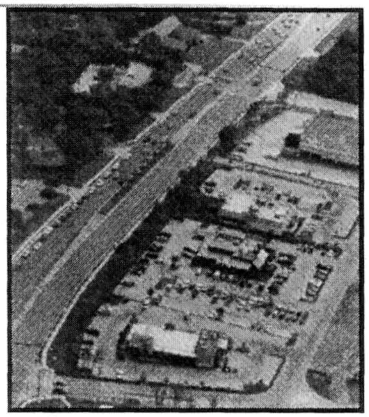




# Raised Median / Cross Access



## Raised Median / Cross Access



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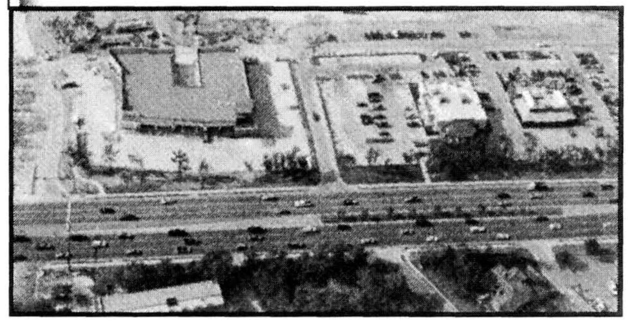
## Raised Median / Cross Access



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## Raised Median / Cross Access

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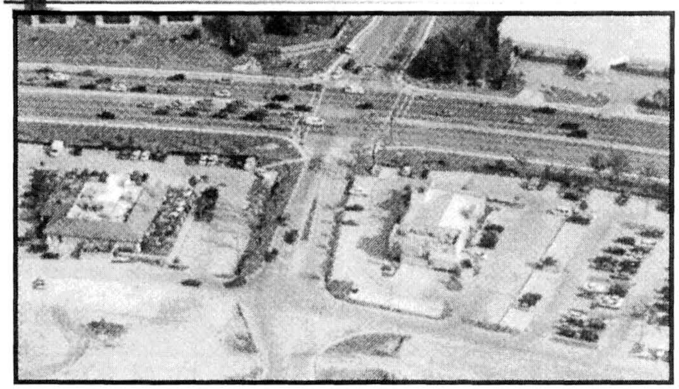
## Raised Median / Cross Access



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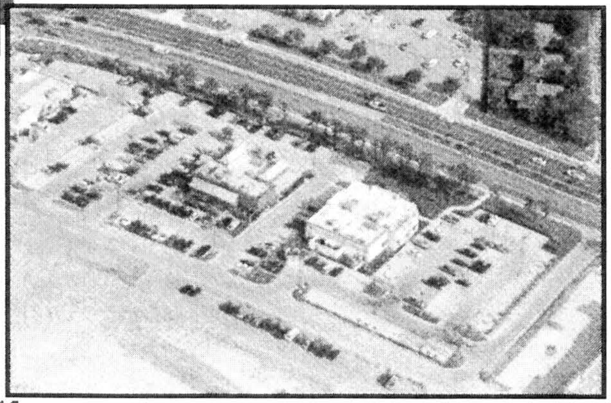
## Raised Median / Cross Access



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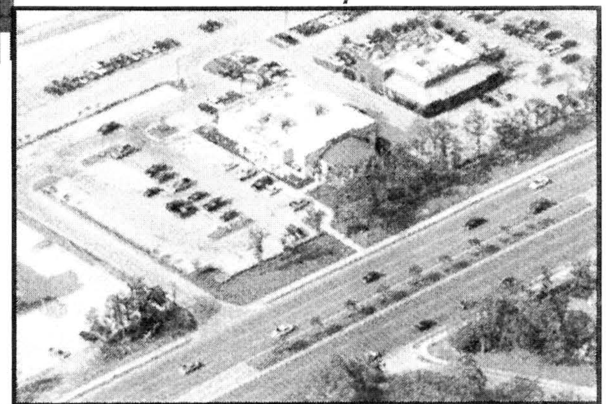
## Raised Median / Cross Access



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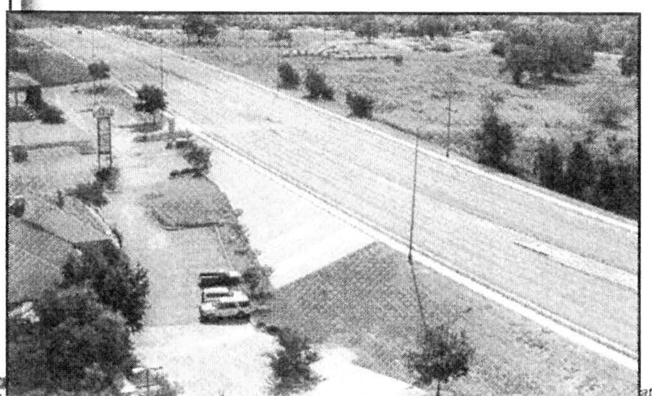
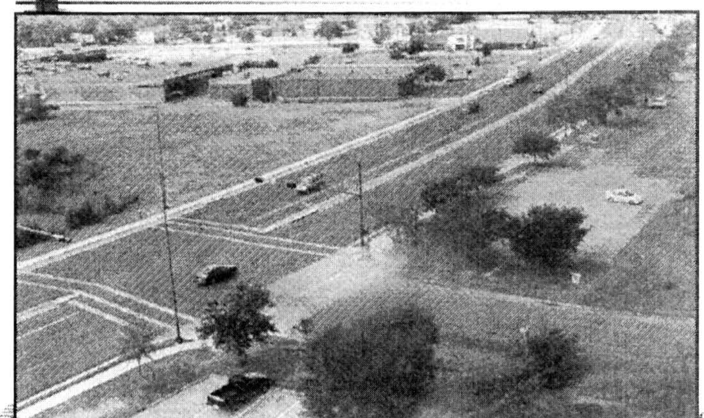
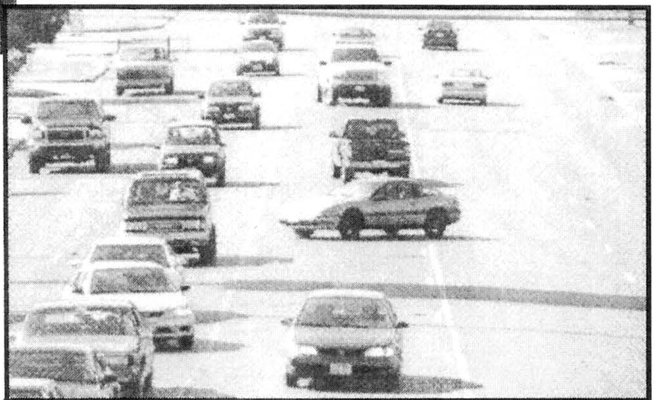
## Raised Median in Advance of Development



## Raised Median in Advance of Development

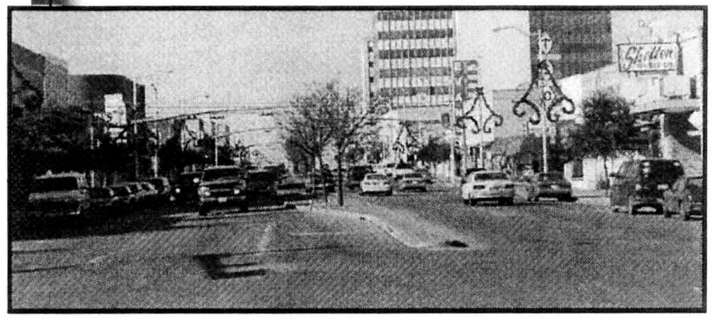


## Two-way Left-Turn Lane Conflicts





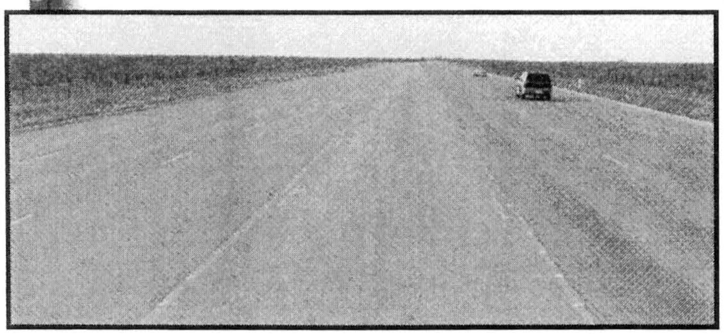
## Raised Median - CBD



- US 385/Grant Ave – Odessa



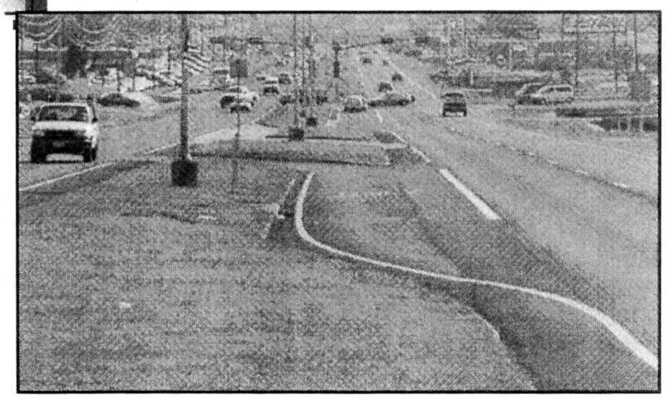
## Potential Access Management Undeveloped Land



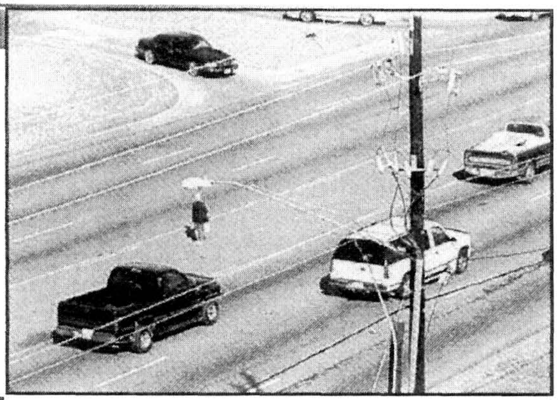
- Grandview Ave – Odessa



## Directional Left-Turns



## Pedestrian Safety



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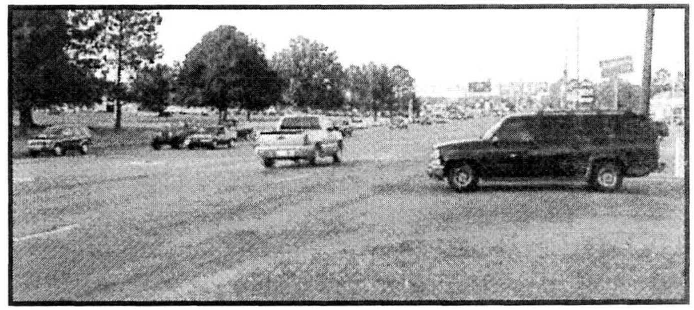
## Safety – Reduce Conflict Points



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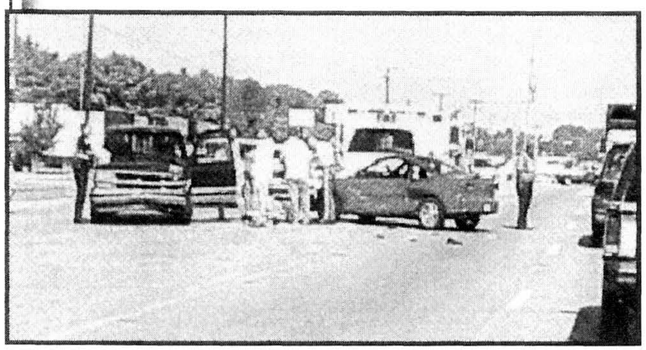
## Safety - Reduce Crashes



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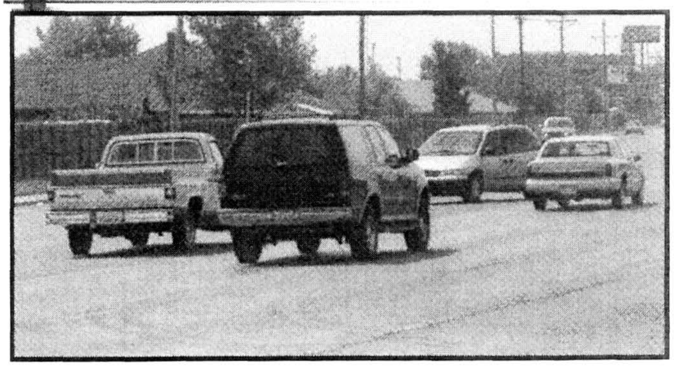
## What Are We Trying to Fix/Avoid?



- TWLTL Conflicting Uses

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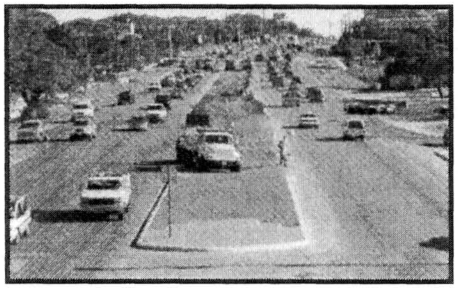
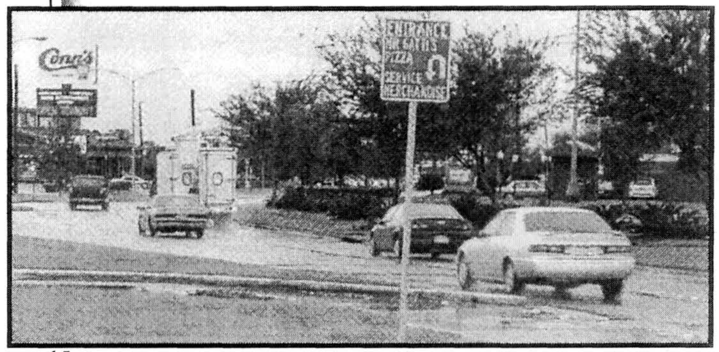
# Medians



- Reduce Conflict Points & Congestion
- Increase Driver Expectations



# Signage for Raised Median Openings



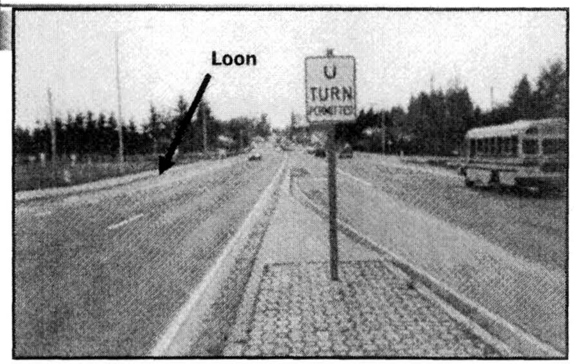
- Provides Direction to Adjacent Businesses



# Raised Median at Close Intersection Spacing

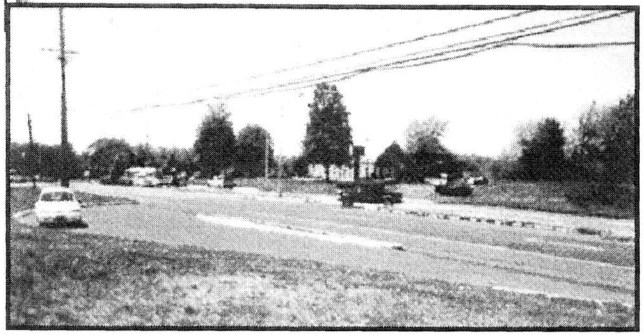


# Word for the Day: "Loon"




Sometimes wider for two-stage turning maneuver (Salem, OR)

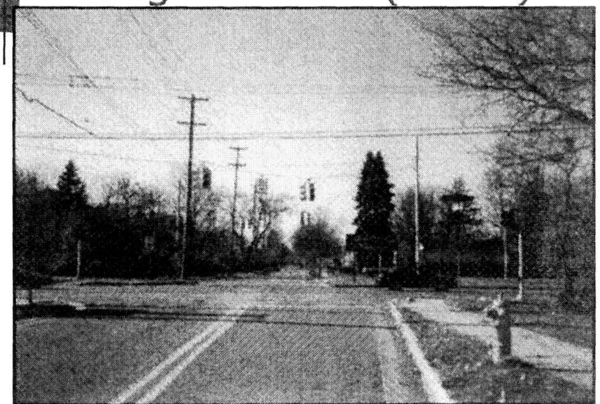
## "Two-stage" Loon



Left-turn and then merge with traffic (New Jersey)

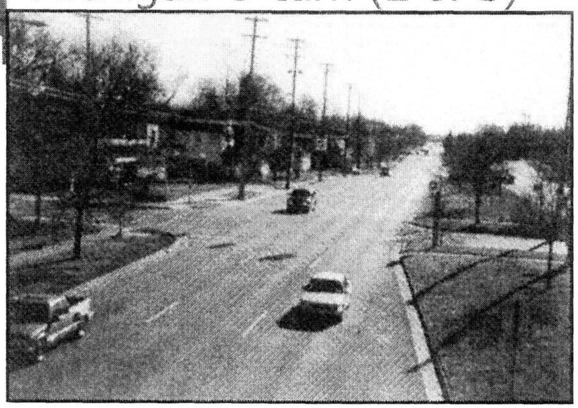


## Michigan U-turn (1 of 3)



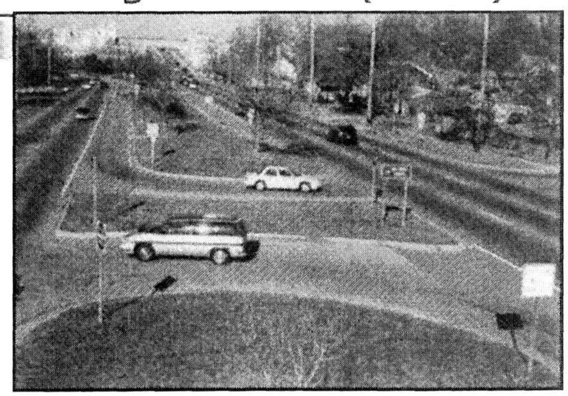


## Michigan U-turn (2 of 3)

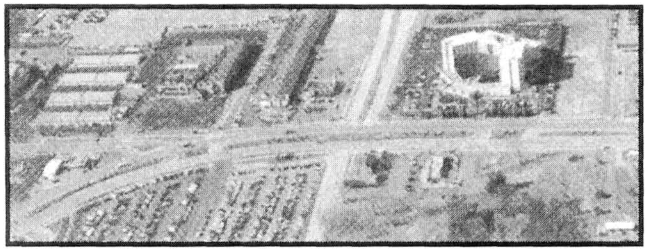




## Michigan U-turn (3 of 3)



## Michigan U-turn



- Detroit, MI



## Michigan U-turn

- Detroit, MI

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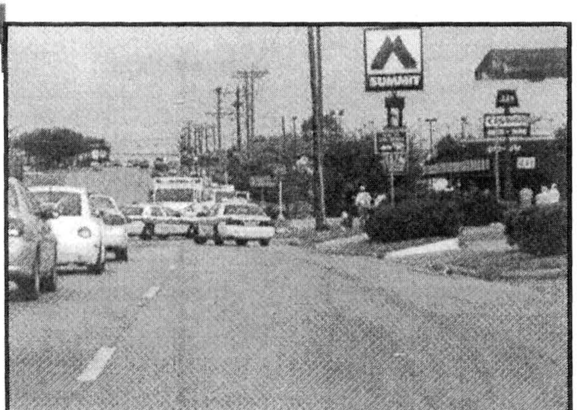
## Safety Impacts



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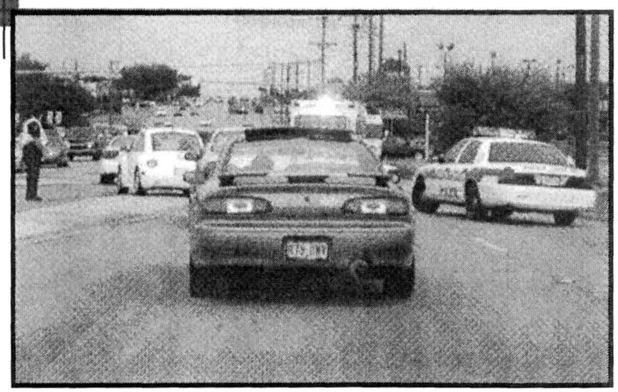
## Safety Impacts



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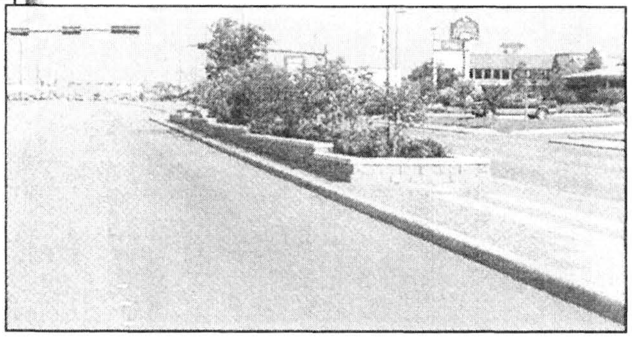
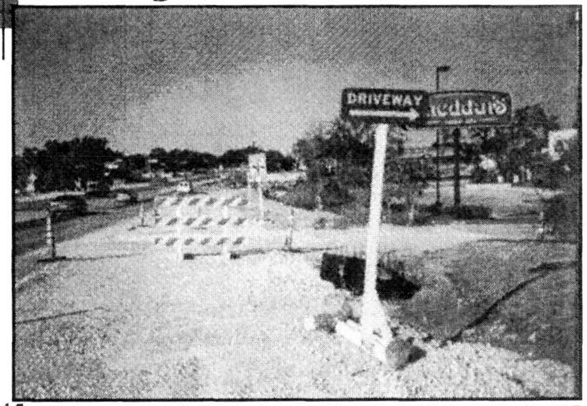
## Landscaping and Pavers



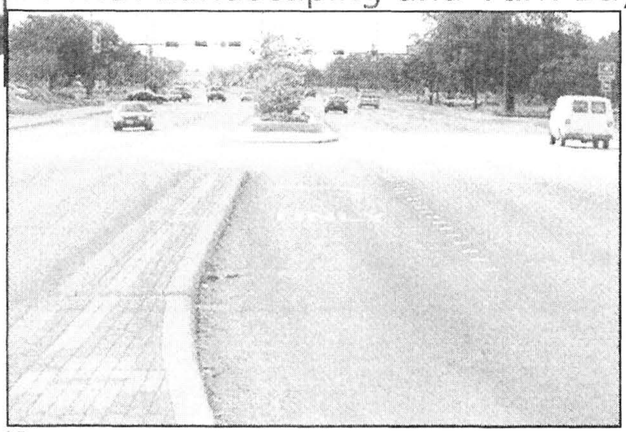


## Maintaining Driveway Access During Construction



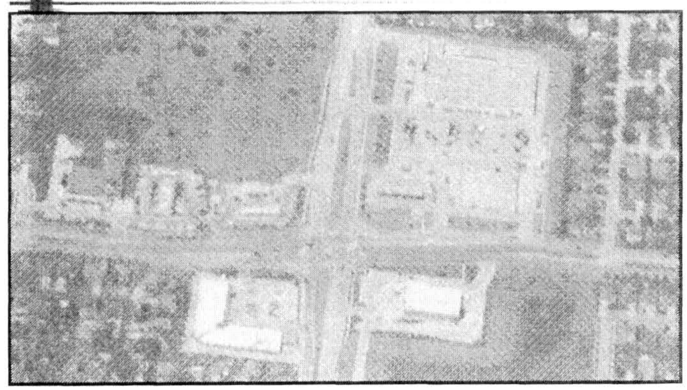



## RM with Landscaping and Turn Bays



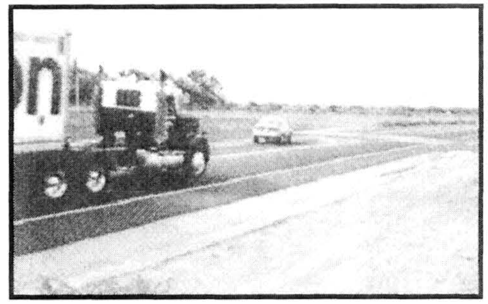


## Corner Clearances and Medians



## Acceleration and Deceleration Lanes

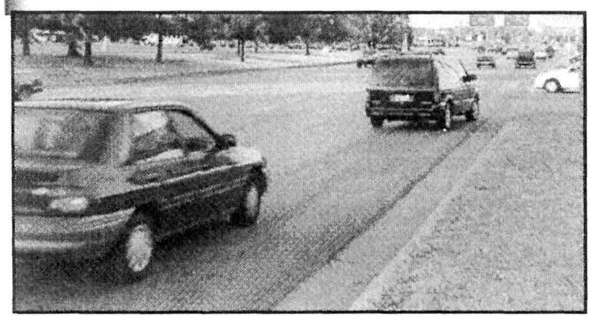
## Turn Lanes



- Separate Speeds and Create Safe Havens



## What Are We Trying to Fix/Avoid?



- Speed Differentials



## Decel Lane and Architectural Standards

## Architectural Standards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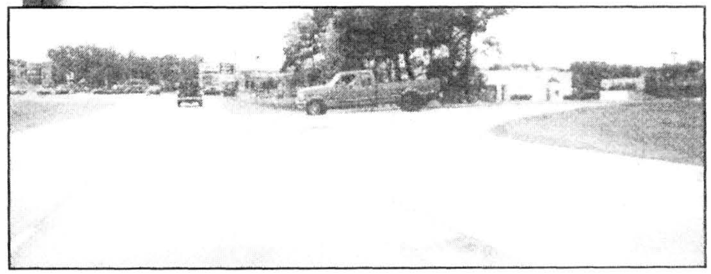
## Deceleration Lane



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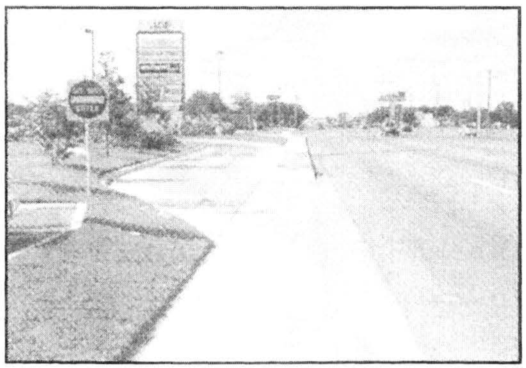
## Right-In / Right-Out with Queue Storage



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## Limited Length Deceleration Lane

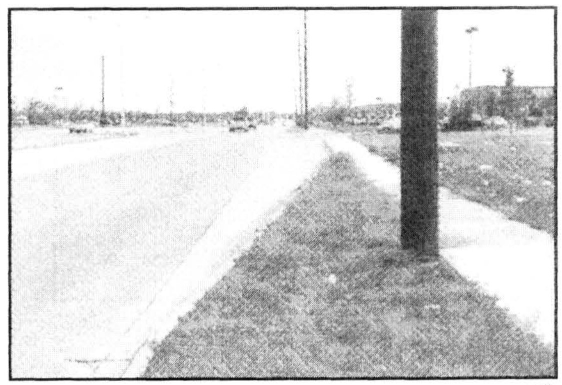

*Photo courtesy City of Garland*

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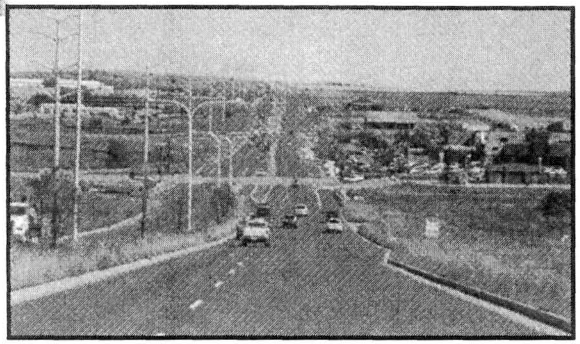
## Decel / Accel Lanes

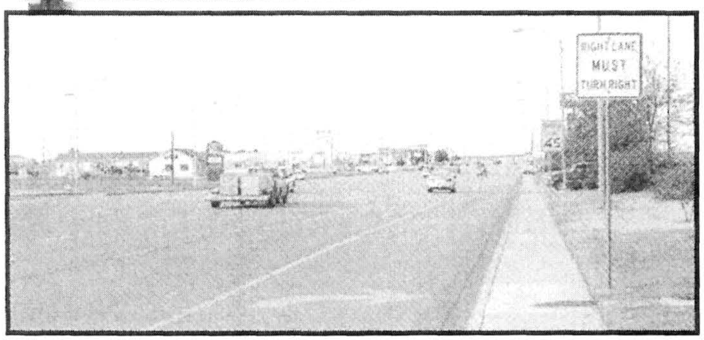


- Colorado Springs, CO



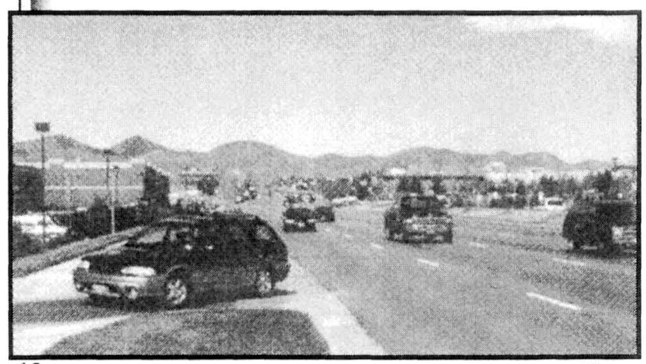
## Auxiliary Lanes

## Auxiliary Lane



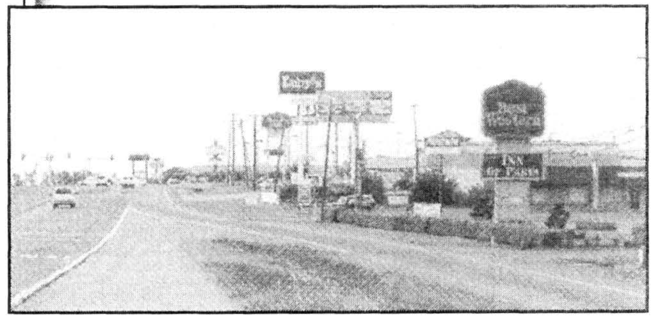



## Auxiliary Lane



# Freeway Frontage Roads

# Driveways and Ramp



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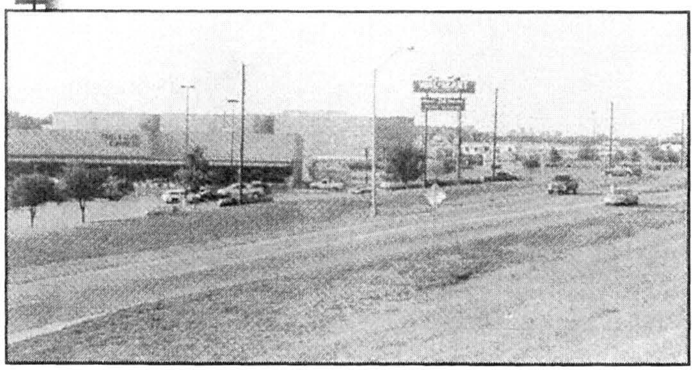
# Driveway – Ramp Spacing



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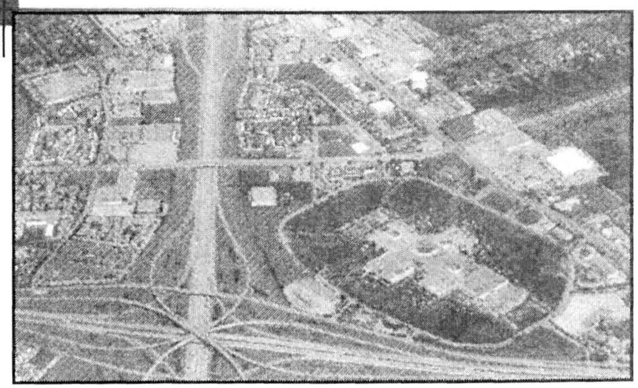
# Development Without Frontage Roads



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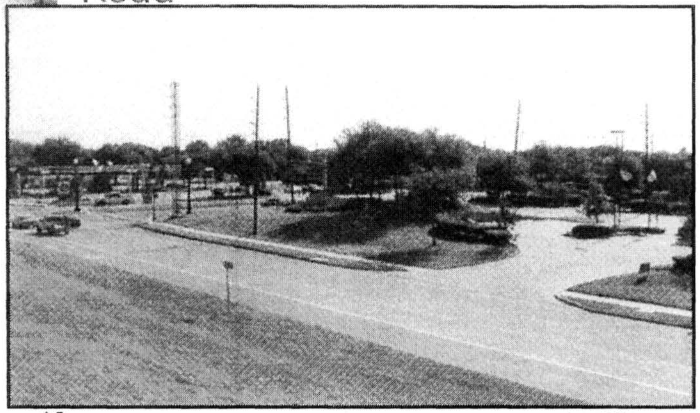
## Corner Clearance on Frontage Road



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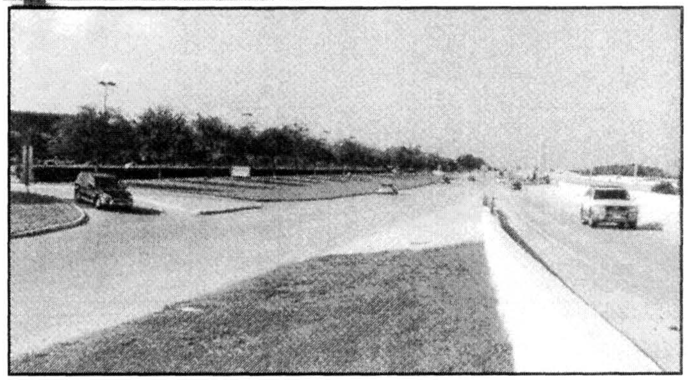
Texas Transportation Institute

## Driveway/Ramp Spacing and Right-In/Right Out



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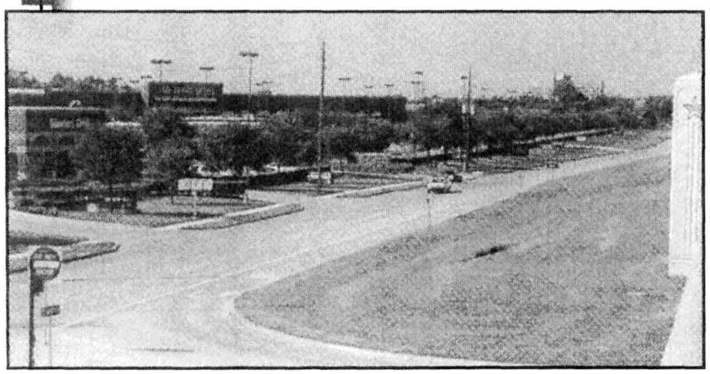
## Access Spacing on Frontage Road and Home Depot Architecture



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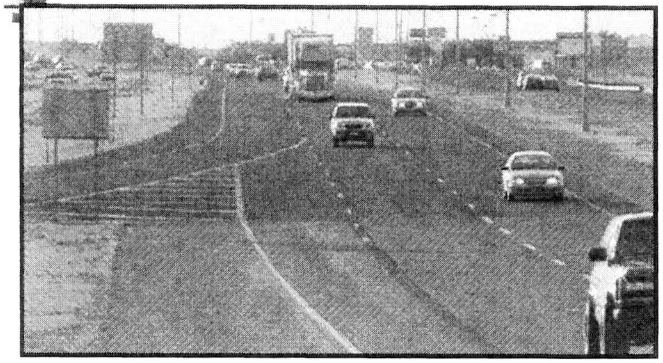
Texas Transportation Institute

## Limited Access on Frontage Road

Texas Department of Transportation

Texas Transportation Institute

## Freeway Auxiliary Lane Transition



- Loop 250 – Midland

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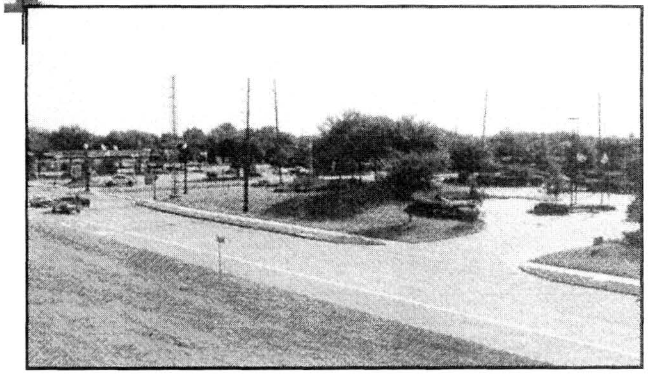
## Corner Clearance on Frontage Road



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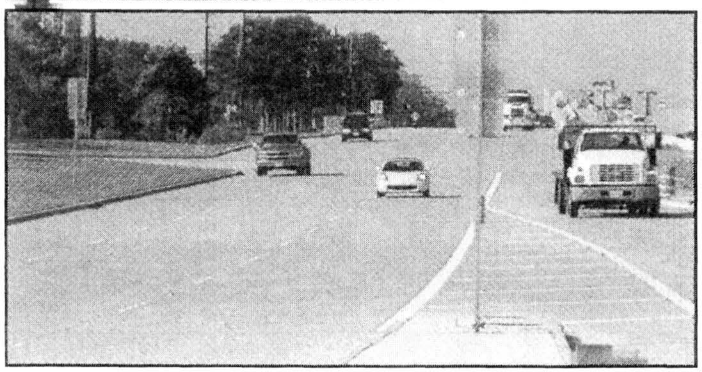
## Driveway/Ramp Spacing



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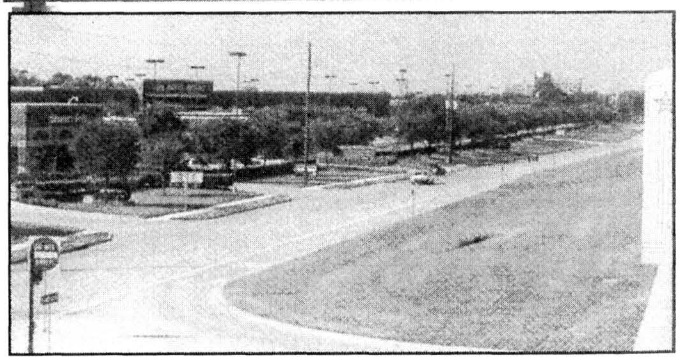
## Access Spacing on Frontage Road



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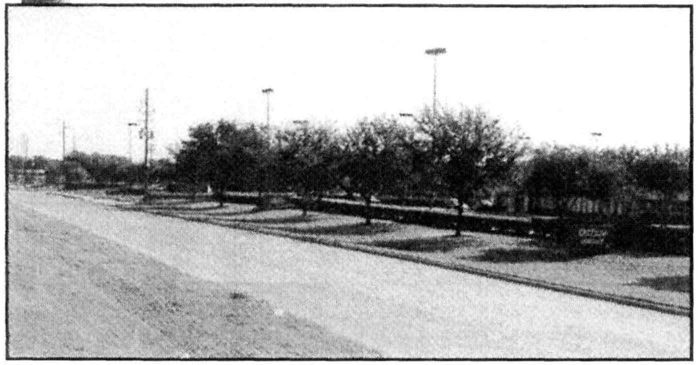
## Limited Access on Frontage Road



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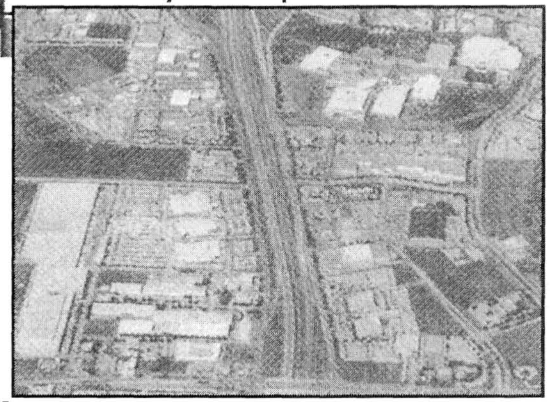
## Mall Entrance – Proximity to Freeway Ramp



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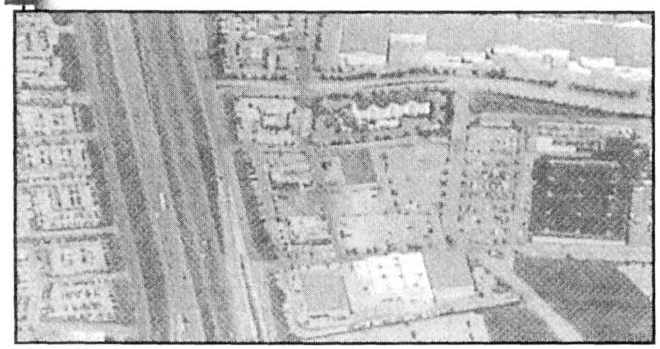
## Mall Entrance – Proximity to Freeway Ramp



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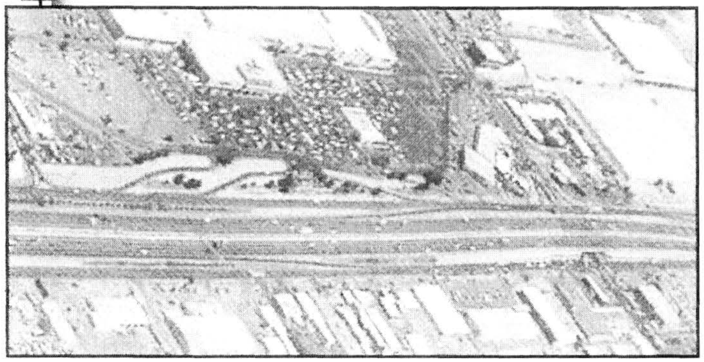
Texas Transportation Institute

## Mall Ingress and Egress on Frontage Road

Texas Department of Transportation

Texas Transportation Institute

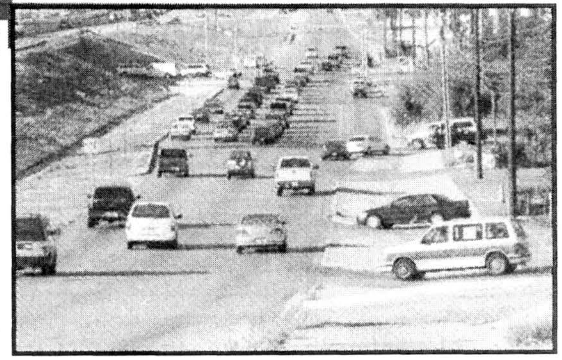
## Mall Ingress and Egress on Frontage Road – Close Up



Texas Department of Transportation

Texas Transportation Institute

## What Are We Trying to Fix/Avoid?



- Multiple Conflict Opportunities

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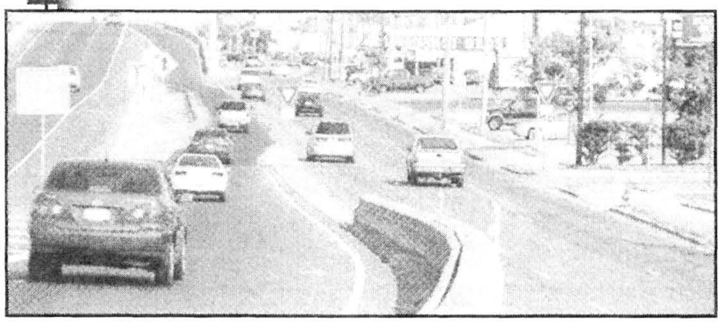
## Driveways at Ramp Gores



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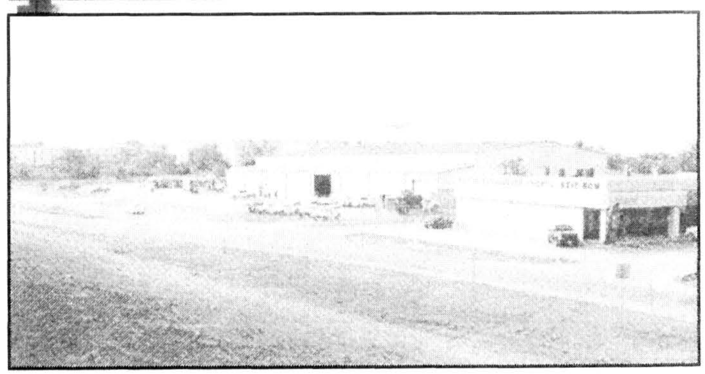
## What Are We Trying to Fix/Avoid?



- Ramp Gore – Driveway Spacing

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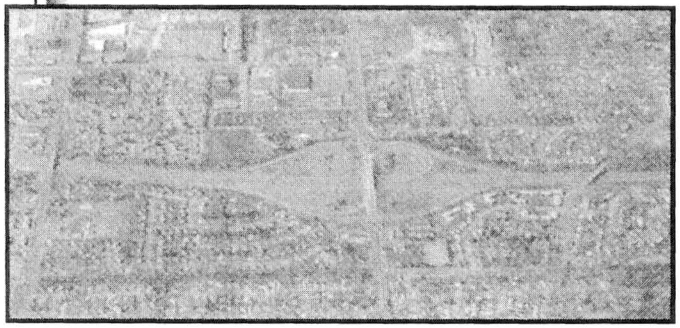
## No Frontage Roads – Access via City Streets



- Detroit, MI



## No Frontage Roads – Access via City Streets

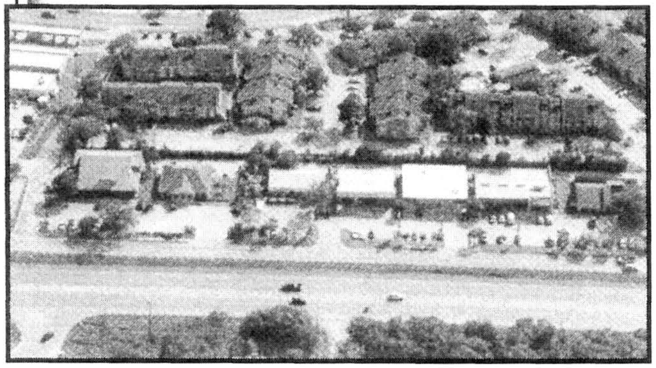
- Detroit, MI



## Arterial Frontage Road

## Arterial Frontage Road

## Arterial Frontage Road



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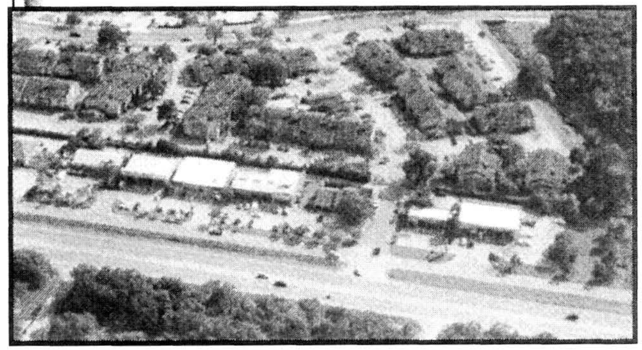
## Arterial Frontage Road



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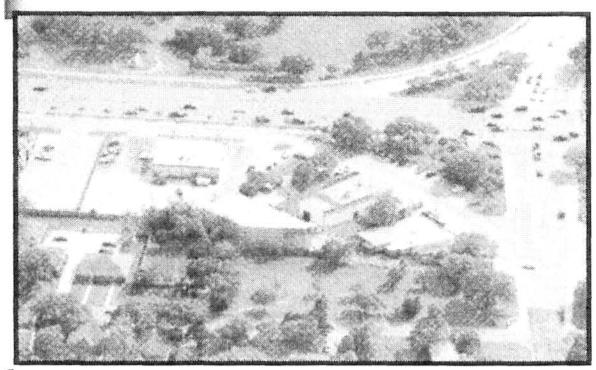
## Arterial Frontage Road



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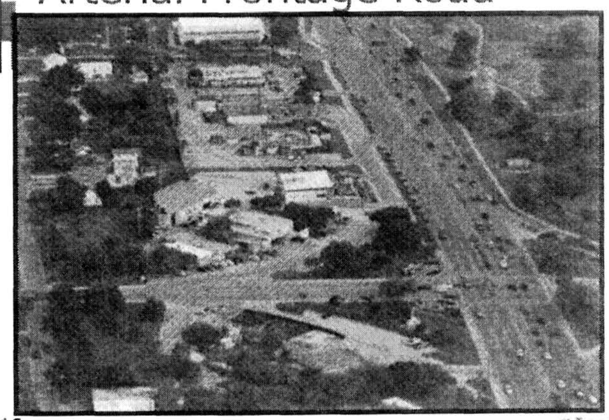
## Arterial Frontage Road



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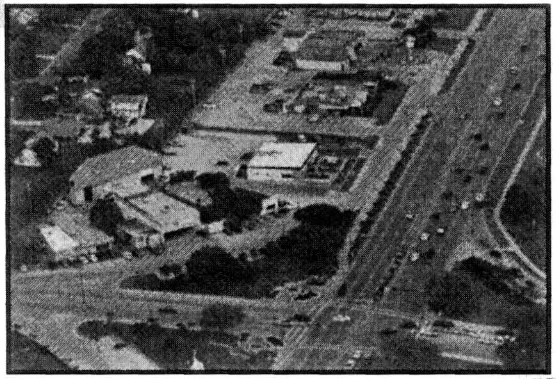
## Arterial Frontage Road



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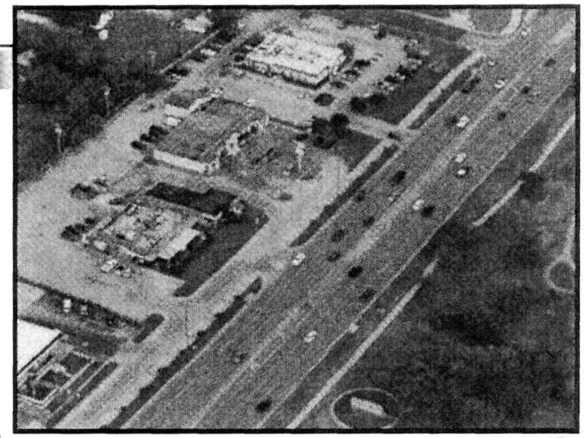
## Arterial Frontage Road / Raised Median



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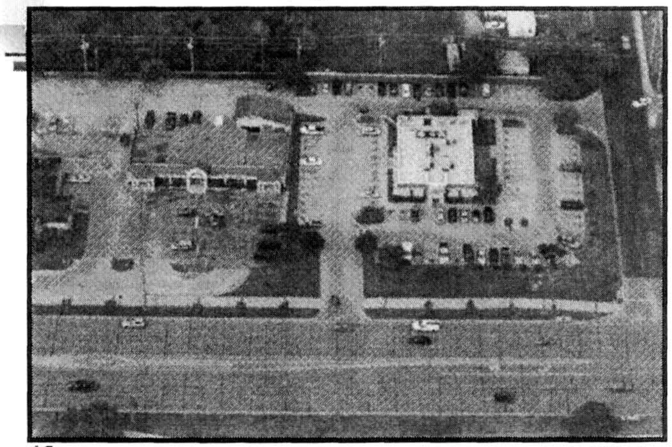
## Arterial Frontage Road / Cross Access

Texas Department of Transportation · Texas Transportation Institute

## Arterial Frontage Road / Cross Access



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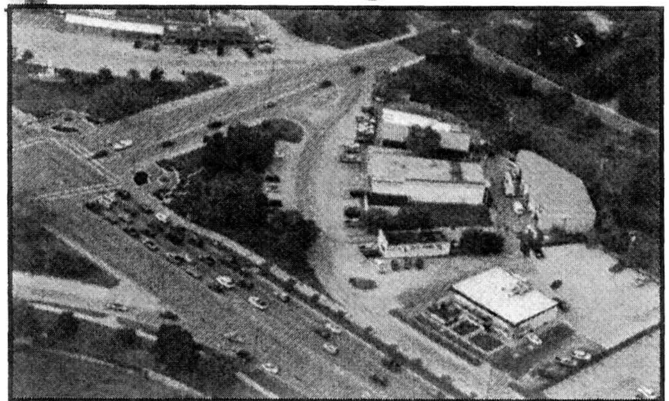
## Arterial Frontage Road



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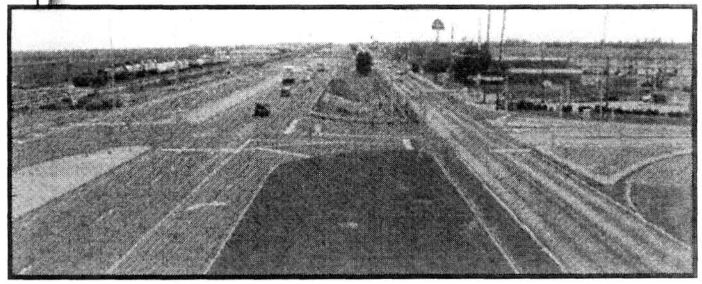
## Arterial Frontage Road



- Bus IH 20 – Odessa

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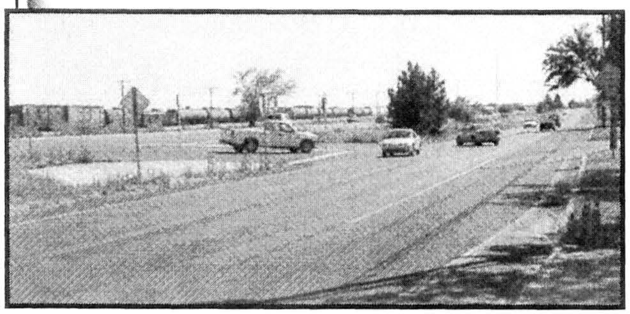
## Arterial Frontage Road



Intersection Spacing

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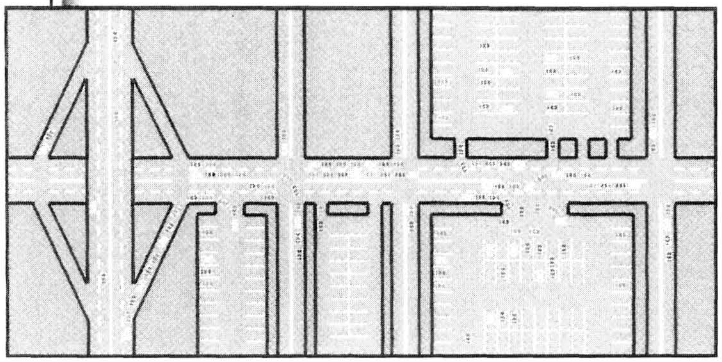
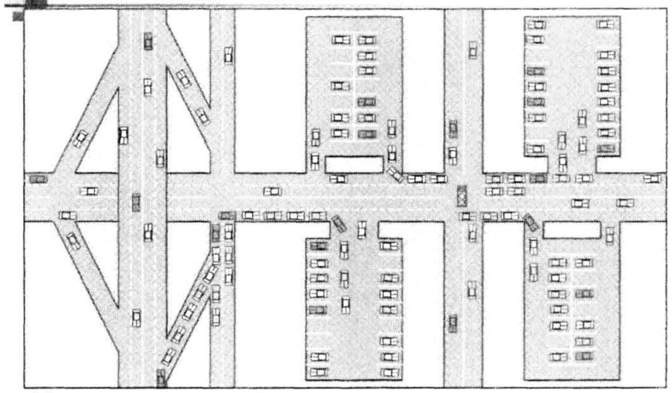
## Summary

# Case Study Illustrating Access Management Opportunities



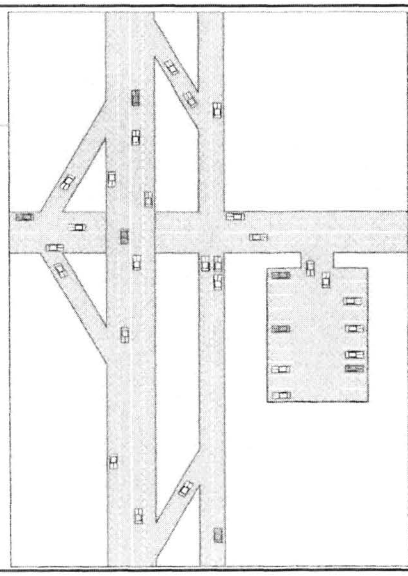


# Poor Access and Mobility



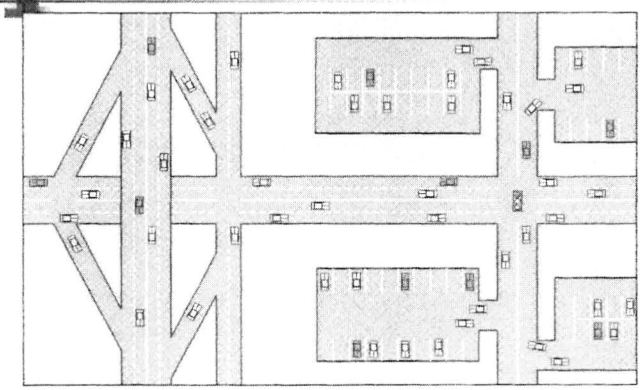


# Improved Access and Mobility





# Improved Access and Mobility



## Resources (TxDOT Manuals)

- TxDOT *Access Management Manual*
  - http://manuals.dot.state.tx.us/dynaweb/coldesig/acm
- TxDOT *Roadway Design Manual*
  - http://manuals.dot.state.tx.us/dynaweb/coldesig/rdw
- Texas Manual on Uniform Traffic Control Devices
  - http://www.dot.state.tx.us/TRF/mutcd.htm

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## Resources (TxDOT Research)

- Frawley, W.E., and W.L. Eisele. *Summary of Access Management Benefits.* Research Report 4221-S. Texas Transportation Institute. College Station, Texas. April 2004.
- Eisele, W.L, W.E. Frawley, and C.M. Toycen. *Estimating the Impacts of Access Management Techniques: Final Results.* Research Report 4221-2. Texas Transportation Institute. College Station, Texas. April 2004.
- Frawley, W.E. and W.L. Eisele. *Investigation of Access Point Density and Raised Medians: Crash Analysis and Micro-simulation.* Research Report 0-4221-P1. Texas Transportation Institute. College Station, Texas. October 2004.
- Frawley, W.E. and W.L. Eisele. *Access Management Guidebook for Texas.* Research Report 4141-P3. Texas Transportation Institute. College Station, Texas. May 2004.

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## Resources (National)

- *Access Management Manual.* National Research Council, Transportation Research Board, Washington, D.C., 2003.
- *Impacts of Access Management Techniques.* National Cooperative Highway Research Program Report 420, National Research Council, Washington, D.C., 1999.
- *Capacity and Operational Effects of Midblock Left-turn Lanes.* National Cooperative Highway Research Program Report 395, National Research Council, Washington, D.C., 1997.

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## Resources (National)

- *Access Management on Crossroads in the Vicinity of Interchanges.* National Cooperative Highway Research Program Synthesis 332, National Research Council, Washington, D.C., 2004.
- *Safety of U-turns at Unsignalized Median Openings.* National Cooperative Highway Research Program Report 524, National Research Council, Washington, D.C., 2004.
- *Geometric Design of Highways and Streets.* Fifth Edition. American Association of State Highway and Transportation Officials. Washington, D.C., 2004.

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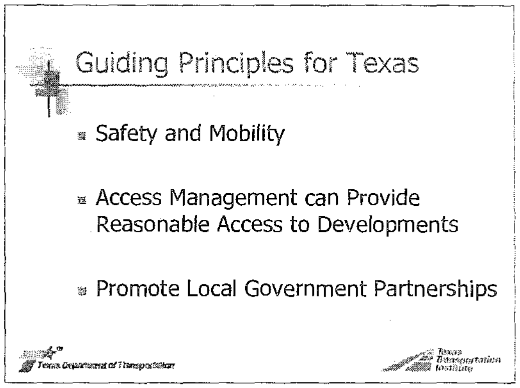
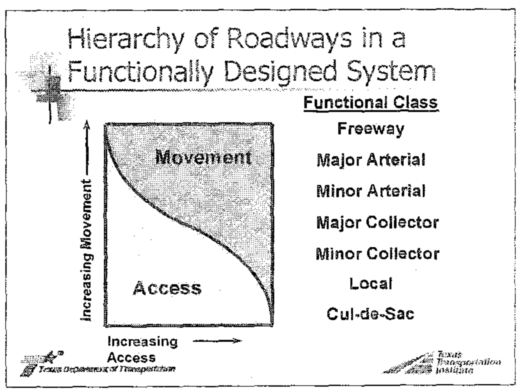
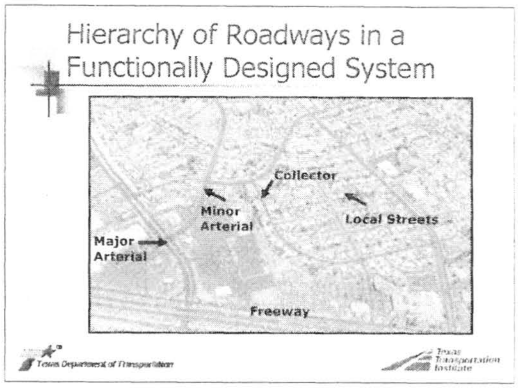


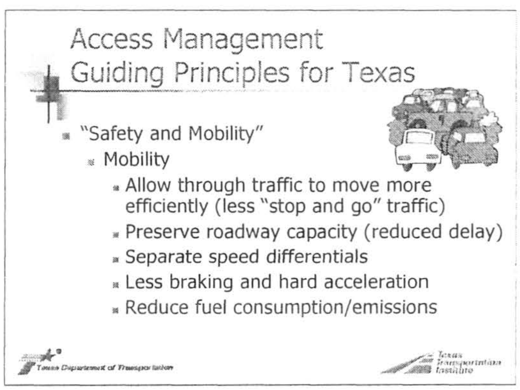

TxDOT developed these three guiding principles for implementing access management in Texas. The first guiding principle is that access management improves safety and mobility. Secondly, properly implementing access management treatments can provide reasonable access to developments. Finally, TxDOT wishes to promote local government partnerships by implementing access management. Access Management is facilitated when there is a strong cooperative spirit between TxDOT and local agencies.




Roadways are planned, designed and built to serve a primary function. As this graphic shows, the function of freeways and arterials are to provide movement, whereas collectors and local streets primarily provide access. It is imperative that the primary function of the roadways be maintained when roadways are built. Allowing too much access on arterials, for example, will degrade their operation and not allow them to function as planned.




This photograph shows the hierarchy of roadways in a functionally designed system and how the roadways are connected to provide access and movement.




On the "mobility" side of this guiding principle, it is important to note that access management treatments allow through traffic to move more efficiently (i.e., there is less "stop and go" traffic). We can preserve through-movement capacity with the construction of acceleration and deceleration lanes, which separate speed differentials. The smoother roadway operation created by access management treatments leads to less braking and hard acceleration and subsequently reduced fuel consumption/emissions.

## Access Points and Free-flow Speed

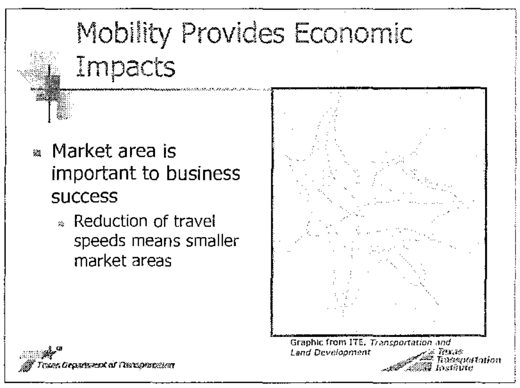
| Access Points and Free-flow Speed | |
|---|---|
| Access points per mile | Reduction in free-flow speed, mph |
| 0 | 0.0 |
| 10 | 2.5 |
| 20 | 5.0 |
| 30 | 7.5 |
| 40 or more | 10 |

National research in National Cooperative Highway Research Program (NCHRP) Report 420 *Impacts of Access Management* illustrates that as the access points (signalized and unsignalized) per mile increases, there is a reduction in the free-flow speed along a roadway.

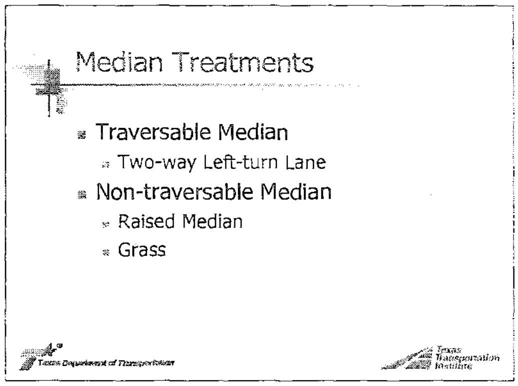
## Travel Time and Signal Density

| Percentage Increase in Travel Times as Signal Density Increases | |
|---|---|
| Signals per Mile | Percent Increase in Travel Times (compared with 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 |

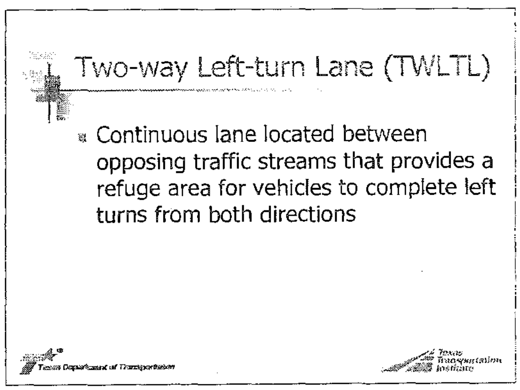
This table is also documentation from NCHRP Report 420. It indicates that as signal density increases, there is an increase in travel times. For example, going from 2 signals per mile to 4 signals per mile can cause a 16 percent increase in travel time.



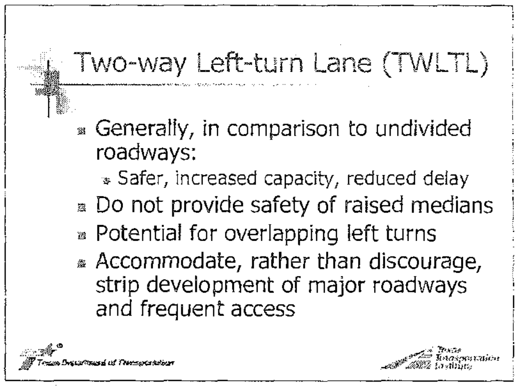

This slides illustrates the important connection between mobility and economic impacts. Imagine that the outer line represents the market share at 45 mph for a grocery store located in the middle of this urban area. If speeds are degraded along the corridors leading to the store to 30 mph, the market area shrinks to that shown by the dashed line. Speeds can be reduced by not practicing good access management.



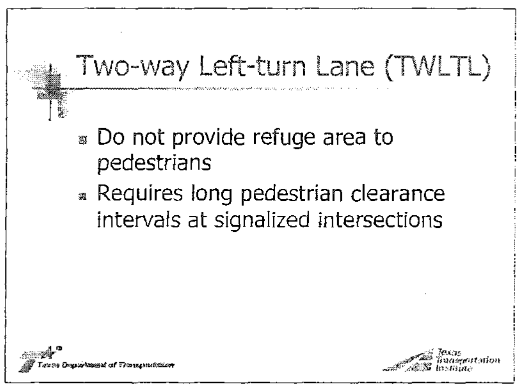

One common form of access management is the installation of a median. There are two types of medians: traversable and non-traversable medians. The most common form of a traversable median is a two-way left-turn lane (TWLTL). Non-traversable medians typically take the form as raised medians or grass medians.



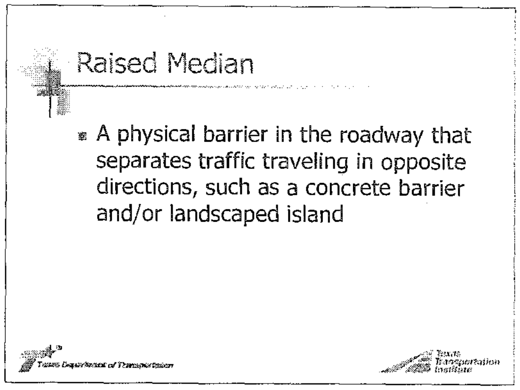

A TWLTL is a continuous lane located between opposing traffic streams that provides a refuge area for vehicles to complete left turns from both directions.



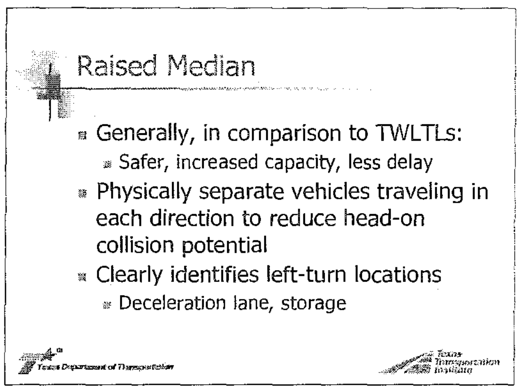

TWLTLs generally are safer and provide increased capacity and reduced delay in comparison to undivided roadways. They do not provide the safety of non-traversable (raised) medians. They allow for the potential of overlapping left turns. Finally, they accommodate, rather than discourage, strip development of major roadways and frequent access because they do not limit access to selected locations.



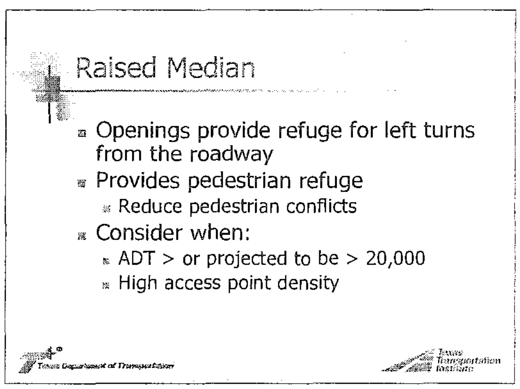

There are a few downsides to TWLTLs when it comes to pedestrians. They do not provide a safe refuge for pedestrians. Therefore, they also required a longer clearance interval at signalized intersections because there is not a safe place for pedestrians to stand in the TWLTL. This can equate to increased signal delay.




A common non-traversable median is a raised median. A raised median separates opposing flows of traffic like a TWLTL, but it is a physical boundary and not just pavement markings on the roadway. The raised median can be constructed of concrete, pavers, and/or landscaping.




Raised medians are advantageous for several reasons. Raised medians have been found to be safer than TWLTLs because they provide a physical separation between opposing flows of traffic. They also provide a safe haven for pedestrians. A raised median increases the capacity of the roadway by providing a clearly defined turn bay and storage for left-turning and U-turning vehicles. In short, raised medians better manage traffic flow and access along a corridor. This leads to improved safety and mobility.

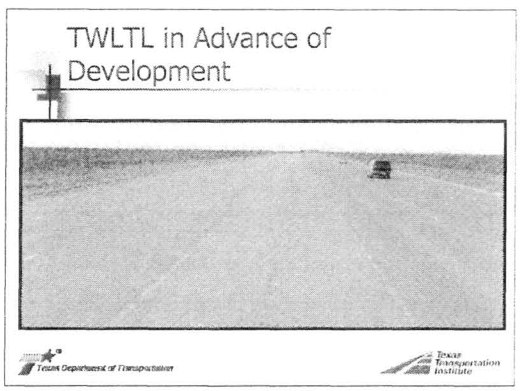



As previously mentioned, median openings can be designed to provide refuge for left-turning vehicles. They also provide pedestrian refuge to reduced pedestrian-auto conflicts.

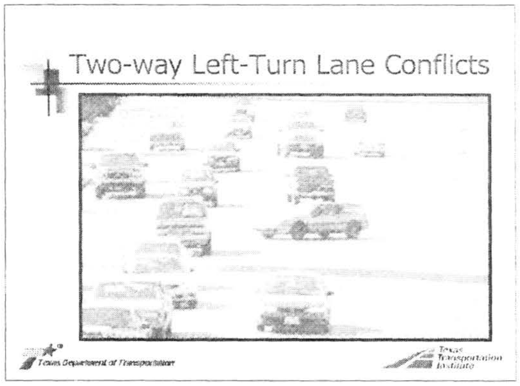
The TxDOT *Roadway Design Manual* suggests that raised medians be considered when roadway average daily traffic (ADT) exceeds 20,000 vehicles per day. Planning ahead, it is good to think about roads that are projected to have volumes greater than 20,000. In addition, raised medians can help alleviate problems that TWLTLs experience with high access point densities, as well as higher volumes.

## Median Photographs

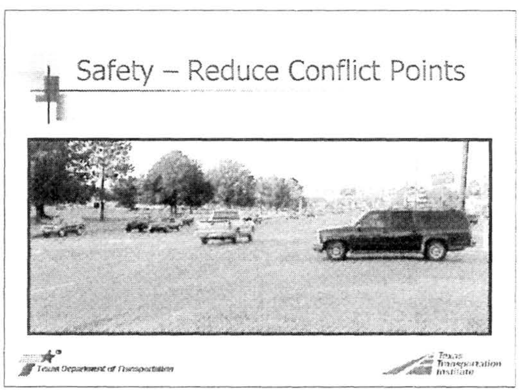
This presentation includes several photographs related to different median designs.



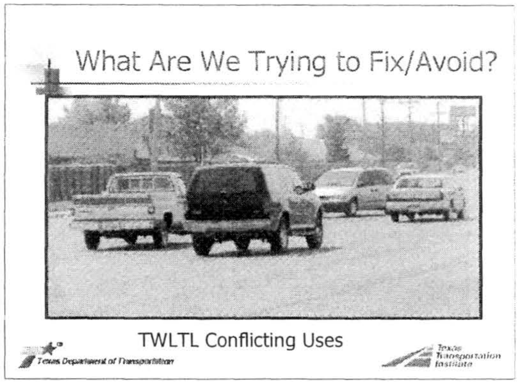

This photograph shows a 7-lane cross section including a two-way left-turn lane in advance of development.



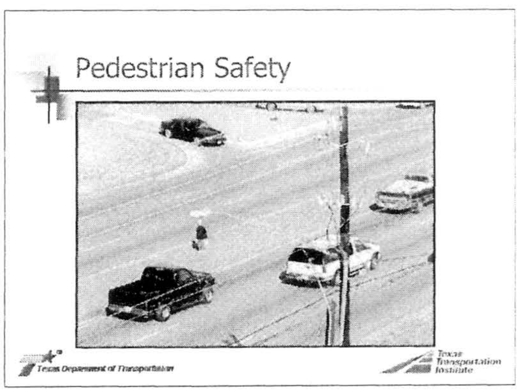

This photograph illustrates numerous driveways along this roadway and a very busy TWLTL. A raised median along this corridor would assist in controlling traffic maneuvers and conflicts. Because it is a 5-lane cross section, roadway widening and/or flaring intersections and/or mid-block locations would be necessary to facilitate U-turns.



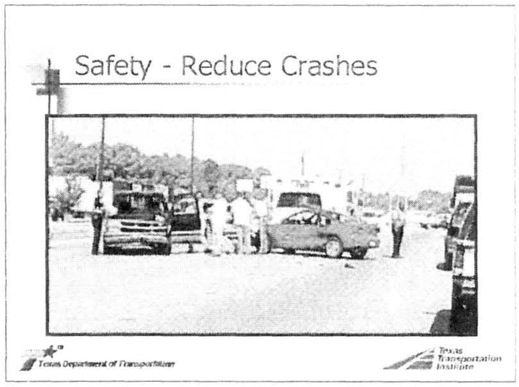

As roadways with TWLTLs increase in traffic volume, a raised median should be considered.



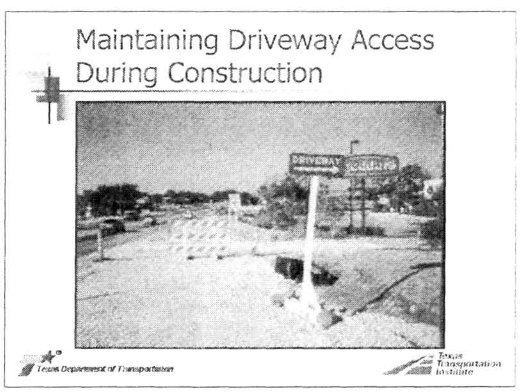

This photograph shows the conflicting uses (head-on turning traffic) that can occur in a TWLTL.



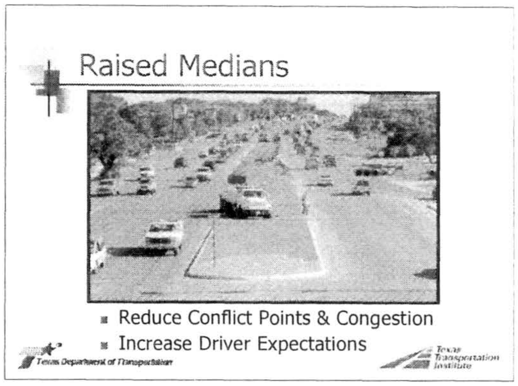

This pedestrian would benefit from a raised median that would provide refuge when crossing the roadway.



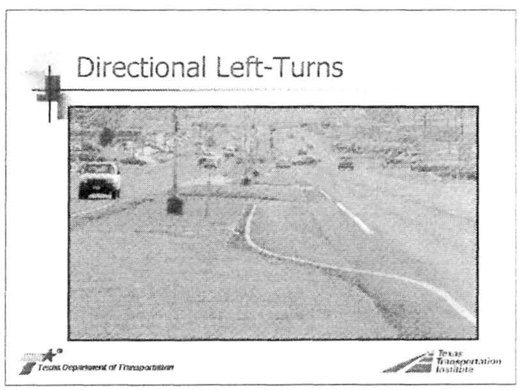

Unfortunately, conflicts along a TWLTL can result in crashes.



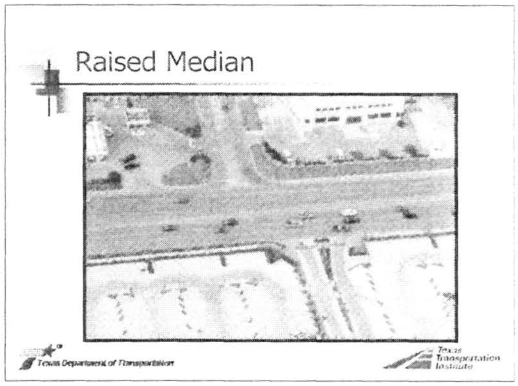

This photograph shows the importance of clearly identifying driveway locations during roadway construction. In this case, the arterial was being expanded by one lane in each direction and a raised median was being installed to replace the two-way left-turn lane (TWLTL).



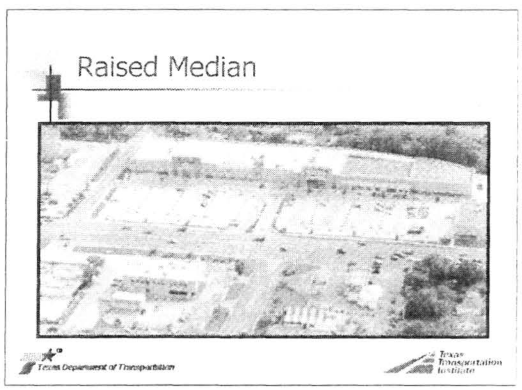

Here is another photograph of a raised/grassy median along a high-volume corridor.



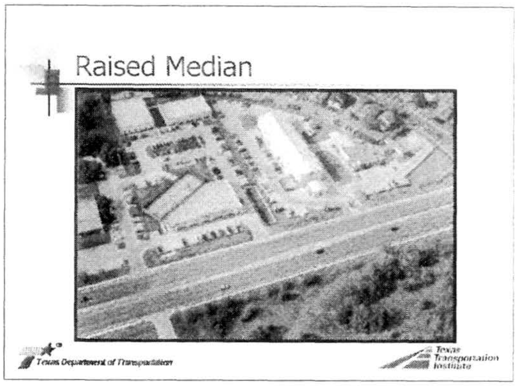

This photograph shows directional left-turns allowed at a median opening.



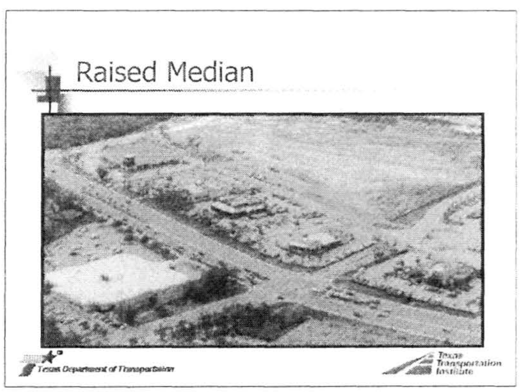

The raised median along this corridor reduces conflict points at this intersection by providing only right-in/right-out maneuvers at the city street on the top of the photograph and at the shopping center on the bottom of the photograph.



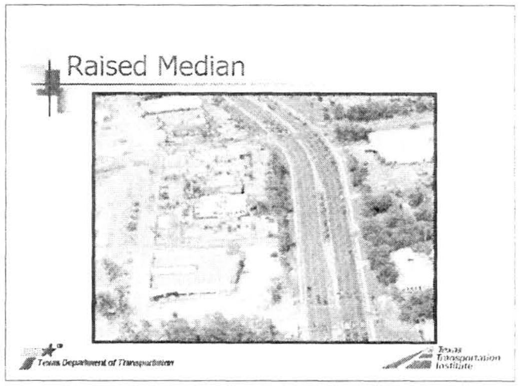

This photograph shows the same site as the prior photograph, but from the opposite side of the street.



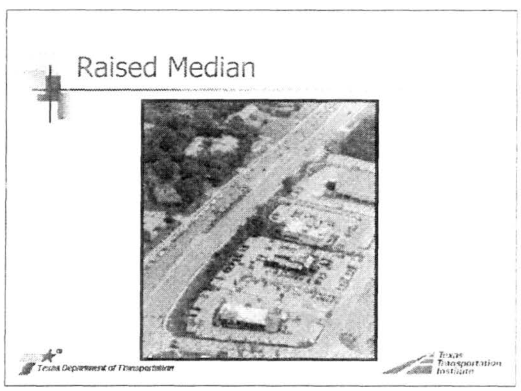

This photograph shows a raised median, which controls turning movements along this corridor.



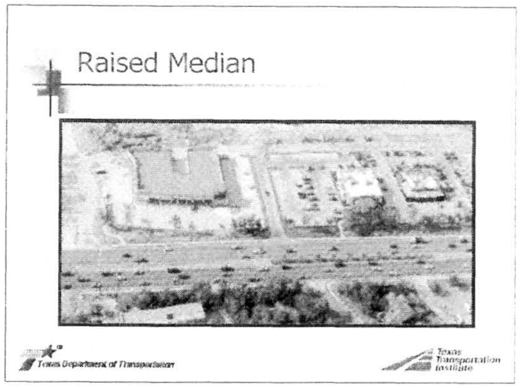

This photograph shows a raised median, cross access, and shared access along this roadway.



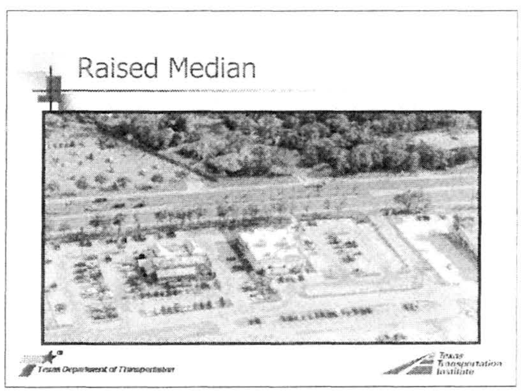

From another angle, this photograph shows a raised median, cross access, and shared access along this roadway.



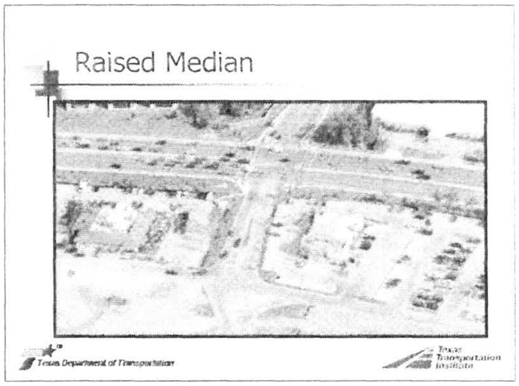

From another angle, this photograph shows a raised median, cross access, and shared access along this roadway.



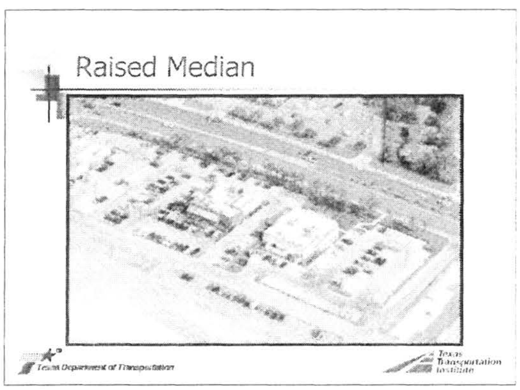

From another angle, this photograph shows a raised median, cross access, and shared access along this roadway.



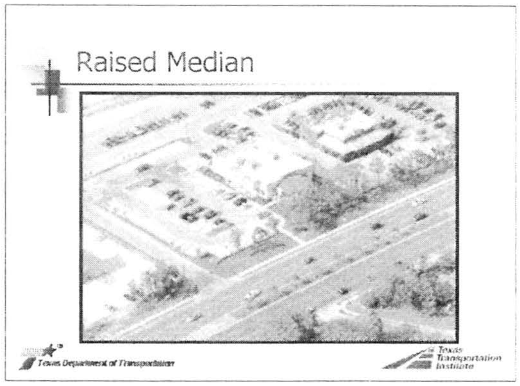

From another angle, this photograph shows a raised median, cross access, and shared access along this roadway.



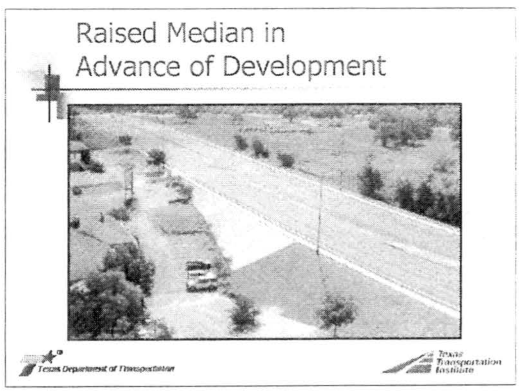

From another angle, this photograph shows a raised median, cross access, and shared access along this roadway. Also, as shown in the center of this picture, good driveway throat length is provided at the primary signalized access point to the development.



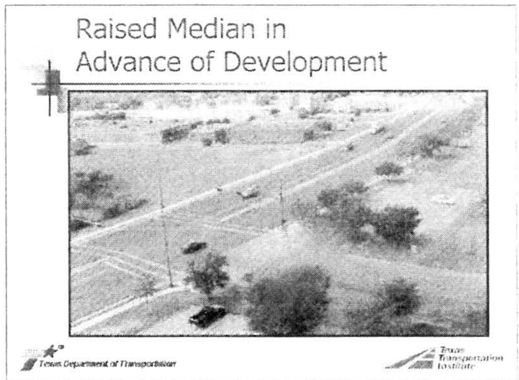

From another angle, this photograph shows a raised median, cross access, and shared access along this roadway.



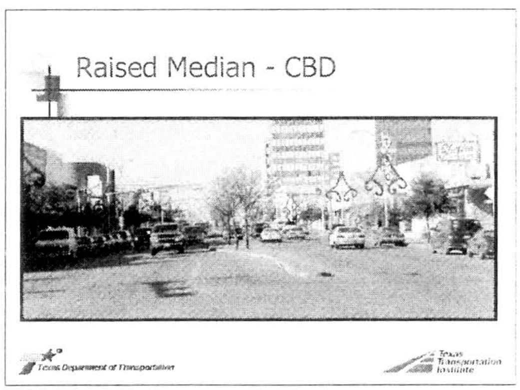

From another angle, this photograph shows a raised median, cross access, and shared access along this roadway.



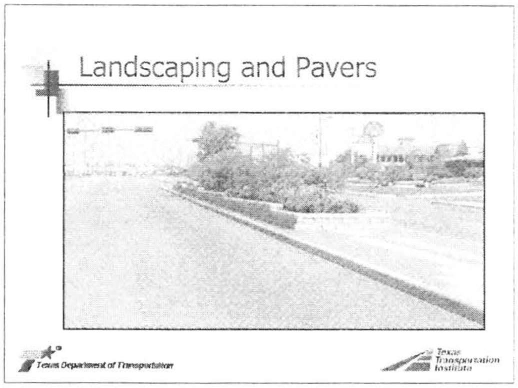

This photograph shows where a raised median has been installed in advance of development.



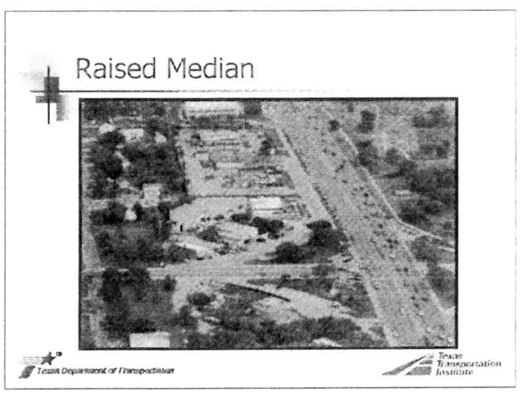

This photograph shows the raised median further along the roadway.




This photograph shows the installation of a raised median in a central business district (CBD).




This photograph shows how aesthetics can be incorporated into the raised median design. This includes landscaping and brick pavers. Consideration must be given to ensuring that sight distance is not compromised by landscaping.




Here is another aerial photograph of a raised median treatment. Designated left-turn bays can be seen in the raised median. Shared and cross access is also shown at the businesses in the center of the photograph to reduce the number of driveways on the roadway.

## Signage for Raised Median Openings

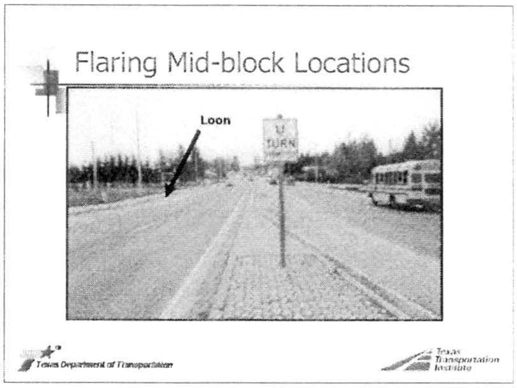
Provides Direction to Adjacent Businesses

Texas Department of Transportation

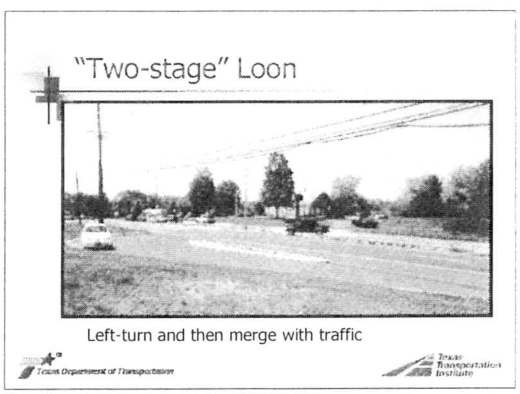
Texas Transportation Institute

This photograph shows how signage can be used to guide motorists to particular businesses after the installation of the raised median.

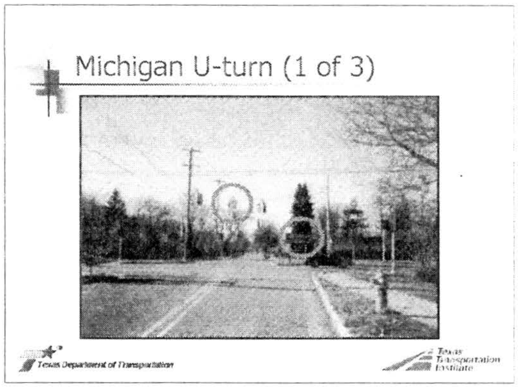
## Beyond Texas: Raised Median Designs




This photograph shows a widened mid-block section of a roadway. This geometric element is called a "loon." The additional space provided by the loon allows U-turns when the cross section is limited. This photograph was taken in Salem, Oregon.

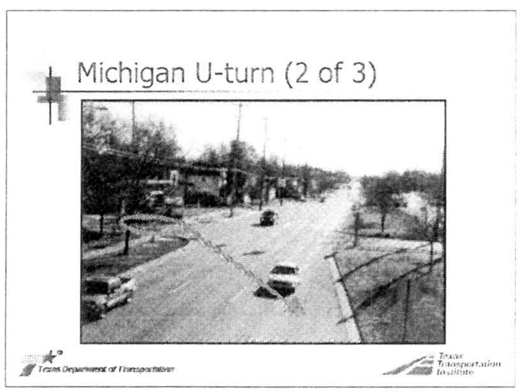



This geometric treatment is called a "jughandle," and it is used in New Jersey. This geometric element acts as a "two-stage" loon. In this case, motorists first turn left into the additional right-of-way and then, looking over their left shoulder, complete the turn in a second maneuver.

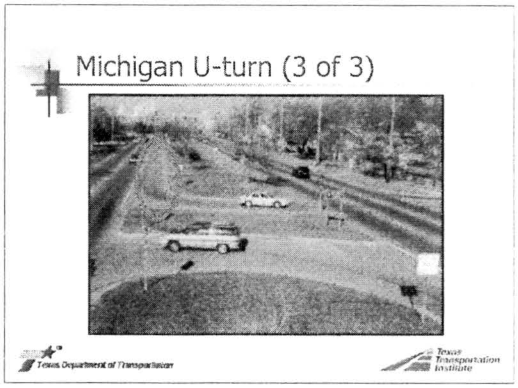



The next three photographs show the "Michigan U-turn" treatment taken in Lansing, Michigan. The benefit of this geometric design is that it removes left turns from the signals along major arterials, which reduces intersection and corridor delay. Removing the left turns at the signals allows for two-phase operation at each signal (one phase for through green in each direction). Left turns are handled by using mid-block U-turn locations.

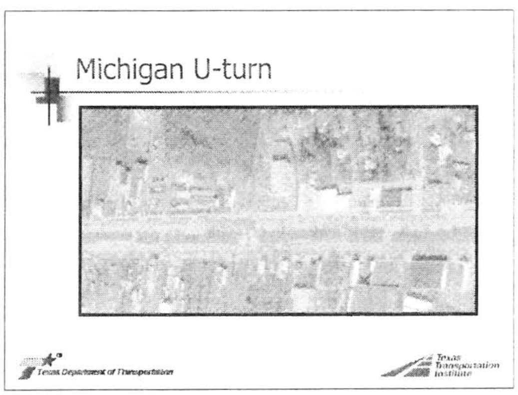
This photograph shows this treatment as the driver approaches from the cross street. The signing (circled upper left) indicates that the roadway is one way. The signage on the lower right indicates that to travel south (i.e., "turn left") on the road, the driver must turn right and then get in the mid-block U-turn to complete the maneuver. Note that vehicles wanting to turn left onto the cross street from the major roadway cannot, and they must also use the mid-block U-turn.



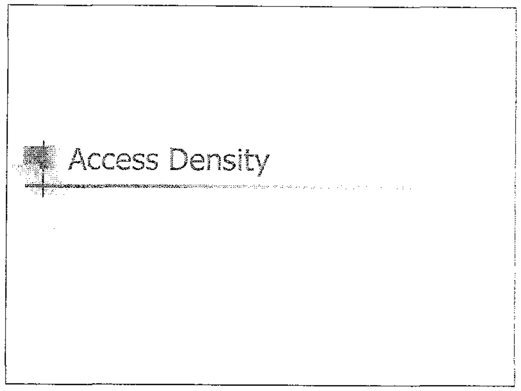

The oval shows where the previous photograph was taken. After the driver takes the right turn, they immediately merge over to the turn bay that begins for the mid-block U-turn. Because the signalized intersection stops traffic, weaving is not difficult.



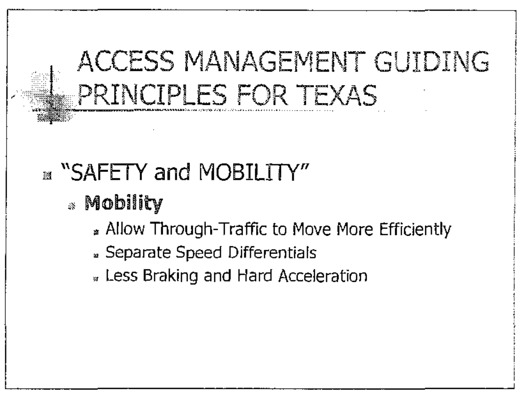

This photograph shows the directional mid-block U-turns that allow for the completion of the maneuver. Though the raised median is very wide in this example, such a design could be implemented with a smaller width raised median, assuming truck traffic can be handled elsewhere. Note that queue storage is a key design feature (see red oval), and ample storage is provided here. While this is a residential setting on the fringe of an urban area, this treatment is very successful in urban/commercial settings as well.




This photograph shows the use of the Michigan U-turn along a highly retail corridor in suburban Detroit, Michigan.




This presentation explains how access point density (including driveways and public street intersections) relates to crash rates observed in research performed nationally, as well as here in Texas.




In addition to trying to improve safety on the roadways, TxDOT also wants to gain the mobility improvements that access management techniques can yield. These include allowing through traffic to move through a corridor more efficiently by moving the turning vehicles to turn and auxiliary lanes. These improvements reduce the amount of slowing and speeding up that vehicles must do.

## Access Points and Free Flow Speed

| Access Points and Free Flow Speed | |
|---|---|
| Access points per mile | Reduction in free flow speed, mph |
| 0 | 0.0 |
| 10 | 2.5 |
| 20 | 5.0 |
| 30 | 7.5 |
| 40 or more | 10 |

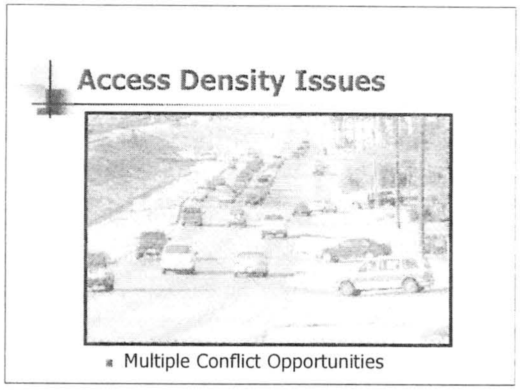
This chart illustrates that as driveway density increases, traffic free flow decreases. This follows the concept in the previous slide – if you have more opportunities to turn, there are more opportunities to have to slow down; therefore, it will take longer to drive through a corridor. These results come from National Cooperative Highway Research Project number 4-20.

## Access Density Issues

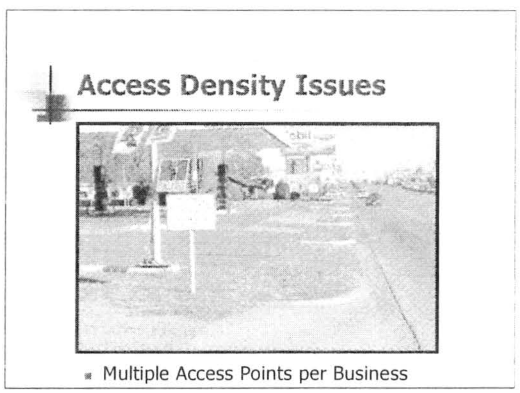
- Driver Expectations
- Speed Differentials

The fewer access points there are along a corridor, the better levels of expectations drivers can have of what will happen ahead of them.

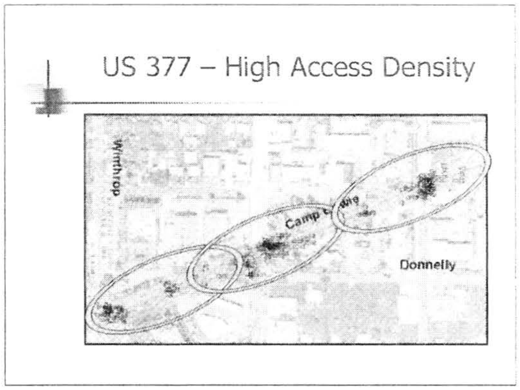
The brake lights on the car in this photo illustrate how through traffic must slow for vehicles making right turns when no turn lane is present. Additionally, the curb return radius of the driveway dictates how slowly the turning vehicle must be going when executing the turn maneuver, and, therefore, how much the through vehicle must slow. A right-turn lane would reduce how much the through vehicle must slow (and accelerate).



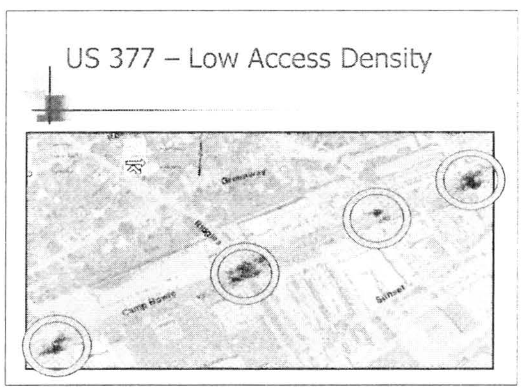

As access point frequency increases, so does the load of what a driver has to consider as he traverses the corridor.




Businesses should be granted an appropriate number of access points, not as many as they can fit in their frontage. This gasoline station has four driveways – note how small the sections of curb are, as well as how close the next business's driveway is.




This graphic illustrates the number, location and type of crashes along US 377 (Camp Bowie Boulevard) in Ft. Worth, Texas. This segment of US 377 is just south of I-30, and one can see there is a relatively high density and the major streets intersect US 377 at skewed angles. This results in crashes located across the corridor at major intersections and at mid-block locations. This is in contrast to the next slide.




This slide shows US 377 further south of the segment shown in the prior slide. Here the major intersections have been aligned at right angles to US 377, and access density is much lower than the prior slide.

## US 377 – Total Crashes

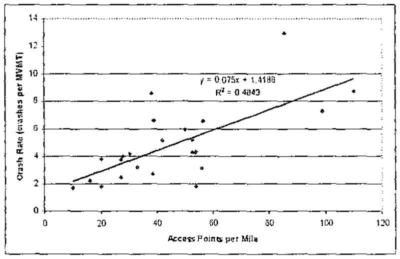
| Year | Segment | Access Density (pts/mi) | Number of Crashes | Crashes / Million VMT |
|---|---|---|---|---|
| 1993 | East | 110 | 28 | 9.59 |
| | West | 50 | 27 | 7.40 |
| 1994 | East | 110 | 27 | 9.25 |
| | West | 50 | 22 | 6.03 |
| 1995 | East | 110 | 29 | 9.46 |
| | West | 50 | 16 | 4.17 |
| 1996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

This table, and the table on the next slide, illustrate that the crash rate is lower on the west segment that has a lower access density than the east segment of US 377.

## 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 |

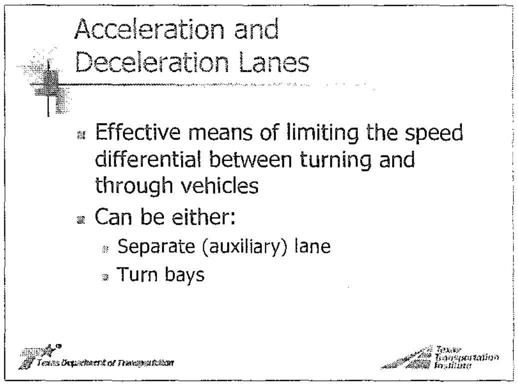
## Access Density and Crash Rates



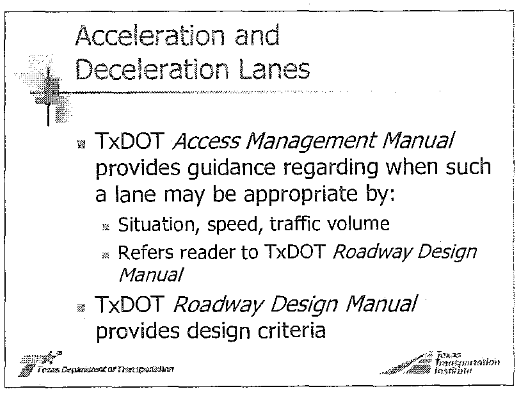

Using data from research performed on several corridors, a trend was derived to illustrate the relationship between access density and crash rate. Clearly, crash rate increases as access points per mile increase.

## Conclusions

- Higher access point densities correlate to higher crash rates
- Lower access point densities allow for greater speeds on arterial streets
- Lower access point densities require less work for the motorists




Acceleration and deceleration lanes are an effective means of limiting the speed differential between turning and through vehicles, which improves the safety and mobility of a corridor. These lanes can be an entirely separate (auxiliary) lane or a turn bay.

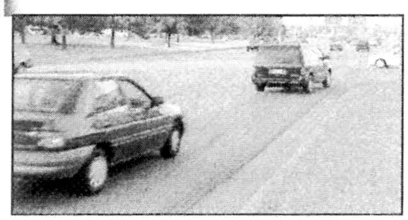



The TxDOT *Access Management Manual* provides guidance regarding when such a lane may be appropriate by maneuver, speed, and traffic volume. Subsequently, the designer can consult the TxDOT *Roadway Design Manual* for the proper design criteria, once it is determined that an acceleration or deceleration lane would be appropriate.

## Acceleration and Deceleration Lanes Photographs

This presentation includes several photographs of acceleration and deceleration lanes.

## What Are We Trying to Fix/Avoid?

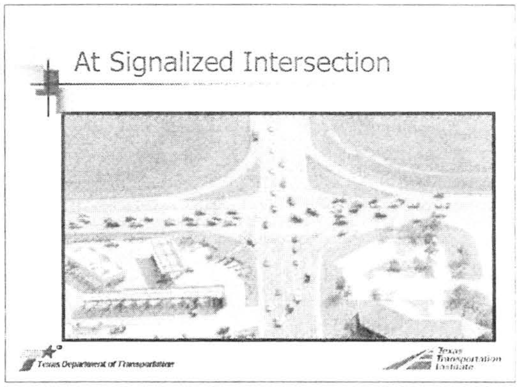


Speed Differentials

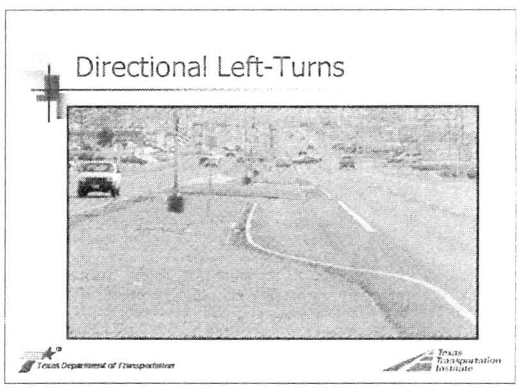
Texas Department of Transportation

Texas Transportation Institute

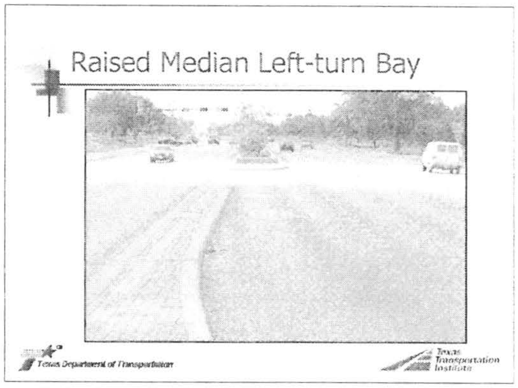
Without a deceleration lane, right-turning traffic influences the speed of vehicles in the through lanes that must also slow down. This photograph illustrates this. A deceleration lane would allow this van to decelerate less in the through lane. It would separate the large speed differential.



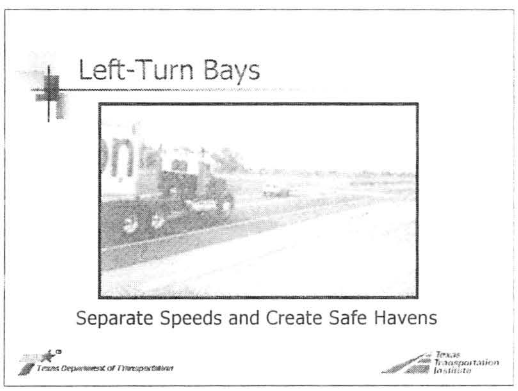

Note the deceleration and acceleration lanes at the top of the photograph.



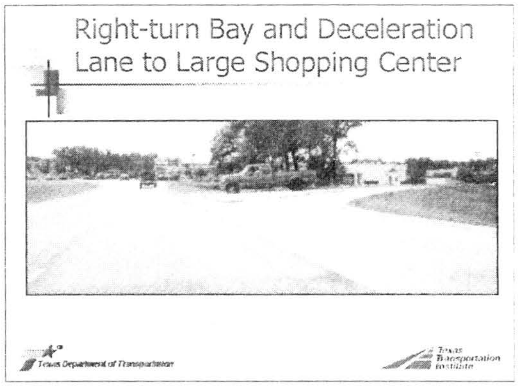

This photograph shows directional left-turns allowed at a median opening.



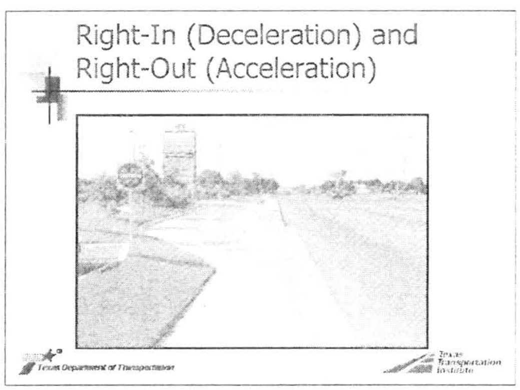

This photograph shows a left-turn bay as part of a raised median.



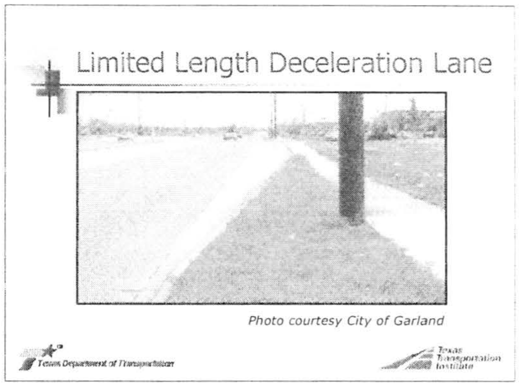

We have all had a large 18-wheeler bearing down on us from behind. Turn lanes provide the opportunity to separate speed differentials and create safe havens from through traffic.



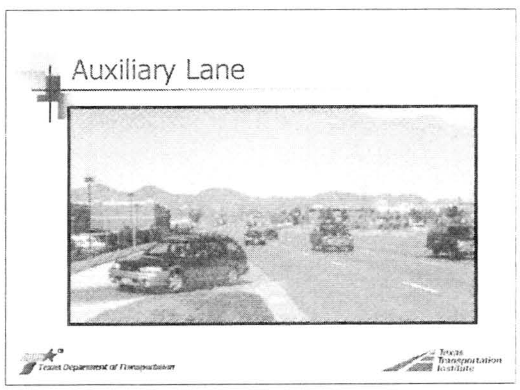

This photograph shows a deceleration lane for a large big box development off a frontage road.



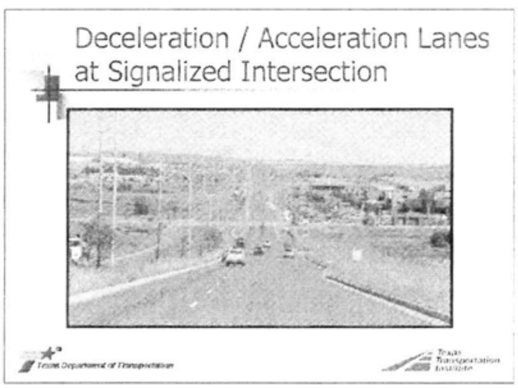

This photograph shows a deliberate design of a right-in/right-out driveway with adequate storage. This particular driveway was designed to angle exiting traffic to turn right out of the development.




This photograph illustrates a very short deceleration lane (right-turn bay). Though shorter than desirable, the relocation of the utility poles/lines were cost prohibitive. Therefore, a shorter deceleration lane was constructed to provide deceleration/storage for at least a couple cars, rather than no separation of the right turn and through movements.




This photograph shows an auxiliary lane in Colorado. The right-most travel lane is for turning traffic only. Note that this is a major arterial with three lanes in one direction and a right-side auxiliary lane. A raised median separates each direction of travel. Note that the driveway is designed on an angle to allow relatively higher speeds of traffic to enter the driveway. The site and driveway must be designed appropriately to handle the higher speeds.

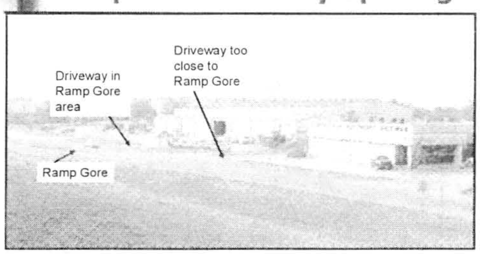



This photograph is from Colorado Springs, Colorado, and it clearly illustrates deceleration and acceleration lanes where two major arterials intersect at a signalized intersection. An acceleration or deceleration lane is present on each leg of the intersection. Though the roadway shows only two lanes in each direction, it will be striped for three lanes in each direction in the future.

## Ramp and Access Point Spacing

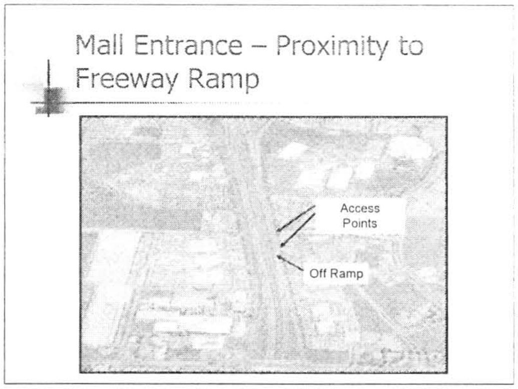
This presentation discusses the relationships between access points along frontage roads and on and off-ramps.

## Ramp and Driveway Spacing

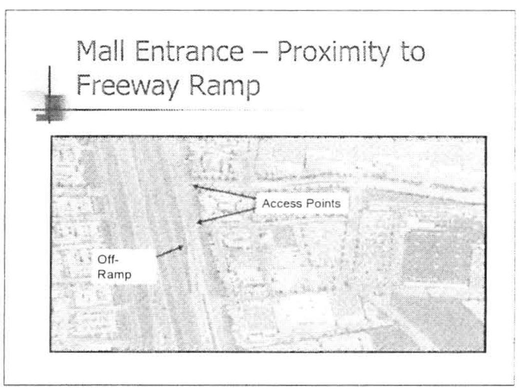



- Ramp Gore Area

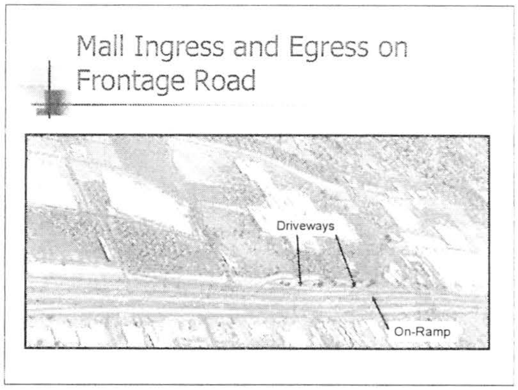
Driveways within, or too close to, the ramp gore can encourage unsafe maneuvers by vehicles exiting those driveways. The higher the traffic volumes on the frontage roads, the more dangerous the maneuvers can be by vehicles wanting to access the entrance ramp to the mainlanes. The driveways need to be a sufficient distance from the ramp gore that will allow the vehicle exiting the driveway to complete a right-turn and then enter the area influenced by the ramp gore.



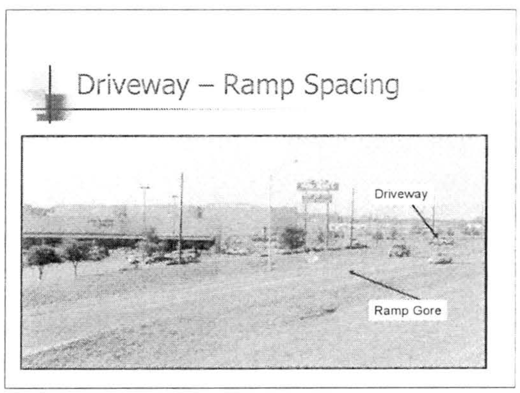

Allowing vehicles that are exiting the freeway and traveling at very high speeds the opportunities to make right-turns very close to the ramp gore sets up a dangerous situation. If there is no way to avoid having driveways near the ramp, there should be a physical feature that prohibits unsafe maneuvers.



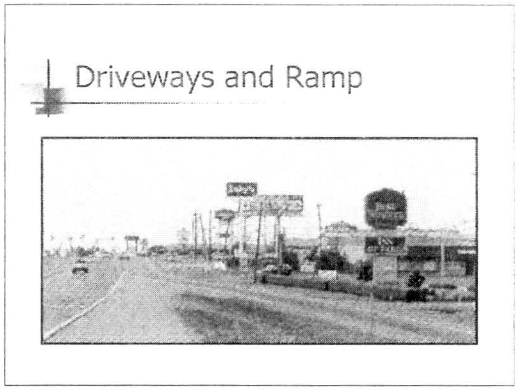

This is a closer, but fuzzier, look at the same situation on I-20 in Arlington.



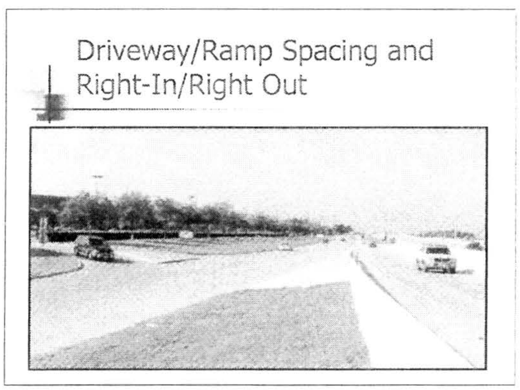

In this case, on I-10 in El Paso, the driveways for a shopping mall are located safely downstream from an on-ramp.




This example from US 75 in Sherman shows a driveway that was located upstream from the ramp gore – setting up a safer situation than if the driveway were located in the ramp gore area.



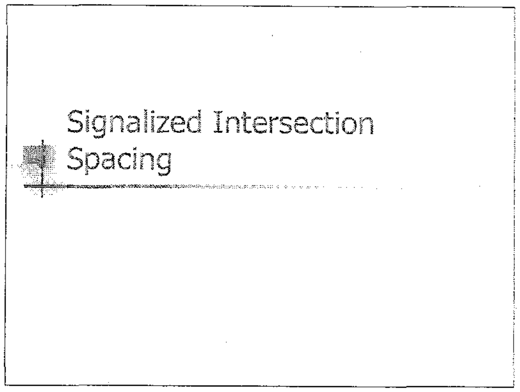

This road is an arterial with some grade-separated intersections that have on and off-ramps. This photograph illustrates driveways that open directly onto an on-ramp, which is not typically desired. Alternative solutions include a frontage road or cross access among adjacent properties leading a shared access point at an appropriate location.

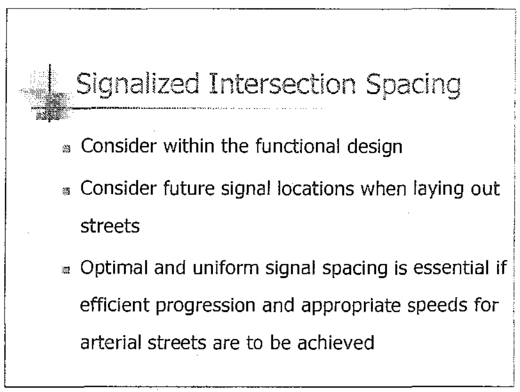



This example from US 59 in Sugarland shows how even when a ramp appears to be out of the gore area, extra physical features to guide the motorists can be useful.

## Conclusions

- Keep access points away (upstream or downstream) from ramp gores
- Use physical features to prohibit unsafe maneuvers
- Keep driveways off of ramps




The spacing of signalized intersections require additional considerations beyond unsignalized streets and driveways. Specifically, these considerations include:

- Functional design should still be considered. Ensuring the appropriate amount of access (signalized or unsignalized) given the functional classification of the roadway.
- Future signal locations should be considered when streets are planned. Consider where future signals may be warranted. Consider future signal locations when locating openings for raised medians also.
- Efficient signal progression is crucial to minimize corridor delay; therefore, optimal and uniform signal spacing is desired.

## Signalization Variables

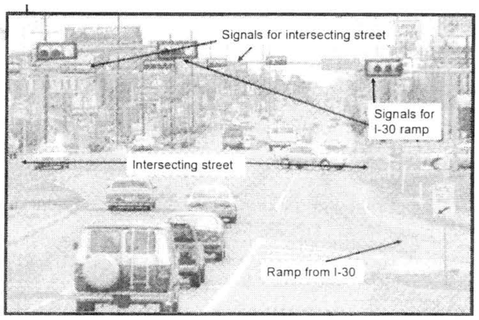
- Roadway Speed and Traffic Volumes
- Cycle Length and Offset
- Signal Spacing
- Efficiency of Progression
- Texas Manual on Uniform Traffic Control Devices

The ideal signalization along a roadway is a function of:

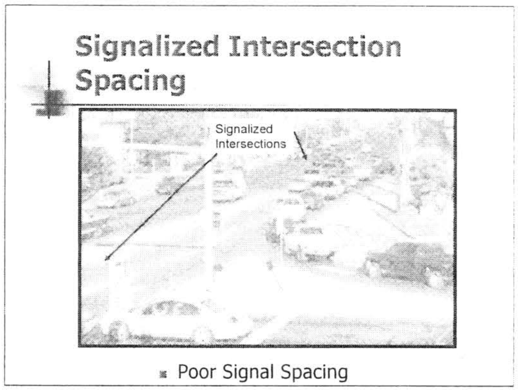
- Roadway speed, traffic volumes and turning movements;
- Signal cycle length and signal offset;
- Signal spacing; and
- The efficiency of progression.

The *Texas Manual on Uniform Traffic Control Devices* provides more detail on when signals are warranted.

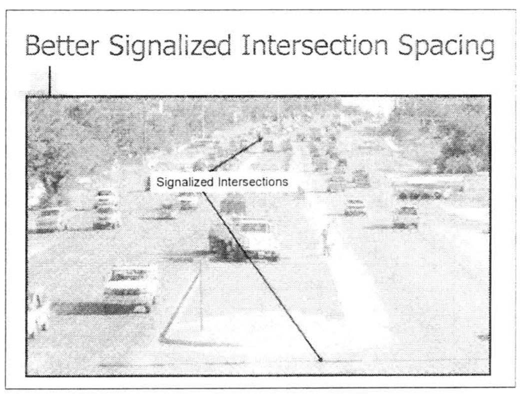
## Intersection spacings - Ramps




This photograph is looking south on State Line Blvd as it crosses I-30 in Texarkana. There are two major intersections whose physical and functional areas overlap each other, causing some operational and safety issues.




These two signalized intersections are so close together that traffic queued up at one is backed up into the previous one, affecting traffic on its intersecting street.




This case from San Antonio is of the best signalized intersection spacing that could be achieved, given the adjacent land uses and needs for access. It is the result of the City, the developers, and TxDOT working together to attain an appropriate solution.

## Travel Time and Signal Density

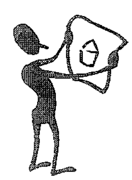
| Percentage Increase in Travel Times as Signalized Density Increases | |
|---|---|
| Signals per Mile | Percent Increase in Travel Times (compared with 2 signals per mile) |
| 2.0 | 0 |
| 3.0 | 9 |
| 4.0 | 16 |
| 5.0 | 23 |
| 6.0 | 29 |
| 7.0 | 34 |
| 8.0 | 39 |

As signal density increases, travel time on a corridor increases. The closer signals are to each other, the harder it becomes to attain a good progression that would allow platoons of vehicles to move through a corridor with minimal stops.

## Unsignalized Intersection Spacing

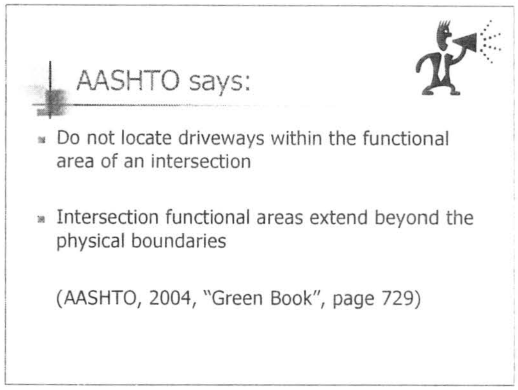
## Unsignalized Access Spacing

- Engineering considerations:
  - Functional intersection area
  - AASHTO guidance
  - Stopping sight distance
  - Intersection sight distance
  - Case-by-case
    - No cookbooks allowed!



There are several engineering considerations when spacing unsignalized access points. These considerations include the functional area of the intersection, guidance from the American Association of State Highway and Transportation Officials (AASHTO), stopping sight distance, and intersection sight distance.

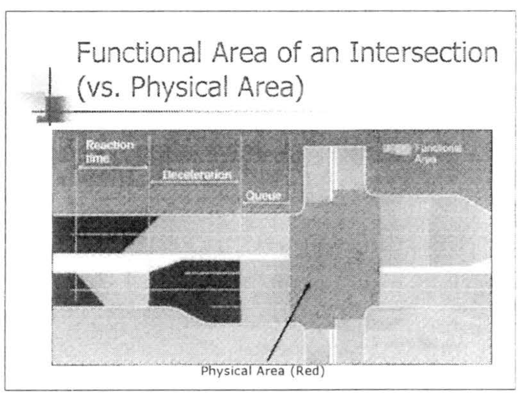
Access management treatment implementation is not a cookbook process. Each corridor must be evaluated on a case-by-case basis as different treatments and techniques may require additional considerations from corridor to corridor or region to region. For example, prior to installing raised medians, truck traffic and deliveries must be evaluated to ensure there are adequate alternate routes to handle truck deliveries. This will be discussed further in a later section of this presentation.



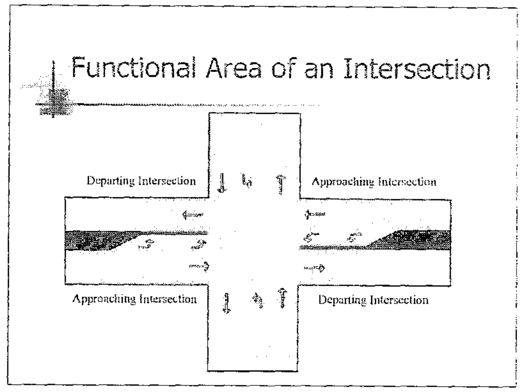

According to the 2004 AASHTO "Green Book" (*A Policy on the Geometric Design of Highways and Streets*), driveways should not be located within the functional area of an intersection. Further, the 2004 "Green Book" indicates that functional areas extend beyond the physical boundaries of the intersection and include the longitudinal limits of auxiliary lanes.

For reference, the following text is directly from the 2004 AASHTO "Green Book" (page 729):

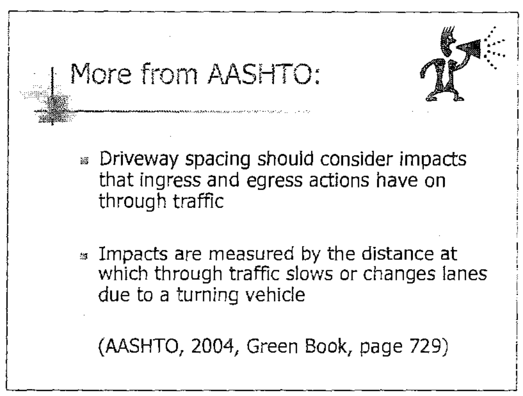
"Ideally, driveways should not be located within the functional area of an intersection or in the influence area of an adjacent driveway. The functional area extends both upstream and downstream from the physical intersection area and includes the longitudinal limits of auxiliary lanes. The influence area associated with a driveway includes (1) the impact length (the distance back from a driveway that cars begin to be affected), (2) the perception-reaction distance, and (3) the car length."




This figure illustrates the difference between the physical area (shown in red) and the larger functional area of the intersection. This graphic shows the detail of what the functional area of the intersection includes along one leg of the intersection—namely, the queue (storage) length, deceleration length and perception-reaction time length.



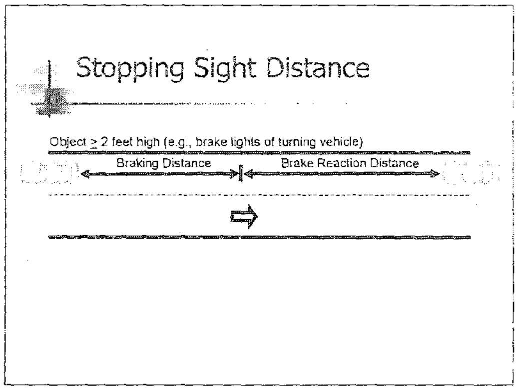

This graphic shows the functional area of the intersection along all legs of the intersection—both approaching and departing the intersection. It is imperative to preserve access in the entire yellow (functional) area of the intersection. Driveways allowed within the "yellow area" will be negatively influenced by the traffic operations (queues, sight distances) of the primary intersection.




The 2004 AASHTO "Green Book" indicates that driveway spacing should consider the impacts that ingress and egress movements have on through traffic. Impacts are measures by the distance at which through traffic slows or changes lanes due to a turning vehicle.

For reference, the following text is directly from the 2004 AASHTO "Green Book" (page 729):

"The spacing of driveways should reflect the impact lengths and influence areas associated with motorists entering or leaving a driveway. The impact length represents the distance upstream when the brake lights of through vehicles are activated or there is a lane change due to a turning vehicle."



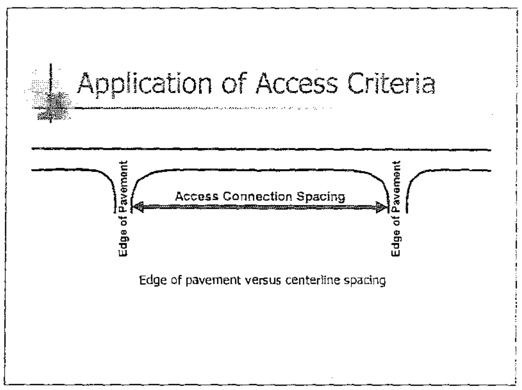

This slide visually illustrates the concept of stopping sight distance.

Per the 2004 AASHTO "Green Book" (page 110):

"Sight distance is the length of the roadway ahead that is visible to the driver. The available sight distance on a roadway should be sufficiently long to enable a vehicle traveling at or near the design speed to stop before reaching a stationary object in its path. Although greater lengths of visible roadway are desirable, the sight distance at every point along a roadway should be at least that needed for a below-average driver or vehicle to stop."

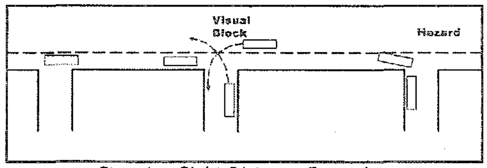
"Stopping sight distance is the sum of two distances: (1) the distance traversed by the vehicle from the instant the driver sights and object necessitating a stop to the instant the brakes are applied; and (2) the distance needed to stop the vehicle from the instant brake application begins. These are referred to as brake reaction distance and braking distance, respectively."

It should be noted that stopping sight distance calculations in the 2004 AASHTO "Green Book" assume an object height of two feet, a driver's eye height of 3.5 feet, and a deceleration rate of 11.2 $ft/s^2$.




TxDOT access spacing between streets or driveways is measured from the two innermost edges of pavement, not from the driveway centerlines.

## Application of Access Criteria




Stopping Sight Distance Example

(Discussion Paper #5C, Oregon DOT)

TxDOT bases minimum access spacing on AASHTO stopping sight distance. This graphic illustrates the use of AASHTO stopping sight distance for access spacing. This concept was first presented in the following manner by Robert Layton of Oregon State University in the development of Oregon DOT's spacing standards.

Imagine that the middle driveway does not exist, and that only the first and third driveways are present. Assume that these remaining driveways are spaced according to stopping sight distance for the speed of the roadway. Therefore, vehicles approaching the right-most driveway (after they pass the first driveway) have plenty of time to perceive, react, and brake when faced with a potential hazard at the right-most driveway. The hazard could include vehicles queuing out into the street (as shown). Therefore, drivers would be reacting to the vehicle's brake lights, which represent the 2-foot object per AASHTO stopping sight distance. Because the driveways are spaced at stopping sight distance, upstream drivers have no problem seeing, reacting to, and braking for the queue at the downstream driveway. Now imagine there is a second (middle) driveway inserted between the two driveways. Now the driveways are not spaced per stopping sight distance. Turning maneuvers at the middle driveway can cause a visual block as turning vehicles cross the sight line of upstream vehicles. In the event of a queue into the street at the third driveway, vehicles passing the first driveway would not have enough time to react and brake for such a queue at the third driveway if there is a visual block at the second (middle) driveway.

## Unsignalized Spacing Criteria (Texas)

| **Other State Highways Minimum Connection Spacing** | |
|---|---|
| Posted Speed (mph) | Distance (ft) |
| ≤ 30 | 200 |
| 35 | 250 |
| 40 | 305 |
| 45 | 360 |
| ≥50 | 425 |

Distances are for passenger cars on level grade. These distances may be adjusted for downgrades and/or significant truck traffic.
When these values are not attainable, refer to the deviation process

This is a table from TxDOT's *Access Management Manual* that illustrates the minimum spacing values for a given posted speed. It should be noted that these values are "minimums." They assume passenger cars on level grade. When a grade is present and/or a significant truck traffic, these values should be adjusted accordingly.

## Corner Clearance

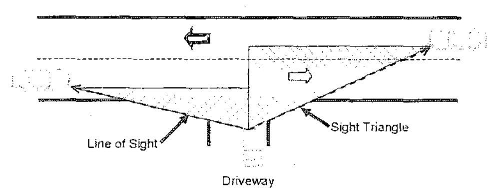
- Based on stopping sight distance (Texas)
- Where adequate space cannot be provided
  - May allow lesser spacing when shared access is allowed
  - Access may be allowed when no alternative exists, but at farthest location from intersection
  - Consideration given to right-in/right-out only operations

We are all familiar with small corner parcels (e.g., gas station, convenience stores) that do not have enough frontage to satisfy access spacing criteria. "Corner clearance" is the distance from the primary intersection to the corner parcel's first driveway. As noted in the TxDOT *Access Management Manual*, corner clearance is subject to AASHTO stopping sight distance.

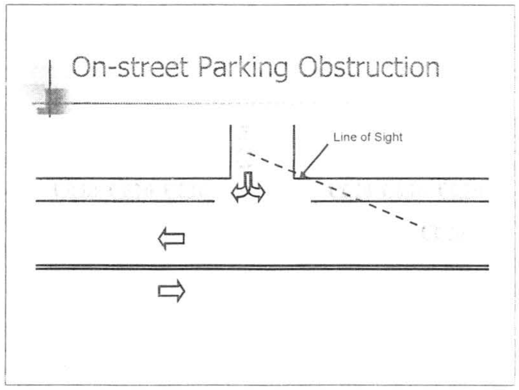
However, when adequate spacing can not be provided at the corner parcel, a couple practical suggestions can be made to mitigate the operational impacts of allowing access on the major street. Ideally, access would only be allowed on the minor street; however, this is not always possible.

Other practical suggestions include allowing a lesser spacing when shared access is allowed with an adjacent business in an effort to reduce the number of driveways; allowing the access, but at the farthest location from the intersection (i.e., the far edge of the property line); or giving consideration to right-in/right-out only operations, which is best facilitated with the presence of a raised median along the roadway.

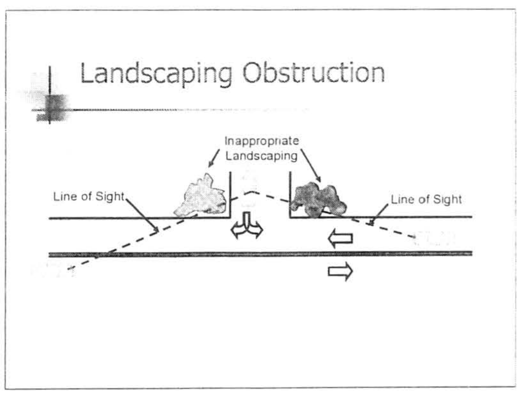
## Intersection Sight Distance (enter / cross roadway)



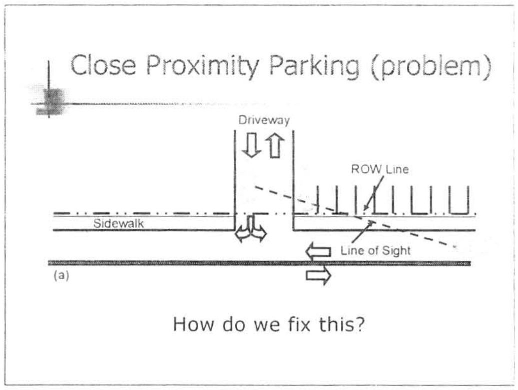

We have discussed stopping sight distance as it relates to driveway spacing along the primary roadway. Intersection sight distance (ISD) for entering and crossing a roadway is also important. TxDOT has limited control over ISD as the proper consideration of ISD goes beyond the right-of-way of the state roadway. Therefore, local agencies (cities) have better opportunity to regulate ISD through ordinances that require and enforce ISD. This typically includes ensuring a proper line of sight and sight triangle at access locations that are free of signing, landscaping and other elements. Of course, TxDOT can ensure line of site and sight triangles within the state right-of-way. An example would be ensuring a raised median treatment that includes landscaping satisfies ISD.




On-street parking can also provide an obstruction to the line of site. When on-street parking is allowed, it should be removed in the vicinity of the intersection to ensure the line of sight is preserved.

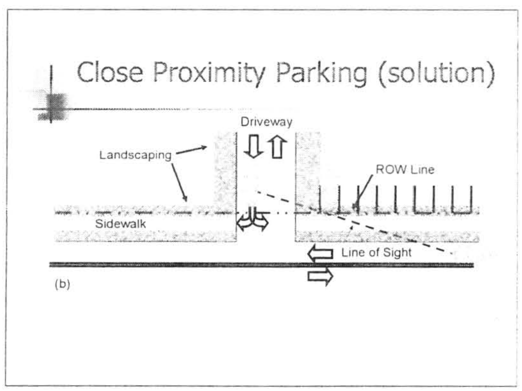



Landscaping can also provide a visual obstruction. Landscaping must not be in the line of sight and regular maintenance should be scheduled to keep sight lines unobstructed.



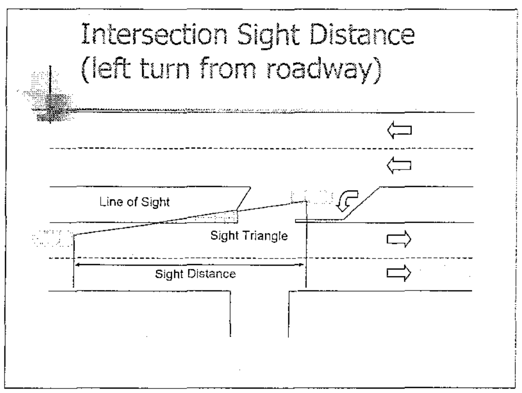

Allowing on-site parking that is directly on the right-of-way line can block the sight line.

How can this problem be fixed or avoided?

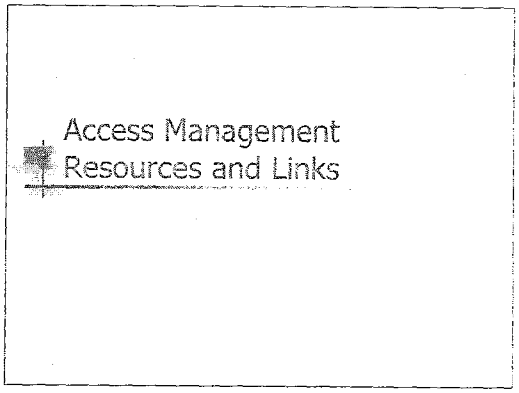



The solution is to add some landscaping between the driveway and the parking. This will allow for an unobstructed line of sight.

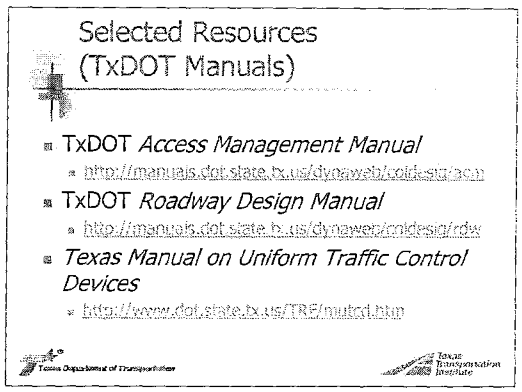
As mentioned previously, because the landscaping and parking issues are beyond the right-of-way line of the state facility, they can not be regulated by the state. They must be addressed in local agency ordinances. They would likely be included in a city's development ordinances. This example illustrates the importance of the needed coordination between local and state agencies to ensure safe driveway design.




Because the design of raised medians is within the right-of-way lines of the state facility, TxDOT can ensure appropriate intersection sight distance at the raised median treatments for left-turning maneuvers from the roadway.




The following slides provide additional resources and links where you can obtain additional information on access management.

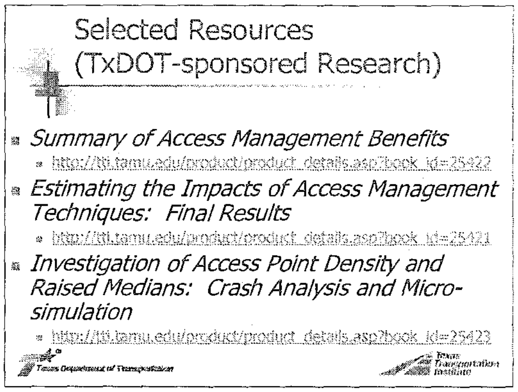



This slide shows three key design references used by the Texas Department of Transportation. Links to each are provided.

The first reference is the Texas Department of Transportation (TxDOT) *Access Management Manual*. This manual is intended to provide guidance for access location determination and procedures for municipalities to be granted permitting authority to the state highway system.

The second reference is the Texas Department of Transportation (TxDOT) *Roadway Design Manual*. This manual is intended to provide guidance in the selection of geometric design criteria for highway and street project development. This manual represents a synthesis of current information and operating practices related to the geometric design of different classifications of roadway facilities.

The third reference is the Texas Department of Transportation (TxDOT) *Texas Manual on Uniform Traffic Control Devices (MUTCD)*. The purpose of traffic control devices, as well as the principles for their use, is to promote highway safety and efficiency by providing for the orderly movement of all road users on streets and highways throughout Texas and across the Nation.

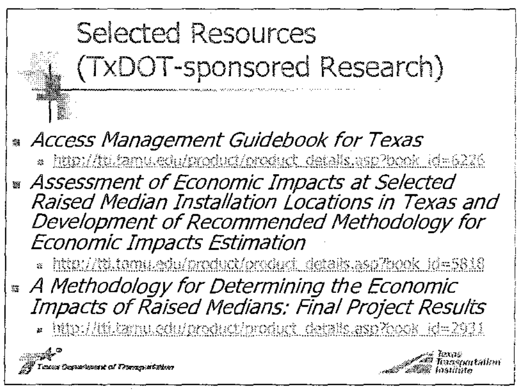



The next two slides include research reports sponsored by the Texas Department of Transportation (TxDOT) and performed by the Texas Transportation Institute (TTI), which relate directly to access management. This slide shows three references from the research project "Benefits of Access Management."

The first resource is the *Summary of Access Management Benefits*. The first objective of the research is to estimate the impacts of access management techniques through field data collection at selected sites in Texas and to perform simulation of traffic performance. The second objective of the research is to estimate the safety benefits of access management treatments by investigating crash data from select corridors where access management treatments have been installed.

The second resource is the research report *Estimating the Impacts of Access Management Techniques: Final Results*. This research report summarizes the research activities and findings of the 2.5-year research project to investigate the impacts of access management treatments.

The third resource is the Texas Transportation Institute's (TTI) *Investigation of Access Point Density and Raised Medians: Crash Analysis and Micro-simulation*. This product provides usable information yielded from researching access management benefits. The product describes the findings of micro-simulation performed on real and theoretical corridors. In addition, the product provides findings from crash analyses performed on case study corridors in Texas and Oklahoma.

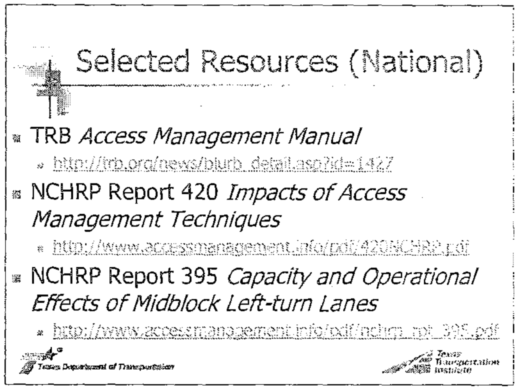



This slide shows three references from the Texas Transportation Institute (TTI) research sponsored by the Texas Department of Transportation (TxDOT).

The first resource is the *Access Management Guidebook for Texas*. This Guidebook explains the principles of access management for a variety of audiences The Guidebook discusses the benefits of access management and the three themes TxDOT is using as a foundation for the statewide program.

The second resource is the *Assessment of Economic Impacts at Selected Raised Median Installation Location in Texas and Development of Recommended Methodology for Economic Impacts Estimation*. The results of this research effort will provide insight to planners, engineers, and researchers investigating the economic impacts of raised median projects.

The final resource is A Methodology for Determining the Economic Impacts of Raised Medians: Final Project Results. This research provided many findings that may help alleviate (business managers' and property owners') concerns regarding raised median installation.

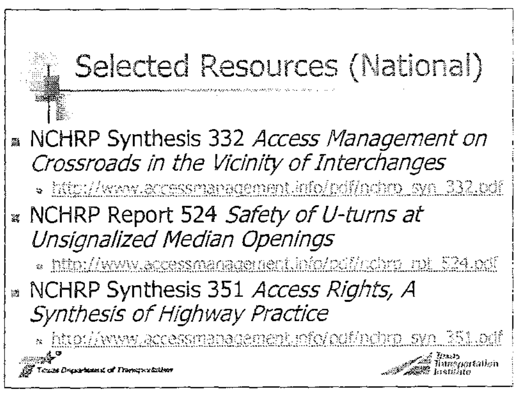



This slide, and the next three, illustrate key national resources related to access management. Links to each are provided.

The first resource is the Transportation Research Board (TRB) *Access Management Manual.* TRB's *Access Management Manual* provides technical information on access management techniques, together with information on how access management programs can be effectively developed and administered.

The second resource is National Cooperative Highway Research Program (NCHRP) Report 420, *Impacts of Access Management Techniques.* This report classifies access management techniques and presents methods for estimating the safety and operational effects of the different techniques.

The third resource shown here is the National Cooperative Highway Research Program (NCHRP) Report 395, *Capacity and Operations Effects of Midblock Left-turn Lanes.* This report examines procedures for estimating the operational, safety, and access impacts of different midblock left-turn treatments and includes guidelines for selecting among raised-curb medians, two-way left-turn lanes, and undivided cross sections.

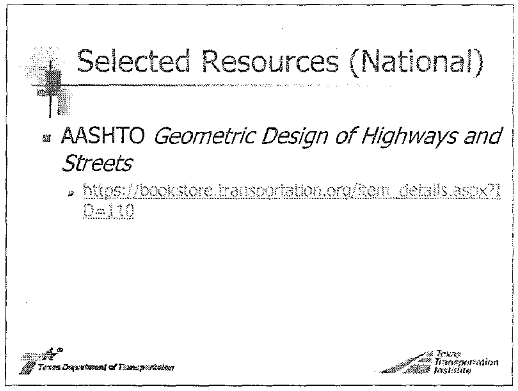



Additional national resources include the following.

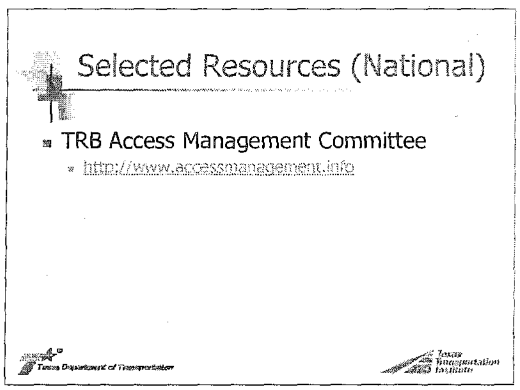
The first resource is the National Cooperative Highway Research Program (NCHRP) Synthesis *Access Management on Crossroads in the Vicinity of Interchanges.* This synthesis examines current practices relating to access location and design on crossroads in the vicinity of interchanges. It identifies standards and strategies used on new interchanges and on the retrofit of existing interchanges.

The second resource is the National Cooperative Highway Research Program (NCHRP) Report *Safety of U-turns at Unsignalized Median Openings.* This report includes recommended guidelines for locating and designing unsignalized median openings, and a methodology for comparing the relative safety performance of different designs.

The third resource is the National Cooperative Highway Research Program (NCHRP) Synthesis *Access Rights, A Synthesis of Highway Practice.* This synthesis documents the state of the practice with the intent to limit the amount of access to the roadway for the purpose of managing highway safety and mobility.




The final national resource is American Association of State Highway and Transportation Officials' (AASHTO) *Geometric Design of Highways and Streets.* This book contains the latest design practices in universal use as the standard for highway geometric design.




The website shown here is for the Transportation Research Board Access Management Committee. It has many other useful resources including further reports, guides, conference proceedings, codes, and handbooks related to access management. Many of the previously-mentioned national references are available at this site.