MANAGING IMPACTS OF LAND DEVELOPMENT

August 28-30, 2007
University of Wisconsin
Madison

WisDOT Traffic Engineering
Technical Training Program

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Managing Traffic Impacts of Land Development Workshop

August 28 – 30, 2007

Presented by Dane Ismart

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Session 1

- Planning Requirement Overview

2

Transportation Planning Process - Terms

MPO (Metropolitan Planning Organization)

TMA (Transportation Management Area)

Non-attainment or Maintenance Area

Models

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Transportation Planning Process - Products

- Transportation Planning Work Programs (SPR & UPWP)
- Long Range Transportation Plans (LRTP)
- Transportation Improvement Programs

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Transportation Planning Process - Coordination

- Plans and TIPs
- TIPs included in STIP
- Air Quality and Transportation Planning
- Other planning, e.g., Land Use and Economic Development Planning

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Transportation Planning Process - Statewide Planning

- Long Range Transportation Plan
  - Multimodal
  - 20-year forecast
  - Consultation with Governments
  - Public Involvement
  - Official State Planning Document
  - Update & revise periodically

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Transportation Planning Process – Statewide Planning

- Statewide Transportation Improvement Program (STIP)
  - 3-year period – project specific
  - Consultation with Governments
  - Public Involvement
  - Consistency with other Plans (LRTP,TIPs, & SIP)
  - Financial constraint
  - Review & approval

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Transportation Planning Process - STIP / TIP

All Federally funded projects need to be listed in the STIP/TIP

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Transportation Planning Process – Metro Planning

Long Range Transportation Plan (LRTP)

- Plan Development (20 year horizon)
- Coordination (other agencies and plans)
- Public Involvement
- Financial Plan
- Conformity w/ SIP

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Transportation Planning Process - Metro Planning

Transportation Improvement Progeram (TIP)

- TIP Development (3 years)
- Cooperative w/ transit
- Public Involvement
- Projects need to be in TIP
- Consistent w/ other plans/programs
- Financially constrained
- Priorities (yr. 1; yr. 2; yr. 3)
- Approved by MPO and Governor

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Transportation Planning Process – Metro Planning

- Congestion Management System (CMS)
  - Required in all Transportation Management Areas (TMAs)
  - Single Occupant Vehicle (SOV) projects

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Transportation Planning Process – Metro Planning

Planning Certification

- Self certifications
- Special certification actions in TMAs
- Joint actions by FTA & FHWA

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Finance: Highway Trust Fund

- History
- User Taxes & Collection
- Pay as you go

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Session 2

- Federal-aid Funding

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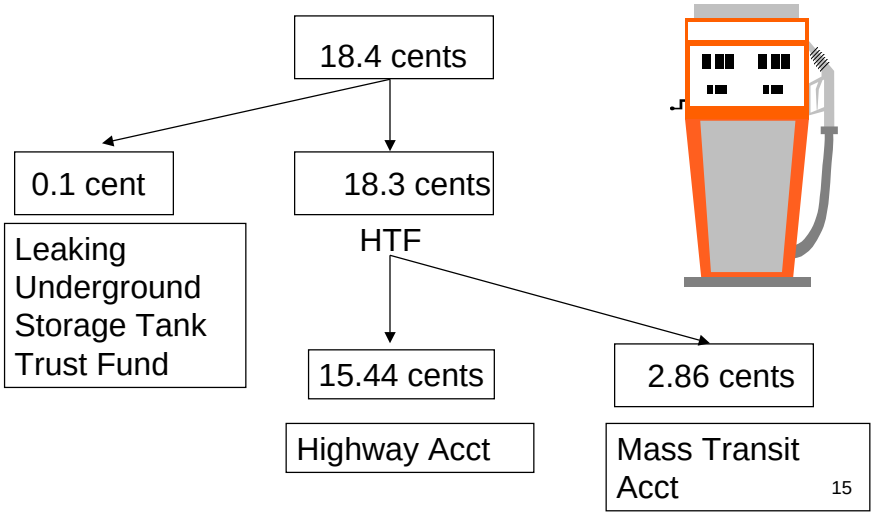
Finance: Highway Trust Fund

FEDERAL GASOLINE TAX BREAKDOWN



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Finance: Authorization Act / Appropriations Act

Budget Authority

- Contract Authority

- Appropriated Budget Authority

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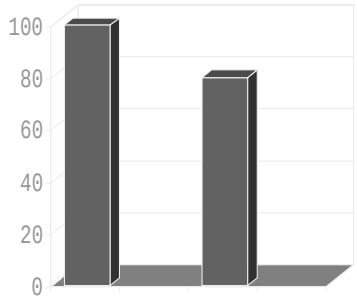
Finance: Authorization Act / Appropriations Act (cont.)

Obligation Authority

- Limitation
- Redistribution



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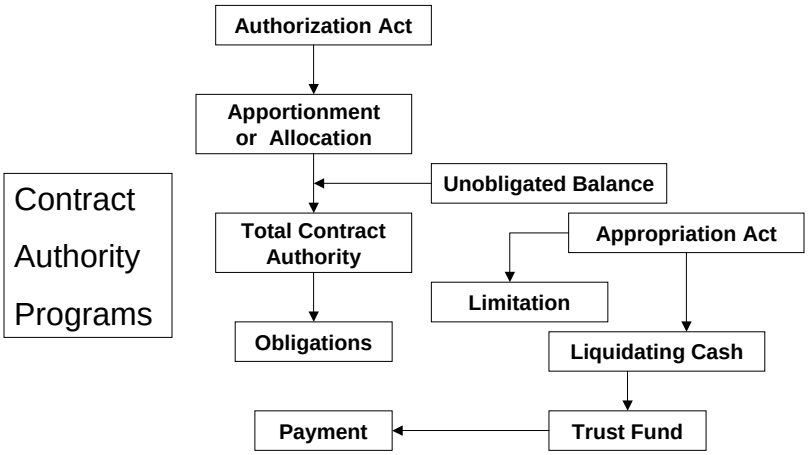
Finance: Authorization Act / Appropriations Act (cont.)



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Finance: Federal-aid Financing Procedures

- Reimbursable Program
- Distribution of Funds
  - Apportionments
  - Penalties / Incentives
  - Set-asides
  - Additional Distribution
  - Allocations
  - Funding equity (Equity Bonus)

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Finance: Federal-aid Financing Procedures (cont.)

- Availability of Funds
- Eligibility
  - Activities
  - Class of highway (functional classification)
  - Timing of work/authorization
- Transferability

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Finance: Federal-aid Financing Procedures (cont.)

Federal Share

- Matching Ratio/Federal Share (80%)
- Exceptions to 80%
  1. Interstate System (90%)
  2. Sliding Scale (23 USC 120(b))
  3. 100 % Federal Funding (FLH, ER..)
  4. Tapered Match
- Sources for Matching Funds

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Session 3

- Traffic Impact Analysis

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Standard Site Impact Process

1. Methodology Development
2. Existing Condition Analysis
3. Background Traffic
4. Trip Generation
5. Trip Distribution
6. Mode Split
7. Assignment
8. Future Conditions Analysis
9. Mitigation Analysis
10. Site Access, Circulation, and Parking

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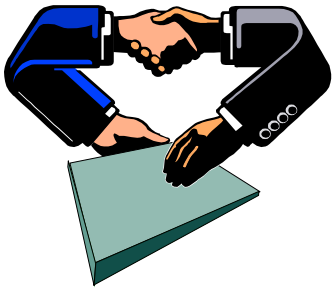
Step 1

Methodology Development

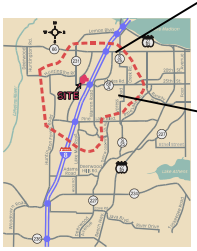
How can we study the impacts of development to assure the community get the best transportation possible?

- Avoid wasted time and effort
- Agree on critical features of the study



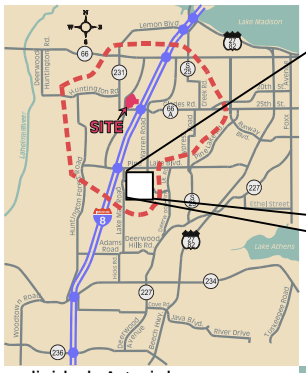
Step 1

Methodology Development
Establishing the study area



Using Hourly Directional Table to Determine Impact Area

Let's use 5% as significant



Development adds **300** Peak Hour directional trips to segment

1,710 Maximum Service Volume at LOS D

$$\frac{300}{1,710} = 18\%$$

- 4 Lane divided Arterial
- from Directional Peak Hour Tables. Urbanized Class II , LOS D = 1,710.

Yes, this is significant

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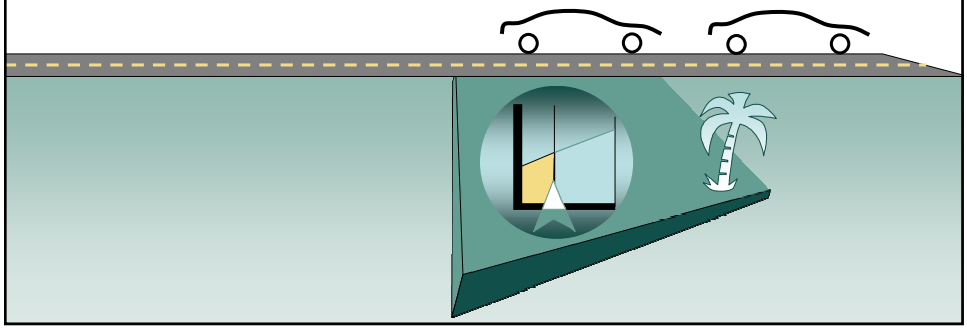
Step 2

Existing Conditions Analysis

What are the physical and operational conditions of roadways and intersections?

- Get traffic counts
- Determine roads, lanes, and other service
- HCM (LOS) generally used

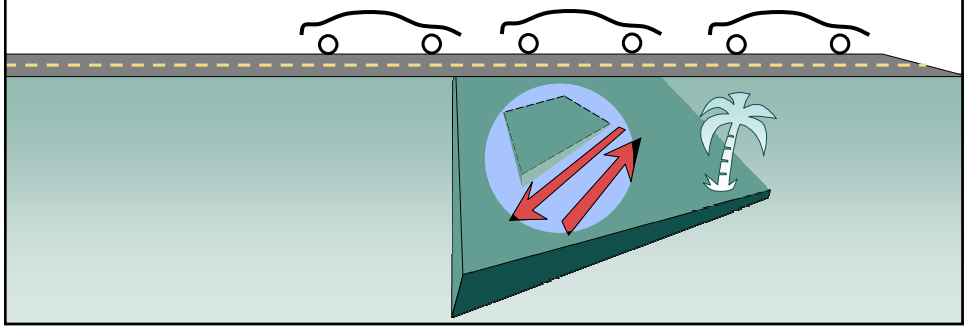


Step 3

Background Traffic

How much will traffic grow **without** the development?

- Manually projects volumes from historic data
- Computer can also model growth

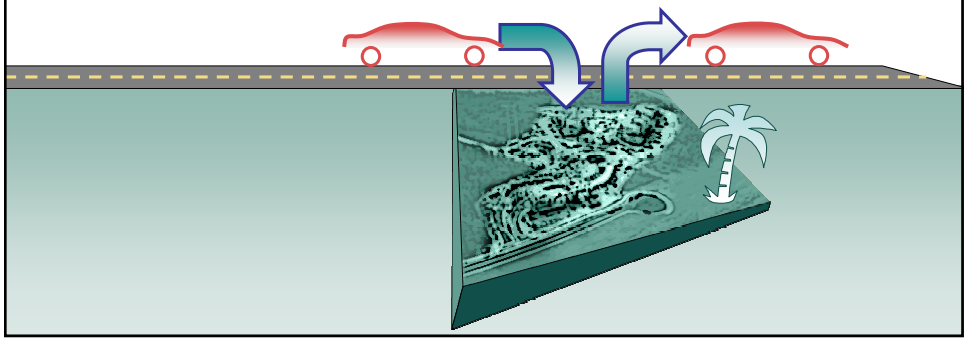


Step 4

Trip Generation

How many trips are expected from the development?

- Use known relationships found in the Institute of Transportation Engineers (ITE) Trip Generation Report, Seventh Edition

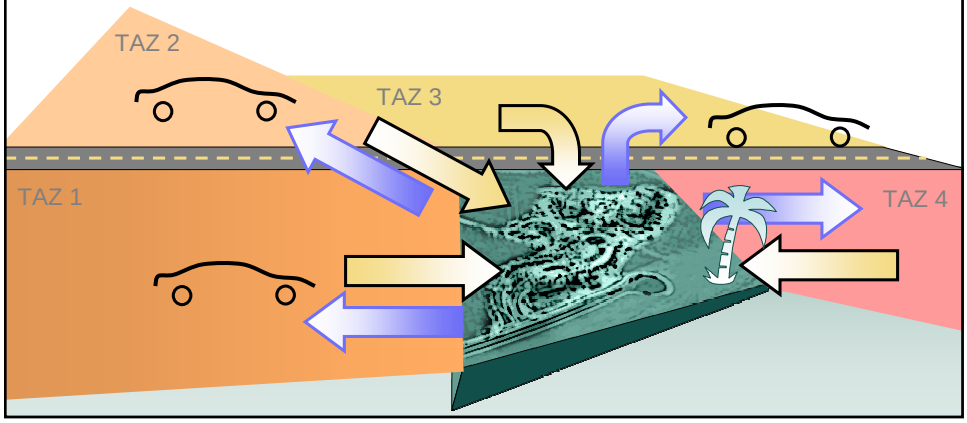


Step 5

Trip Distribution

Where do trips come from and go to?

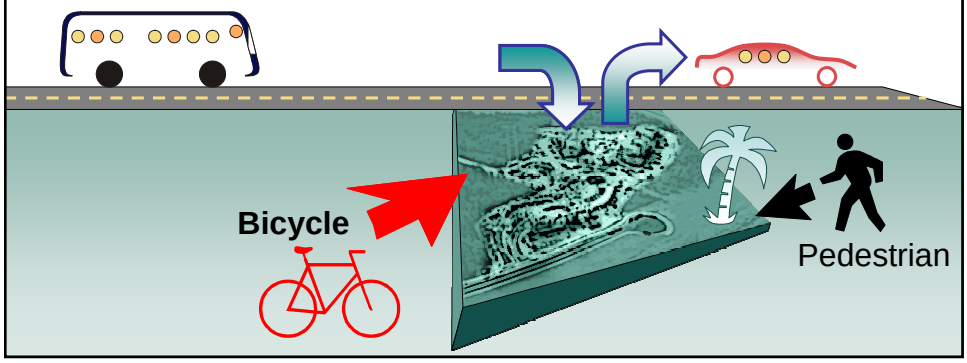
- Can use Urban Models
- Determine origin and destination of trips



Step 6

Mode Split

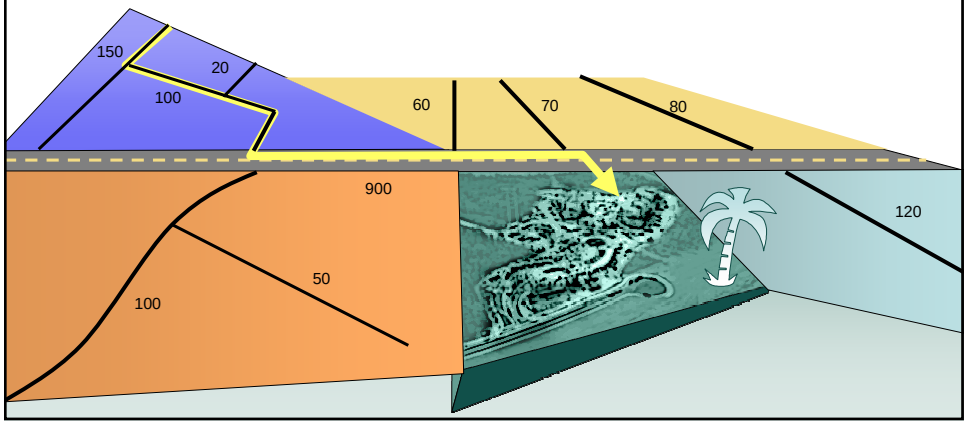
- How many people get there in each vehicle?
  - Estimate the percentage of person trips using each mode of travel
  - Most MPO models contain transit component



Step 7

Assignment

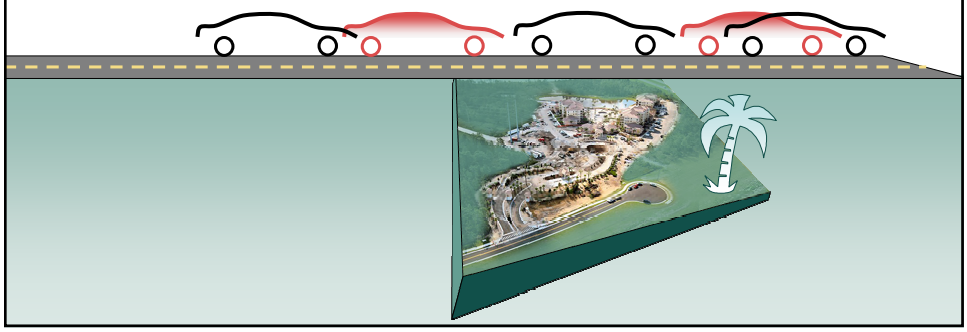
- What route do vehicles take?
  - Can be done manually *(tedious)*
  - MPO models complex



Step 8

Future Conditions Analysis

- What will the traffic conditions be after the development is built?
  - Assess the impacts of the development-generated traffic using the department's LOS guidelines and standards



Step 9

Mitigation Analysis

How can LOS be made acceptable?

- Determine where and how roadway deficiencies must be addressed
  - Create cost estimates
  - Determine the appropriate share of responsibility

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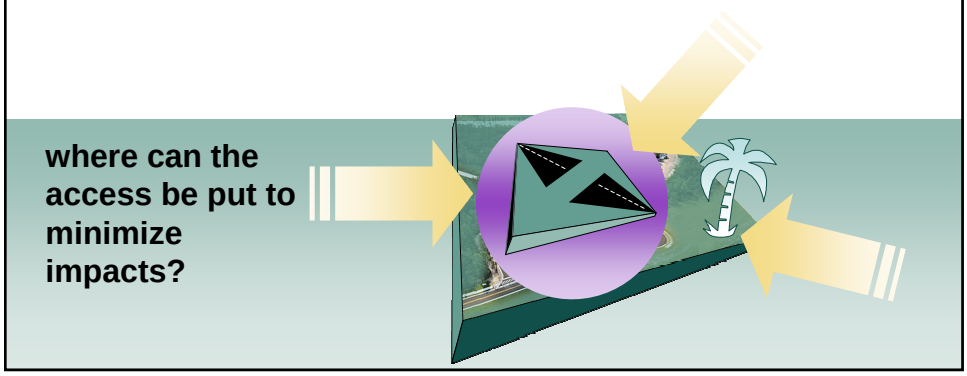
Step 10

Site Planning

How can the site design enhance circulation and minimize traffic conflict?

- Access Management principles



Session 5

- Developing Design Year Traffic

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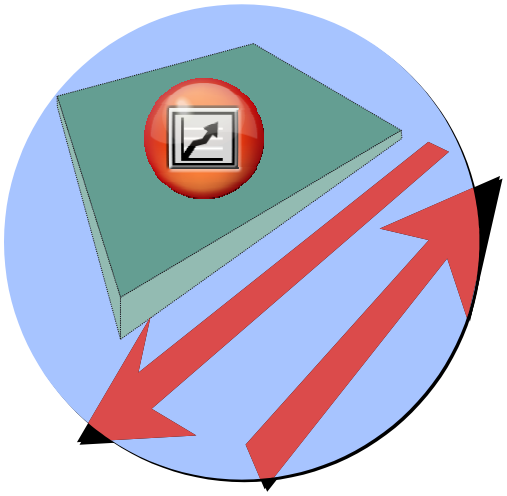
Background Traffic and Trends



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What is Background Traffic?

- Expected increase
  - from overall growth
  - traffic from other developments
    - But not the one you're analyzing

Background Traffic

Traffic trend analysis or

Background traffic is a result of modeling

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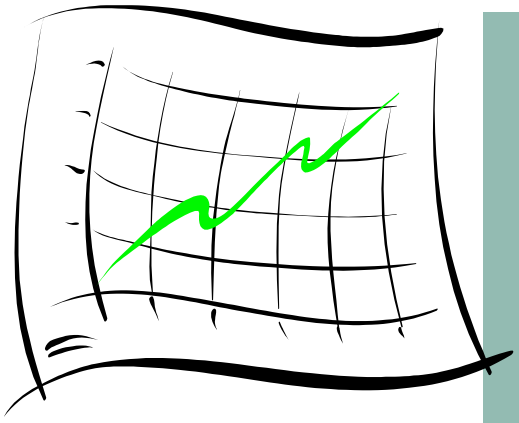
Trend Analysis

- Historical data for at least the last five years
- Check for major transportation changes
  - Which change capacity and attract new trips
- Check for major development changes

Different Types of Trends

- Linear growth
- Geometric growth
- Declining growth

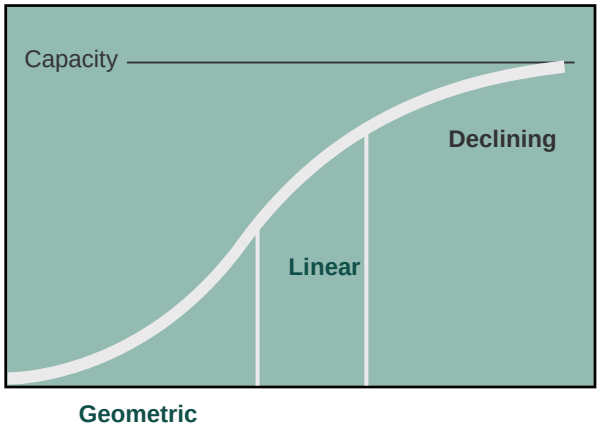
Some Historical Volumes



Year	Volume (AADT)
1997	12,300
1998	12,000
1999	13,500
1998	13,220
1997	13,000
1996	13,775
1997	14,125
1998	15,000
1999	14,000
2000	15,000
2001	15,600
2002	15,300
2003	16,500
2004	15,900
2005	16,500

Different Types Of Traffic Growth

Natural Growth



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How To Apply Growth Rates
(Future Volumes)

- Single rate for all facilities in study area
- Facility by facility

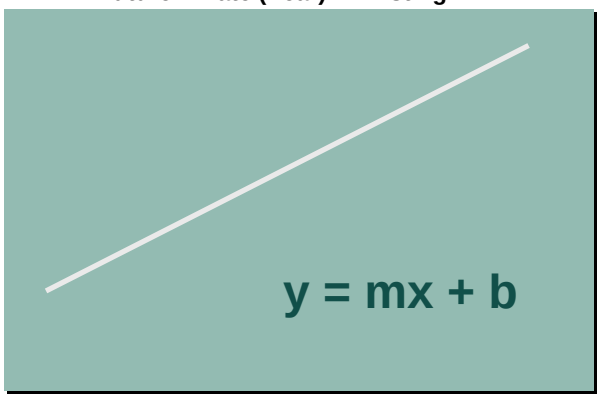
Linear Growth

- Based on a straight line developed from historic traffic growth
  - Assumes constant growth
  - Does not consider capacity restraint
  - Constant land use growth over time

Linear Growth

Future = Rate (Year) + Existing

y



x

For areas experiencing consistent growth

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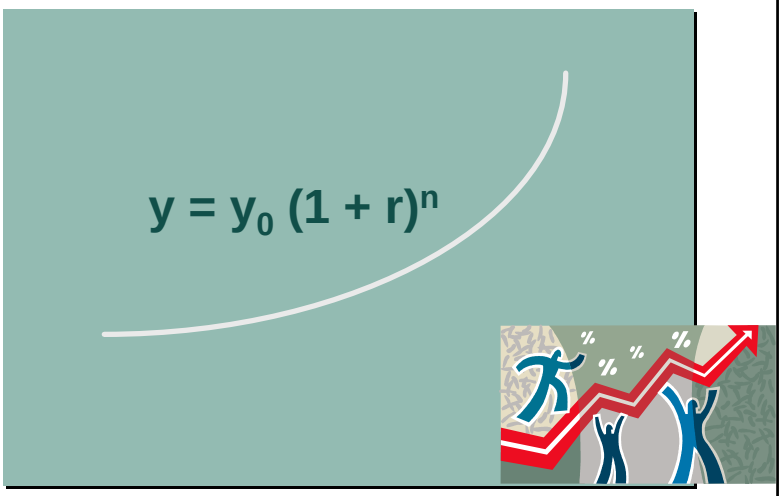
Geometric Growth

- Based on constant percentage of growth from previous year
  - Most applicable with available capacity and exploding growth

Geometric Growth

Future = Existing (1 + Rate) Number of years

y



x

For areas experiencing high growth and less capacity restraint

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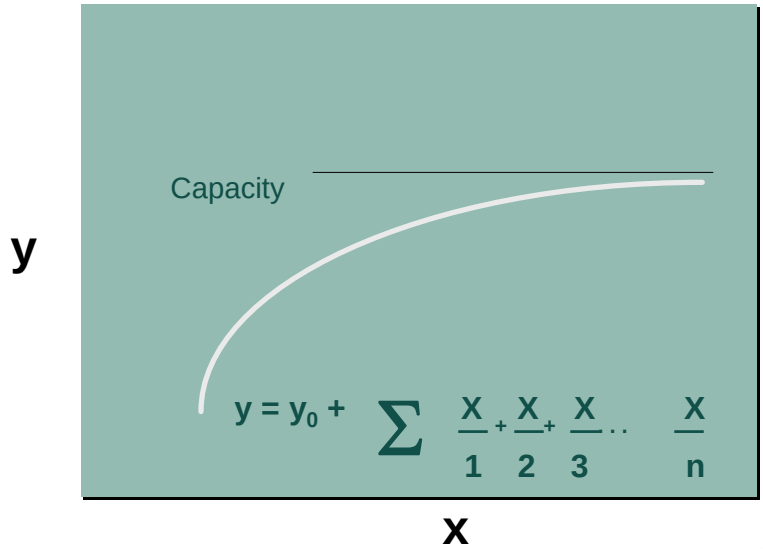
Declining Growth

- Based on declining rate of growth
  - Dense urbanized areas
  - **Remember**: even fast growth areas eventually slow (built out)

Declining Growth



For areas approaching build out and maturity

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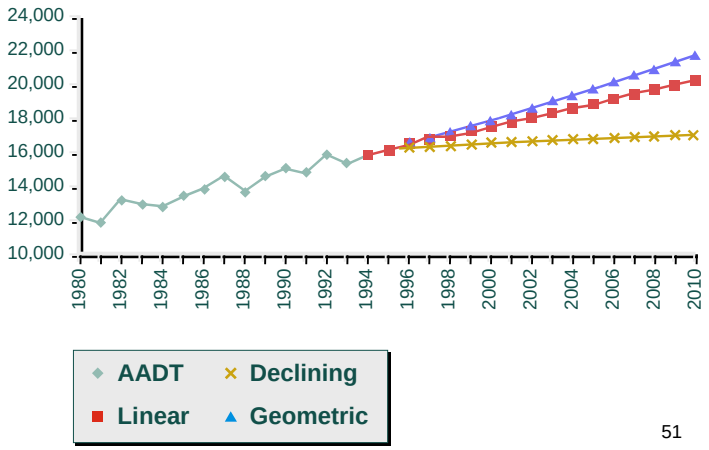
Results Comparison



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Session 6

- Traffic Factors
- AADT
- PHF
- K Factors
- D Factor
- T Percentage
- Design Hour Volume

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AADT

- Average Annual Daily Traffic Volumes
- Accounts for Total Yearly Traffic Divided by 365.
- May Be Adjusted for Seasonal Adjustments and Day of Week Adjustments
- Adjustments May Be Based on Area Type and Functional Classifications

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PHF

- Peak Hour Factor
- Adjusts for Calculating Rate of Flow
- Multiplies Highest 15 Minute Volume by 4 and Dividing into Peak Hour Volume

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PHF

- Ranges From .85 (Rural) to .95 (Urban)
- Obtain Via Traffic Counts or State Provides Default Values
- Design Volumes Are Very Sensitive to PHF
- Example:

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K Factor

- K Factor Converts AADT to a Non-directional Peak Hour Volume
- K is Based on 30th or 100th Highest Hour
- K Typical Ranges From .08 to .12
- More Congestion Lower K factor

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D Factor

- Directional Factor
- D Factor Establishes the Proportion of Traffic During the Peak Hour Traveling in the Predominant Direction
- Major Impact on Level of Service

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Truck Percentage

- Must Define What is Meant By a Truck
- Capacity Manual Defines Truck as Having More Than 4 Tires
- Relationship Between Truck and Passenger Car Equivalents – Depends on Grade, Length of Grade, % of Trucks
- Percentage Varies Significantly Depending on Functional Class – Time of Day

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Design Hour Volume

- DHV Typically Based on 30th Highest Hour
- DHV May Be Developed For Multiple Years
- DHV Factors Include: K, D, T, PHF

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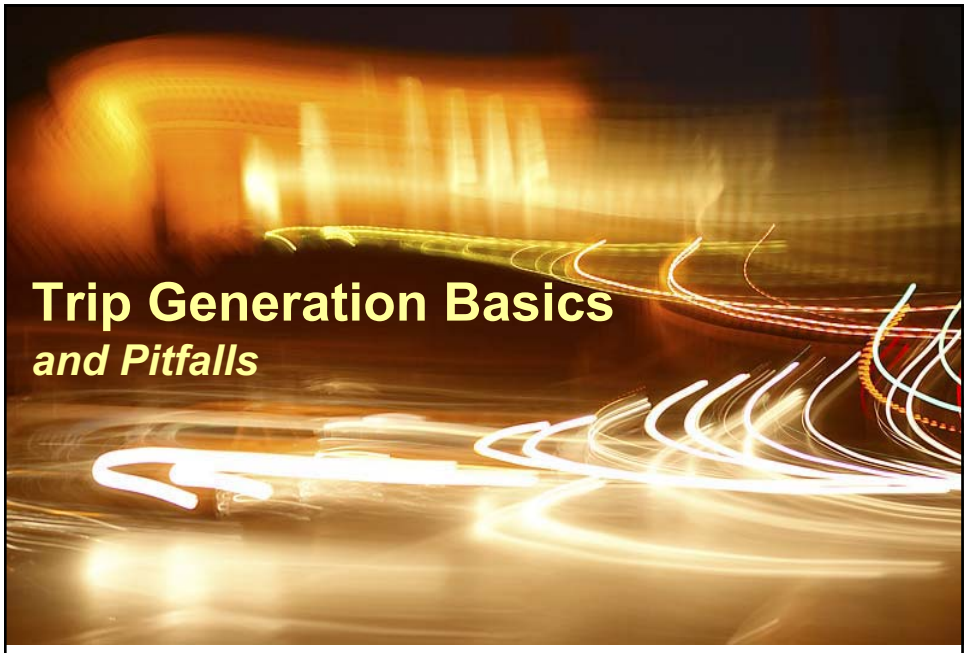


Trip Generation

Simple trip generation calculation needed even when the large scale models are used.

Large scale regional models are not intended for small areas.

Simple Trip Generation Example

10 = Daily Trip Generation Rate for a Single Family Home

10 = Homes being built

- (called "Dwelling Units")
- Homes are the "Independent Variable"

How many daily trips do we project?

100

Trip Generation Report

and use of the 7th Edition

ITE Trip Generation Report and Handbook

ITE Trip Generation Report

Not a Manual

- **National data** – Florida, Arizona and California, played big role
- **Suburban** locations with little or no transit
- Some **small sample** sizes for new **(though important**) uses
  - Discount clubs (861)
  - Stand-alone drug stores (881)
- May not work downtown

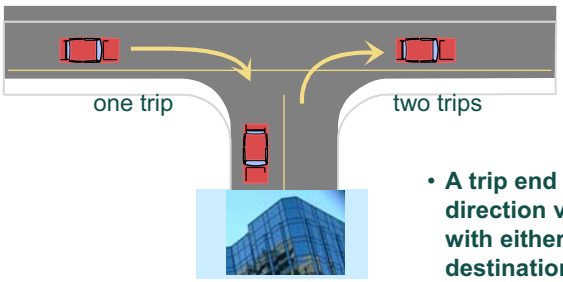
ITE Trip Generation Report

- **Fifth Edition**
  - 7.4 lbs.
  - $21.50/lb.
- **Sixth Edition**
  - $23.00/lb.
    - **But:** you also need the "Handbook" at $90 extra
- **Seventh Edition**
  - 9.75 lbs.
  - $275
  - **$28.21/lbs**.

Thanks to: David Muntean

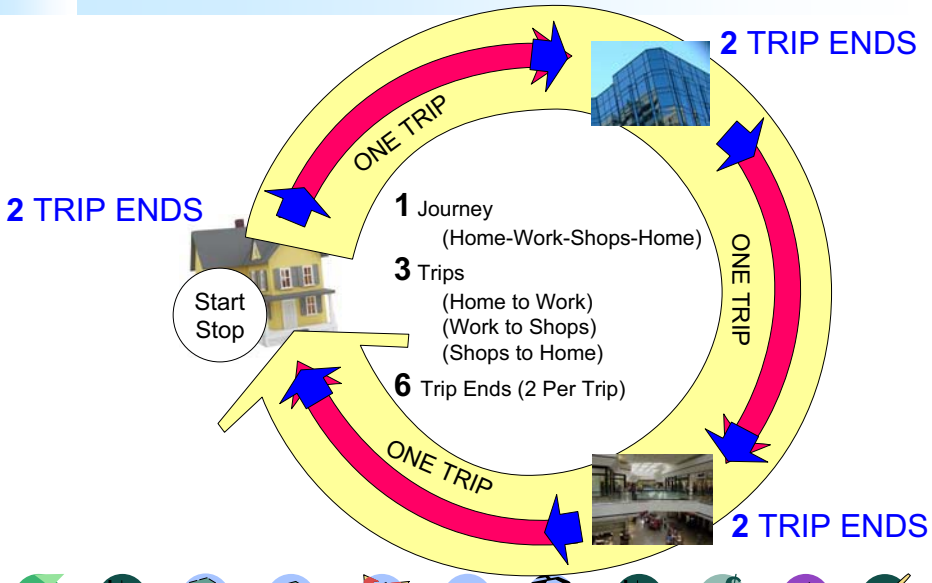
What is a Trip End?

- Number of trips that come in or go out of a development
  - (Volume at Driveways)

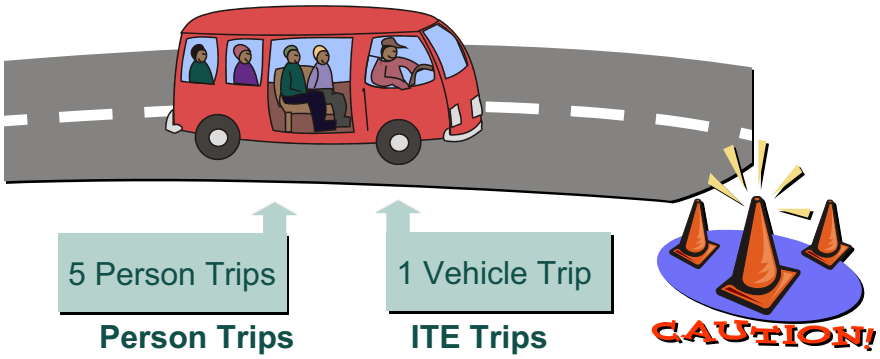


- **A trip end is a single or one-direction vehicle movement with either the origin or destination (exiting or entering) inside the study site.**

Journey/Trip/Trip Ends



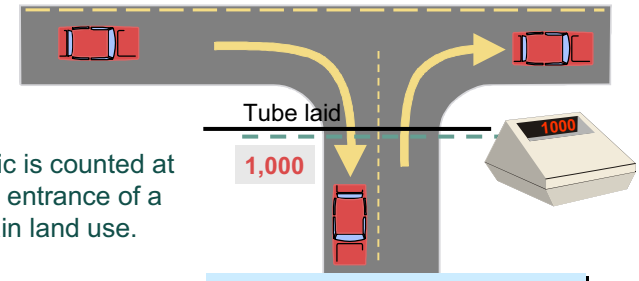
Vehicle Trips (ITE) vs. Person Trips



How Are Trip Generation Rates Determined?

- Traffic is counted at each entrance of a certain land use.

Traffic is then studied in relation to the size of certain "independent variables."



10,000 sq ft store

250 employees

Not This

But this

Sample Page From ITE

Apartment
(220)

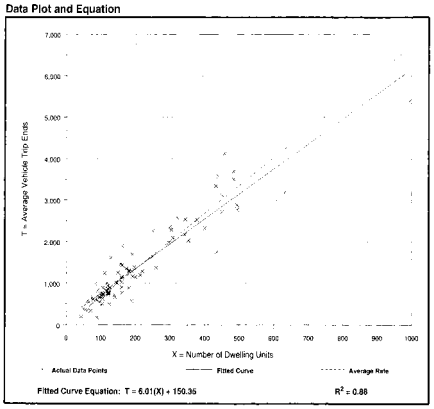
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Number of Studies: 86
Avg. Number of Dwelling Units: 212
Directional Distribution: 50% entering, 50% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
6.72	2.00 - 12.50	3.02

Data Plot and Equation



Fitted Curve Equation: T = 6.01(X) + 150.35 $R^2 = 0.88$

What is Meant by "Daily Trips"?

- For our use, we usually mean the number of WEEKDAY TRIPS.

The ITE Manual Also Has Some Data On:
- **Saturday**
- **Sunday**
- **Christmas Holiday Season**

Land Use
(ITE Code)

Apartment
(220)

Average Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday**

Independent Variable

Time Period

Number of Studies: 86
Avg. Number of Dwelling Units: 212
Directional Distribution: 50% entering, 50% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
6.72	2.00 - 12.50	3.02

6.72

Trip Generation Rate

Independent Variable

Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Time Period

Number of Studies: 86
Avg. Number of Dwelling Units: 212
Directional Distribution: 50% entering, 5

Trip Generation per Dwelling Unit

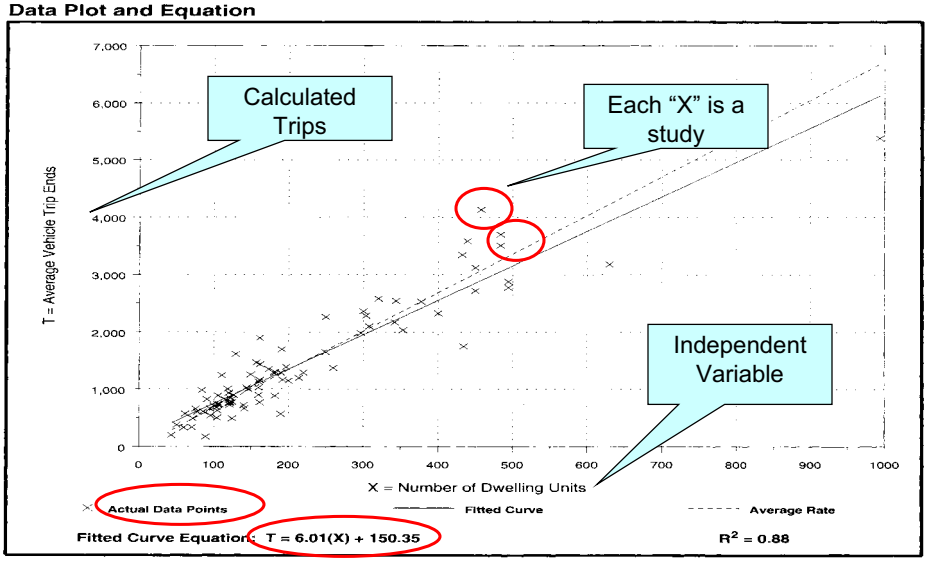
Average Rate	Range of Rates
6.72	2.00 - 12.50

Trip Generation Rate

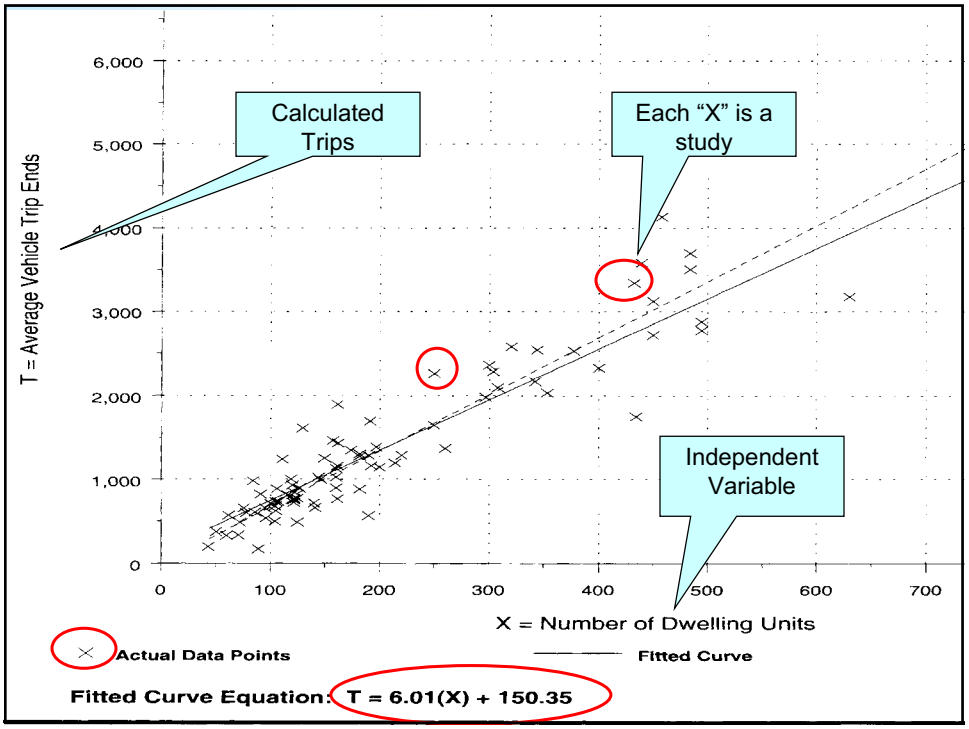
Trip Generation per Dwelling Unit

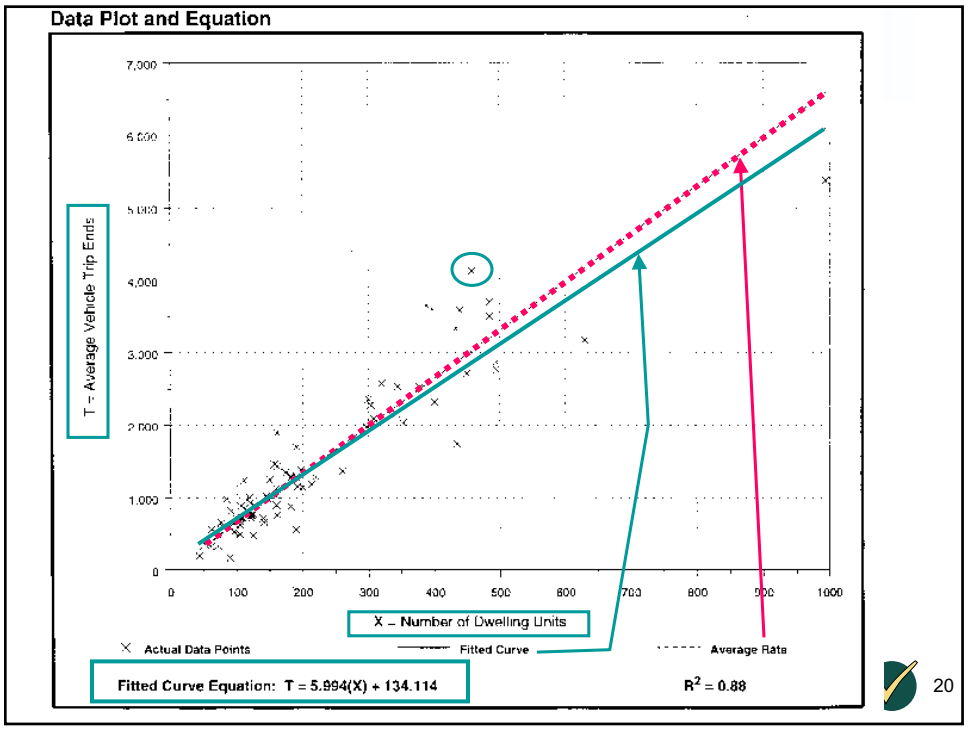
Average Rate	Range of Rates	Standard Deviation
6.72	2.00 - 12.50	3.02

Data Plot and Equation



Fitted Curve Equation: T = 6.01(X) + 150.35 R^2 = 0.88


Calculated Trips
Each "X" is a study
Independent Variable
T = Average Vehicle Trip Ends
X = Number of Dwelling Units
Actual Data Points
Fitted Curve
Fitted Curve Equation: T = 6.01(X) + 150.35


Data Plot and Equation
T = Average Vehicle Trip Ends
X = Number of Dwelling Units
Actual Data Points
Fitted Curve
Average Rate
Fitted Curve Equation: T = 5.994(X) + 134.114
R² = 0.88

Trip Generation Problem #1

- Someone is proposing an apartment complex with 100 dwelling units.
- Using the average trip rate, what are the estimated **daily trips**?

Units Rate Trips

_____ x ____ = _____

What if there were 250 units?

_____ x ____ = _____

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Trip Generation Problem #1

- Someone is proposing an apartment complex with 100 dwelling units.
- Using the average trip rate, what are the estimated **daily trips**?

Units Rate Trips

100 x **6.72** = **672**

What if there were 250 units?

250 x **6.72** = **1,680**

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Apartment PM PEAK Adjacent Street Traffic

Apartment
(220)

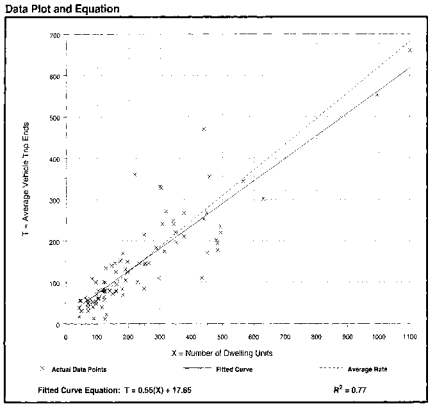
Average Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday,**
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.

Number of Studies: 90
Avg. Number of Dwelling Units: 233
Directional Distribution: 65% entering, 35% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.62	0.10 - 1.64	0.82

Data Plot and Equation



Fitted Curve Equation: $T = 0.55(X) + 17.85$ $R^2 = 0.77$

Trip Generation, 7th Edition 308 Institute of Transportation Engineers

3

Apartment
(220)

Average Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday,**
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.

Number of Studies: 90
Avg. Number of Dwelling Units: 233
Directional Distribution: 65% entering, 35% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviatio
0.62	0.10 - 1.64	0.82

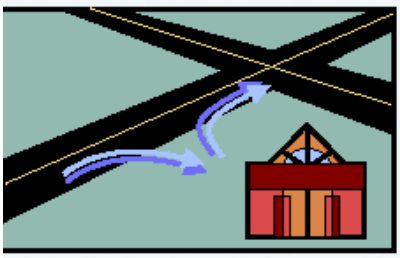
24

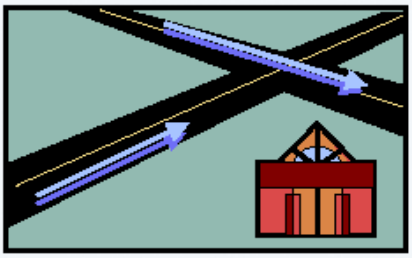
Section B

What's Peak Hour?

- Any 4 consecutive 15 minute periods that equal the highest 1 hour volume
- There are usually morning and evening
  - Some lunch time peaks are important
- We are usually using peak hour of **Adjacent Street Traffic**

Generator vs. Adjacent Street Traffic





- Usually the same PM peak for shopping, office and residential
- Hospitals, industrial and schools may be different due to different work shifts
- Fast food restaurants have short trip durations and peak during mid-day peak periods

Critical Hour Analysis Period for Various Types of Developments

Development	Weekday Street Peak Hour AM	Weekday Street Peak Hour PM	Saturday[1]	Other[1]
Residential	x	x		
Office	x	x		
Retail Shopping[2]		x		
Intersection capacity		x		
Access design		x	11:00 – 15:00	
Banks				
Intersection capacity		x		
Access design		x	11:00 – 12:00	
Restaurants				
Fast food		x		11:00 – 13:00
Dinner Trade		x		
Industrial[3]	x	x		
Motel		x		
Schools				
Grade	x			14:30 – 15:30
High	x			14:30 – 15:30
College	x	x		
Medical				
Hospitals	x	x		6:30 – 8:00

Medical				
Hospitals	x	x		6:30 – 8:00 14:30 – 15:30
Doctors offices		x		9:00 – 10:00 16:00 – 18:00
Service Stations		x		
Sports/Recreational (theme parks, stadiums, etc.)				Peak entry/exit

[1]As noted, one hour within range shown. (Time is given in 24-hour clock system).
[2]In nearly all cases, counts of existing traffic are not needed on Saturday, but projections of site traffic may be prepared for design lengths of turn lane storage.
[3]Industrial plant shifts may precede typical commuter rush hour.

Adapted From: ANALYSIS OF TRAFFIC IMPACT
FOR NEW DEVELOPMENTS
PAUL C. BOX
Paul C. Box and Associates, Inc.
Traffic Engineering Consultants
Skokie, Illinois

Public Works Magazine: February 1981

Trip Generation Problem # 2

- Someone is proposing an apartment complex with 100 dwelling units.
  What would be the **peak hour directional** trips for the PM Peak Hour of adjacent street traffic?

Units		Rate		Trips
_____	X	____	=	_____

Trips		Distribution		Trips	
_____	X	____	=	_____	enter
_____	X	____	=	_____	exit

Trip Generation Problem # 2

- Someone is proposing an apartment complex with 100 dwelling units.
  What would be the
  peak hour directional trips for the PM Peak Hour of adjacent street traffic?

Units		Rate		Trips
100	X	.62	=	62

Trips		Distribution		Trips	
62	X	.65	=	(40.3) 40	enter
62	X	.35	=	(21.7) 22	exit

PM Peak Hour Trips Aren't Always Equal

Shopping Center (820)

– 202,400 sq.ft = **1,000** Peak Hour trips

- 480 in
- 520 out

See peaking characteristics

General Office (710)

– 821,300 sq.ft = **1,000** Peak Hour trips

- 170 in
- 830 out

Think About It

- When would a major office development have the most impact on the surrounding road system?

Best Independent Variables

Shopping Centers and Malls

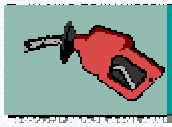
Gross Leaseable Area

Offices and other "Single" uses

Gross Floor Area

Homes and Apartments

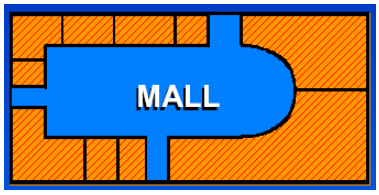
Dwelling Units



Gas Stations

Fueling Positions

Gross Leaseable Area (GLA)

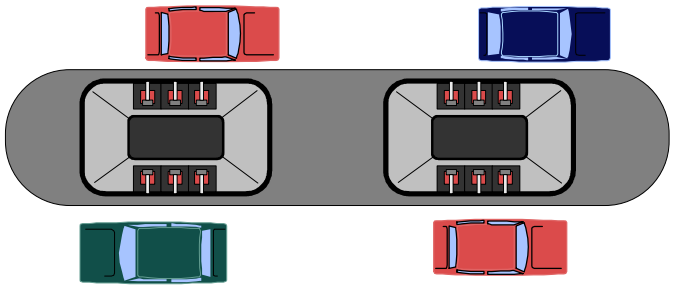


- GLA is only the area that can be used by shops
- Does not include parking areas or common pedestrian areas

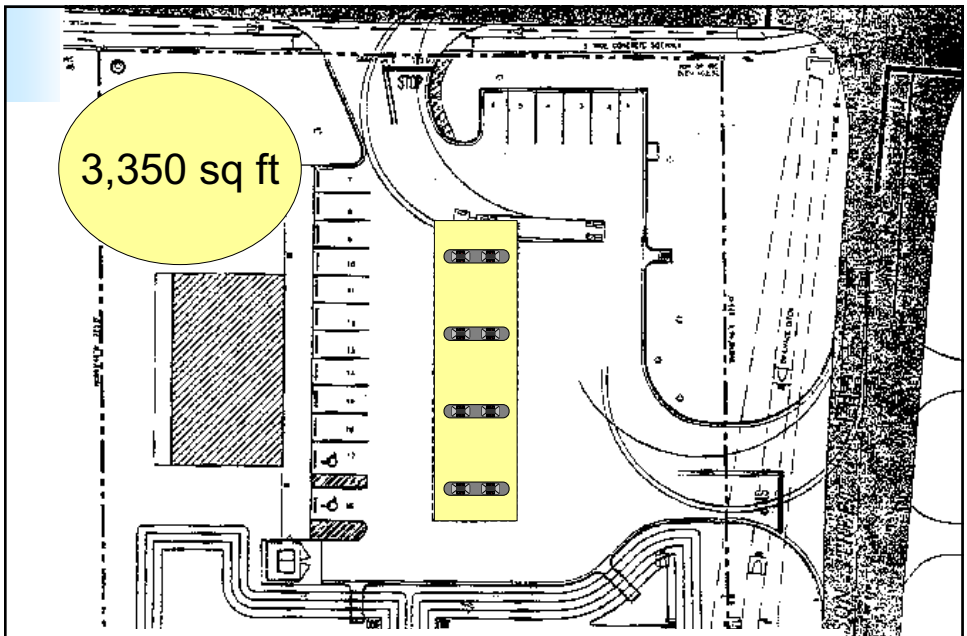
Gross Floor Area (GFA)

- GFA includes all enclosed area for each floor

What's a Fueling Position?



Maximum Number of Vehicles that can be Fueled Simultaneously.



Convenience Market – Applicant Claimed 4 Fueling Positions and 138 Daily Trips

Has the Analyst "Shopped" for the Trip Generation Rate?

Specialty Retail Compared

Specialty Retail Center
(814)

Average Vehicle Trip Ends vs: **1000 Sq. Feet Gross Leasable Area**
On a: **Weekday,**
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.

Number of Studies: 5
Average 1000 Sq. Feet GLA: 69
Directional Distribution: 44% entering, 56% exiting

Trip Generation per 1000 Sq. Feet Gross Leasable Area

Average Rate	Range of Rates	Standard Deviation
2.71	2.03 - 5.16	1.83

Shopping Center
(820)

Average Vehicle Trip Ends vs: **1000 Sq. Feet Gross Leasable Area**
On a: **Weekday,**
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.

Number of Studies: 407
Average 1000 Sq. Feet GLA: 379
Directional Distribution: 48% entering, 52% exiting

Trip Generation per 1000 Sq. Feet Gross Leasable Area

Average Rate	Range of Rates	Standard Deviation
3.75	0.68 - 29.27	2.75

Specialty Retail vs. Shopping Center

Shopping Center (820)

407 studies

379,000 sq.ft. Gross Leasable average

Rate in PM Peak = **3.75**

Specialty Retail Center (814)

5 studies

69,000 sq.ft. Gross Leasable average

Rate in PM Peak = **2.71**

Read the Descriptions in the ITE Report

Read Descriptions – Full of Information

Land Use: 814
Specialty Retail Center

Description

Specialty retail centers are generally small strip shopping centers that contain a variety of retail shops and specialize in quality apparel; hard goods; and services, such as real estate offices, dance studios, florists and small restaurants. Shopping center (Land Use 820) is a related use.

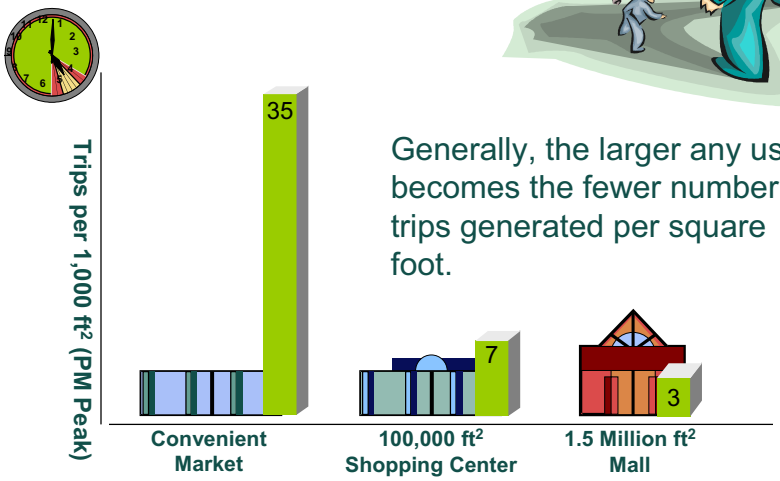
Additional Data

The sites were surveyed from the late 1970s to the 2000s in California, Florida, Georgia, New York and Pennsylvania.

Offices Using Different Independent Variable

- Business Park (770)
- 28 acres average
- 379,000 sq.ft. Gross Floor Area average
  - average density = 379/28= 14K sq.ft. per acre
- An analyst could hide trips by using "acres" if the development was higher than the average

Size Does Matter



Generally, the larger any use becomes the fewer number of trips generated per square foot.

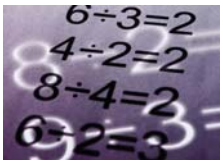
Which to Use:
Rates or Equations?

Compare trips equation and rate

ITE only provides equations for studies with enough data

Consider the "unknowns"

- out parcels
- new land uses



ITE Handbook has more guidance

Shopping Center

Shopping Center
(820)

Average Vehicle Trip Ends vs: **1000 Sq. Feet Gross Leasable Area**
On a: **Weekday,**
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.

Number of Studies: 407
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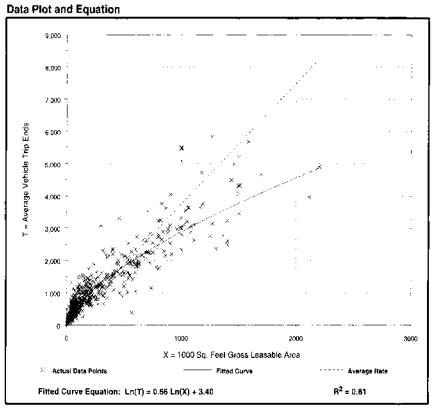
Trip Generation per 1000 Sq. Feet Gross Leasable Area

Average Rate	Range of Rates	Standard Deviation
3.75	0.68 - 29.27	2.75

Data Plot and Equation



Fitted Curve Equation: Ln(T) = 0.68 Ln(X) + 3.40 $R^2 = 0.81$

Trip Generation, 7th Edition 1453 Institute of Transportation Engineers

Shopping Center

Shopping Center
(820)

Average Vehicle Trip Ends vs: **1000 Sq. Feet Gross Leasable Area**
On a: **Weekday,**
Peak Hour of Adjacent Street Traffic,
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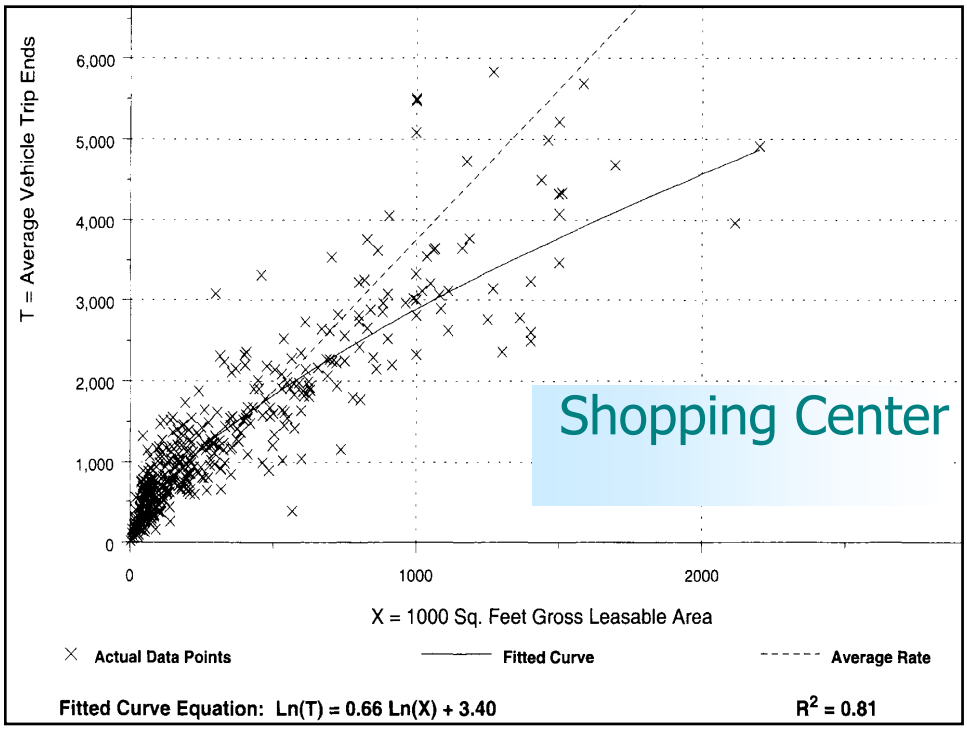
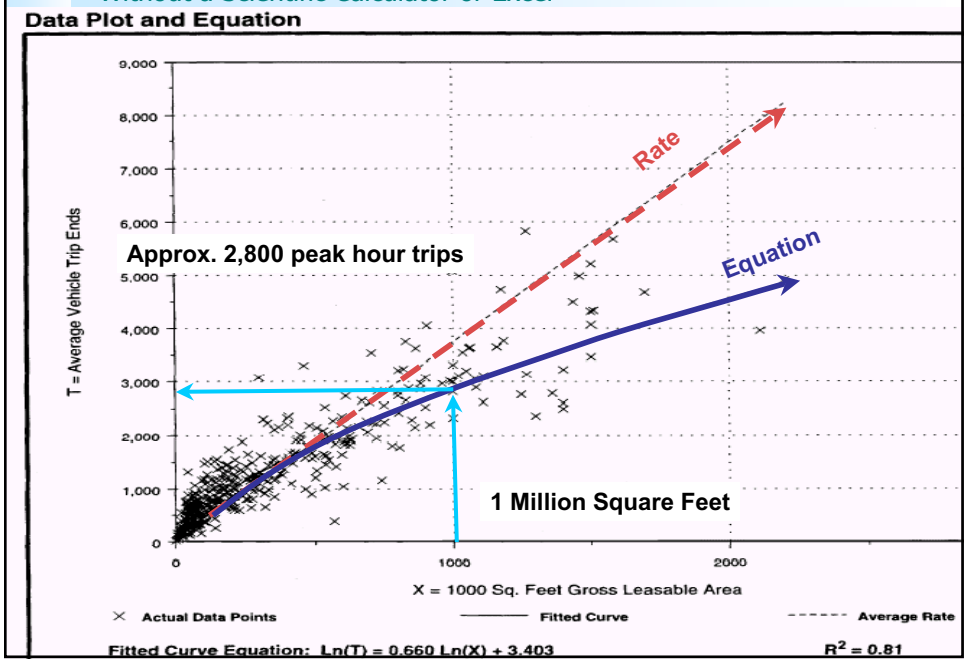
Trip Generation per 1000 Sq. Feet Gross Leasable Area

Average Rate	Range of Rates	Standard Deviation
3.75	0.68 - 29.27	2.75



Fitted Curve Equation: Ln(T) = 0.66 Ln(X) + 3.40 **R^2 = 0.81**

How to Read the Fitted Curve Equation and Determine Trips Without a Scientific Calculator or Excel



What the Formulas Look Like in Excel

PM Peak Shopping Center

PM Peak =EXP(0.66*LN(TSF)+3.40)

PM Peak Office

PM Peak = (1.12*(TSF)+78.81)

What about "Bubble" maps of development?

2.5 Million SqFt Commercial = 2.5 Million SqFt Commercial

Or

2.5 Million SqFt Commercial = 1 Mill. SqFt

1.5 Mill. SqFt Smaller sites

Trip Generation Problem #3

- Someone is proposing a shopping center = 150,000 square feet
- What would be the projected PM Peak Hour of adjacent street traffic?

Use Average Rate:

Units Rate Trips

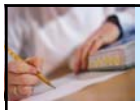
_____ X ____ = _____

What if the mall were to be 1.5 million square feet?

Units Rate Trips

_____ X ____ = _____ **Avg. Rate**

Using Equation Line



Trip Generation Problem #3

- Someone is proposing a shopping center = 150,000 square feet
- What would be the projected PM Peak Hour of adjacent street traffic?

Use Average Rate:

Units		Rate		Trips
150	x	3.75	=	563

What if the mall were to be 1.5 million square feet?

Units		Rate		Trips	
1,500	x	3.75	=	5,625	**Avg. Rate**
				3,700	**Using Equation Line**

Trip Reduction? Parking Reduction?

Traditional Shopping Centers

BY RUTH L. STEINER

"The alternative to sprawl is simple and timely: neighborhoods of housing, parks and schools placed within walking distance of shops, civic services, jobs and transit—a modern version of the traditional town. The convenience of the car and the opportunity to walk or use transit can be blended in an environment with local access for all the daily needs of a diverse community. It is a strategy which could preserve open space, support transit, reduce auto traffic and create affordable housing."
—Peter Calthorpe

University of California Transportation Center:
Access Number 12 Spring 1998

Traditional Shopping Centers

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CONCLUSION

As New Urbanists suggest, traditional shopping areas generate more walking than is usually associated with shopping trips. However, they also attract a significant number of customers who don't live in the adjacent residential area and who drive there. Even those living in adjacent residential areas may drive, especially if they're grocery shopping.

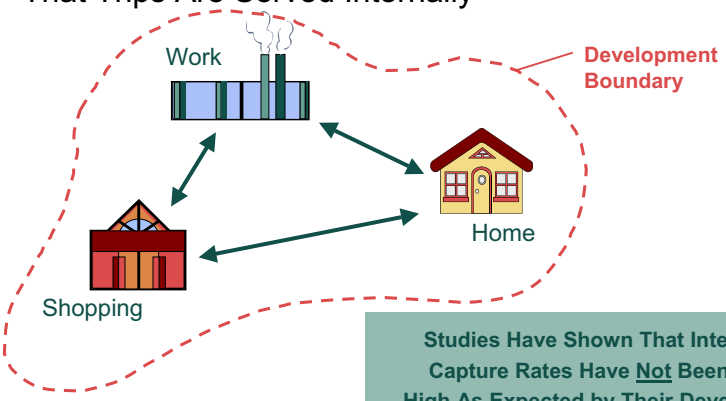
Despite this high frequency of walking, the promise of less automobile traffic is not realized. Counts and surveys taken during average (not major) shopping days reveal levels of traffic and parking demand in excess of comparable standards for peak demand.

http://www.udtc.net/access/access12.pdf

Is Internal Capture Over Optimistic?

Is Internal Capture Optimistic?

Some Developments Are So Large and Diverse That Trips Are Served Internally



Studies Have Shown That Internal Capture Rates Have Not Been As High As Expected by Their Developers

Land Use: 820
Shopping Center

Description

A shopping center is an integrated group of commercial establishments that is planned, developed, owned and managed as a unit. A shopping center's composition is related to its market area in terms of size, location and type of store. A shopping center also provides on-site parking facilities sufficient to serve its own parking demands. Specialty retail center (Land Use 814) and factory outlet center (Land Use 823) are related uses.

Additional Data

Shopping centers, including neighborhood centers, community centers, regional centers and super regional centers, were surveyed for this land use. Some of these centers contained non-merchandising facilities, such as office buildings, movie theaters, restaurants, post offices, banks, health clubs and recreational facilities (for example, ice skating rinks or indoor miniature golf courses). The centers ranged in size from 1,700 to 2.2 million square feet of gross leasable area (GLA). The centers studied were located in suburban areas throughout the United States and therefore represent typical U.S. suburban conditions.

Many shopping centers, in addition to the integrated unit of shops in one building or enclosed around a mall, include outparcels (peripheral buildings or pads located on the perimeter of the center adjacent to the streets and major access points). These buildings are typically drive-in banks, retail stores, restaurants, or small offices. Although the data herein do not indicate which of the centers studied included peripheral buildings, it can be assumed that some of the data show their effect.

Read Descriptions

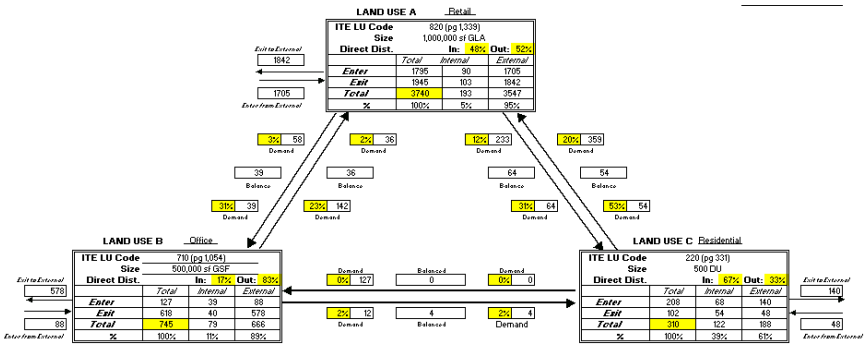
Many shopping centers, in addition to the integrated unit of shops in one building or enclosed around a mall, include outparcels (peripheral buildings or pads located on the perimeter of the center adjacent to the streets and major access points). These buildings are typically drive-in banks, retail stores, restaurants, or small offices. Although the data herein do not indicate which of the centers studied included peripheral buildings, it can be assumed that some of the data show their effect.

ITE Handbook pencil method...

Analyst _____ Date _____

Figure 7.5 Step 7-9 for Multi-Purpose Trip
General Calculation Sample Program

Name of Dvlpt _____ Time Period _____



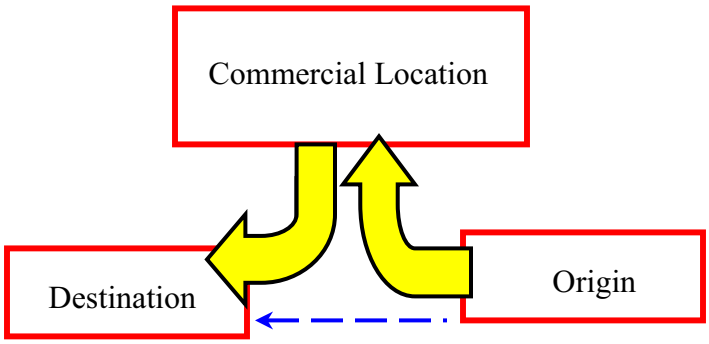
Net External Trips for Multi-Use Development

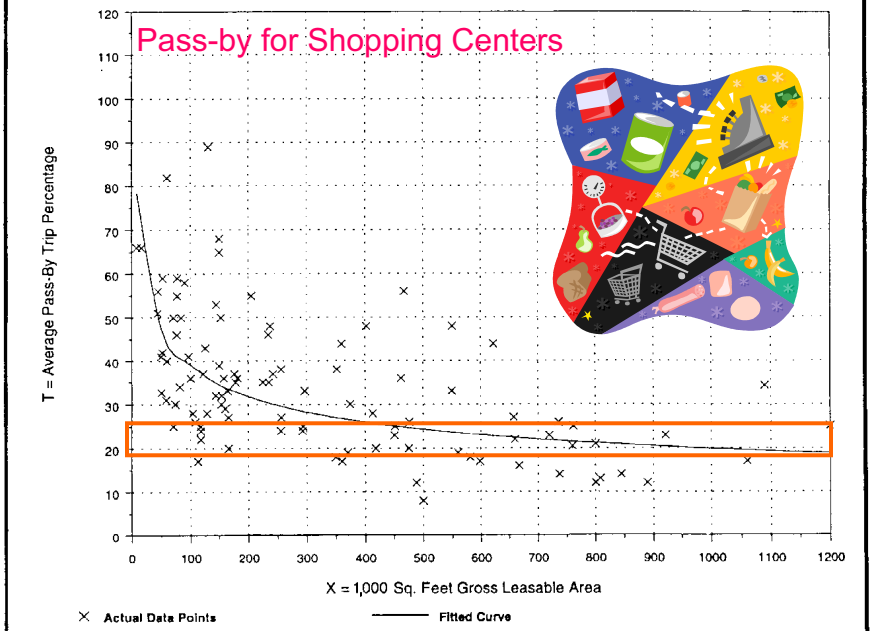
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	1705	88	140	1933	
Exit	1842	578	48	2468	
Total	3547	666	188	4401	
Single-Use Trip Generation	3740	745	310	4795	8.2%
Balanced Internal Capture	5%	11%	39%		

- Lookup of data
- A minimum of 21 user data entry items for 3 land uses

Are Pass-by Trips Over Estimated?

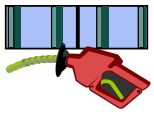
What's a Pass-By Trip?



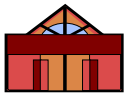


Are Pass-by Trips Over Predicted?

The smaller and more "convenience-oriented" a business is, the higher the proportion of trips generated that are already on the road.



Gasoline /Convenience Mkts ITE #845
45 - 80% (measured - but use caution)



Shopping Center ITE #820
20% and more (measured - but use caution)

Source: ITE Trip Generation, Handbook Oct 1998

Florida's Site Impact Handbook Gives Guidance for Large Developments

- **Pass-by** based on **type** and **size** of retail space
- Generally, the number of pass-by trips should not exceed:
  - **10 percent of the adjacent street traffic** during peak hour or
  - 25 percent of project's external trip generation ***if it is a large scale development***

Don't Count Twice,

It's not alright

If internal capture is considered:

Use internal capture first;

then apply pass-by percentages to **shopping external trips** *only*

Trip Generation
- Internal Capture
= External Trip Generation

- Pass-By Trips (% of External)
= New External Trip Generation

North DRI
PM Peak Hour Trip Generation Analysis
Internalization

		Residential		Schools		Commercial		Office		Total		
Trip Reduction	Rate	In	Out	In	Out	In	Out	In	Out	In	Out	Total
Percent		66%	34%	50%	50%	48%	39%	17%	83%	53%	47%	100%
Gross Trips		675	351	123	125	460	499	36	177	1,294	1,152	2,446
Internalization												
Commercial/Residential	20%	-100	-92			-92	-100			-192	-192	-384
Commercial/Schools	0%			0	0	0	0			0	0	0
Commercial/Office	10%					-18	-4	-4	-18	-21	-21	-43
Residential/Office	10%	-18	-4					-4	-18	-21	-21	-43
Residential/Schools	10%	-13	-12	-12	-13					-25	-25	-50
Schools/Office	0%			0	0			0	0	0	0	0
Subtotal Internalization		-130	-108	-12	-13	-110	-103	-7	-35	-259	-259	-518
Trips Less Internalization		545	243	111	113	350	396	29	142	1,035	893	1928
Percent Internal	21.0%	23.2%		10.0%		22.2%		20.0%		21.2%		
Passer-By Reduction	10.0%					-46	-50			-46	-50	-96
Net Internal Trips	75.0%	545	243	111	113	304	346	29	142	989	843	1,832

65

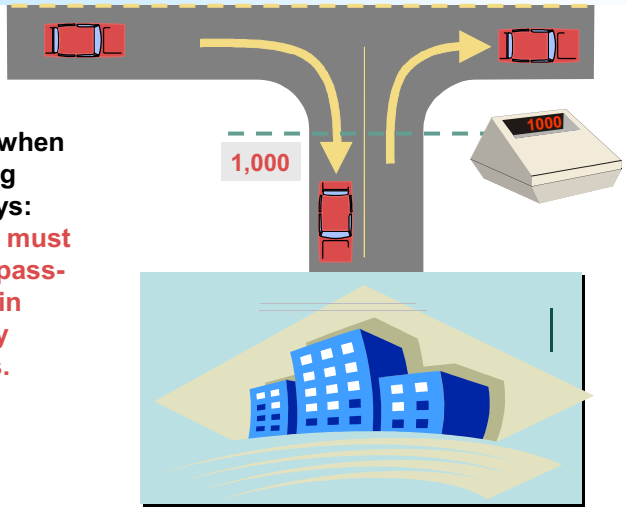
Percent		66%	34%	50%	50%	48%	39%
Gross Trips		675	351	123	125	460	499
Internalization							
Commercial/Residential	20%	-100	-92			-92	-100
Commercial/Schools	0%			0	0	0	0
Commercial/Office	10%					-18	-4
Residential/Office	10%	-18	-4				
Residential/Schools	10%	-13	-12	-12	-13		
Schools/Office	0%			0	0		
Subtotal Internalization		-130	-108	-12	-13	-110	-103
Trips Less Internalization		545	243	111	113	350	396
Percent Internal	21.0%	23.2%		10.0%		22.2%	
Passer-By Reduction	10.0%					-46	-50

66

Section B

Driveway Traffic Will Include All Of The Pass By Traffic

Beware when analyzing driveways: **analysis must include pass-by trips in driveway volumes.**



Roughly Right — or — Precisely Wrong

BY DONALD SHOUP

Access Magazine – Spring 2002

Distance from San Francisco to San Diego?

1. Roughly 400 to 500 miles?
2. Or, 632.12 miles?

What you need to Know About Trip Generation

What you need to Know About Trip Generation

- Simple trip generation is always needed
- Read the descriptions of the ITE Report
- Trip Generation studies are just estimates
  - Don't be fooled by the precision
- ITE's Trip Generation methods may not work downtown
- Be skeptical of major trip reductions until more studies are done
- Don't blindly use a "stock" percentage for internalization

Avoid Blind Reliance

On Extreme Variables And Trends

Left Turn Bays on 2 Lane Roadways

Harmelink Method for Left Turn Lanes

(Early 1960s)

- $t_{median} = \frac{2}{3} t_A = \frac{2}{3} \cdot \frac{3600}{V_A} = \frac{2400}{VA}$
- volume (through, left-turning, and right-
- in VA.

s, then, the mean arrival rate is the nur
s behind left-turning vehicles:

$$\lambda \approx [L(1 - L)\ V_A]\ \frac{t_w + t_e}{\frac{2}{3} t_A}$$

Figure 7. Warrant for left-turn storage lanes on two-lane highways.

From AASHTO
Adapted from
Harmelink

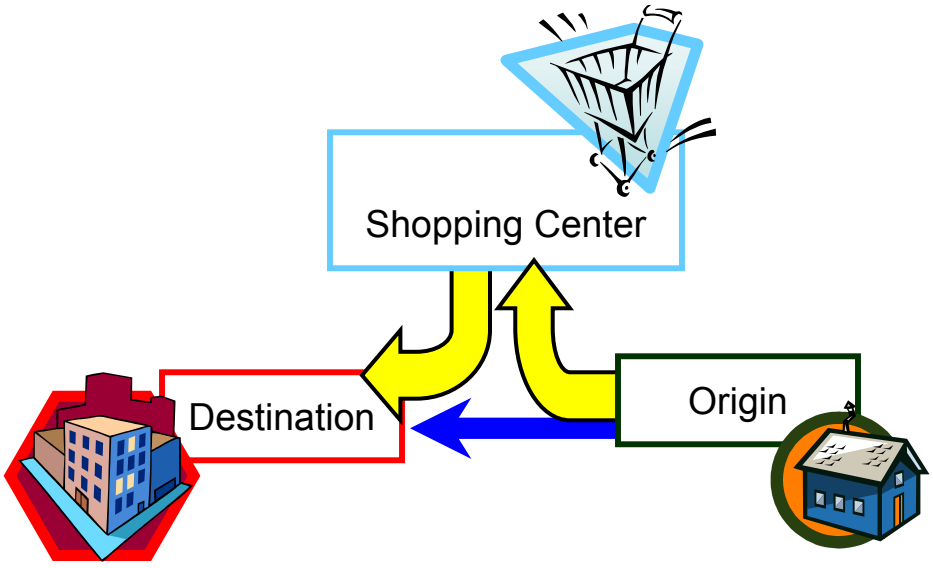
Opposing volume (veh/h)	Advancing volume (veh/h) 5% left turns	10% left turns	20% left turns	30% left turns
40-mph operating speed				
800	330	240	180	160
600	410	305	225	200
400	510	380	275	245
200	640	470	350	305
100	720	515	390	340
50-mph operating speed				
800	280	210	165	135
600	350	260	195	170
400	430	320	240	210
200	550	400	300	270
100	615	445	335	295
60-mph operating speed				
800	230	170	125	115
600	290	210	160	140
400	365	270	200	175
200	450	330	250	215
100	505	370	275	240

AASHTO Green Book 2001, Exhibit 9-75 – page 689

Common Florida Example

For a common Florida 2 lane roadway (600 vehicles peak direction/400 non-peak), you would consider a separate left turn bay if 20 vehicles were expected to turn left into the driveway or side street. This is based on a 40-mph roadway with 20 left turns expected (5% of 410) and 600 opposing vehicles. If the operating speed was 60 mph, then the number of left turns would be 15 left turns.

What are Pass-By Trips?

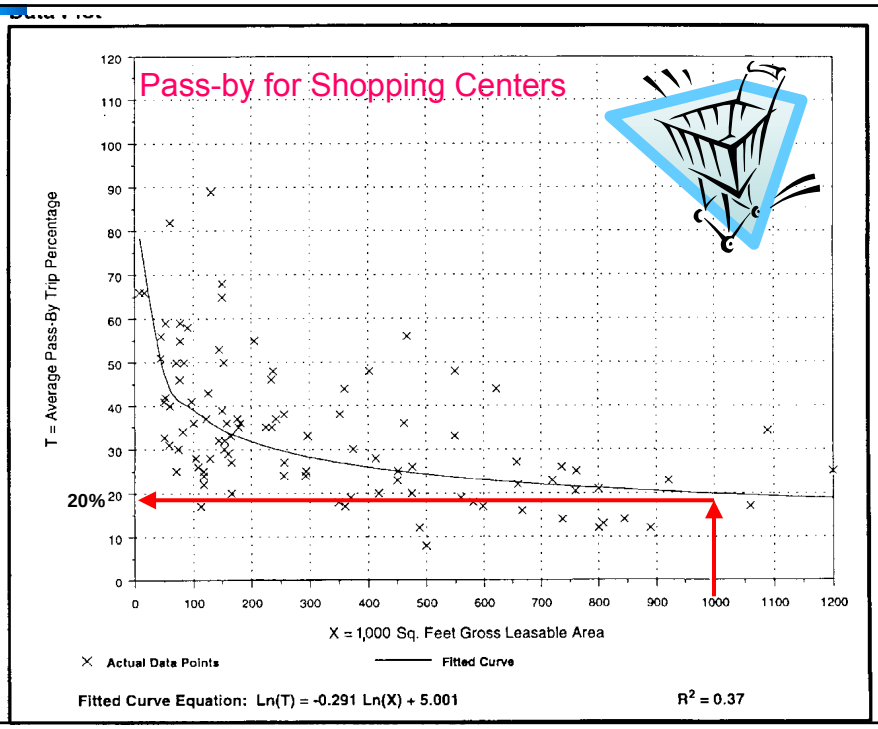


Pass-By Trips

- **Definition:** Trips that would have traveled on a street adjacent to a **Retail Center** even if the retail was not constructed
- Applied only to retail-oriented land uses
  - Shopping centers
  - Convenience markets
  - Gas stations
  - Fast-food restaurants
  - Drive-in banks

- Results in reduction of new trips added to network attributable to retail center

2



Pass-By Trips

- ITE Provides guidance on appropriate percentages
  - Shopping center percentages based on:
    - size of retail space
    - volume of adjacent street traffic (10% max)

Pass-by Reasonableness Checks

- The number of pass-by trips should not exceed **10 percent** of the adjacent street traffic during peak hour
- Strong justification must be provided to document pass-by rates greater than **25 percent** of the total external trip generation for the developments retail portions
  - Ensure proposed development displays ideal characteristics to generate pass-by trips

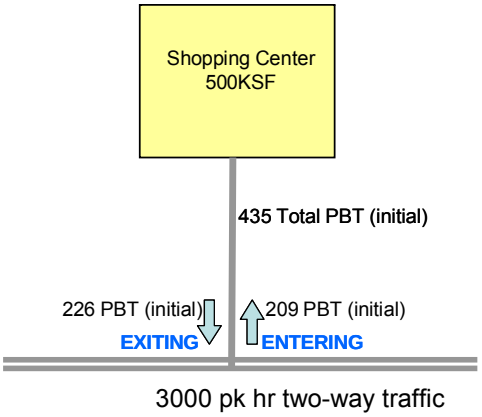
5

10% of Adjacent Street Traffic

- Represents maximum number of trip ends that can be subtracted from base trip generation for pass-by analysis.

6

Pass By Trips:
10% Adjacent Street Traffic Guideline



EXAMPLE

Proposed: 500,000 gross square feet of shopping center space

1,811 peak hour generation

869 entering, 942 exiting
(48%/52% split from ITE Report)

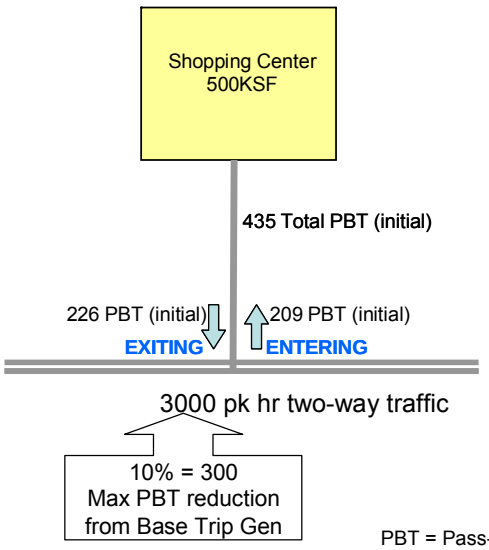
24% pass-by trips
(ITE Trip Generation Handbook)

= **435** pass-by trips
(209 entering, 226 exiting)

Adjacent street traffic volume (peak hour): **3,000**

10% of adjacent street traffic = 300

Incorrect method:



PBT = Pass-by trips

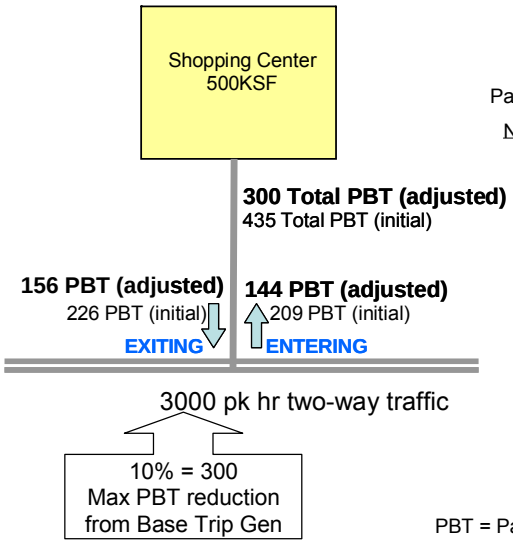
	Initial Calculation
Base pk hr gen	1811
Pass-by (24% of gen)	- 435
New trips generated	1376

Incorrect method:
- Allow up to 300 entering **and** 300 exiting pass-by trips (600 total)

435 pass-by trips in the example is less than 600, so no adjustment is necessary

Correct Method

	Initial Calculation	Adjusted Calculation
Base pk hr gen	1811	1811
Pass-by (24% of gen)	- 435	- 300
New trips generated	1376	1511



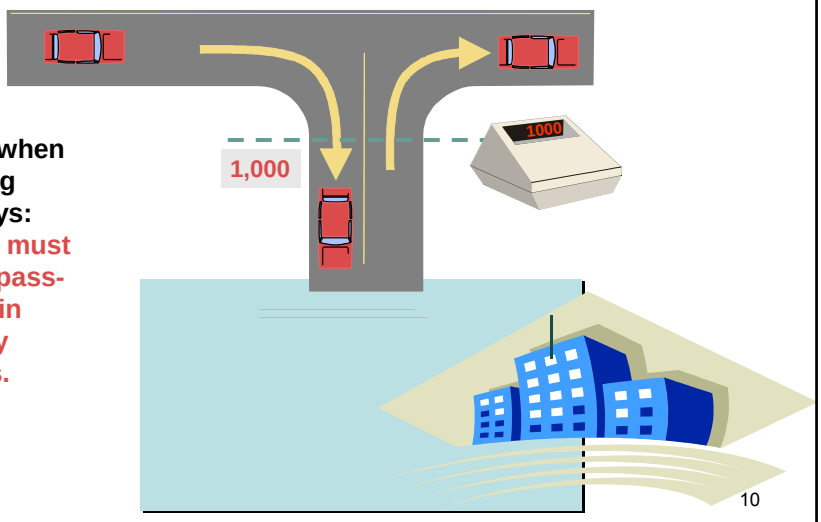
PBT = Pass-by trips

Correct method:

- Adjust pass-by trips to equal 300 (144 in, 156 out)

Driveway Traffic Will Include All Of The Pass By Traffic

Beware when analyzing driveways: analysis must include pass-by trips in driveway volumes.



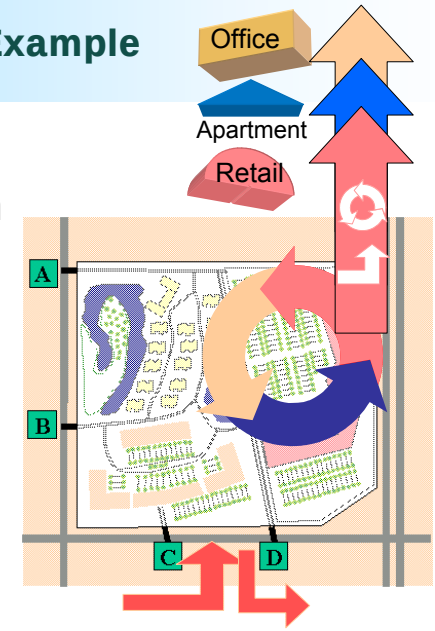
10

Pass-by Trips Example

Total Trip Generation
- Internal Capture

= External Trips
- Pass-by Percent

= External Trips New to the System



11

External Trips Worksheet

	Apartment	Retail	Office	TOTAL
Total Trip Generation	310	3740	745	4795
Exiting Internal Capture	26	43	62	131
Entering Internal Capture	52	66	13	131
Total Internal Capture	78	109	75	262

12

External Trips Worksheet

	Apartment	Retail	Office	TOTAL
Total Trip Generation	310	3740	745	4795
Exiting Internal Capture	26	43	62	131
Entering Internal Capture	52	66	13	131
- Total Internal Capture	78	109	75	262
External Trips	232	3631	670	4533
- Pass-by Trips				

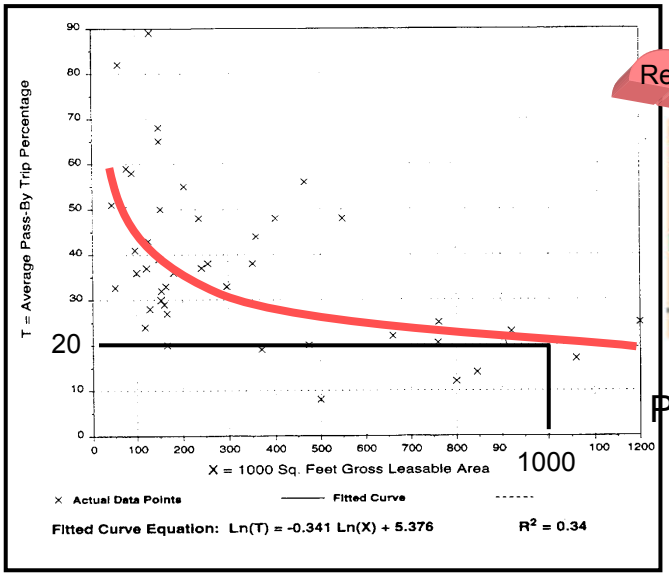
13

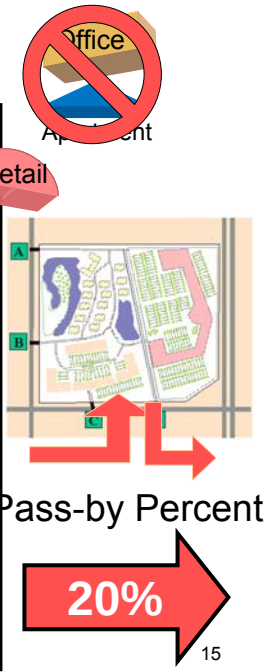
External Trips Worksheet

	Apartment	Retail	Office	TOTAL
Total Trip Generation				
Exiting Internal Capture				
Entering Internal Capture				
- Total Internal Capture				
External Trips				
- Pass-by Trips				

14

Shopping Center Pass-by Trips
Weekday, P.M. Peak Hour of Adjacent Street Traffic





15

Pass-by Trips Worksheet

	Apartment	Retail	Office	TOTAL
Total Trip Generation	310	3740	745	4795
Exiting Internal Capture	26	43	62	131
Entering Internal Capture	52	66	13	131
Total Internal Capture	78	109	75	262
External Trips	232	3631	670	4533
Pass-by Percent	0%	20%	0%	
Pass-by Trips	0	726	0	726
External Trips New to System	232	2905	670	3807

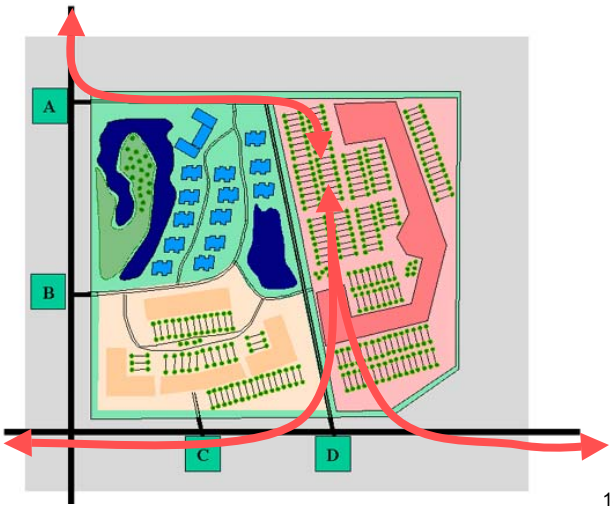
16

Pass-by Trips Worksheet

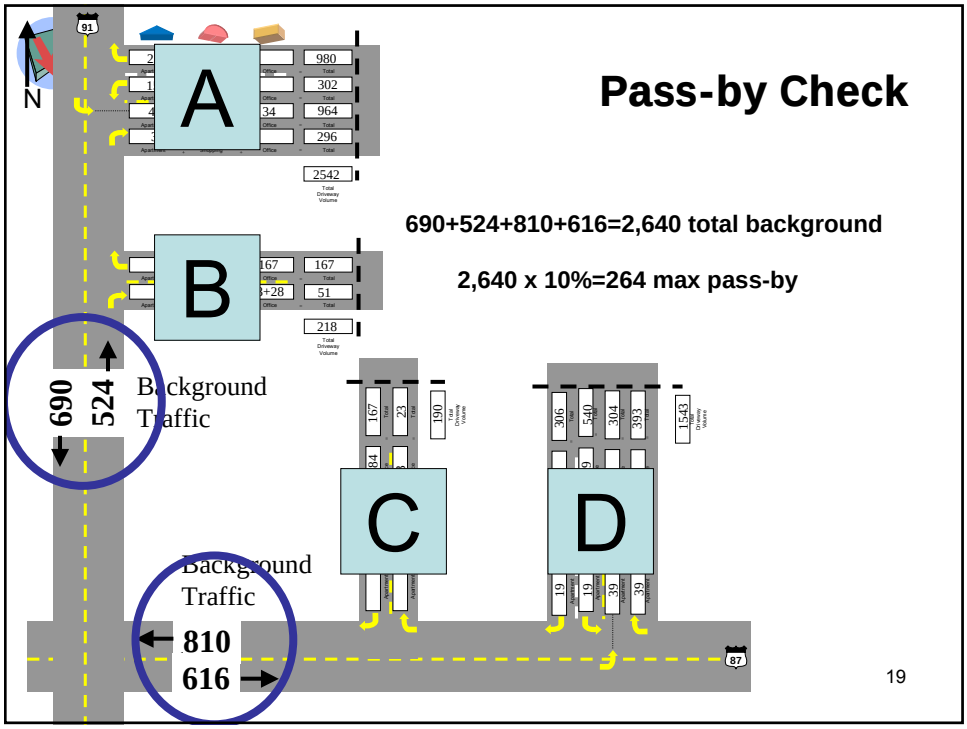
	Apartment	Retail	Office	TOTAL
Total Trip Generation				
Exiting Internal Capture				
Entering Internal Capture				
Total Internal Capture				
External Trips				
Pass-by Percent				
Pass-by Trips				
External Trips New to System				

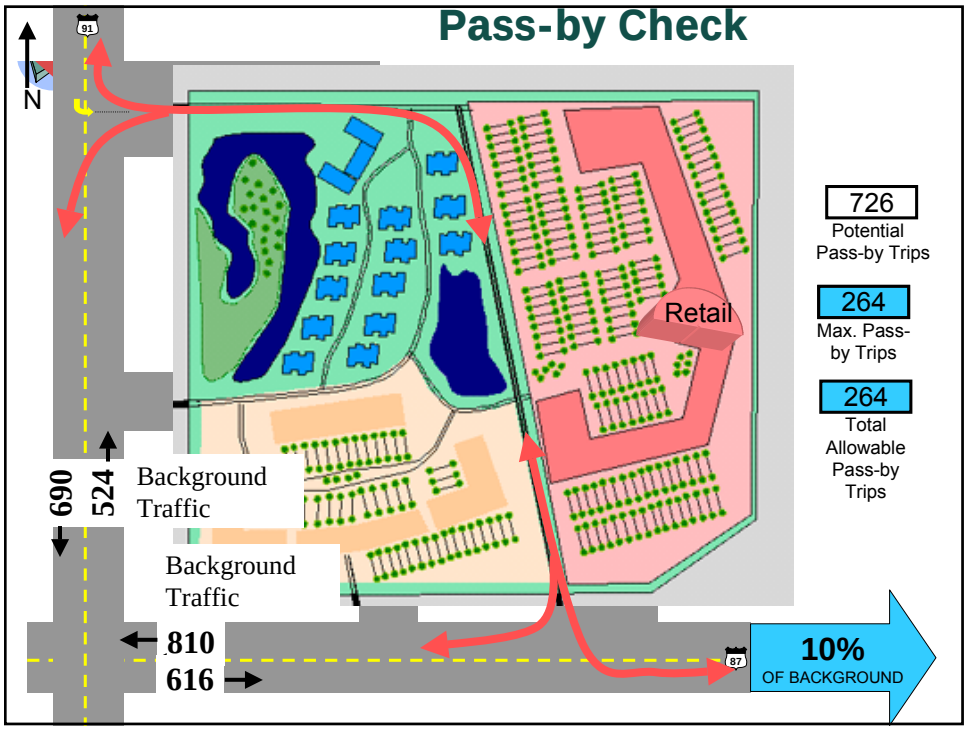
17

Pass-by Check



18


Pass-by Check
690+524+810+616=2,640 total background
2,640 x 10%=264 max pass-by
A
B
C
D
N
690
524
Background Traffic
Background Traffic
810
616
19


Pass-by Check
N
Retail
726
Potential Pass-by Trips
264
Max. Pass-by Trips
264
Total Allowable Pass-by Trips
690
524
Background Traffic
Background Traffic
810
616
10%
OF BACKGROUND

Pass-by Trips Worksheet

	Apartment	Retail	Office	TOTAL
Total Trip Generation	310	3740	745	4795
Exiting Internal Capture	26	43	62	131
Entering Internal Capture	52	66	13	131
Total Internal Capture	78	109	75	262
External Trips	232	3631	670	4533
Pass-by Percent (background)	0%	10% backgrd	0%	
Pass-by Trips	0	264	0	264
Actual Pass-by % of Retail				
External Trips New to System				

21

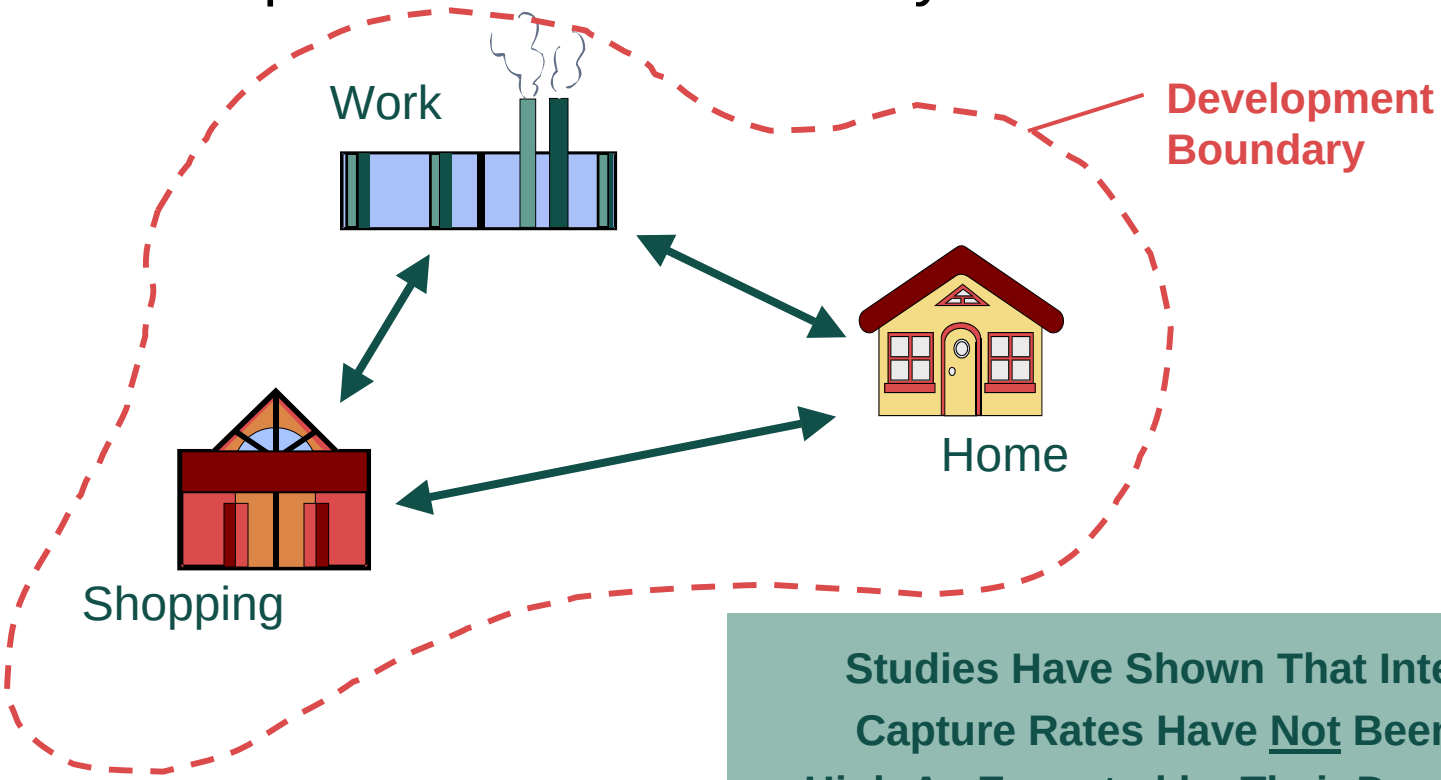
Pass-by Trips Worksheet

	Apartment	Retail	Office	TOTAL
Total Trip Generation	310	3740	745	4795
Exiting Internal Capture	26	43	62	131
Entering Internal Capture	52	66	13	131
Total Internal Capture	78	109	75	262
External Trips	232	3631	670	4533
Pass-by Percent (background)	0%	10% backgrd	0%	
Pass-by Trips	0	264	0	264
Actual Pass-by % of Retail			**264 / 3631 =**	7.3%
External Trips New to System	232	3367	670	4269

22

What is Internal Capture?

Some Developments Are So Large and Diverse That Trips Are Served Internally

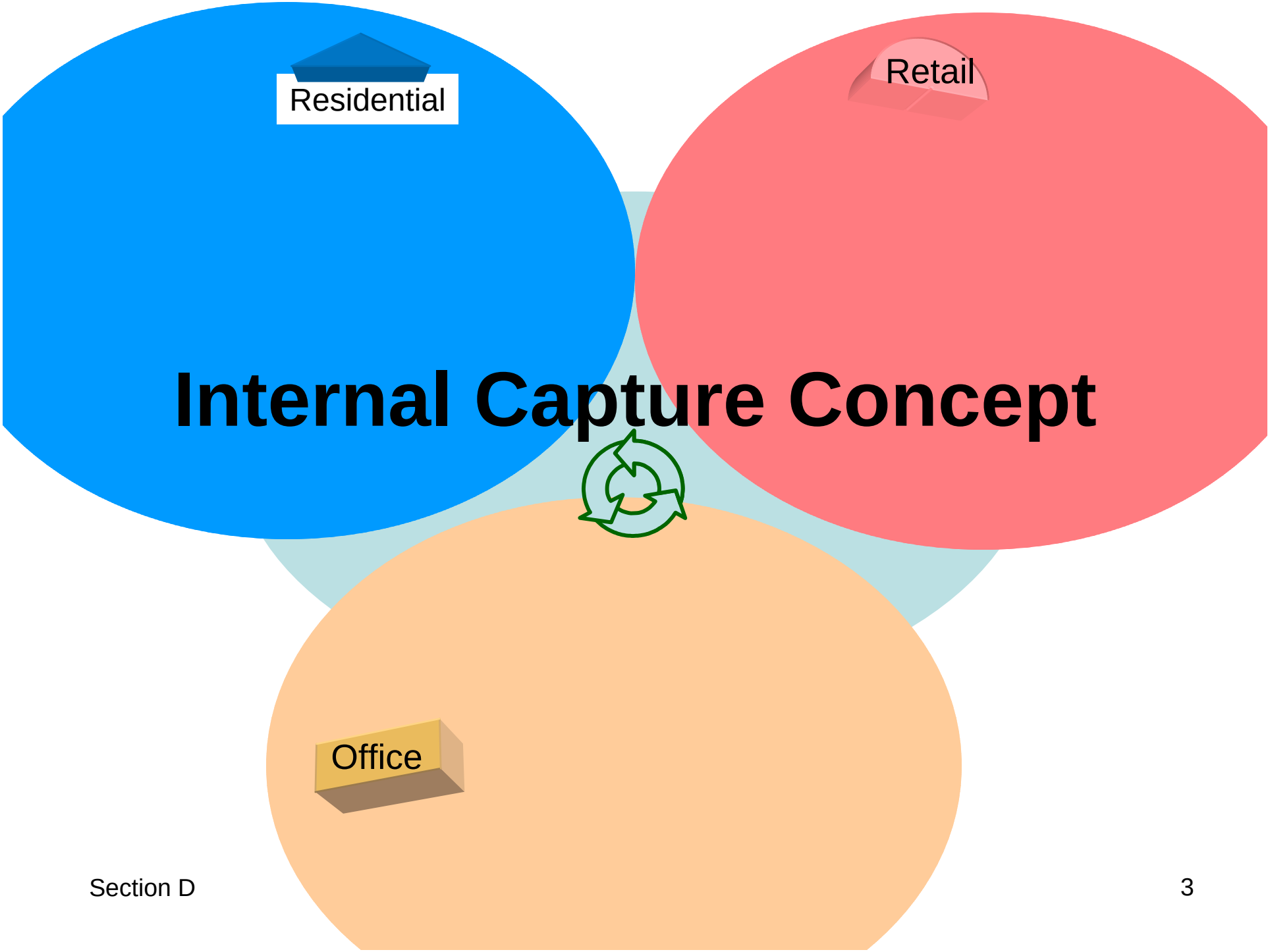


Studies Have Shown That Internal Capture Rates Have Not Been As High As Expected by Their Developers

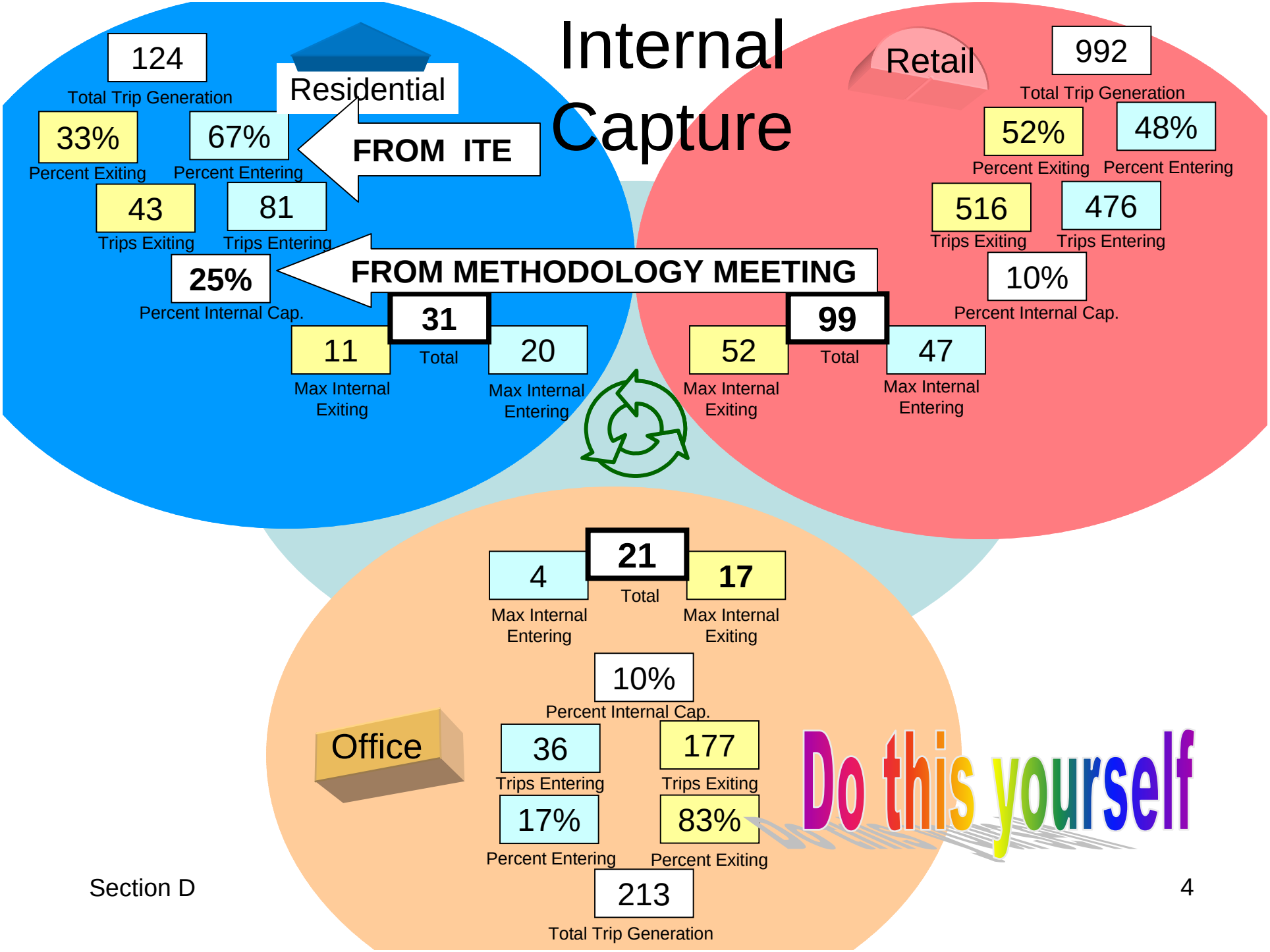
Mixed-Use Developments

- Developments that contain two or more land use components
- Trip generation is calculated separately for each land use component
- Total development trip generation (external + internal) is determined by summing components

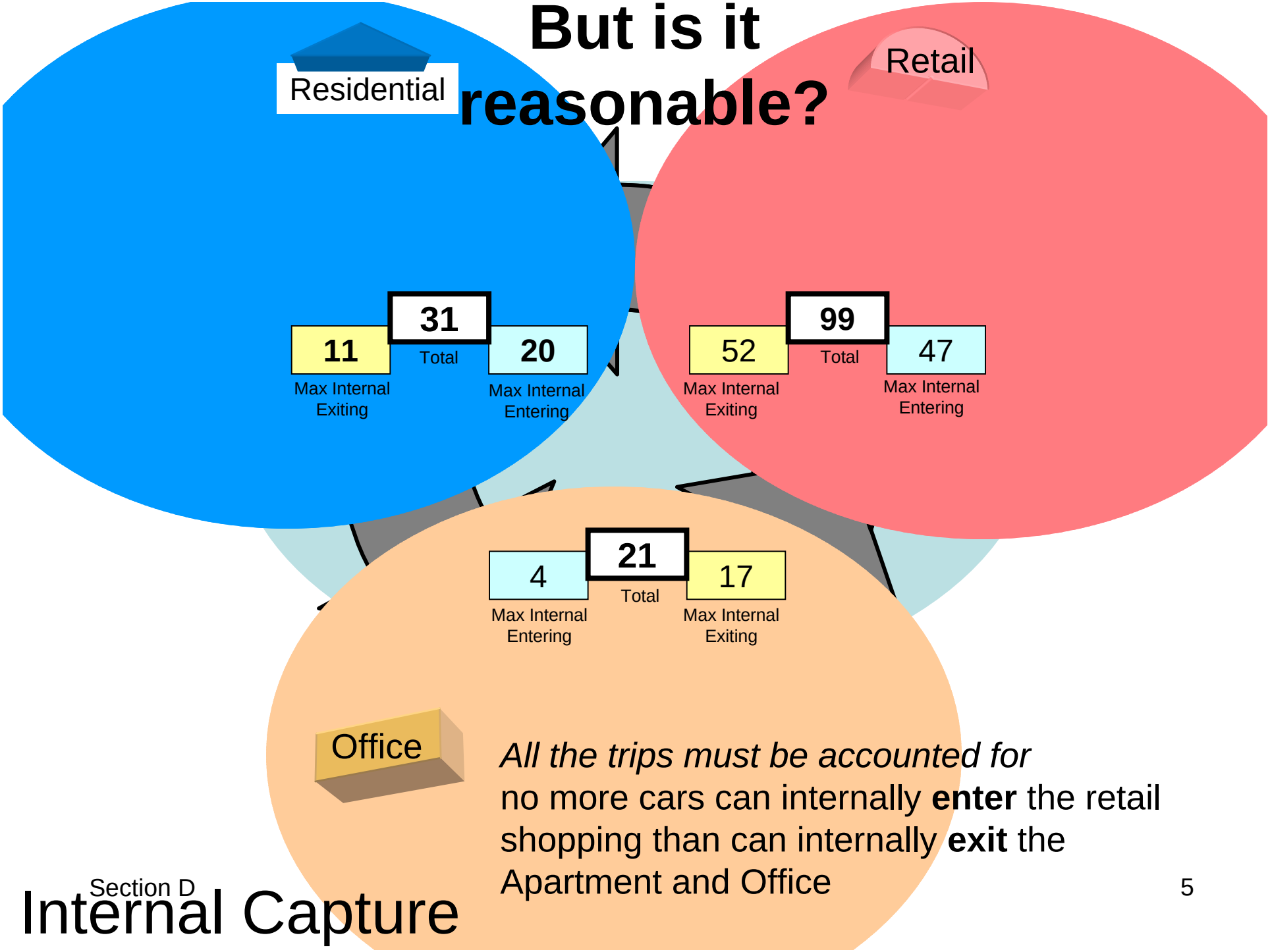
Internal Capture Concept



Internal Capture



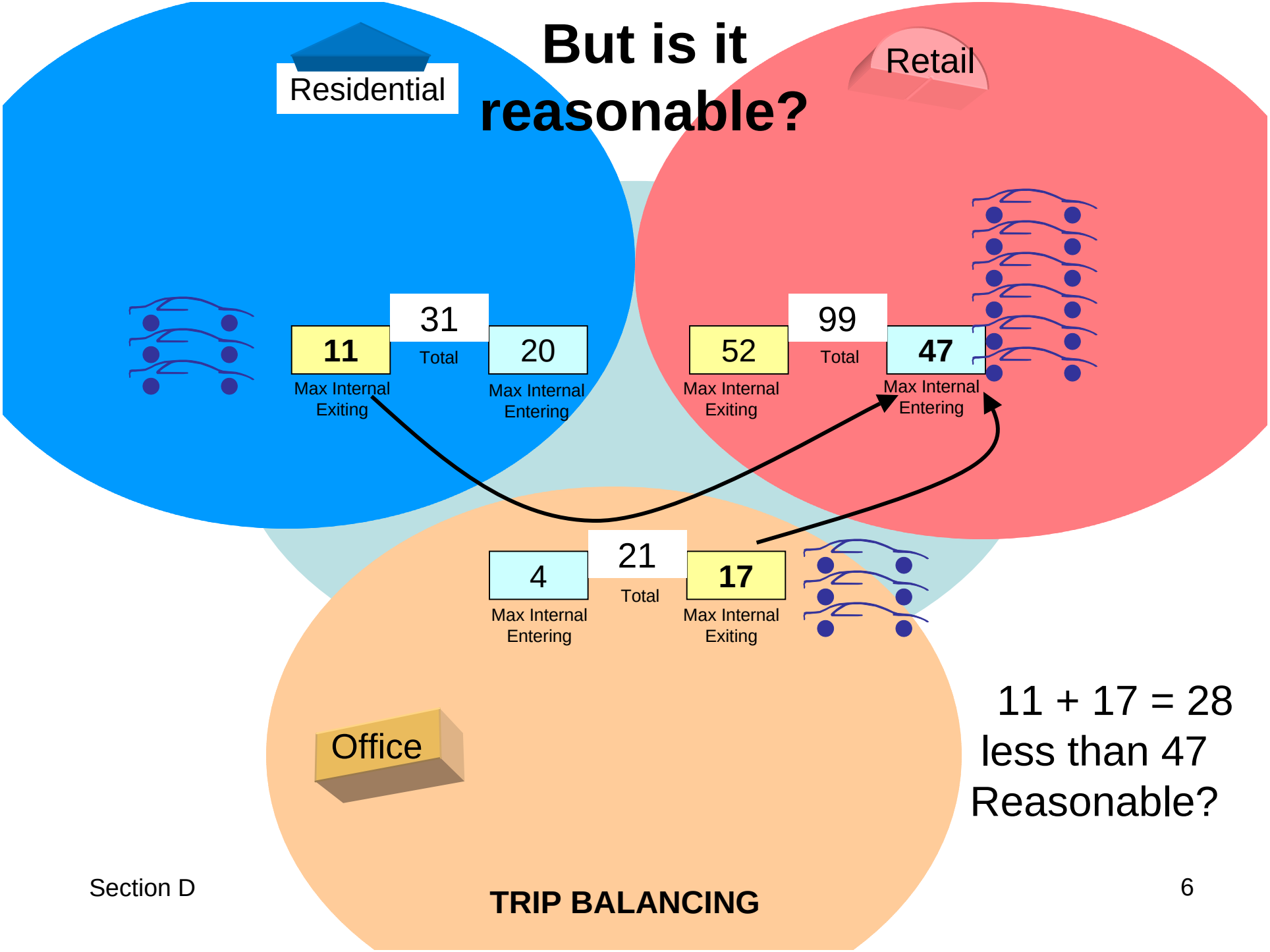
But is it reasonable?



All the trips must be accounted for

no more cars can internally **enter** the retail shopping than can internally **exit** the Apartment and Office

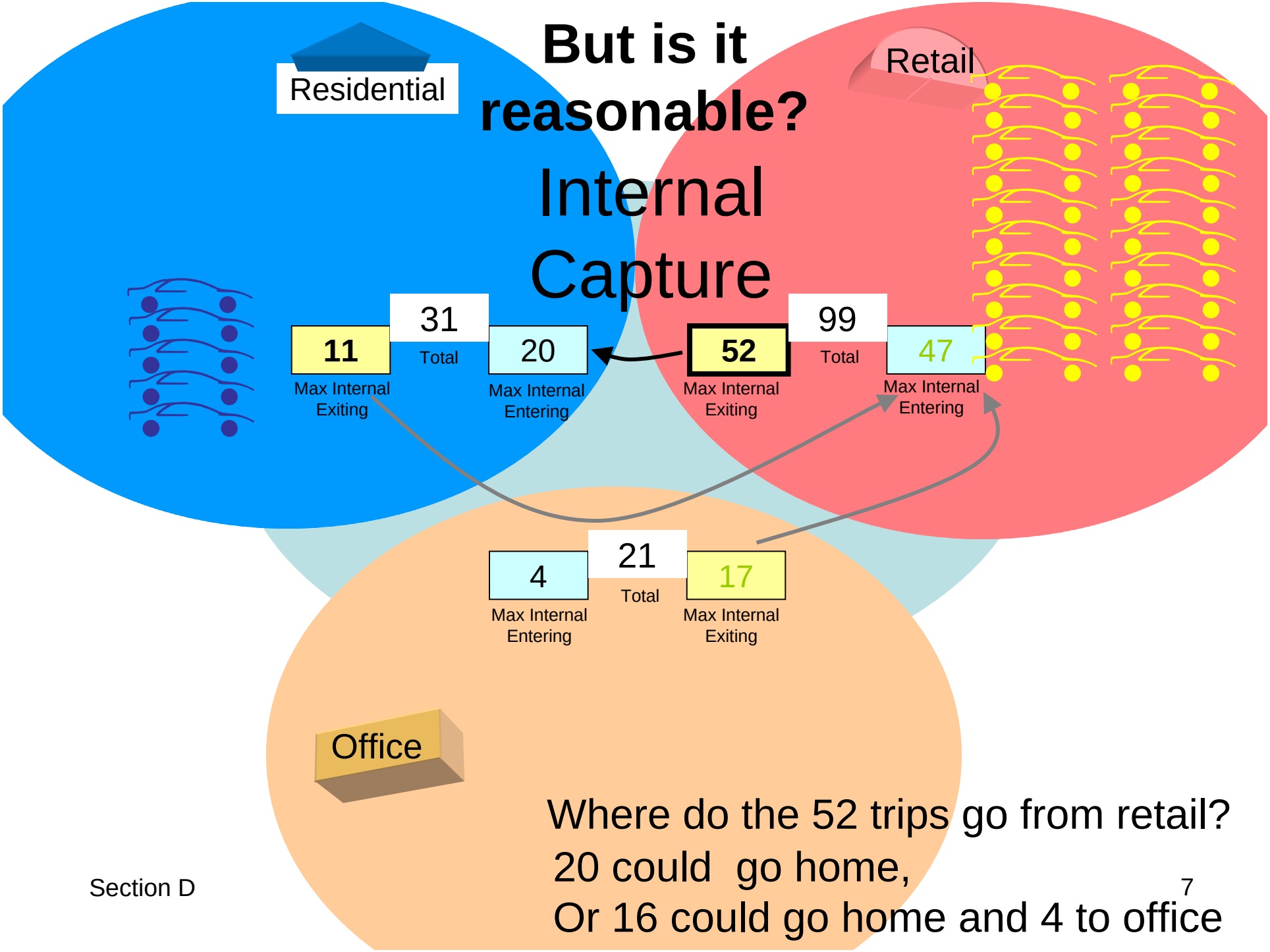
But is it reasonable?



11 + 17 = 28
less than 47
Reasonable?

But is it reasonable?

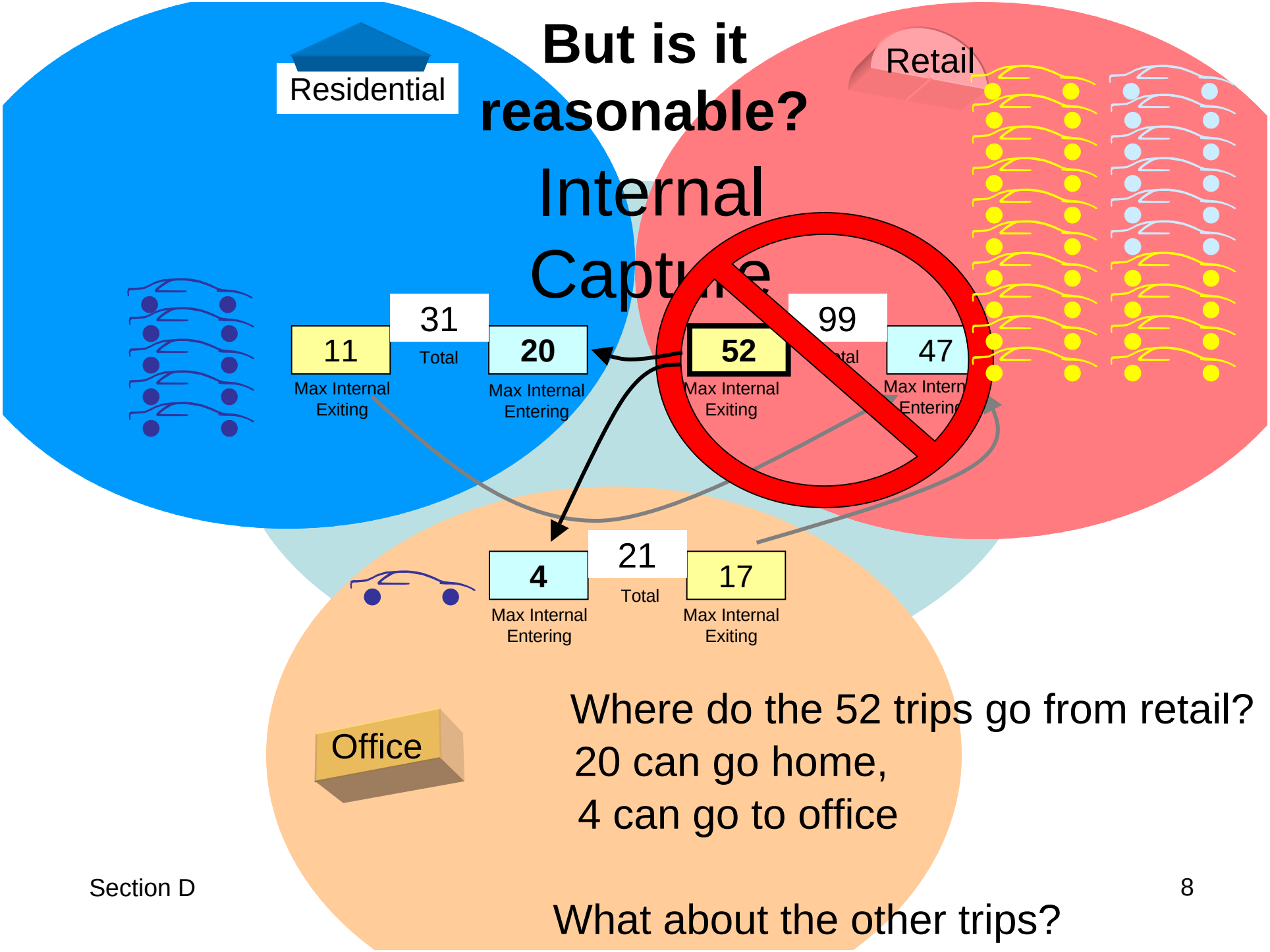
Internal Capture



Where do the 52 trips go from retail?
20 could go home,
Or 16 could go home and 4 to office

But is it reasonable?

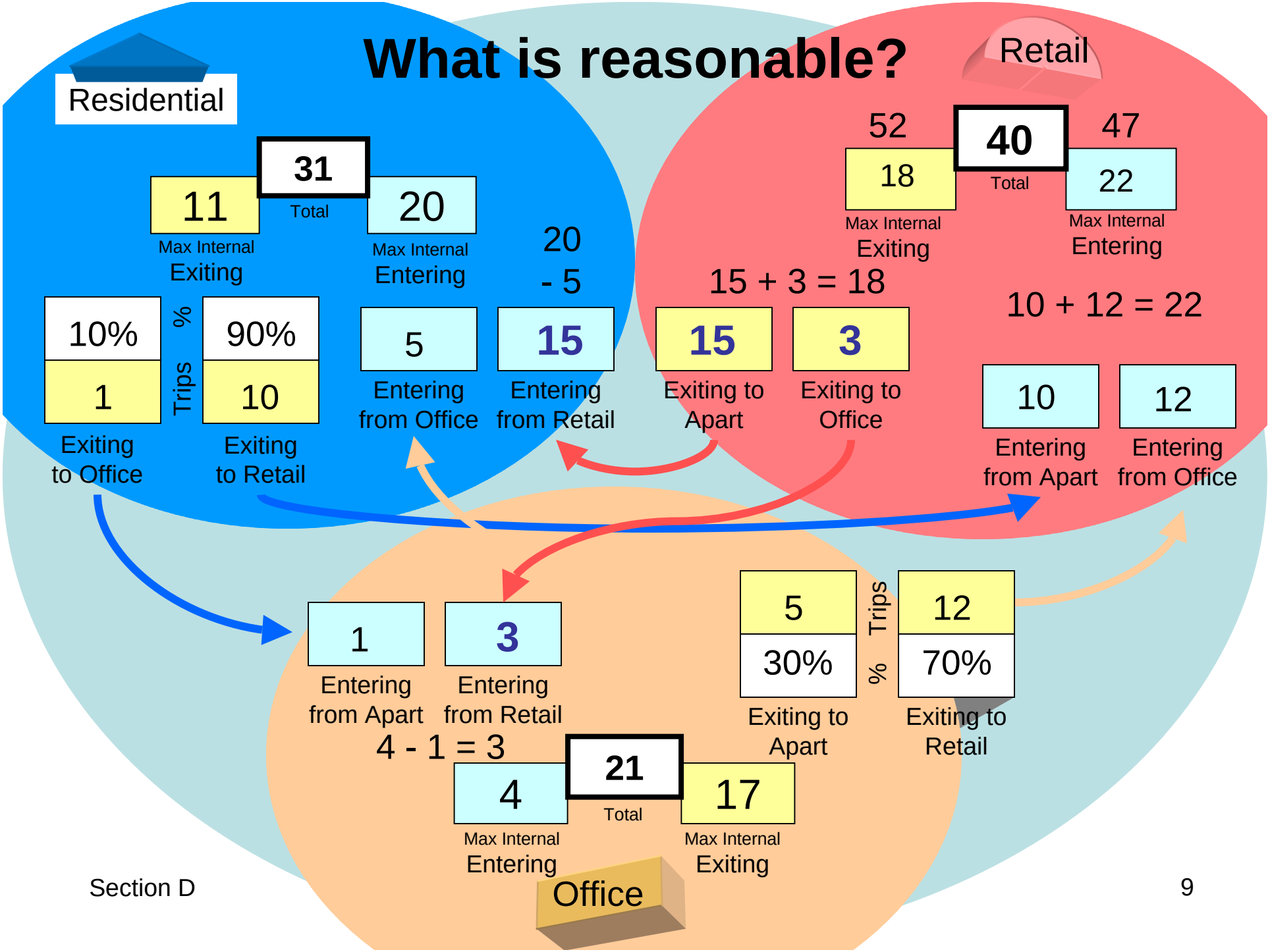
Internal Capture



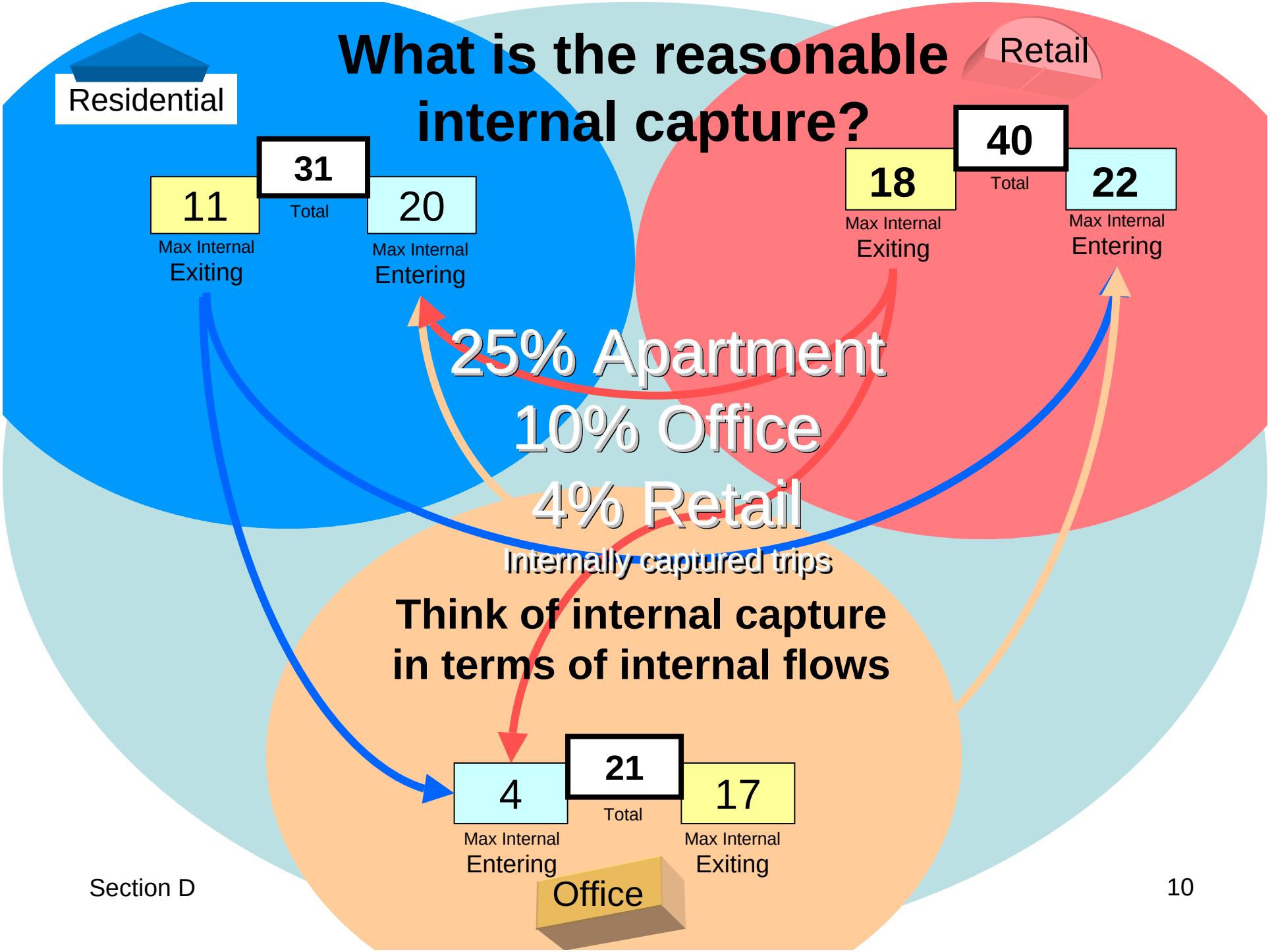
Where do the 52 trips go from retail?
20 can go home,
4 can go to office

What about the other trips?

What is reasonable?



What is the reasonable internal capture?

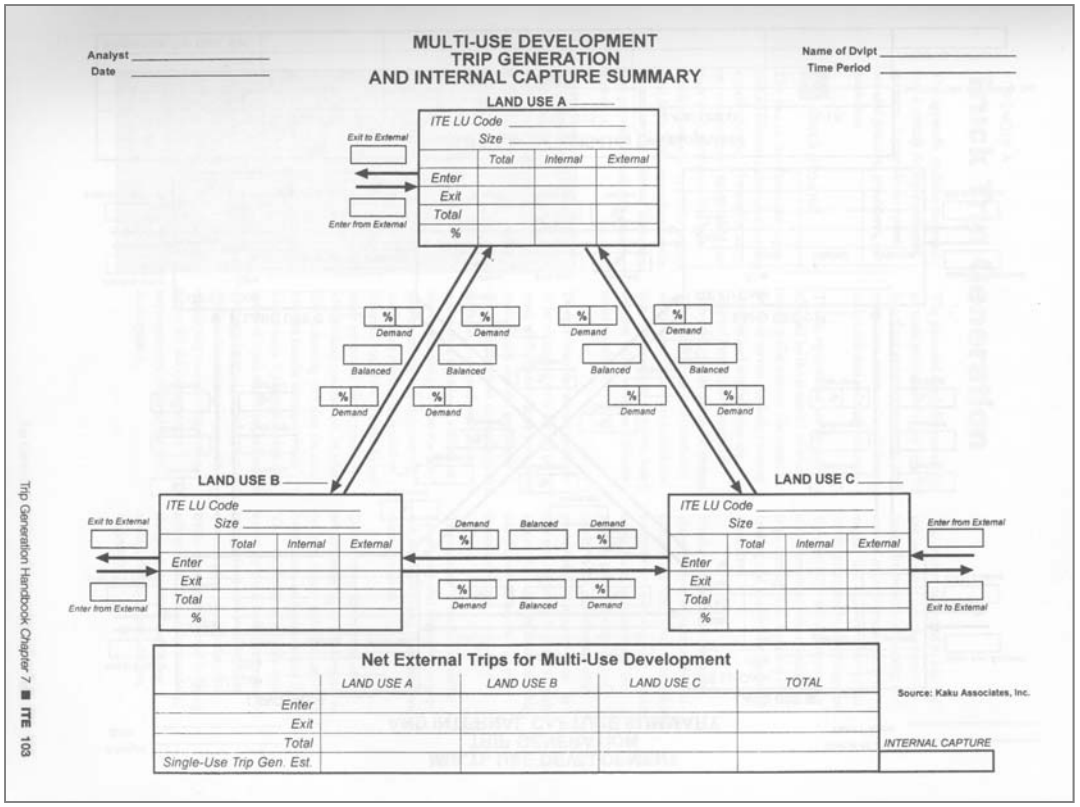


Internal Capture Considerations

- Residential and employment centers should be **compatible** (with respect to income levels) to allow internal capture
- **On-site employment** may not attract work trips from on-site homes for several years
- **Remote projects** may have higher internal capture
- Trips that cross or use the **public road system** cannot be subtracted with the internal trip component

Trip Internalization

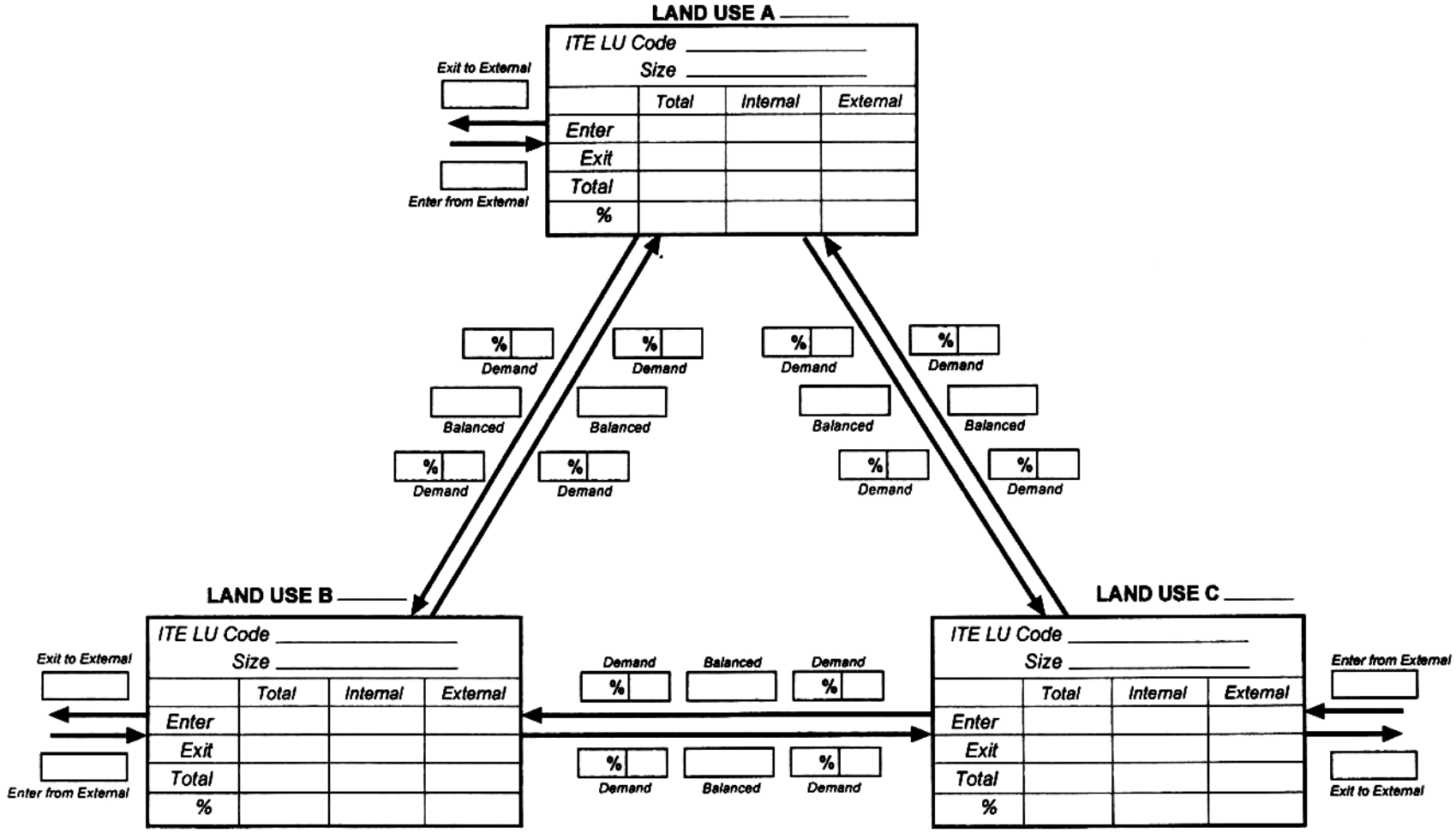
- The ITE Handbook provides a worksheet for multi-use development trip generation and internal capture summary.
  (page 103 6th edition.)



MULTI-USE DEVELOPMENT TRIP GENERATION AND INTERNAL CAPTURE SUMMARY

Analyst _____
Date _____

Name of Dvlpt _____
Time Period _____



Net External Trips for Multi-Use Development

	LAND USE A	LAND USE B	LAND USE C	TOTAL
Enter				
Exit				
Total				
Single-Use Trip Gen. Est.				

INTERNAL CAPTURE

Source: Kaku Associates, Inc.

Trip Internalization

- The ITE Handbook also provides typical demand rates for trip origins and destinations. *(page 87-88 March 2001 edition.)*

Table 7.1 Unconstrained Internal Capture Rates for Trip Origins within a Multi-Use Development

		WEEKDAY
		MIDDAY PEA
from OFFICE	to Office	2%
	to Retail	20%
	to Residential	0%
from RETAIL	to Office	3%
	to Retail	29%
	to Residential	7%
from RESIDENTIAL	to Office	N/A
	to Retail	34%
	to Residential	N/A

Caution: The estimated typical internal capture rates prese
limited number of multi-use sites in Florida. While ITE re
the only known credible data on multi-use internal capture
local data on internal capture rates by paired land uses ca

N/A — Not Available; logic indicates there is some interac
data sample on which this table is based did not record any

Table 7.2 Unconstrained Internal Capture Rates for Trip Destinations Within a Multi-Use Development

		WEEKDAY		
		MIDDAY PEAK HOUR	P.M. PEAK HOUR OF ADJACENT STREET TRAFFIC	DAILY
to OFFICE	from Office	6%	6%	2%
	from Retail	38%	31%	15%
	from Residential	0%	0%	N/A
to RETAIL	from Office	4%	2%	4%
	from Retail	31%	20%	28%
	from Residential	5%	9%	9%
to RESIDENTIAL	from Office	0%	2%	3%
	from Retail	37%	31%	33%
	from Residential	N/A	N/A	N/A

Caution: The estimated typical internal capture rates presented in this table rely directly on data collected at a limited number of multi-use sites in Florida. While ITE recognizes the limitations of these data, they represent the only known credible data on multi-use internal capture rates and are provided as illustrative of typical rates. ***If local data on internal capture rates by paired land uses can be obtained, the local data may be given preference.***

N/A — Not Available; logic indicates there is some interaction between these two land uses; however, the limited data sample on which this table is based did not record any interaction.

Table 7.1 Unconstrained Internal Capture Rates for Trip Origins within a Multi-Use Development

Think of this as the "push"

		WEEKDAY		
		MIDDAY PEAK HOUR	P.M. PEAK HOUR OF ADJACENT STREET TRAFFIC	DAILY
from OFFICE	to Office	2%	1%	2%
	to Retail	20%	23%	22%
	to Residential	0%	2%	2%
from RETAIL	to Office	3%	3%	3%
	to Retail	29%	20%	30%
	to Residential	7%	12%	11%
from RESIDENTIAL	to Office	N/A	N/A	N/A
	to Retail	34%	53%	38%
	to Residential	N/A	N/A	N/A

Section E

Table 7.2 Unconstrained Internal Capture Rates for Trip Destinations Within a Multi-Use Development

Think of this as the "pull"

		WEEKDAY		
		MIDDAY PEAK HOUR	P.M. PEAK HOUR OF ADJACENT STREET TRAFFIC	DAILY
to OFFICE	from Office	6%	6%	2%
	from Retail	38%	31%	15%
	from Residential	0%	0%	N/A
to RETAIL	from Office	4%	2%	4%
	from Retail	31%	20%	28%
	from Residential	5%	9%	9%
to RESIDENTIAL	from Office	0%	2%	3%
	from Retail	37%	31%	33%
	from Residential	N/A	N/A	N/A

Section E

Trip Internalization

- Note: Several land uses in the 6th edition retail classification (800-899) have been reclassified as 'Services' in the 7th edition. These land uses include banks, restaurants, and service stations.

Table 7.1 Unconstrained Internal Capture Rates for Trip Origins within a Multi-Use Development

		WEEKDAY
		MIDDAY PEA
from OFFICE	to Office	2%
	to Retail	20%
	to Residential	0%
from RETAIL	to Office	3%
	to Retail	29%
	to Residential	7%
from RESIDENTIAL	to Office	N/A
	to Retail	34%
	to Residential	N/A

Caution: The estimated typical internal capture rates prese
limited number of multi-use sites in Florida. While ITE re
the only known credible data on multi-use internal capture
local data on internal capture rates by paired land uses ca

N/A — Not Available; logic indicates there is some interac
data sample on which this table is based did not record any

Table 7.2 Unconstrained Internal Capture Rates for Trip Destinations Within a Multi-Use Development

		WEEKDAY		
		MIDDAY PEAK HOUR	P.M. PEAK HOUR OF ADJACENT STREET TRAFFIC	DAILY
to OFFICE	from Office	6%	6%	2%
	from Retail	38%	31%	15%
	from Residential	0%	0%	N/A
to RETAIL	from Office	4%	2%	4%
	from Retail	31%	20%	28%
	from Residential	5%	9%	9%
to RESIDENTIAL	from Office	0%	2%	3%
	from Retail	37%	31%	33%
	from Residential	N/A	N/A	N/A

Caution: The estimated typical internal capture rates presented in this table rely directly on data collected at a limited number of multi-use sites in Florida. While ITE recognizes the limitations of these data, they represent the only known credible data on multi-use internal capture rates and are provided as illustrative of typical rates. ***If local data on internal capture rates by paired land uses can be obtained, the local data may be given preference.***

N/A — Not Available; logic indicates there is some interaction between these two land uses; however, the limited data sample on which this table is based did not record any interaction.

Trip Internalization

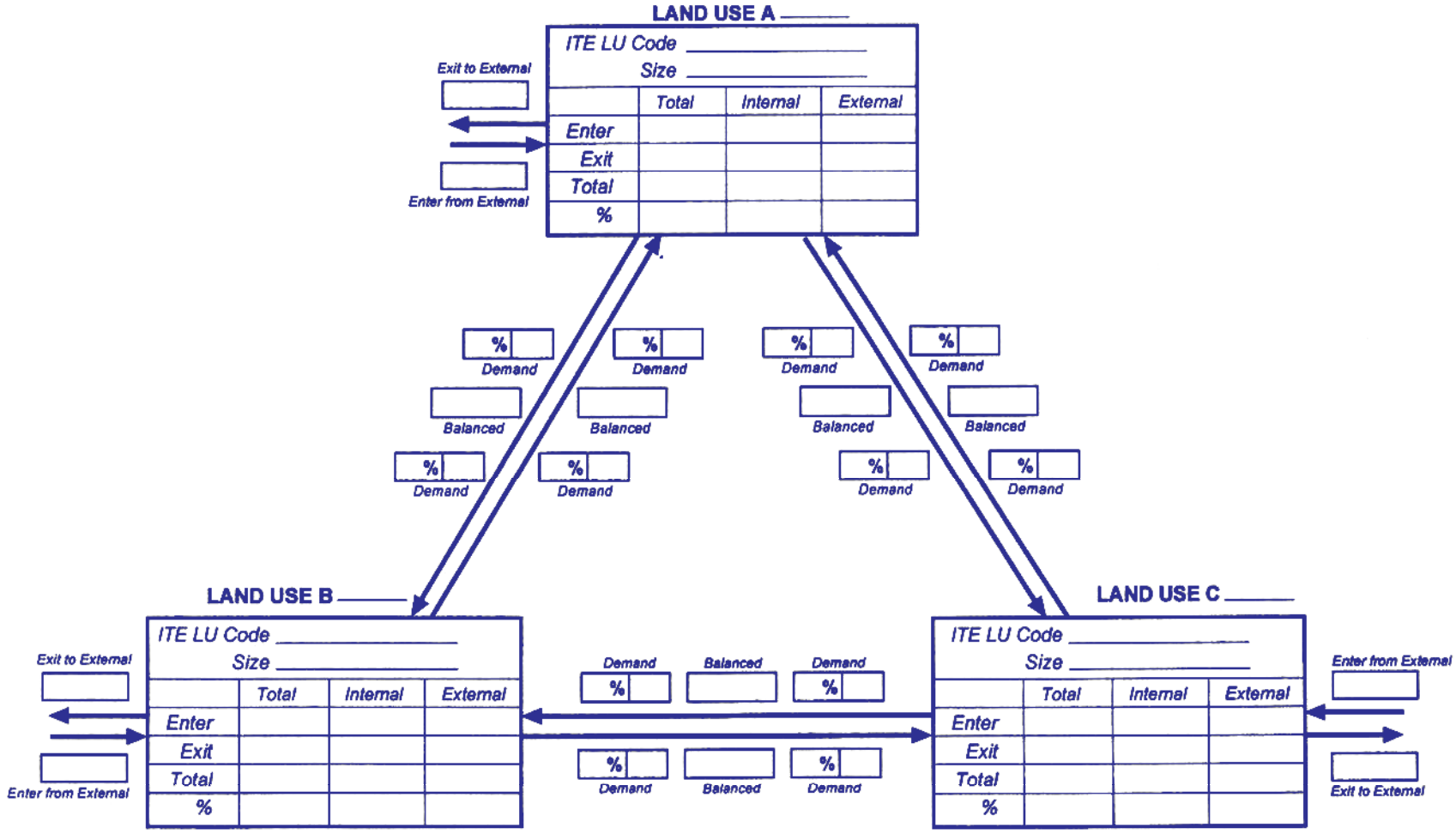
- Problem
  - Using these land uses and the trip origins/ destination rate from the ITE Handbook, what is the internal capture rate of the following development:
    - **a 200,000 f^2 Shopping Center (ITE #820)**
    - **a 120,000 f^2 Office (ITE #710)**
    - **a 200 f^2 Low Rise Apartments (ITE #221)**

Go to Page 177 for the form

MULTI-USE DEVELOPMENT TRIP GENERATION AND INTERNAL CAPTURE SUMMARY

Analyst _____
Date _____

Name of Dvlpt _____
Time Period _____



Net External Trips for Multi-Use Development

	LAND USE A	LAND USE B	LAND USE C	TOTAL
Enter				
Exit				
Total				
Single-Use Trip Gen. Est.				

INTERNAL CAPTURE

Source: Kaku Associates, Inc.

Analyst _____
Date _____

MULTI-USE DEVELOPMENT TRIP GENERATION AND INTERNAL CAPTURE SUMMARY

Name of Dvlpt _____
Time Period _____

LAND USE A Shopping Center

ITE LU Code	820		
Size	200,000 f²		
	Total	Internal	External
Enter	475		
Exit	514		
Total	989		
%			

Exit to External
Enter from External

LAND USE B General Office

ITE LU Code	720		
Size	120,000 f²		
	Total	Internal	External
Enter	36		
Exit	177		
Total	213		
%			

Exit to External
Enter from External

LAND USE C Low Rise Apt

ITE LU Code	221		
Size	200 Units		
	Total	Internal	External
Enter	81		
Exit	43		
Total	124		
%			

Enter from External
Exit to External

Demand 3 % Balanced Demand % Balanced Demand 23%

Demand 12% Balanced Demand % Balanced Demand 53%

Demand % Balanced Demand 0 %

Demand 2 % Balanced Demand %

Using table 7.1, What is the percent demand from a retail to an office establishment? (PM Peak) 3%

What is the percent demand from an office to a retail establishment? (PM Peak) 23%

What is the total number of trips generated?

1.20 K f² X 1.775 = 213

17% entering, 83% exiting
213 X 0.17 = 36 entering
213 X 0.83 = 177 exiting

What is the directional distribution of trips?

What is the total number of trips generated? 200 K f² X 4.945 = 989

What is the percent demand from a residential to a retail establishment? (PM Peak)

65% entering, 35% exiting
989 X 0.48 = 475 entering
898 X 0.52 = 514 exiting

What is the percent demand from a retail to a residential establishment? (PM Peak) 53%

What is the directional distribution of trips?

65% entering, 35% exiting
124 X 0.65 = 81 entering
124 X 0.35 = 43 exiting

200 DU X 0.62 = 124

What is the total number of trips generated?

What is the percent demand from an office to a residential establishment? (PM Peak) 2%

What is the percent demand from a residential to an office establishment? (PM Peak) 0%

Net External Trips for Multi-Use Development

	LAND USE A	LAND USE B	LAND USE C	
Exit				
Total				INTERNAL CAPTURE
Single-Use Trip Gen. Est.				

Analyst _____
Date _____

MULTI-USE DEVELOPMENT TRIP GENERATION AND INTERNAL CAPTURE SUMMARY

Name of Dvlpt _____
Time Period _____

Using table 7.2, What is the percent demand to a retail from an office establishment? (PM Peak)

2%

What is the percent demand to a residential from a retail establishment? (PM Peak)

31%

What is the percent demand to a retail from a residential establishment? (PM Peak)

9%

What is the percent demand to an office from a retail establishment? (PM Peak)

31%

What is the percent demand to a residential from an office establishment? (PM Peak)

2%

What is the percent demand to an office from a residential establishment? (PM Peak)

0%

LAND USE A Shopping Center

ITE LU Code	820		
Size	200,000 f²		
	Total	Internal	External
Enter	475		
Exit	514		
Total	989		
%			

Exit to External
Enter from External

LAND USE B General Office

ITE LU Code	720		
Size	120,000 f²		
	Total	Internal	External
Enter	36		
Exit	177		
Total	213		
%			

Exit to External
Enter from External

LAND USE C Low Rise Apt

ITE LU Code	221		
Size	200 Units		
	Total	Internal	External
Enter	81		
Exit	43		
Total	124		
%			

Enter from External
Exit to External

	Demand	Balanced	Demand
A → B	3%		31%
A → C	2%		23%
C → A	12%		31%
C → B	9%		53%
B → C	0%		0%
C → B	2%		2%

Net External Trips for Multi-Use Development

	LAND USE A	LAND USE B	LAND USE C	
Exit				
Total				INTERNAL CAPTURE
Single-Use Trip Gen. Est.				

Analyst _____
Date _____

MULTI-USE DEVELOPMENT TRIP GENERATION AND INTERNAL CAPTURE SUMMARY

Name of Dvlpt _____
Time Period _____

How many vehicles are exiting the shopping center to the office?
3% X 514 = 15

How many vehicles are entering the Shopping center from the office?
2% X 475 = 10

How many vehicles are entering the office from the shopping center?
31% X 36 = 11

How many vehicles are exiting the office to shopping center?
23% X 177 = 41

How many vehicles are exiting the office to the apartments? 2% X 177 = 4

How many vehicles are entering the office from the apartments' 0% X 36 = 0

How many vehicles are exiting the shopping center to the apartments?
12% X 514 = 62

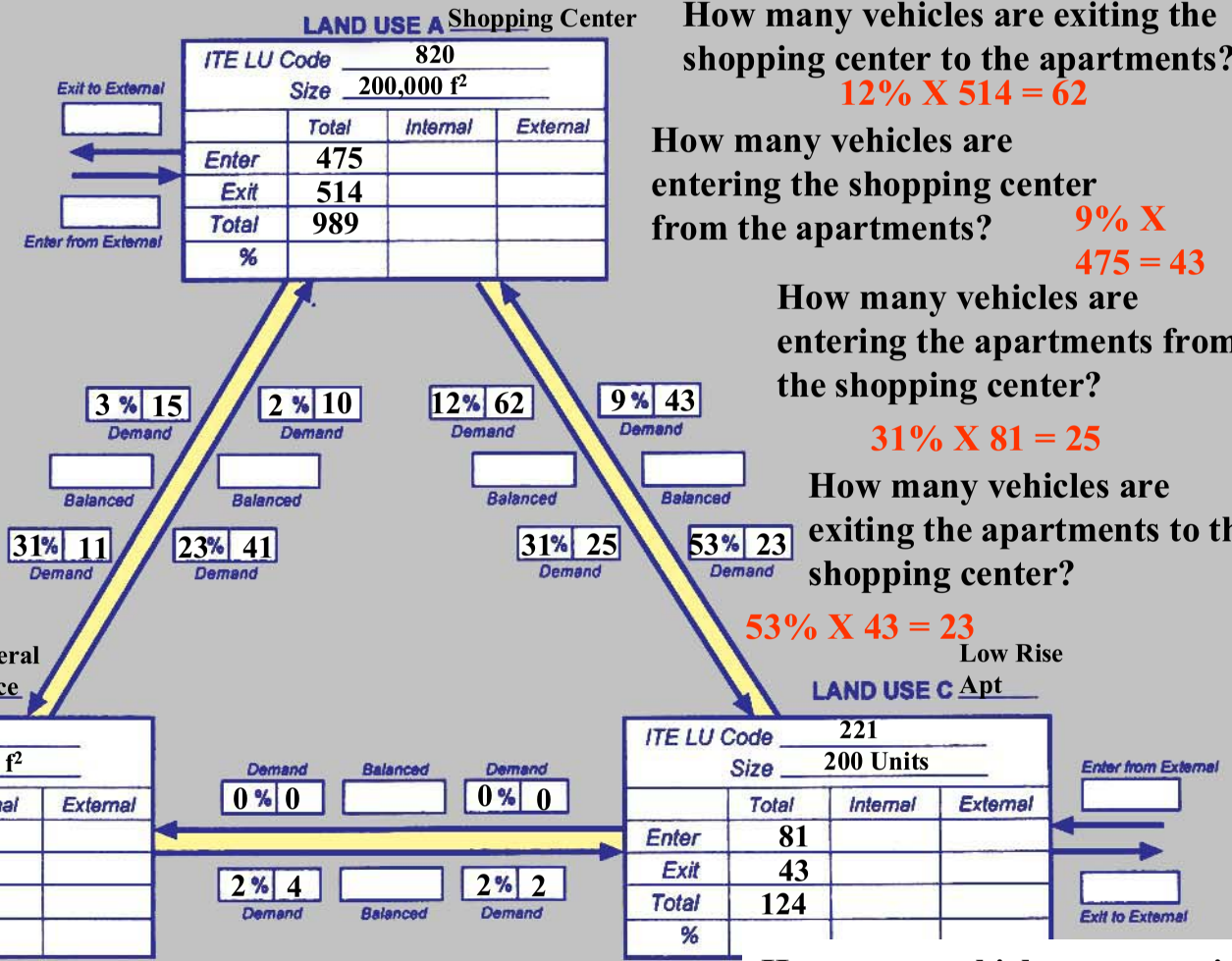
How many vehicles are entering the shopping center from the apartments? 9% X 475 = 43

How many vehicles are entering the apartments from the shopping center?
31% X 81 = 25

How many vehicles are exiting the apartments to the shopping center?
53% X 43 = 23

How many vehicles are entering the apartments from the office?
2% X 81 = 2

How many vehicles are exiting the apartments to the shopping center? 53% X 43 = 23



Net External Trips for Multi-Use Development

	LAND USE A	LAND USE B	LAND USE C	TOTAL
Enter				
Exit				
Total				
Est.				

Source: Kaku Associates, Inc.

Analyst _____
Date _____

MULTI-USE DEVELOPMENT TRIP GENERATION AND INTERNAL CAPTURE SUMMARY

Name of Dvlpt _____
Time Period _____

Balance the trips exiting the shopping center and entering the office with the least number of trips. (no more vehicles can enter than can exit.) 15 versus 11

Balance the trips entering the Shopping Center and exiting the office .

10 exiting vs. 41 entering balances to 10

Balance the trips entering the office and exiting the apartments.

0 exiting vs. 0 entering balances to 0

46 exiting vs. 23 entering balances to 23

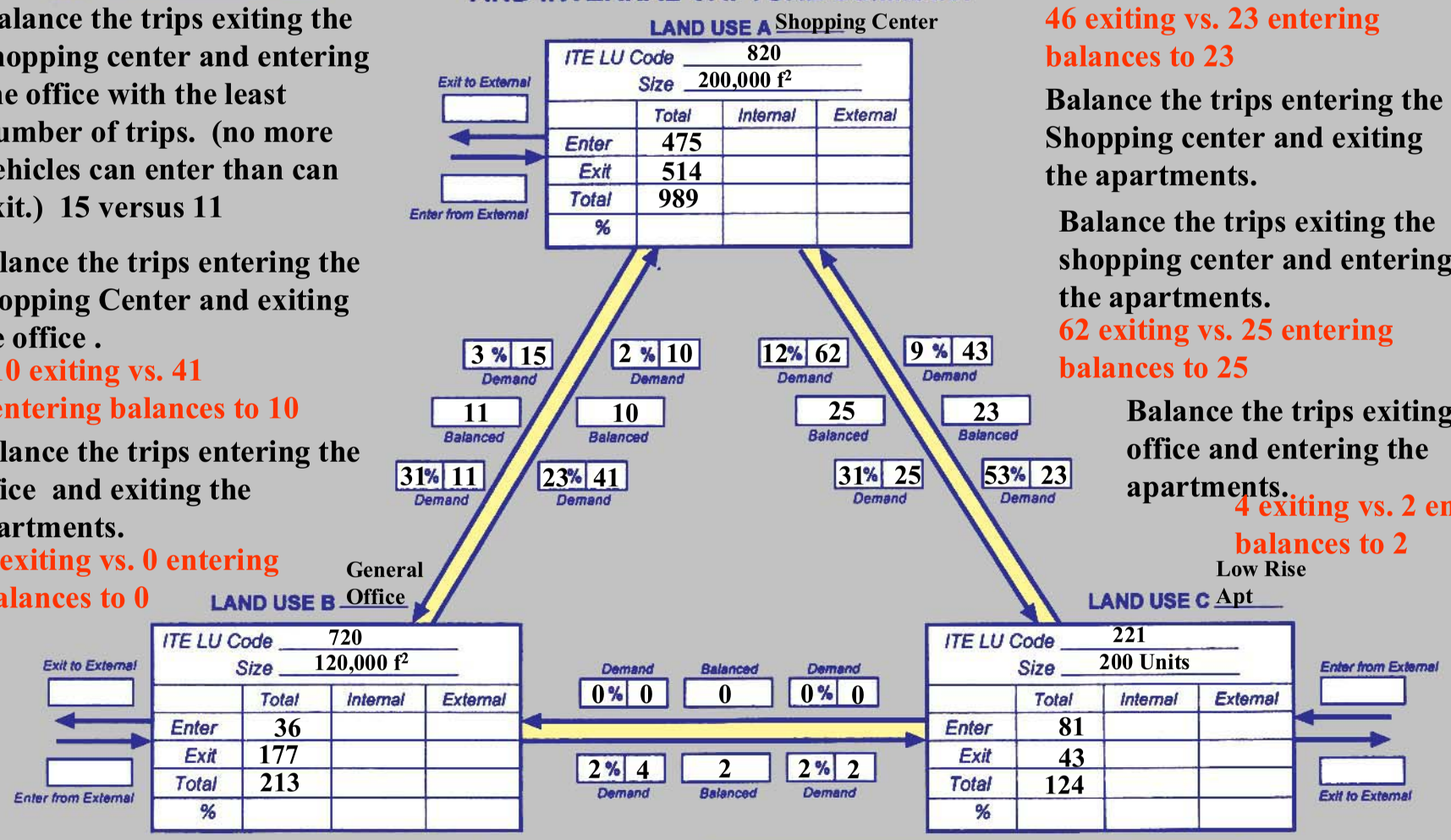
Balance the trips entering the Shopping center and exiting the apartments.

Balance the trips exiting the shopping center and entering the apartments.

62 exiting vs. 25 entering balances to 25

Balance the trips exiting the office and entering the apartments.

4 exiting vs. 2 entering balances to 2



Net External Trips for Multi-Use Development

	LAND USE A	LAND USE B	LAND USE C	TOTAL
Enter				
Exit				
Total				
Single-Use Trip Gen. Est.				

INTERNAL CAPTURE

Source: Kaku Associates, Inc.

Analyst _____
Date _____

MULTI-USE DEVELOPMENT TRIP GENERATION AND INTERNAL CAPTURE SUMMARY

Name of Dvlpt _____
Time Period _____

Add the balanced trips entering the shopping center

10 (from the office) + 23 (from the apartments) = 33

Add the balanced trips exiting the shopping center.

11 (to the office) + 25 (to the apartment) = 36

Total the internally captured trips.

33 entering + 36 exiting = 69 trips

Subtract the internal trips from the total trips to calculate the external trips.

475 - 33 = 442
514 - 36 = 478
898 - 69 = 920

Calculate the percent internal and external capture by dividing the total from the sum of Internal / External trips.

69 / 989 = 7%
920 / 989 = 93%

Repeat for the additional land uses.

LAND USE A Shopping Center

ITE LU Code 820
Size 200,000 f²

	Total	Internal	External
Enter	475	33	442
Exit	514	36	478
Total	989	69	920
%		7%	93%

Exit to External
Enter from External

3% 15 Demand
11 Balanced
31% 11 Demand

2% 10 Demand
10 Balanced
12% 41 Demand

12% 62 Demand
25 Balanced
31% 25 Demand

9% 43 Demand
23 Balanced
53% 23 Demand

LAND USE B General Office

ITE LU Code 720
Size 120,000 f²

	Total	Internal	External
Enter	36	11	25
Exit	177	12	165
Total	213	23	190
%		11%	89%

Exit to External
Enter from External

Demand 0% 0 — Balanced 0 — Demand 0% 0

2% 4 Demand — 2 Balanced — 2% 2 Demand

LAND USE C Low Rise Apt

ITE LU Code 221
Size 200 Units

	Total	Internal	External
Enter	81	27	54
Exit	43	23	20
Total	124	50	74
%		40%	60%

Enter from External
Exit to External

Net External Trips for Multi-Use Development

	LAND USE A	LAND USE B	LAND USE C	TOTAL
Enter				
Exit				
Total				
Single-Use Trip Gen. Est.				

INTERNAL CAPTURE

Source: Kaku Associates, Inc.

Analyst _____
Date _____

MULTI-USE DEVELOPMENT TRIP GENERATION AND INTERNAL CAPTURE SUMMARY

Name of Dvlpt _____
Time Period _____

Using the information calculated on the tables, enter in the remaining fields for trips Exiting/ Entering from External sources

The percent internal capture is calculated by the sum of the internally captured trips divided by the Total Single-Use Trips.

(69 + 23 + 50) / 1326 = 11%

Now copy the values to the summary table on the bottom

Repeat for the additional land uses.

LAND USE A Shopping Center

ITE LU Code 820
Size 200,000 f²

Exit to External: 478
Enter from External: 442

	Total	Internal	External
Enter	475	33	442
Exit	514	36	478
Total	989	69	920
%		7%	93%

3 % 15 Demand
11 Balanced
31% 11 Demand

2 % 10 Demand
10 Balanced
12% 41 Demand

12% 62 Demand
25 Balanced
31% 25 Demand

9 % 43 Demand
23 Balanced
53% 23 Demand

LAND USE B General Office

ITE LU Code 720
Size 120,000 f²

Exit to External: 165
Enter from External: 25

	Total	Internal	External
Enter	36	11	25
Exit	177	12	165
Total	213	23	190
%		11%	89%

LAND USE C Low Rise Apt

ITE LU Code 221
Size 200 Units

Enter from External: 54
Exit to External: 20

	Total	Internal	External
Enter	81	27	54
Exit	43	23	20
Total	124	50	74
%		40%	60%

Demand 0 % 0 — Balanced 0 — Demand 0 % 0

2 % 4 Demand — 2 Balanced — 2 % 2 Demand

Net External Trips for Multi-Use Development

	LAND USE A	LAND USE B	LAND USE C	TOTAL
Enter	442	25	54	521
Exit	478	165	20	663
Total	920	190	74	1184
Single-Use Trip Gen. Est.	989	213	124	1326

INTERNAL CAPTURE 11%

Source: Kaku Associates, Inc.

Trip Internalization

The IC Max Rate should be agreed upon in the Methodology Meeting.

A rate of 100% is for validation to replicate ITE rates only!

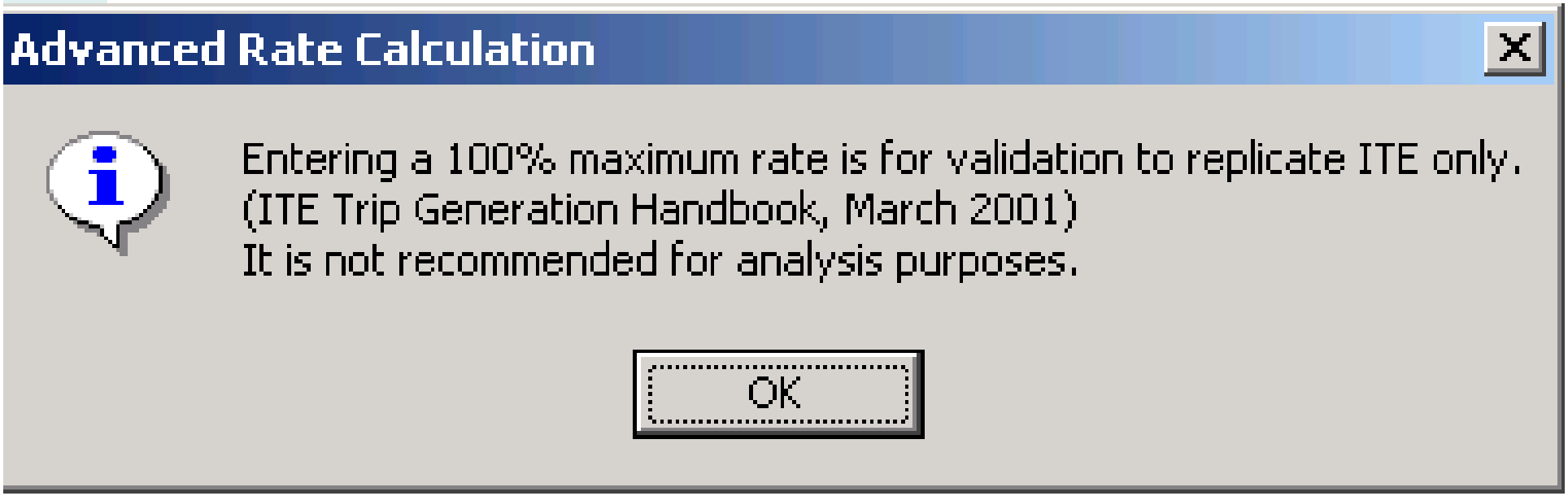


Table 7.1

Table 7.1 Unconstrained Internal Capture Rates for Trip Origins within a Multi-Use Development

		WEEKDAY		
		MIDDAY PEAK HOUR	P.M. PEAK HOUR OF ADJACENT STREET TRAFFIC	DAILY
from OFFICE	to Office	2%	1%	2%
	to Retail	20%	23%	22%
	to Residential	0%	2%	2%
from RETAIL	to Office	3%	3%	3%
	to Retail	29%	20%	30%
	to Residential	7%	12%	11%
from RESIDENTIAL	to Office	N/A	N/A	N/A
	to Retail	34%	53%	38%
	to Residential	N/A	N/A	N/A

Caution: The estimated typical internal capture rates presented in this table rely directly on data collected at a limited number of multi-use sites in Florida. While ITE recognizes the limitations of these data, they represent the only known credible data on multi-use internal capture rates and are provided as illustrative of typical rates. ***If local data on internal capture rates by paired land uses can be obtained, the local data may be given preference.***

N/A — Not Available; logic indicates there is some interaction between these two land uses; however, the limited data sample on which this table is based did not record any interaction.

Table 7.2

Table 7.2 Unconstrained Internal Capture Rates for Trip Destinations Within a Multi-Use Development

		WEEKDAY		
		MIDDAY PEAK HOUR	P.M. PEAK HOUR OF ADJACENT STREET TRAFFIC	DAILY
to OFFICE	from Office	6%	6%	2%
	from Retail	38%	31%	15%
	from Residential	0%	0%	N/A
to RETAIL	from Office	4%	2%	4%
	from Retail	31%	20%	28%
	from Residential	5%	9%	9%
to RESIDENTIAL	from Office	0%	2%	3%
	from Retail	37%	31%	33%
	from Residential	N/A	N/A	N/A

Caution: The estimated typical internal capture rates presented in this table rely directly on data collected at a limited number of multi-use sites in Florida. While ITE recognizes the limitations of these data, they represent the only known credible data on multi-use internal capture rates and are provided as illustrative of typical rates. ***If local data on internal capture rates by paired land uses can be obtained, the local data may be given preference.***

N/A — Not Available; logic indicates there is some interaction between these two land uses; however, the limited data sample on which this table is based did not record any interaction.

Analyst _____
Date _____

MULTI-USE DEVELOPMENT TRIP GENERATION AND INTERNAL CAPTURE SUMMARY

Name of Dvlpt _____
Time Period _____

LAND USE A Shopping Center

ITE LU Code 820
Size 200,000 f²

	Total	Internal	External
Enter	475	33	442
Exit	514	36	478
Total	989	69	920
%		7%	93%

Exit to External: 478
Enter from External: 442

3 % 15 Demand
11 Balanced
31% 11 Demand

2 % 10 Demand
10 Balanced
12% 41 Demand

12% 62 Demand
25 Balanced
31% 25 Demand

9 % 43 Demand
23 Balanced
53% 23 Demand

Repeat for the additional land uses.

LAND USE B General Office

ITE LU Code 720
Size 120,000 f²

	Total	Internal	External
Enter	36	11	25
Exit	177	12	165
Total	213	23	190
%		11%	89%

Exit to External: 165
Enter from External: 25

Demand 0 % 0 | Balanced 0 | Demand 0 % 0

2 % 4 Demand | 2 Balanced | 2 % 2 Demand

LAND USE C Low Rise Apt

ITE LU Code 221
Size 200 Units

	Total	Internal	External
Enter	81	27	54
Exit	43	23	20
Total	124	50	74
%		40%	60%

Enter from External: 54
Exit to External: 20

Net External Trips for Multi-Use Development

	LAND USE A	LAND USE B	LAND USE C	TOTAL
Enter	442	25	54	521
Exit	478	165	20	663
Total	920	190	74	1184
Single-Use Trip Gen. Est.	989	213	124	1326

INTERNAL CAPTURE 11%

Source: Kaku Associates, Inc.

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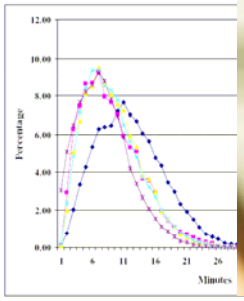
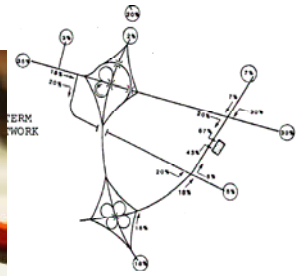
Manual Distribution

GROWTH MANAGEMENT



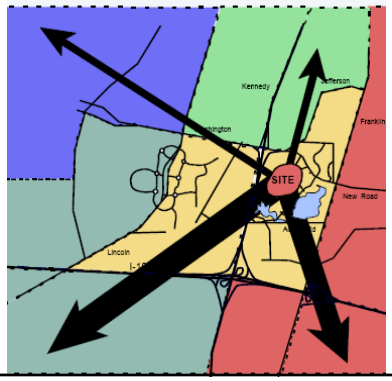


1

Trip Distribution / Assignment

GROWTH MANAGEMENT

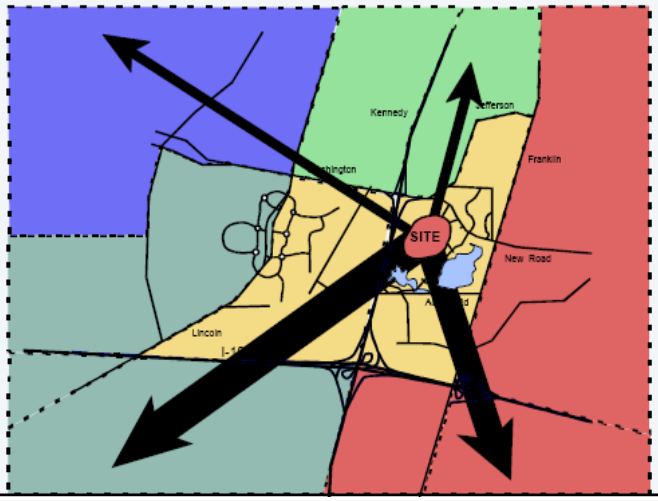
- Analyzing where trips come from and go to in relation to development
- Results in a determination of traffic that will use each access point and route on the roadway network



2

Distribution Desire Lines

- Estimating percentage of use in general directions from development area



GROWTHMANAGEMENT

3

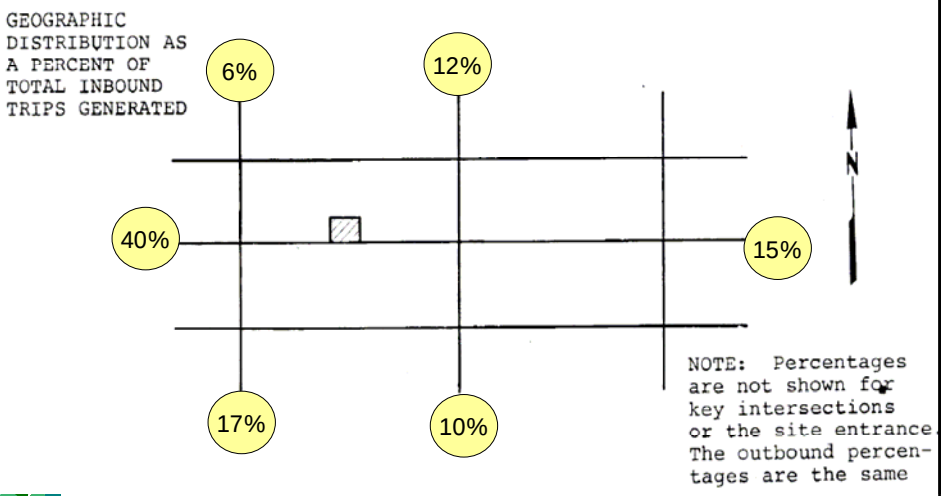
Manual Methods

- Trip Attenuation Method
- Manual Gravity Model Calculations
- Analogy Method
- Market-Based Method

GROWTHMANAGEMENT

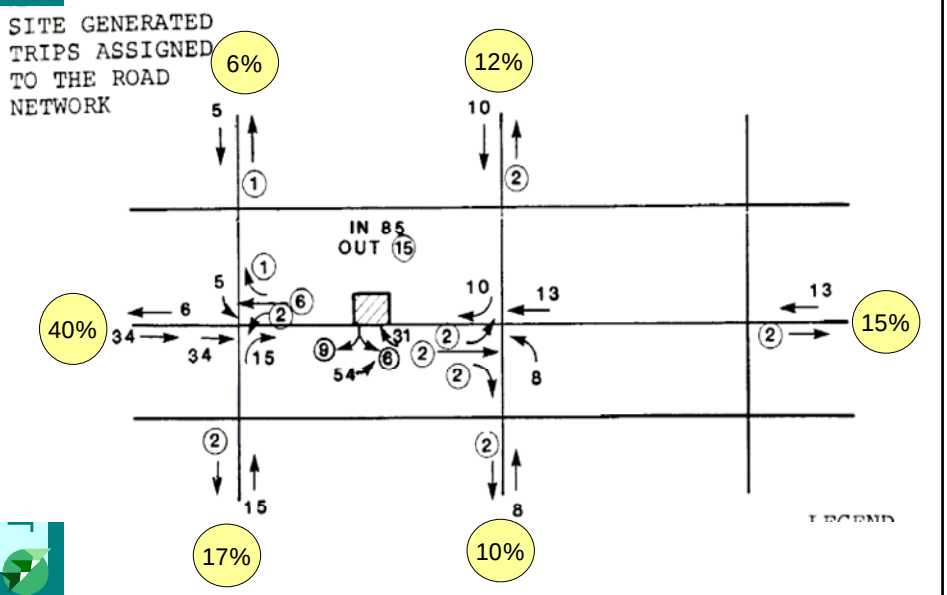
4

You Start With Major Directions



5

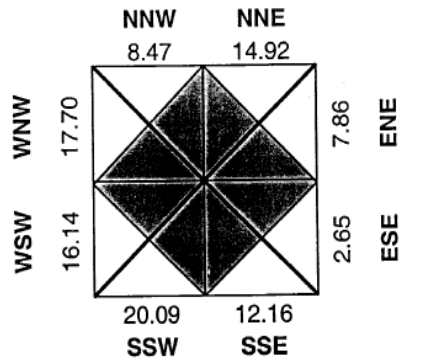
Then You Distribute Trips To The Network



6

Major Directions Decided

GROWTH MANAGEMENT

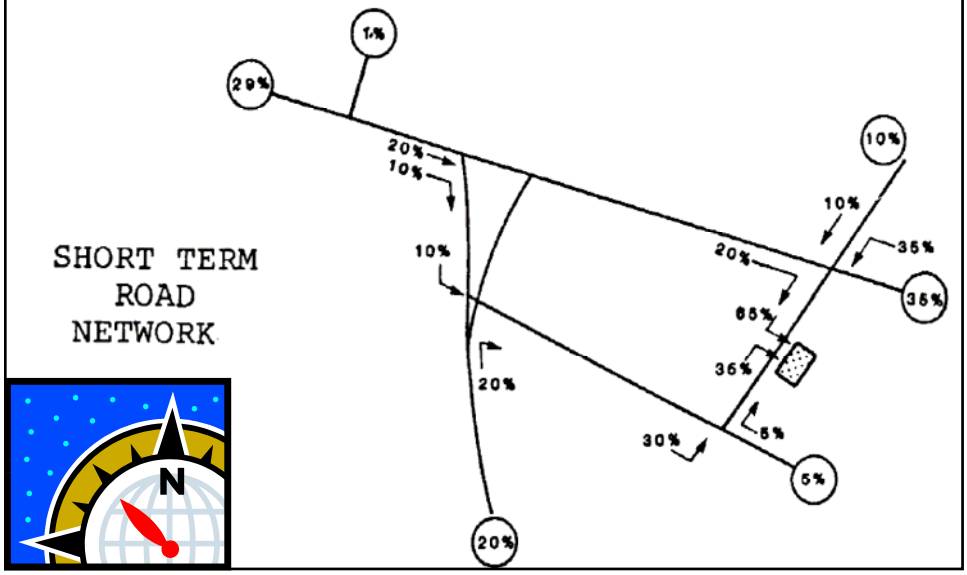


To/From NORTH	To/From EAST	To/From SOUTH	To/From WEST
23.39%	10.51%	32.25%	33.84%

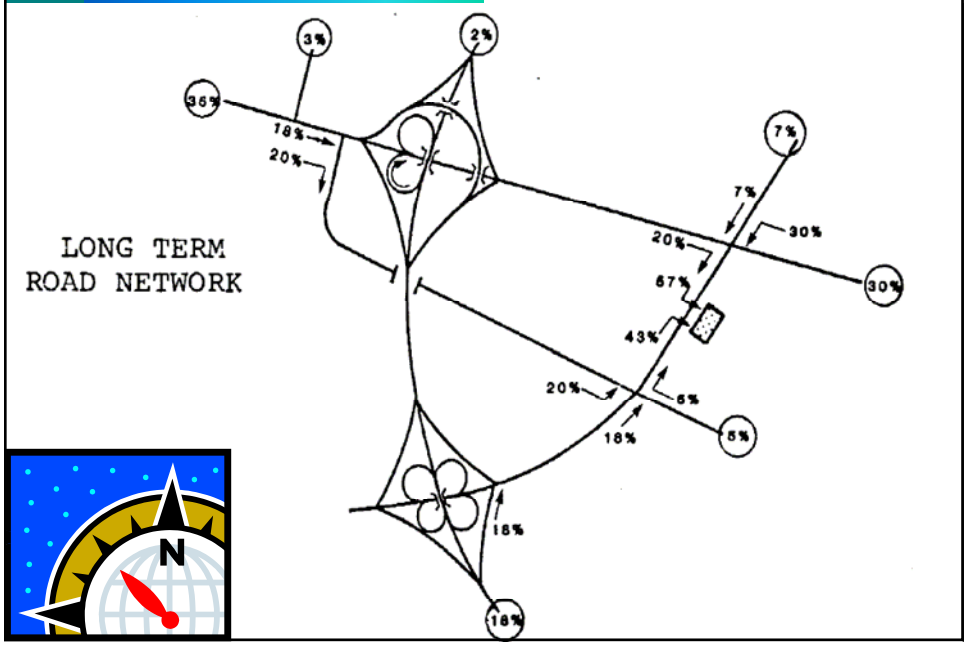
From Kimley Horn

CARDINAL DISTRIBUTION
TAZ 324
Miami-Dade County

Distributions Can Change Over Time



Distributions Can Change Over Time



Trip Attenuation

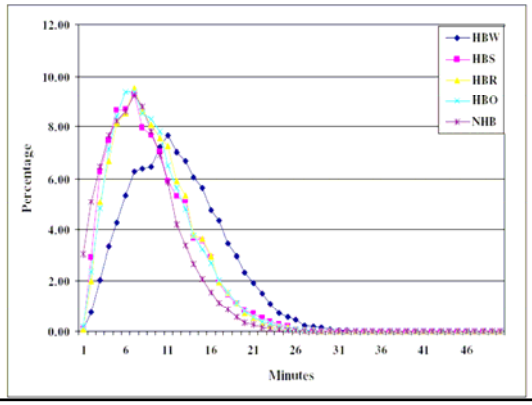
GROWTH MANAGEMENT

- Assign site traffic according to turn percentages
- Reduce site volumes using attenuation factors to account for “intervening opportunities” for the trip to end

Sources For Trip Length Frequency

GROWTHMANAGEMENT

- Travel Characteristics Survey
- National Personal Transportation Survey (NPTS)



11

Trip Attenuation Method

GROWTHMANAGEMENT

Assumed:

18 mph = Avg. speed w/delay

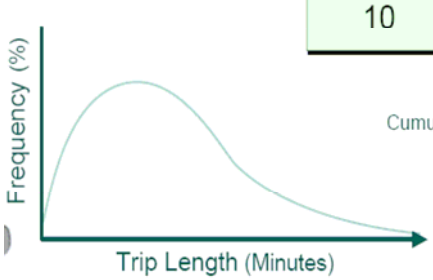
18 mph x 1/60 = 0.3 mi./min.

Note: The lower the assumed speed is, the shorter the trips will be!

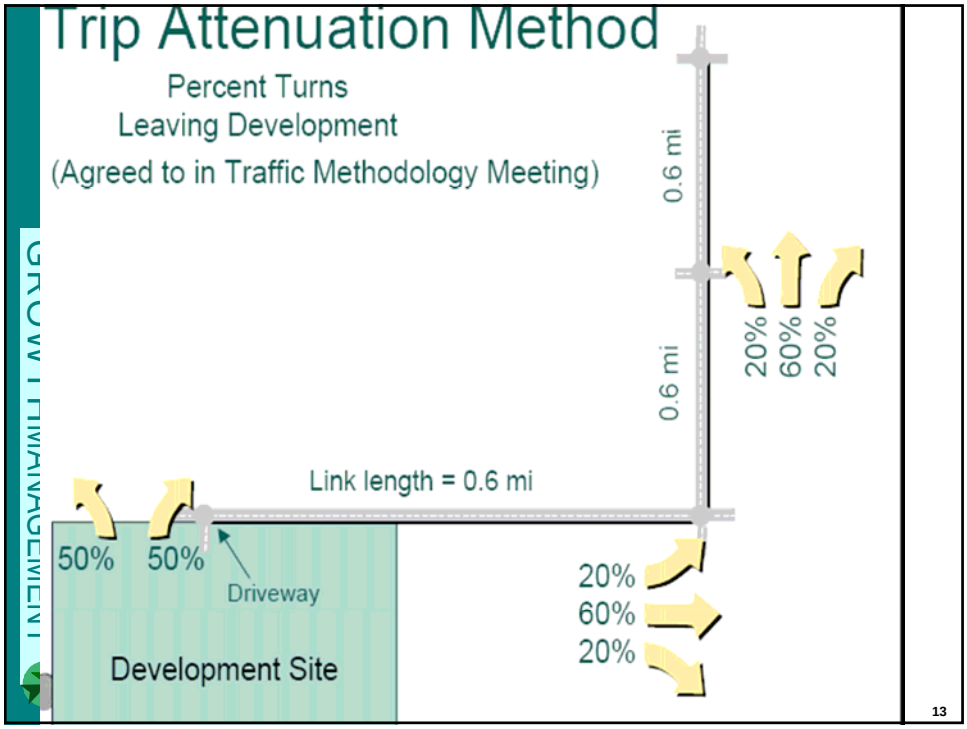
Minutes	%	Miles
2	5	0.6
4	15	1.2
6	30	1.8
10	50	3.0

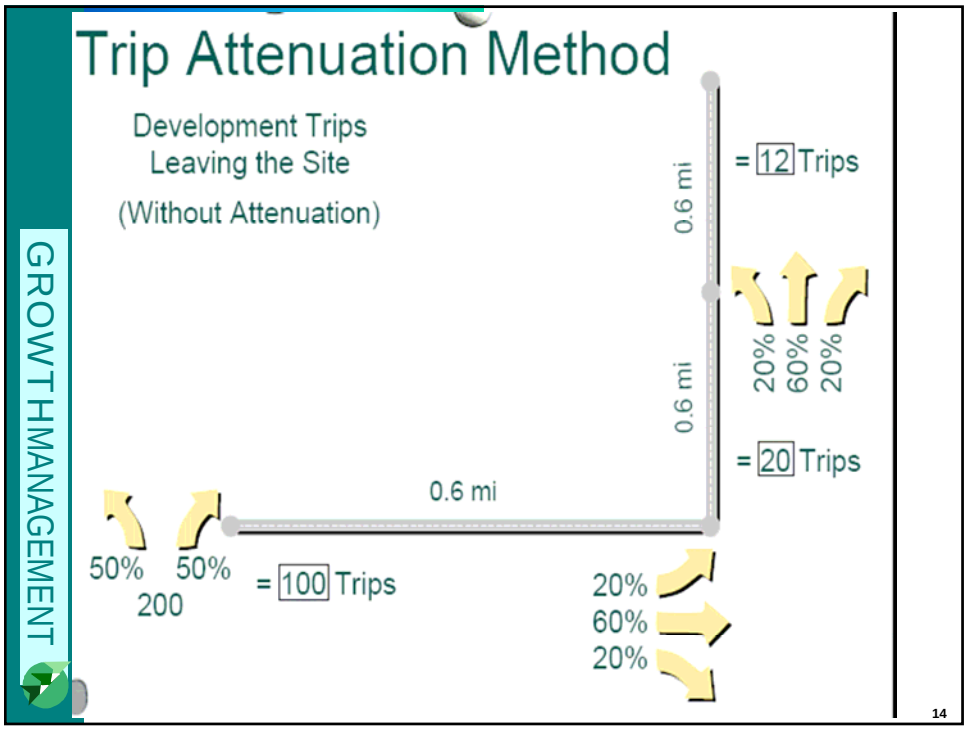
Cumulative

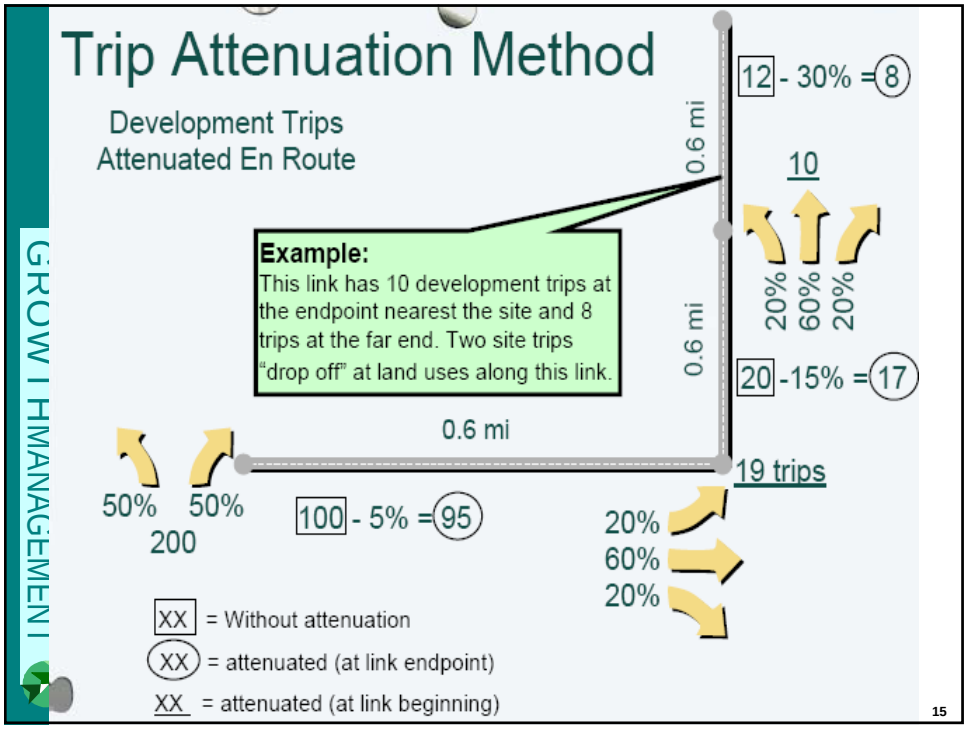
Convert minutes of travel to miles of travel (typically using 18-30 miles per hour)

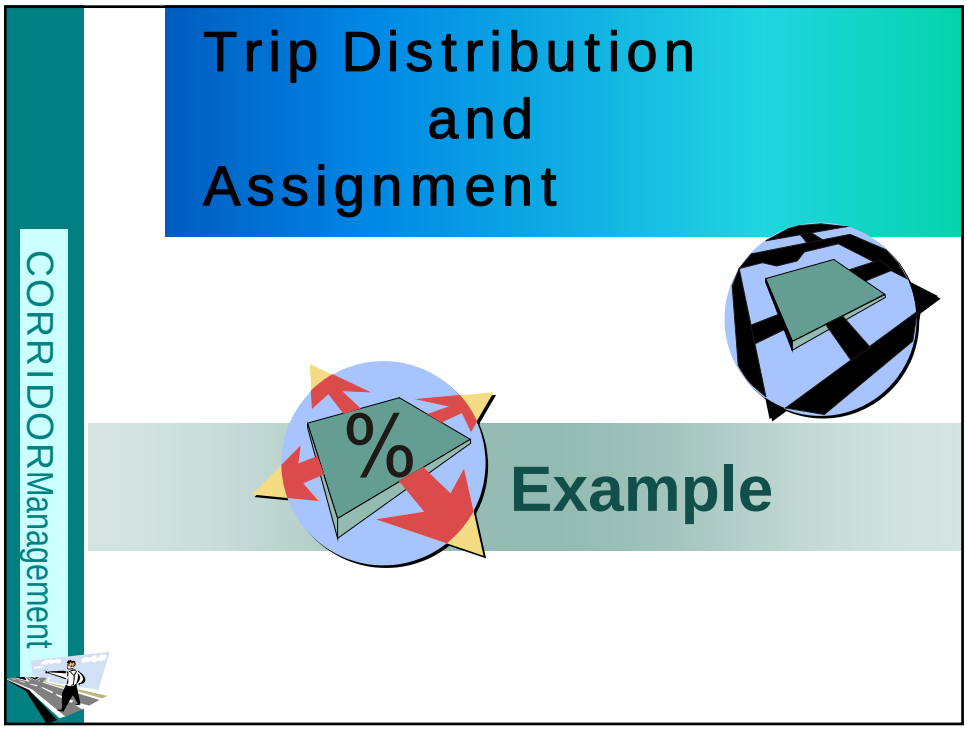


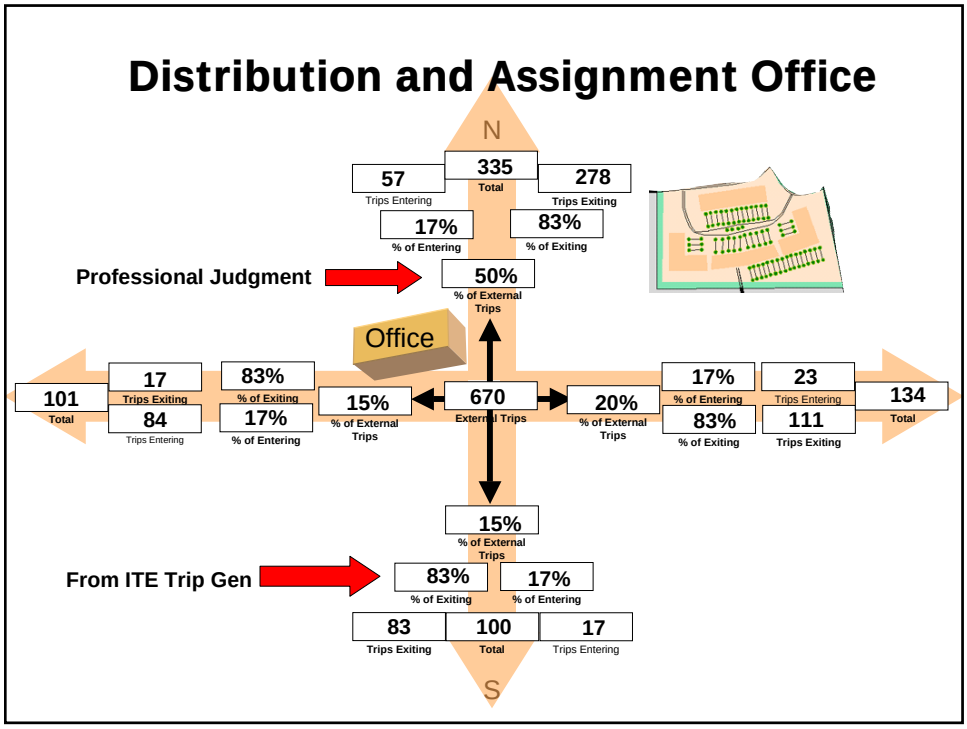
12

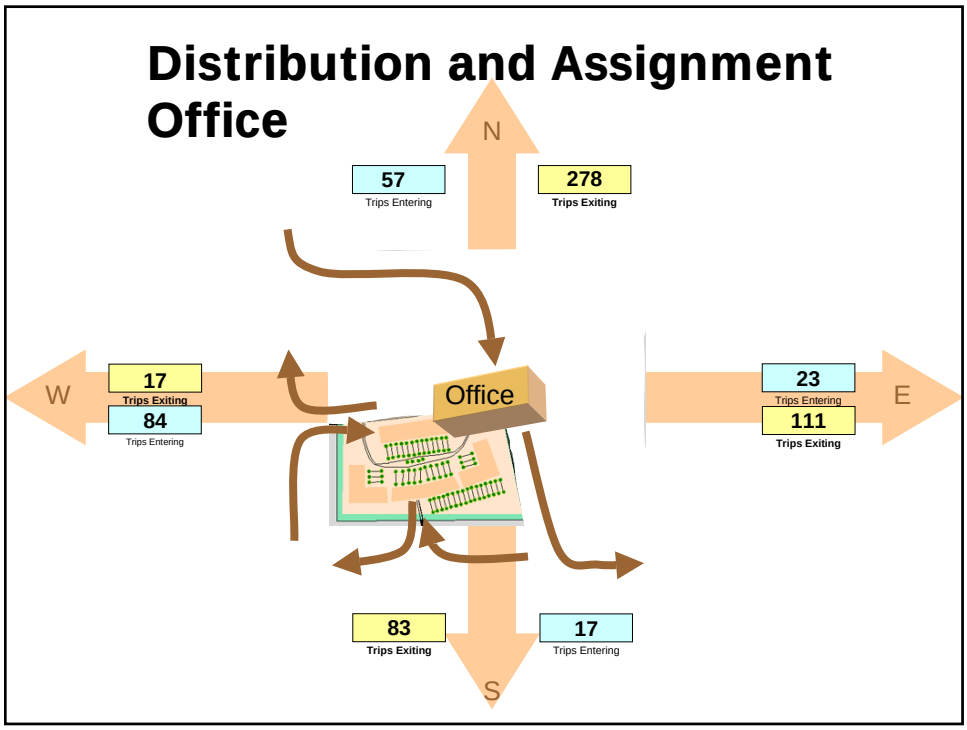

Trip Attenuation Method
Percent Turns
Leaving Development
(Agreed to in Traffic Methodology Meeting)
GROWTH MANAGEMENT
0.6 mi
0.6 mi
20%
60%
20%
Link length = 0.6 mi
50%
50%
Driveway
Development Site
20%
60%
20%
13

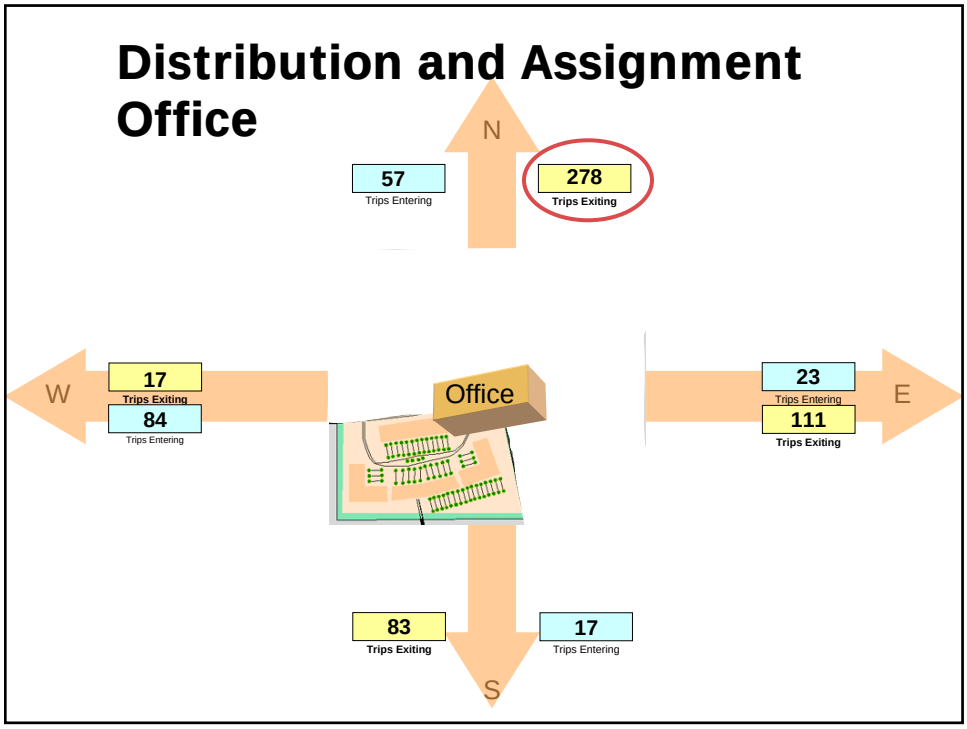

Trip Attenuation Method
Development Trips
Leaving the Site
(Without Attenuation)
GROWTH MANAGEMENT
0.6 mi
= 12 Trips
0.6 mi
20%
60%
20%
= 20 Trips
0.6 mi
50%
50%
200
= 100 Trips
20%
60%
20%
14

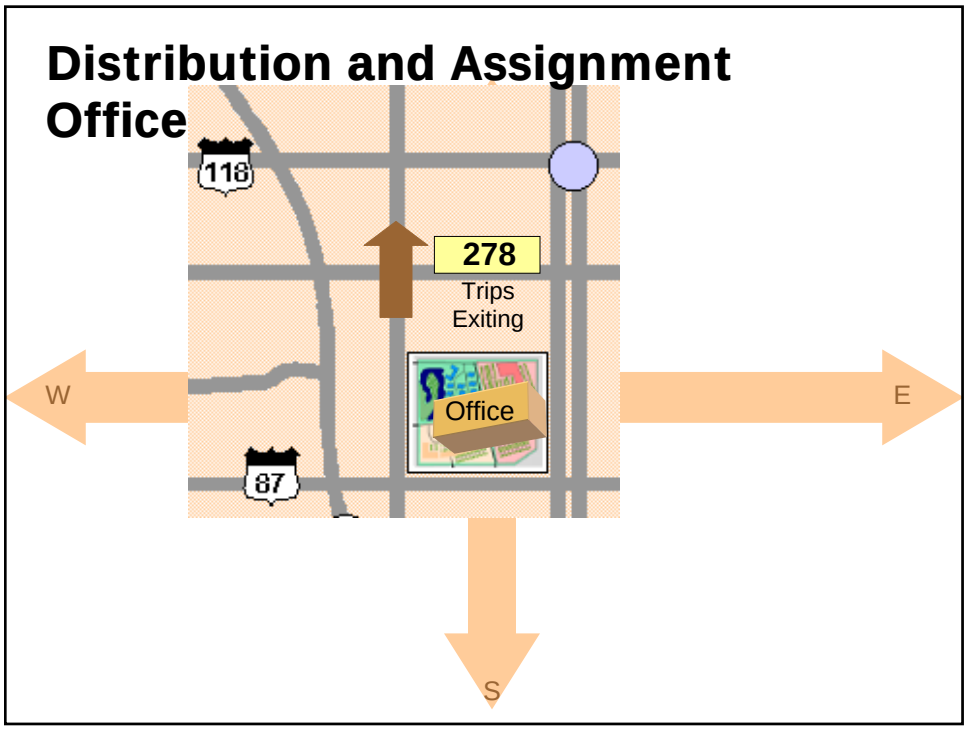

Trip Attenuation Method
Development Trips
Attenuated En Route
Example:
This link has 10 development trips at the endpoint nearest the site and 8 trips at the far end. Two site trips "drop off" at land uses along this link.
12 - 30% = 8
10
20% 60% 20%
20 -15% = 17
19 trips
0.6 mi
0.6 mi
0.6 mi
50% 50%
200
100 - 5% = 95
20%
60%
20%
XX = Without attenuation
XX = attenuated (at link endpoint)
XX = attenuated (at link beginning)
GROWTH MANAGEMENT
15


Trip Distribution
and
Assignment
%
Example
CORRIDORManagement

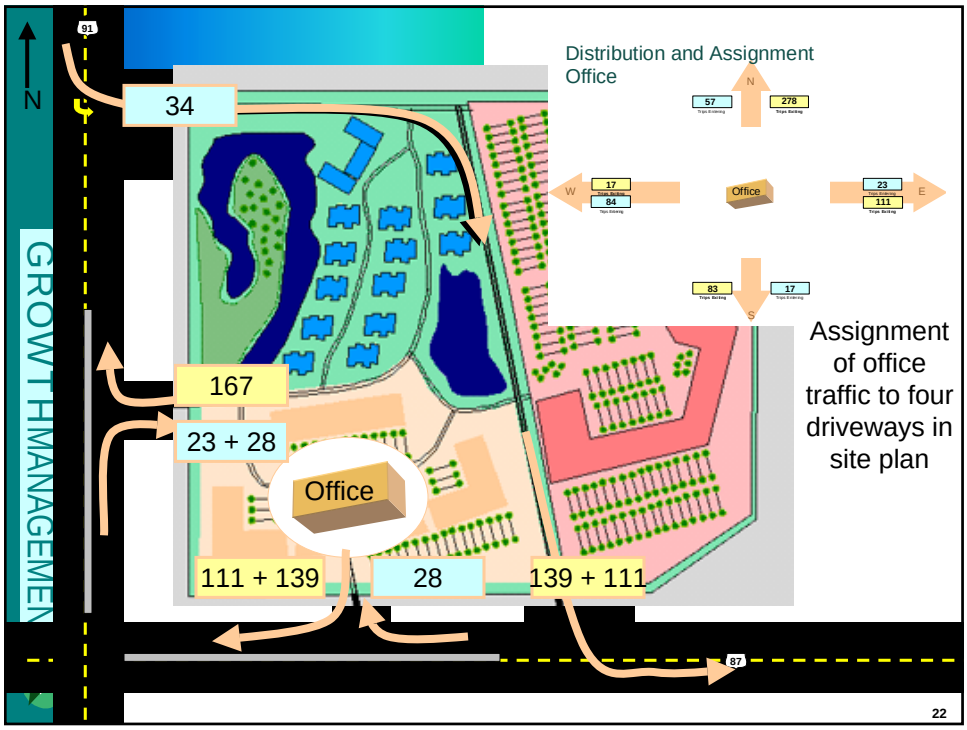

Distribution and Assignment Office
N
57
Trips Entering
335
Total
278
Trips Exiting
17%
% of Entering
83%
% of Exiting
Professional Judgment
50%
% of External Trips
Office
101
Total
17
Trips Exiting
84
Trips Entering
83%
% of Exiting
17%
% of Entering
15%
% of External Trips
670
External Trips
20%
% of External Trips
17%
% of Entering
83%
% of Exiting
23
Trips Entering
111
Trips Exiting
134
Total
15%
% of External Trips
From ITE Trip Gen
83%
% of Exiting
17%
% of Entering
83
Trips Exiting
100
Total
17
Trips Entering
S

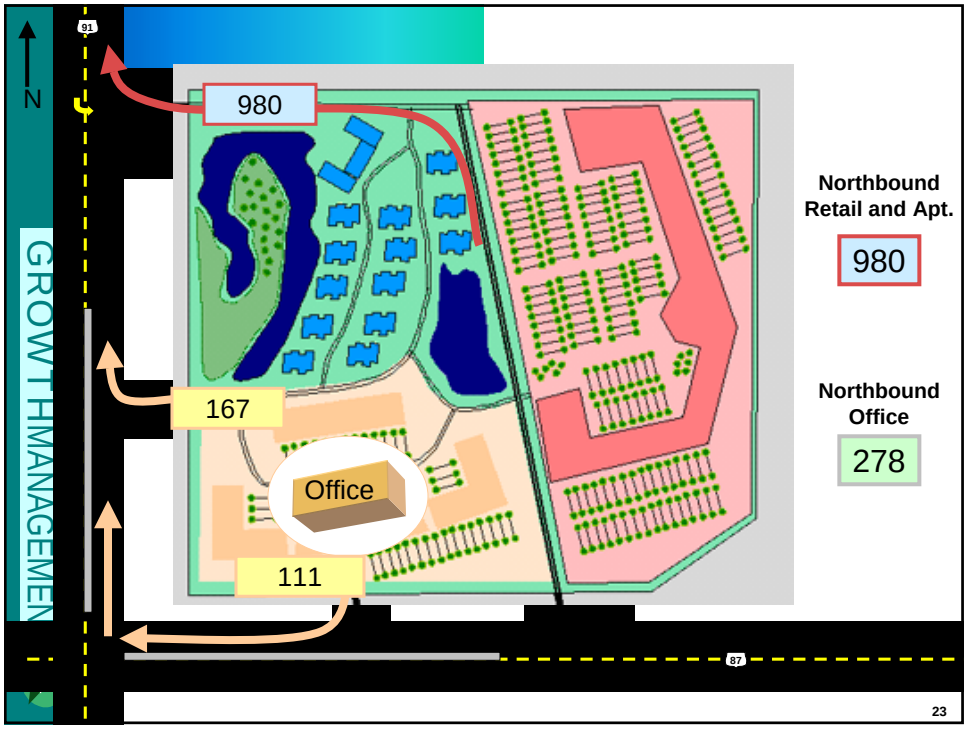

Distribution and Assignment Office
N
57
Trips Entering
278
Trips Exiting
W
17
Trips Exiting
84
Trips Entering
Office
23
Trips Entering
111
Trips Exiting
E
83
Trips Exiting
17
Trips Entering
S

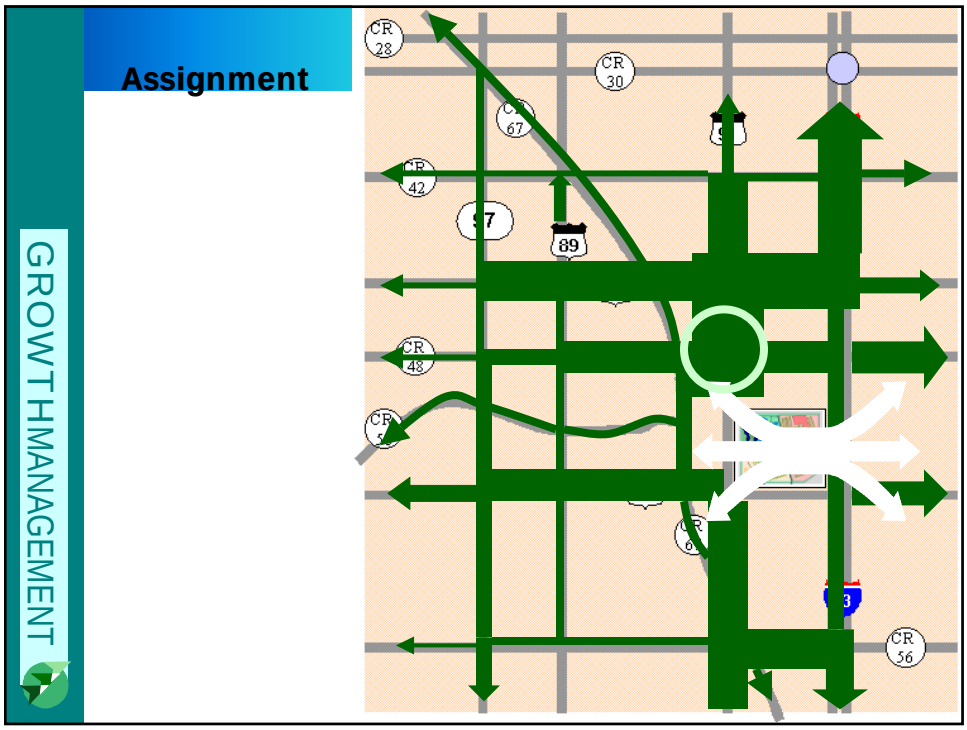

Distribution and Assignment
Office
N
57
Trips Entering
278
Trips Exiting
W
17
Trips Exiting
84
Trips Entering
Office
23
Trips Entering
111
Trips Exiting
E
83
Trips Exiting
17
Trips Entering
S

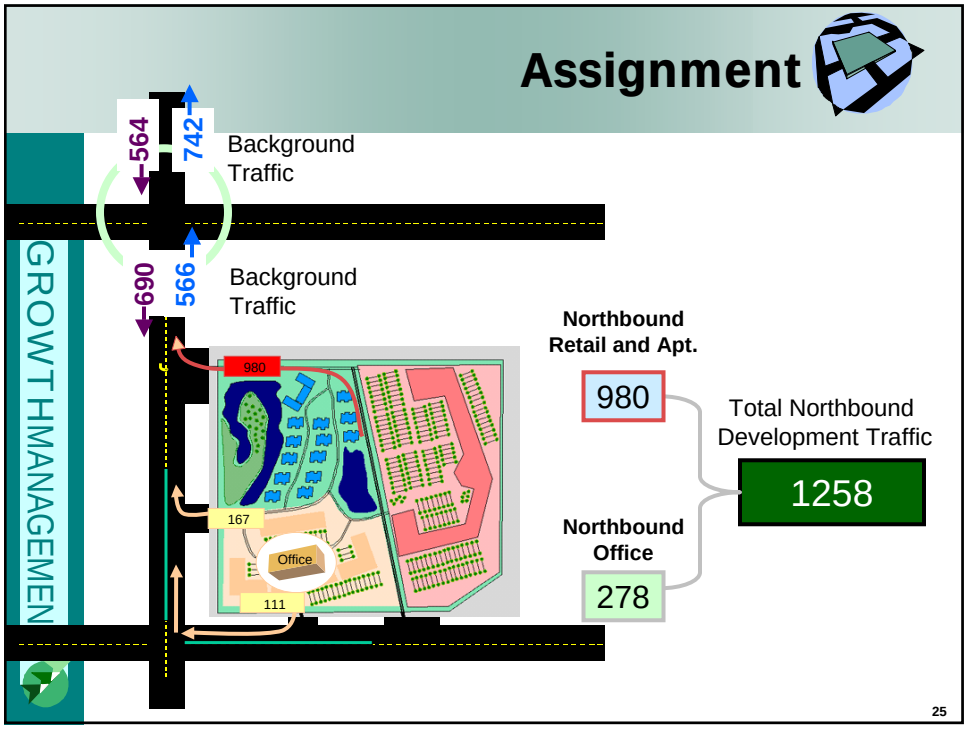

Distribution and Assignment
Office
118
278
Trips
Exiting
W
Office
E
87
S

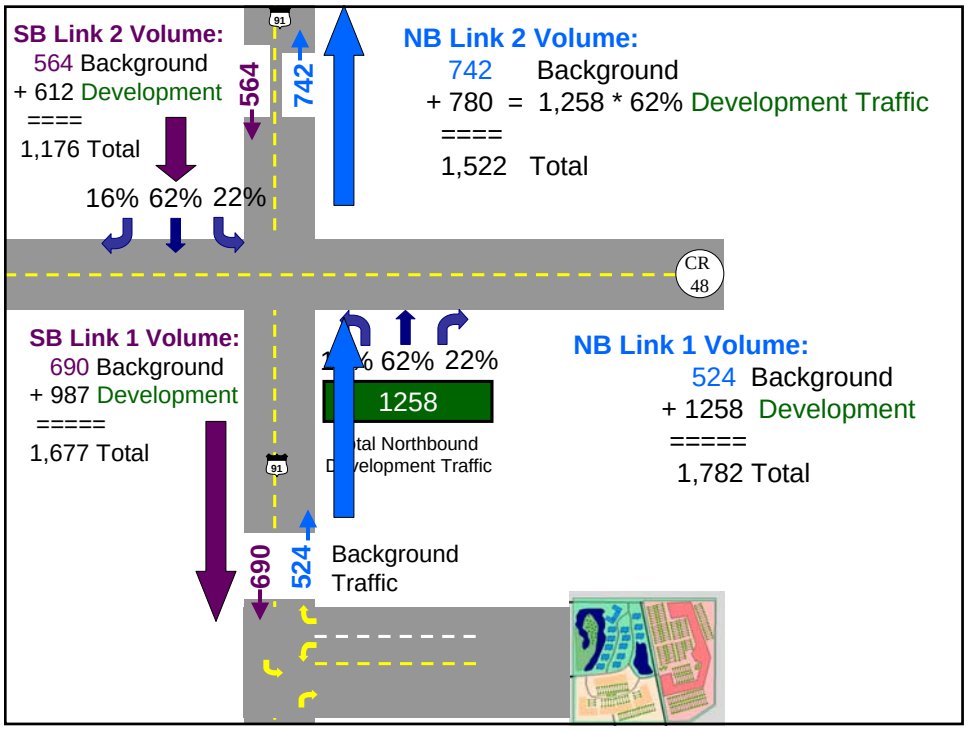
N
GROWTH MANAGEMEN
91
87
167
Office
111
167
+111
Northbound
Office
278
21

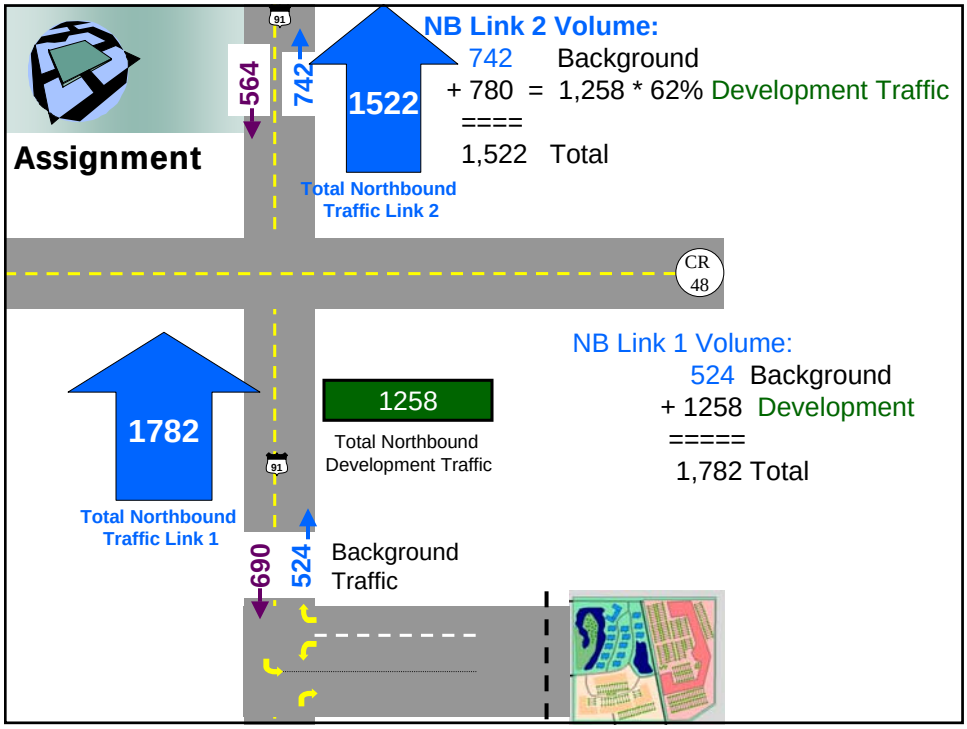

N
GROWTH MANAGEMEN
91
87
34
167
23 + 28
Office
111 + 139
28
139 + 111
Distribution and Assignment
Office
57
278
17
84
Office
23
111
83
17
Assignment of office traffic to four driveways in site plan
22


N
GROWTH MANAGEMEN
980
167
Office
111
Northbound
Retail and Apt.
980
Northbound
Office
278
23


Assignment
GROWTH MANAGEMENT
CR 28
CR 30
CR 42
CR 48
CR 56
89


Assignment
564
742
Background Traffic
690
566
Background Traffic
GROWTHMANAGEMEN
980
167
Office
111
Northbound Retail and Apt.
980
Total Northbound Development Traffic
1258
Northbound Office
278
25


SB Link 2 Volume:
564 Background
+ 612 Development
====
1,176 Total
564
742
NB Link 2 Volume:
742 Background
+ 780 = 1,258 * 62% Development Traffic
====
1,522 Total
16% 62% 22%
CR 48
SB Link 1 Volume:
690 Background
+ 987 Development
=====
1,677 Total
62% 22%
1258
NB Link 1 Volume:
524 Background
+ 1258 Development
=====
1,782 Total
690
524
Background Traffic



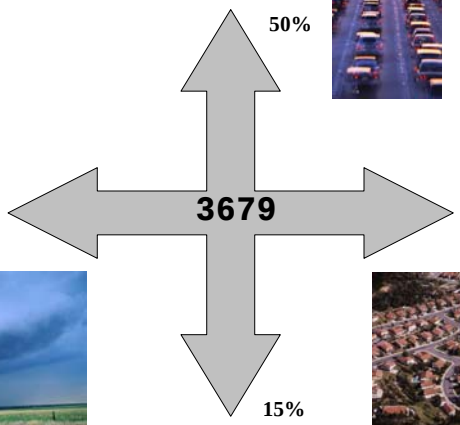
Distribution of Trips- Shopping

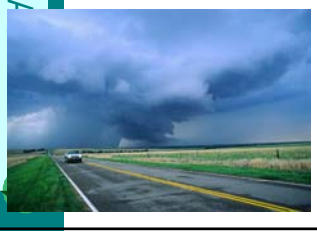
- From the Methodology Meeting:
  - Approved site plan with number (**4**) of planned driveway connections
  - **3679** total trips exiting and entering from **four** driveway connections
  - Approved upon percentages by applicant and FDOT:
    - **50%**
    - **15%**
    - **15%**
    - **20%**

GROWTH MANAGEMENT

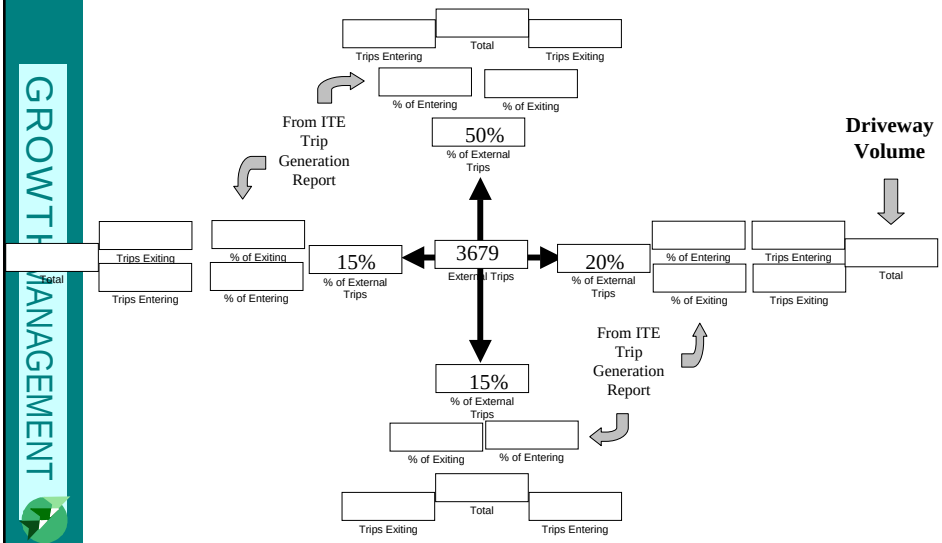
28

Distribution of Trips- Shopping





Distribution of Trips- Shopping



Directional Distribution of Office Trips in the Evening

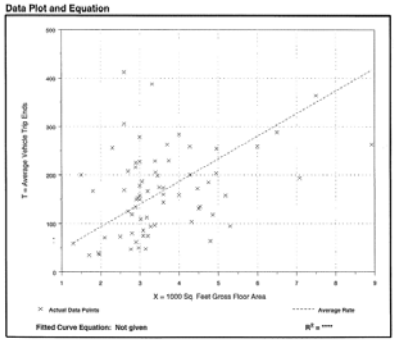
- 17% Entering
- 83% Exiting

Average 1000 Sq. Feet GFA: 4
Directional Distribution: 52% entering, 48% exiting

Trip Generation per 1000 Sq. Feet Gross Floor Area

Average Rate	Range of Rates	Standard Deviation
46.08	13.33 - 158.46	26.41

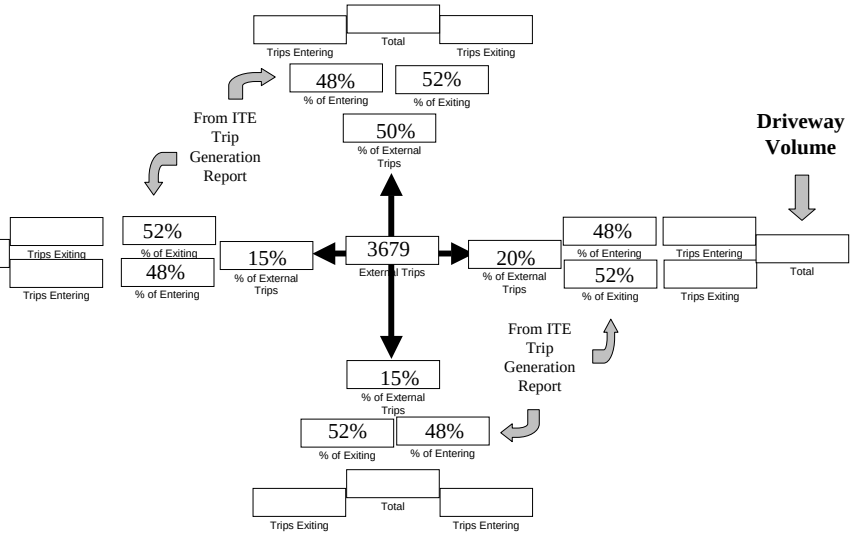
Data Plot and Equation



Trip Generation, 7th Edition 1755 Institute of Transportation Engineers

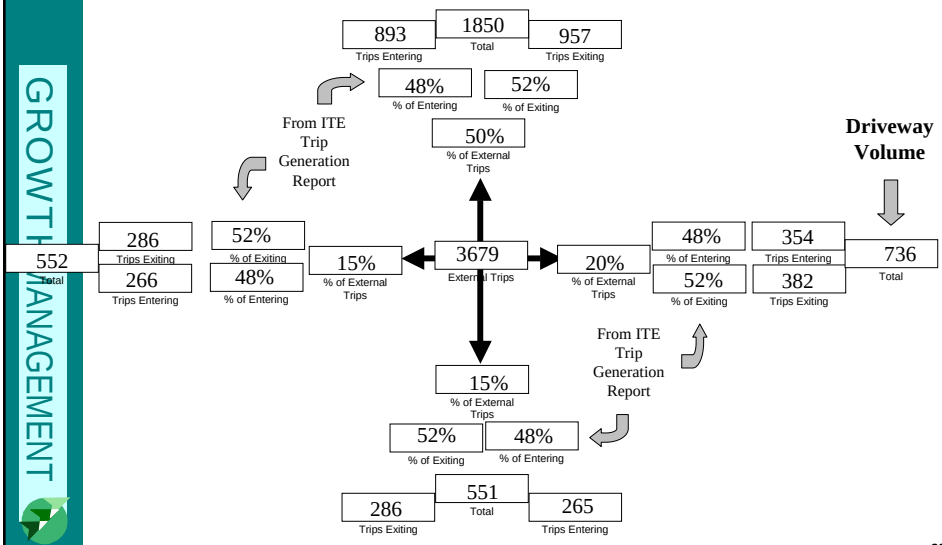
GROWTHMANAGEMENT

Distribution of Trips- Shopping

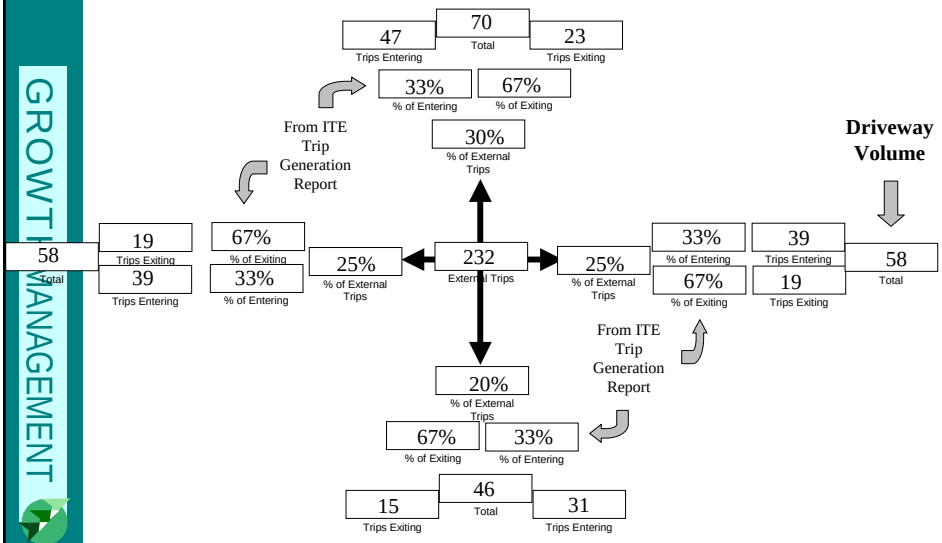


GROWTHMANAGEMENT

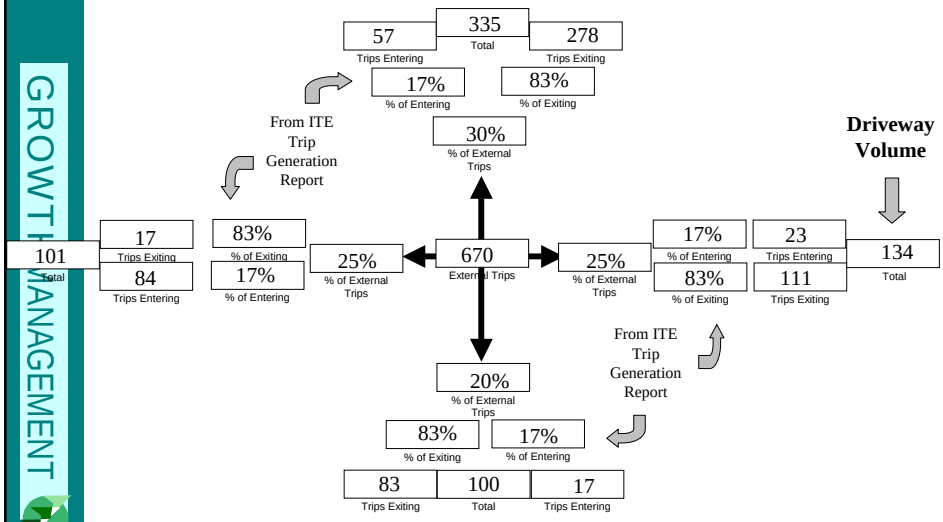
Distribution of Trips- Shopping



Distribution of Trips- Apartment



Distribution of Trips- Office



GROWTH MANAGEMENT

35

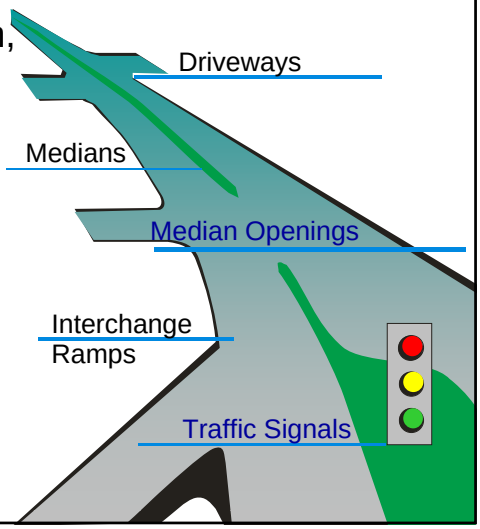
Introduction to Access Management

Questions?

1

What is Access Management?

The control and regulation of the spacing, location, and design of:



What are the Benefits of Access Management?

- **Safety**
  - Fewer / less severe accidents
  - Less auto / pedestrian conflict
- **Efficiency**
  - Higher levels of service
  - Less stop and go traffic
- **Aesthetics**
  - More room for landscaping and pedestrians
  - More attractive corridors
  - Less asphalt

Access Management Benefits

- Summary
- Continuous Two Way Left Turn Lane – 35% Reduction in Crashes
- Non-Traversable Median – 55% Reduction in Crashes
- Replace TWLTL With Non-Traversable Median – Reduction in Crashes 15-57%
- Add a Left Turn Lane – 25-75% Reduction in Crashes

4

Access Management Benefits

- Add Right Turn Lane – 20% Reduction in Crashes
- Increase Driveway Speed – 50% Reduction in Delay Per Maneuver
- Visual Cues – 42% Reduction in Crashes
- Prohibit Parking – 20 to 40% Reduction in Crashes
- Signal Spacing – 42% Reduction in Travel Time

5

Access Management Policies

- Mississippi Example

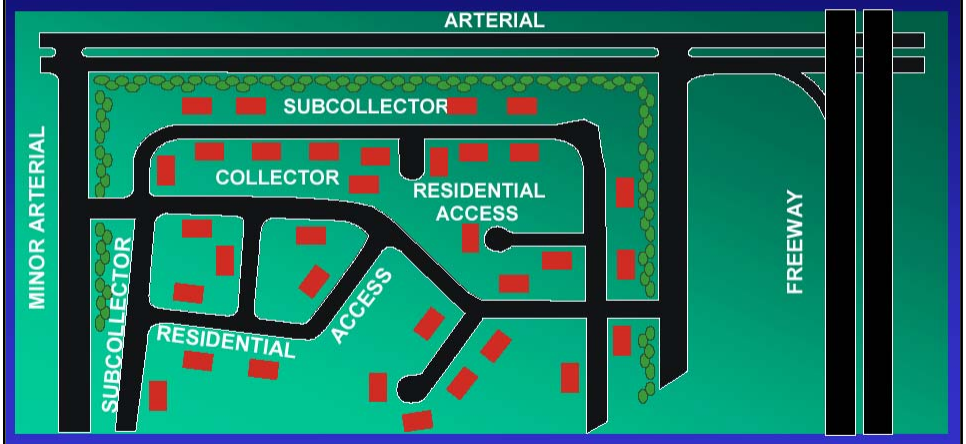
6

How Do We Plan Access Management?

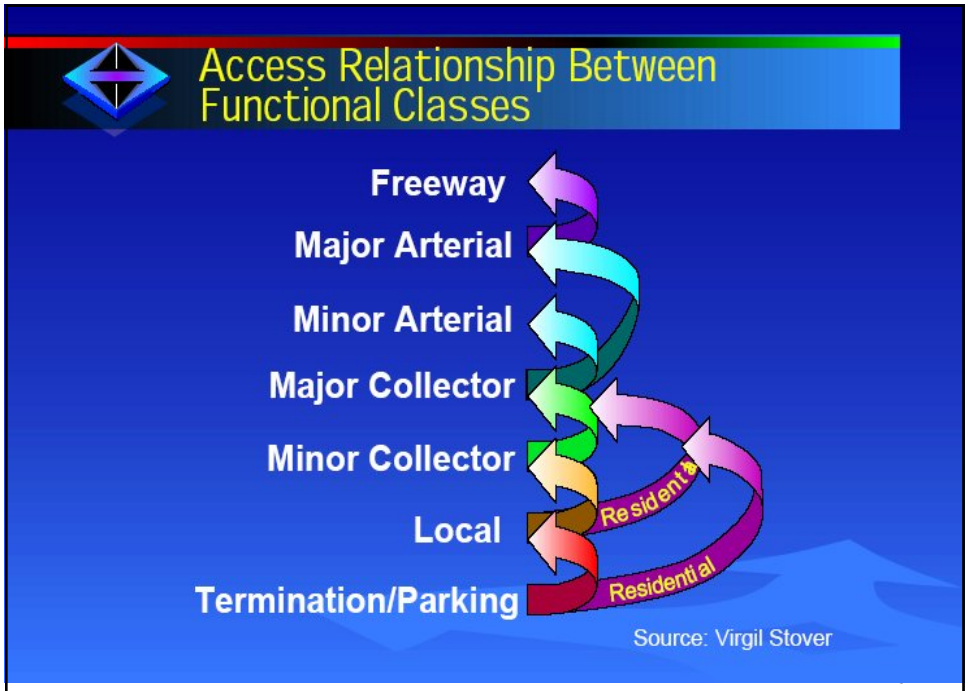
- **Planning** *before Preliminary Engineering*
  1. Access management classification
  2. Does action plan/corridor plan exist?
  3. Determine signal locations
  4. Identify possible median opening locations
  5. Shared access possibilities
  6. Initial safety study

7

Roadway Classification



Listokin, D. and Walker, C. The Subdivision and Site Plan Handbook, New Jersey: The State University of New Jersey, 1989



Roadway Function & Access

10

11

Levels of Access

- Serves as a Summary of Levels of Access Based on Roadway Classifications

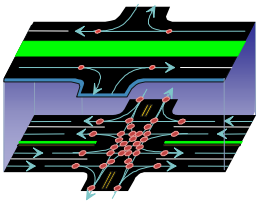
12

Access Management Standards

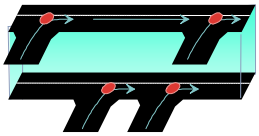
	Class	Medians	Connection >45mph	Connection ≤45mph	Median Opening Directional	Median Opening Full	Signal
	Freeways	GENERALLY DEVELOPING OR UNDEVELOPED					
Well planned with system of service roads	2	Restrictive w/ Service Roads	1320	660	1320	2640	2640
Essentially the same except for medians	3	Restrictive	660	440	1320	2640	2640
	4	Non-Restrictive	660	440			2640
		GENERALLY DEVELOPED					
Essentially the same except for medians	5	Restrictive	440	245	660	2640/ 1320	2640/ 1320
	6	Non-Restrictive	440	245			1320
The Urban/ Suburban Strip	7	Both Median Types	125		330		320

13

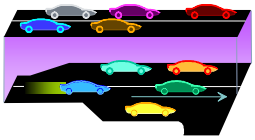
What Are The Principles of Access Management?



- **Limit** the number of conflict points



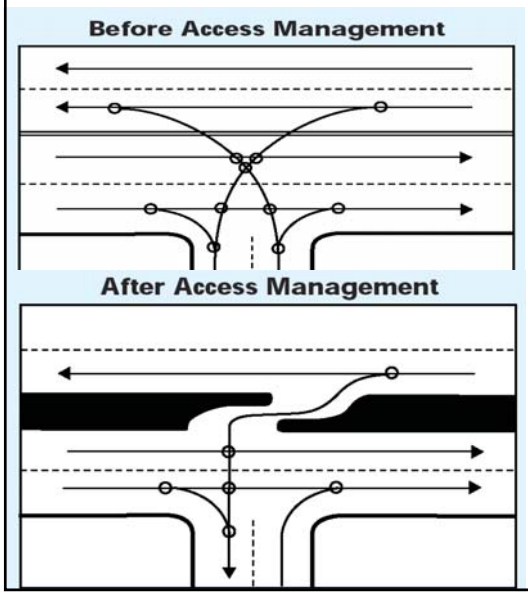
- **Separate** the conflict points



- **Control** turning movements and queues from through movements

14

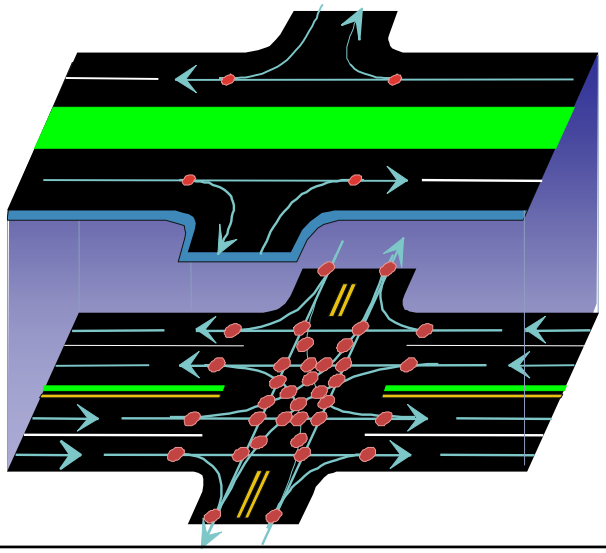
What Are Conflict Points?



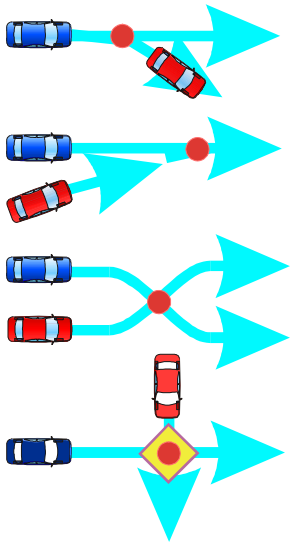
- BEFORE = More
- AFTER = Less

15

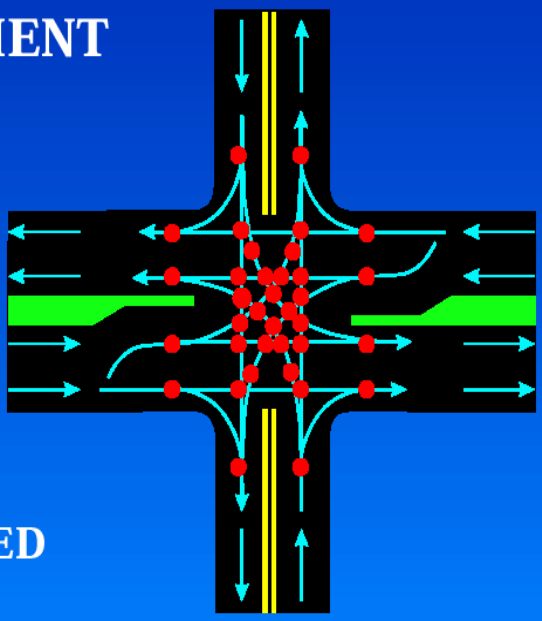
Goal 1 **Limit** Conflict Points



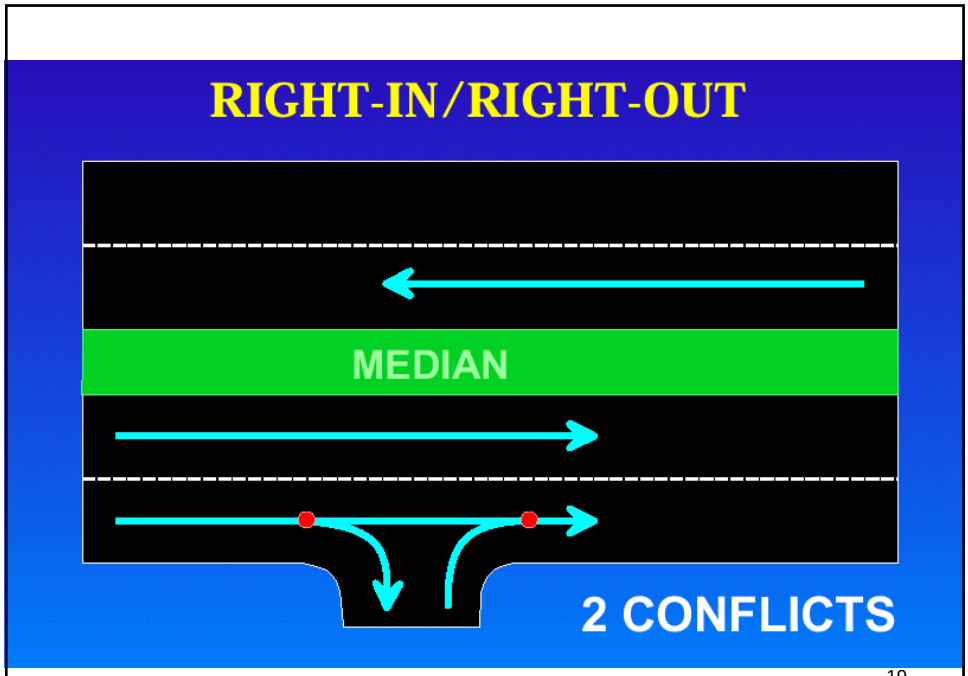
What is a Traffic Conflict?

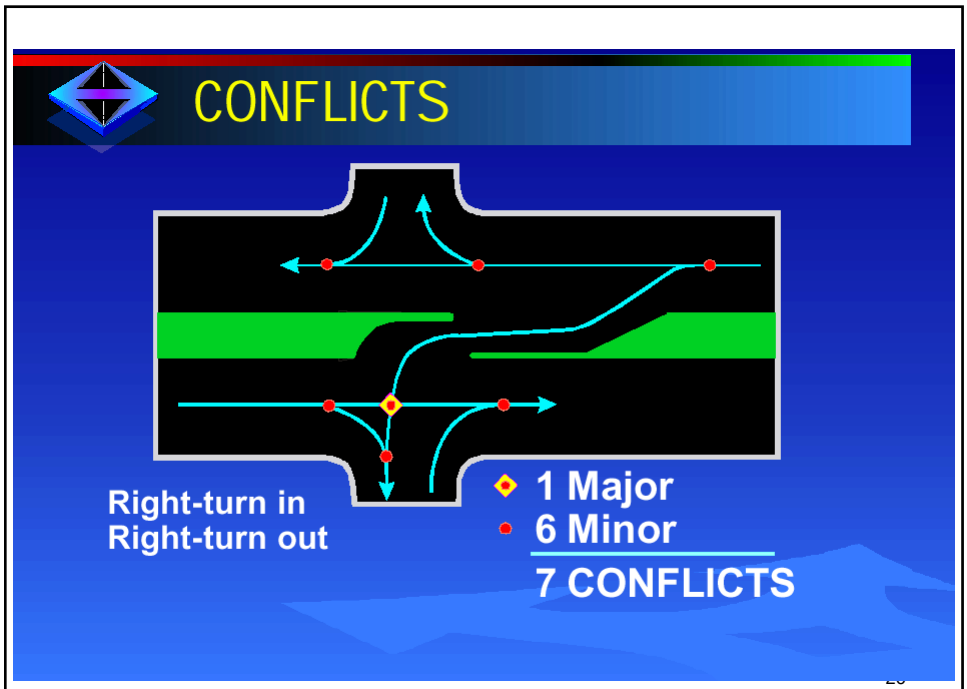


FULL MOVEMENT



36 CONFLICTS
22 IF SIGNALIZED


RIGHT-IN/RIGHT-OUT
MEDIAN
2 CONFLICTS
19


CONFLICTS
Right-turn in
Right-turn out
1 Major
6 Minor
7 CONFLICTS

Driveway Location Principles

Driveway Location

Driveways don't operate in isolation. Their operations are impacted by traffic on the roadway, as well as neighboring traffic features. Because of this, it is important to consider the location of driveways in relation to the distance to:

- Neighboring streets
- Signalized intersections
- Neighboring driveways
- Median openings
- Freeway interchange ramps
- Bus Stops.

21

Access Management Techniques

- Techniques
- Principles
- Design Guidelines

22

Install Median Barrier With No Left Turns at the Median Opening

- ADT's > 10,000
- Speed > 40 MPH
- Driveways > 30 MPH
- Left Turns >150 per Mile

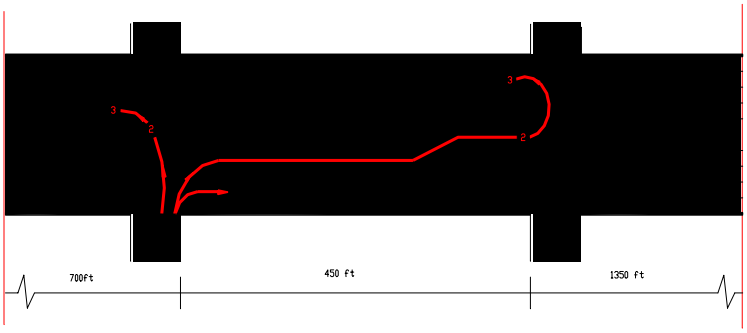
23

Apalachee Parkway
Tallahassee, FL
NEW

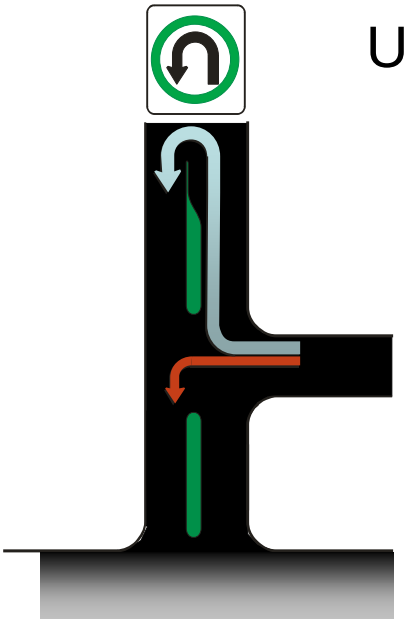
24

University of South Florida Study - 2001

Safety Evaluation of
Left Turn vs. Right Turn Plus U-Turn



U-Turns



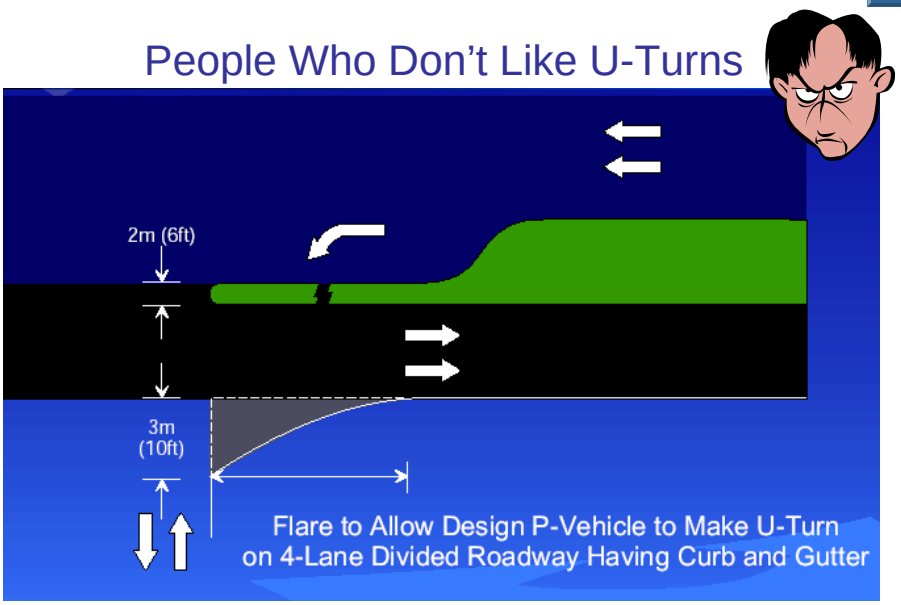
18%
Total crash rate reduction

27%
Injury fatality crash rate reduction

U-turns are often much safer than direct left turns, Especially on high volume, high speed, or congested roadways

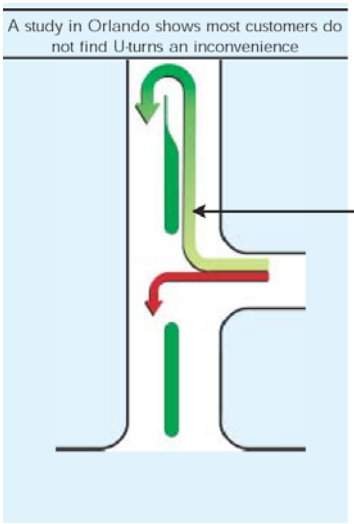
John Lu, PhD., P.E. University of South Florida 2001

People Who Don't Like U-Turns



27

People Who Don't Like U-Turns



18% total crash rate reduction

27% injury fatality crash rate reduction

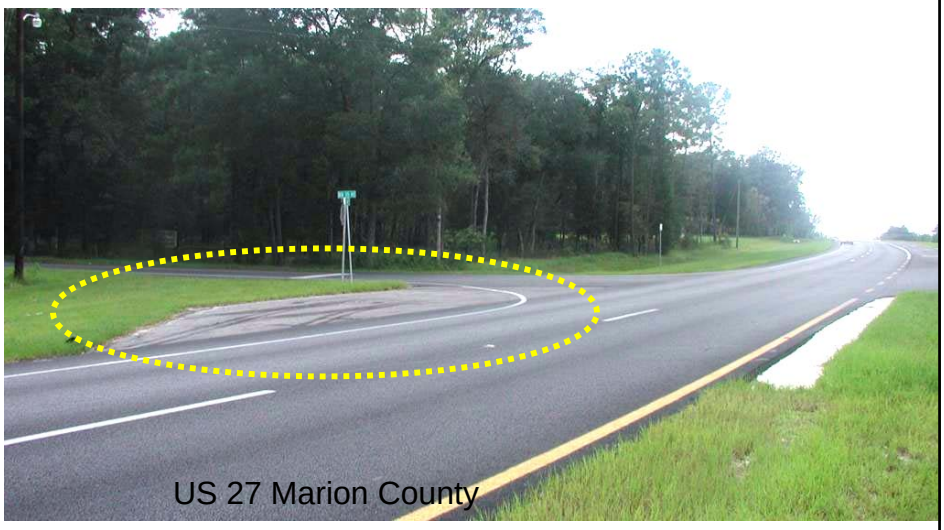
John Lu, Ph.D., P.E. University of South Florida 2001

U-turns are often much safer than direct left turns, especially on high volume, high speed, or congested roadways.

28

People Who Don't Like U-Turns

6 lane roads provide room for u-turns even with narrower median widths.



US 27 Marion County

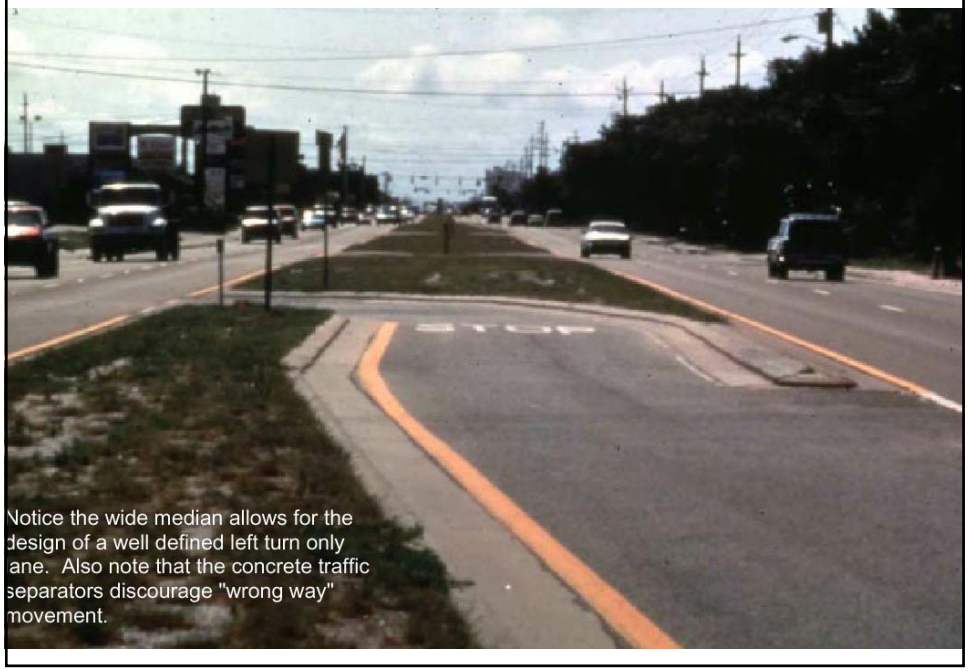
Install Raised Median Divider With Left Turn Deceleration

- Speeds >30 MPH
- ADT's > 10,000
- Left Turns > 150 Per Mile
- High Crashes – Left Turn Egress

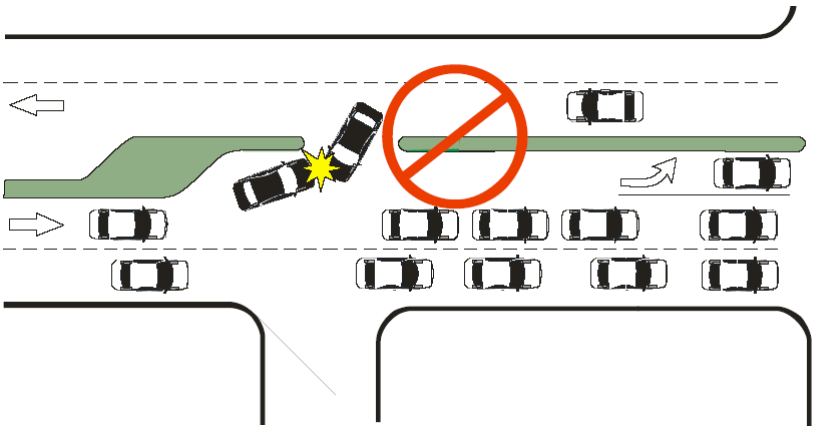
31

U-Turn before signal

2



Driveways Across From Median Openings

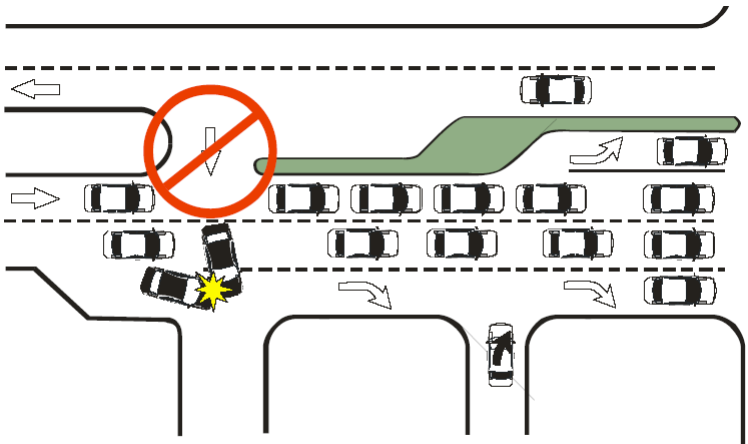


34

I-275 & Fowler

Source: CUTR

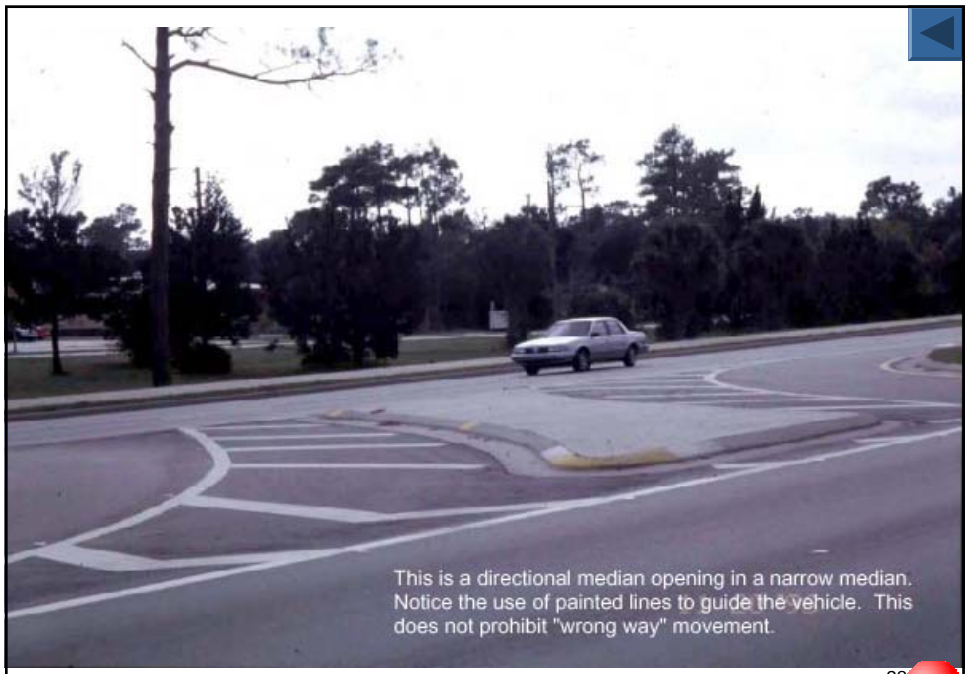
Driveways, Median Openings and Right Turn Lanes



Avoid median openings across right turn lanes

36

US 98 – Walton County



Not as much control with a 22 foot wide median

Install One Way Operation

- Speed > 30 MPH
- Commercial Driveways > 30 Per Mile
- Turns > 30% Per Mile
- Improved Safety

39

Install Traffic Signal at High Volume Driveway

- Should Not Interfere With Progression
- Should Have Proper Spacing to Maintain Speed
- Speed Should Match Functional Requirements

40

Channelize Median Opening To Prevent Left Turn Ingress or Egress

41

Median Closure To Restrict Ingress and Egress Vehicles

- Multilane With Speeds >30 MPH
- ADT >40,000
- Access Points >30 Per Mile

42

Pedestrian conflicts?

Divisional Island to Discourage Entry Into Left Turn Lane

- Inadequate Weave Length Results in High Crash Rates

Install Physical Barrier to Prevent Uncontrolled Access Along Frontages

- Best Benefit ADT >10,000
- Driveways >45 Per Mile
- Site Traffic >500 VPD

45

Wide Open Frontages

46

Without Access Management

- Asphalt
- No guidance

Wide Open Frontage

Wide Open Frontages

49

One of the dangers of wide open frontages 50

Install Median Channelization to Control Merge of Egress Vehicles

- ADT >10,000 VPD
- Left-turn Egress >50 Vehicles During Peak Hour

51

Offset Opposing Driveways

- Undivided Highways
- ADT <10,000 VPD
- Speeds Between 30 – 45 MPH
- Driveway Separation 300-ft

52

Locate Driveway Opposite a 3-Leg Intersection or Driveway

- Installation of Signal
- Must Meet MUTCD Warrants

53

Install Two One-Way Driveways in Lieu of One Two-Way Driveway

- Speeds <35 MPH
- Frontage at Least 150 Feet

54

Install Two Two-Way Driveways with Limited Turns

- ADT >10000
- Speeds >35 MPH
- Frontage at Least 200 Feet

55

Install Two –One-Way Driveways in Lieu of Two Two-Way Driveways

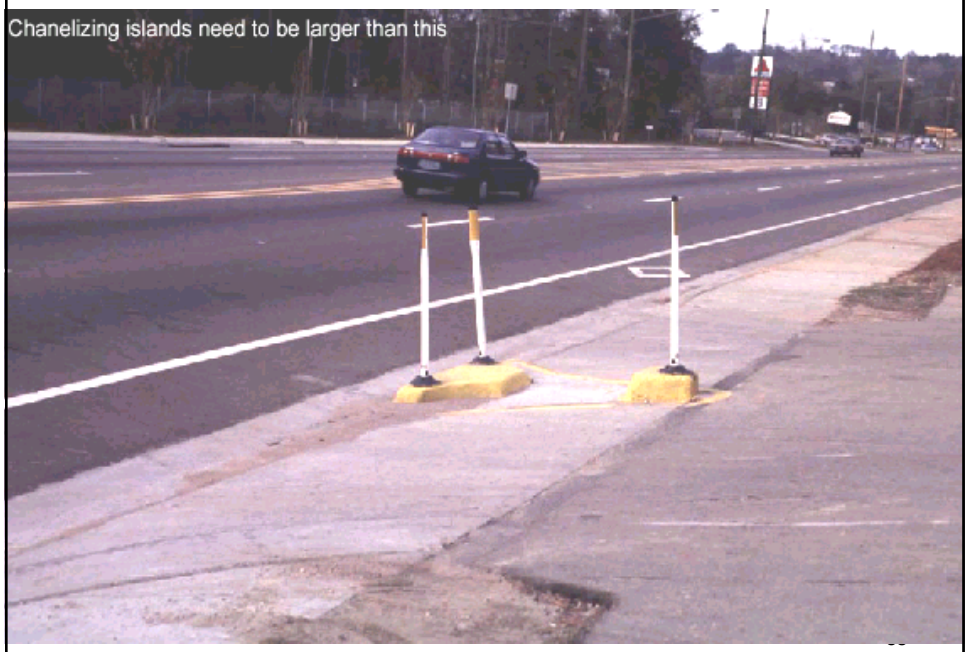
- ADT >10,000 VPD
- Driveway Volumes >300 VPD
- Minimum Frontage Width 120 Feet – Speed 20 MPH

56

Install Channelizing Island to Discourage Left Turn Maneuvers

- Undivided Highways – Speeds 30-45 MPH
- ADT >5,000 VPD

57



Limiting Turns with Driveway Design Alone

Pork Chop

59

60

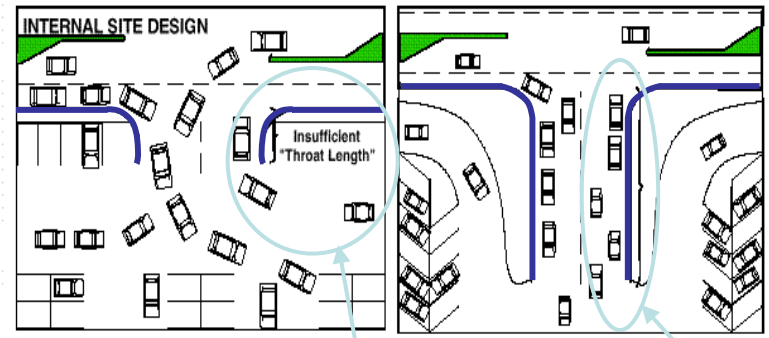
e roadway and driveway designs are
e most critical message to the driver

Install Driveway Divisional Island to Prevent Driveway Encroachment

- Median Should Be 4 to 10 Feet Wide
- Length 25 to 120 Feet

62

Driveway or “Throat” Length



Insufficient
“Throat Length

Sufficient
“Throat Length

63

Entrance design helps traffic flow

64

Entrance design helps traffic flow

Other Techniques

- Install Channelizing Island To Control the Merge Area of Right Turn Egress Vehicles
- Regulate the Maximum Width of Driveways

Regulate Minimum Spacing of Driveways

- ADT >5,000 VPD
- Speed > 25 MPH
- Right Turn Overlap

67

WHY SEPARATE CONFLICTS?

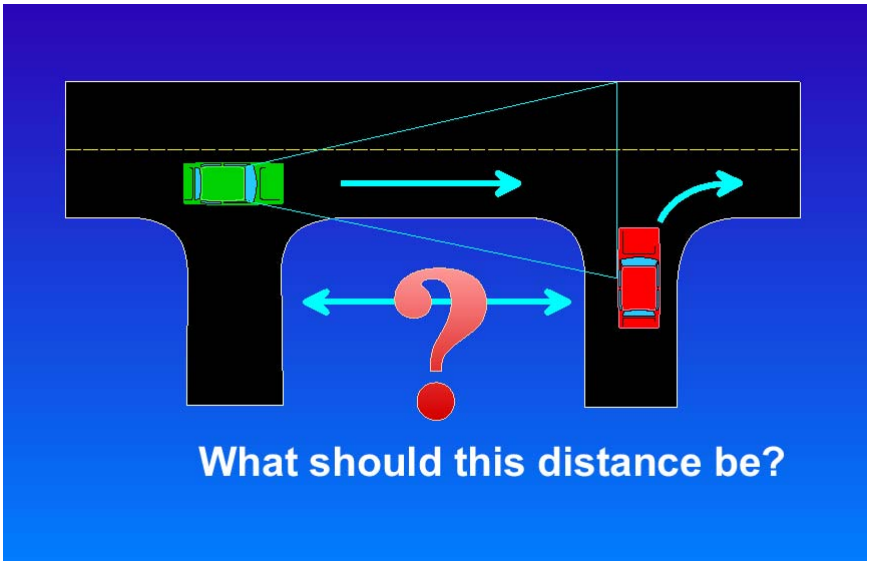
PRINCIPLE # 1

A driver can only "handle" one conflict at a time

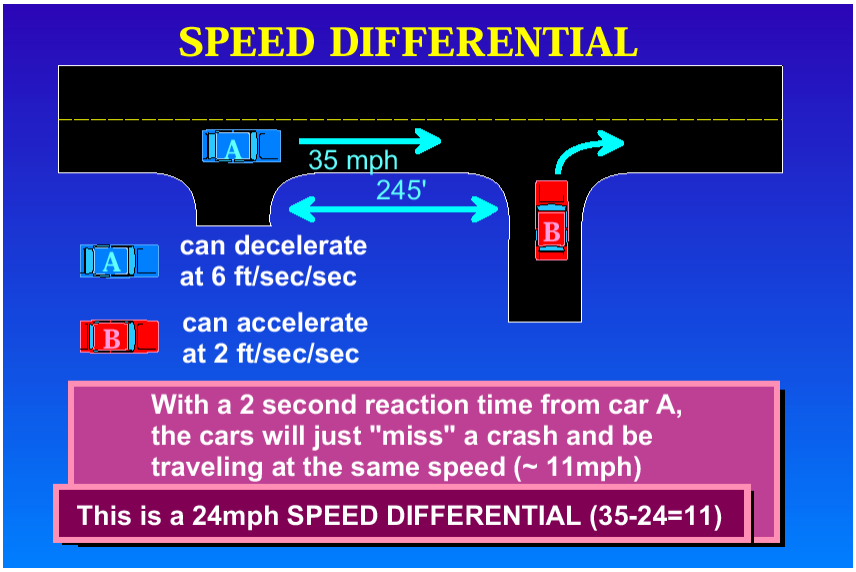
PRINCIPLE # 2

Provide enough time and space to react to the unexpected

68


What should this distance be?

69

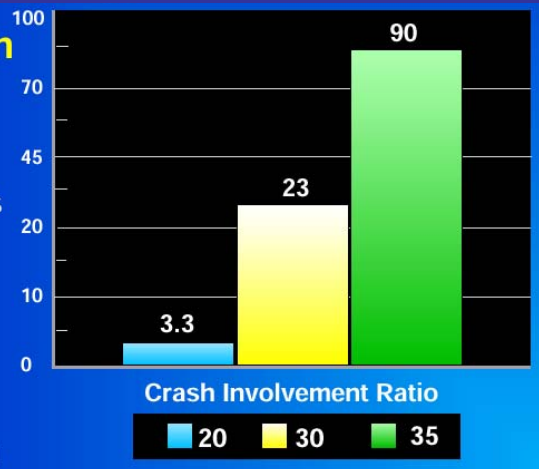

SPEED DIFFERENTIAL
A
35 mph
245'
B
A
can decelerate
at 6 ft/sec/sec
B
can accelerate
at 2 ft/sec/sec
With a 2 second reaction time from car A,
the cars will just "miss" a crash and be
traveling at the same speed (~ 11mph)
This is a 24mph SPEED DIFFERENTIAL (35-24=11)

70

10 MPH Speed Differential Desired

Relative crash involvement rate ratios

in comparing speed differentials over 10 mph for arterial roads

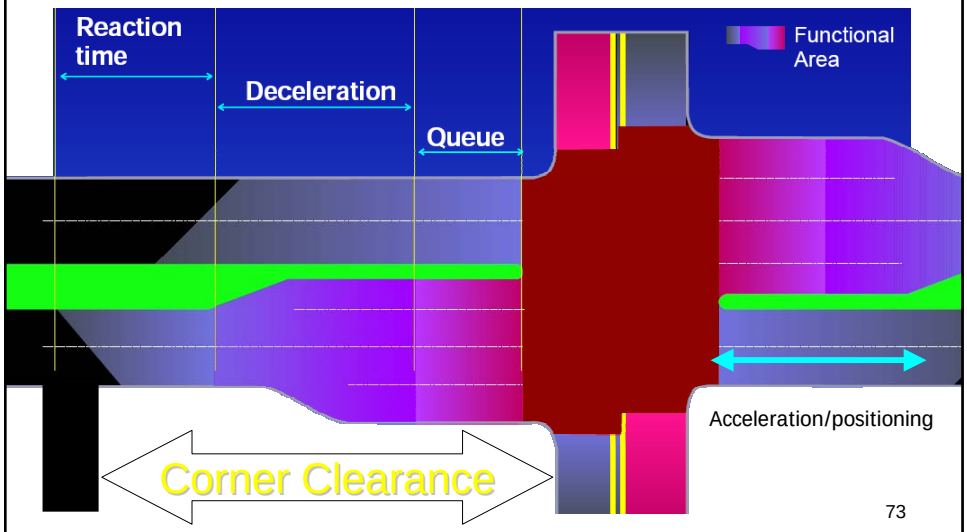


Solomon: 1964
Bureau of Public Roads
Accidents on Main Rural
Highways related to speed

Regulate Minimum Corner Clearance

- Applicable to All Roadways
- Many Standards
- Keep Out of Intersections Functional Area

Functional Area of Intersection



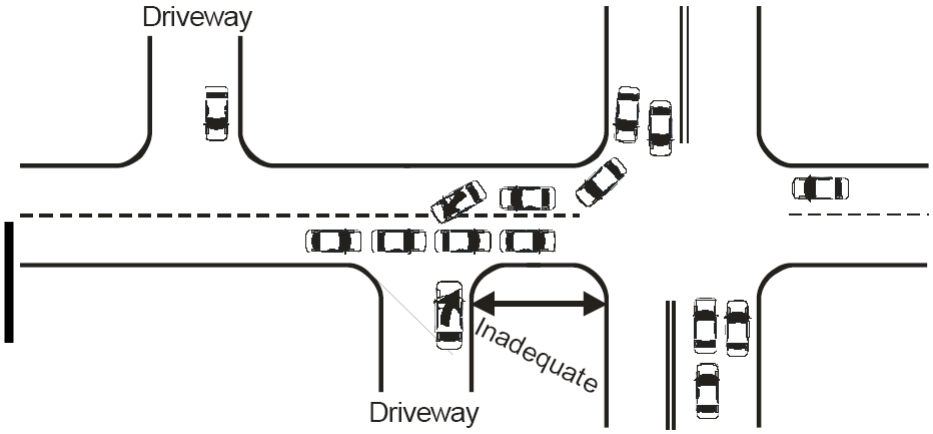
73

Driveway too close to signal

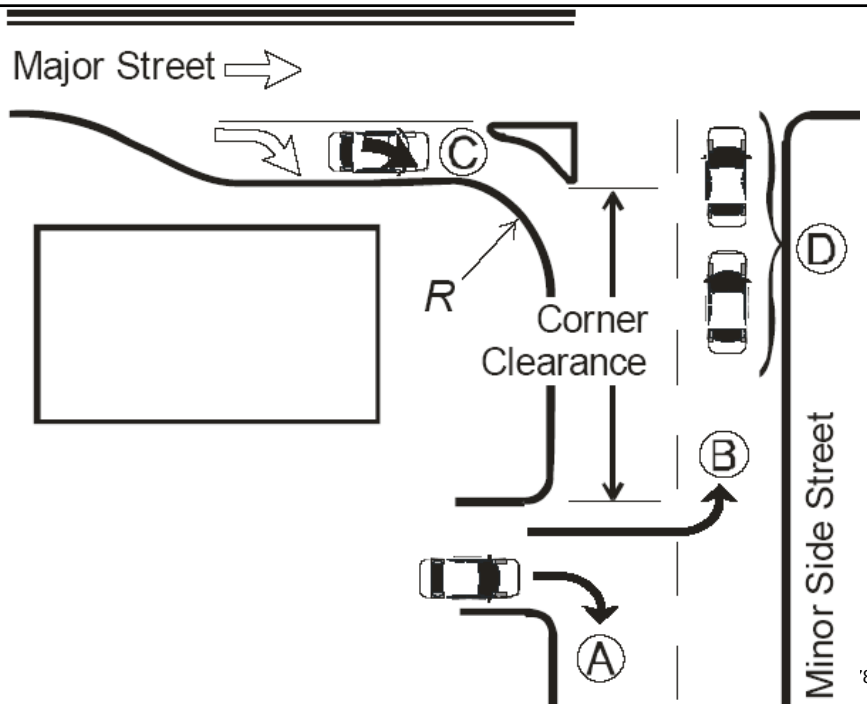
74

Driveway in Right Turn Lane and Radius

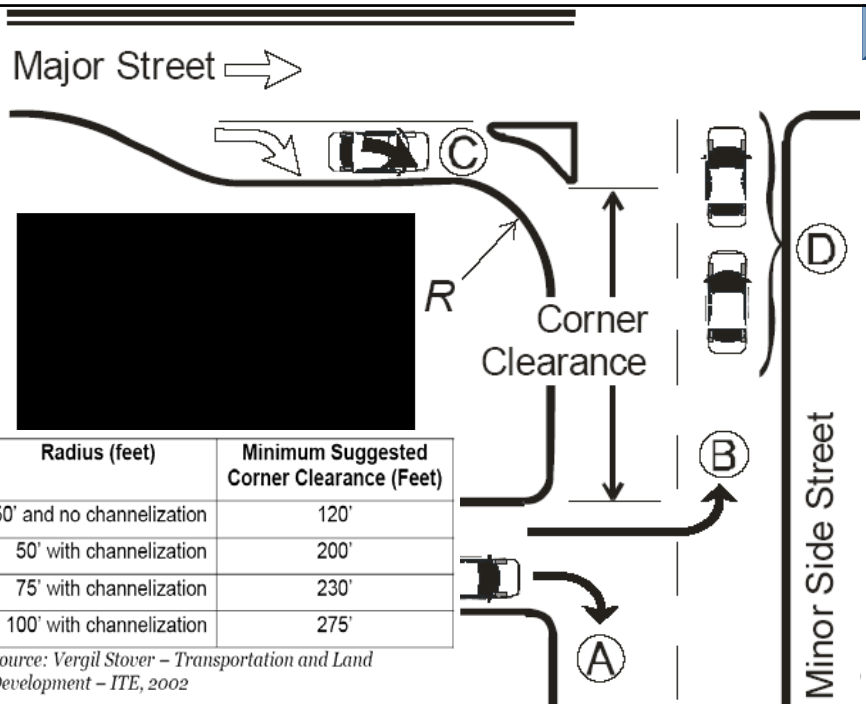
Corner Clearance Main Road



77



78



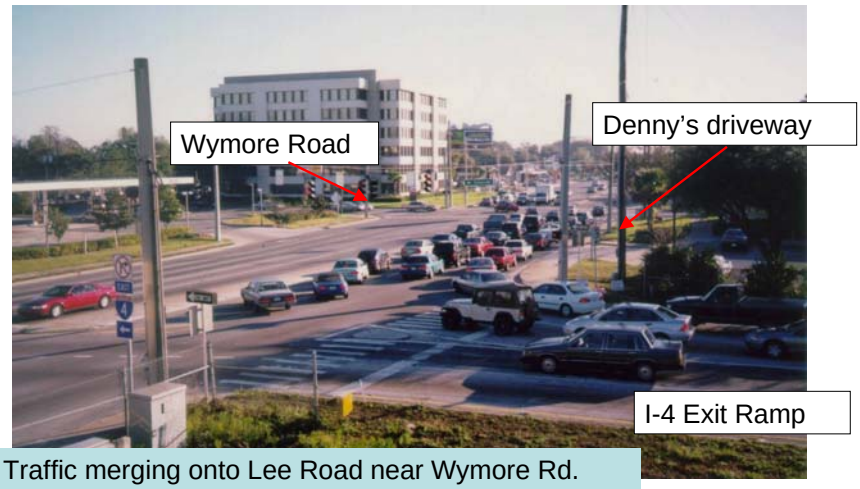
Radius (feet)	Minimum Suggested Corner Clearance (Feet)
50' and no channelization	120'
50' with channelization	200'
75' with channelization	230'
100' with channelization	275'

Source: Vergil Stover – Transportation and Land Development – ITE, 2002

Regulate Minimum Property Clearance

- Minimum clearance should be 25 feet from property line.

ROW issues I-4 & Lee Road

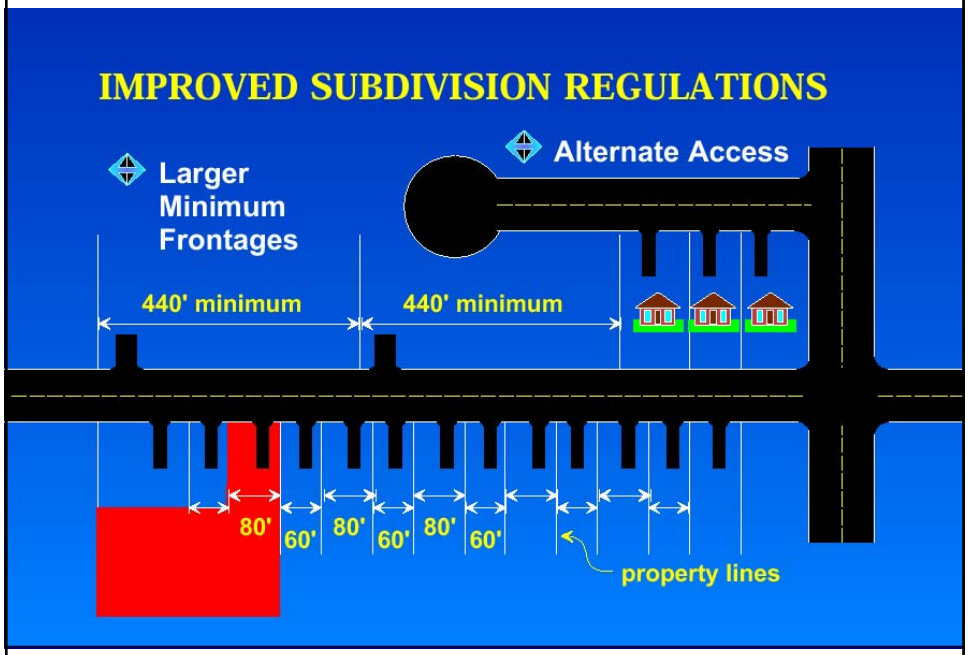


Traffic merging onto Lee Road near Wymore Rd. intersection frequently backs up onto the main line.

Source: CUTR

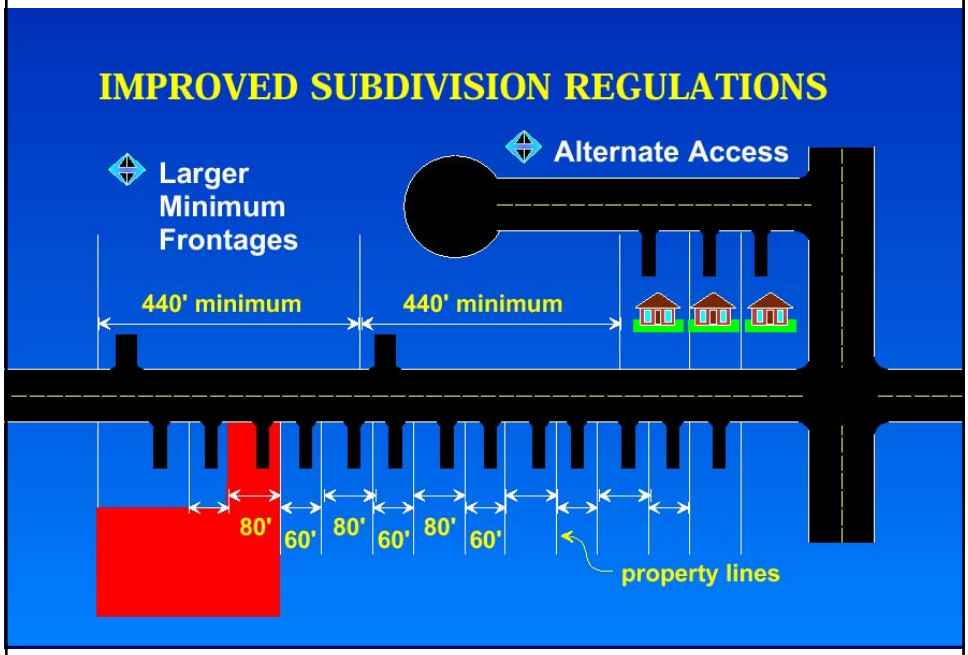
Optimize Driveway Spacing in the Permit Authorizing Stage

- Optimize Spacing of Driveways



Regulate Maximum Number of Driveways Per Property Frontage

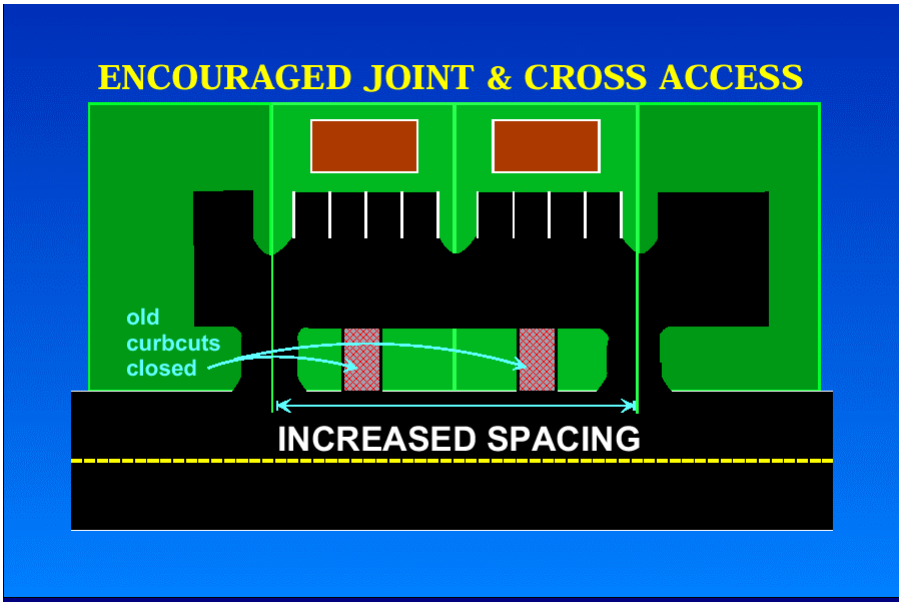
- Ranges From 300 Feet to 1250 Feet For a Second Driveway



Consolidate Access for Adjacent Properties

- Speeds >35 MPH
- Driveways >50 Vehicles Each

86



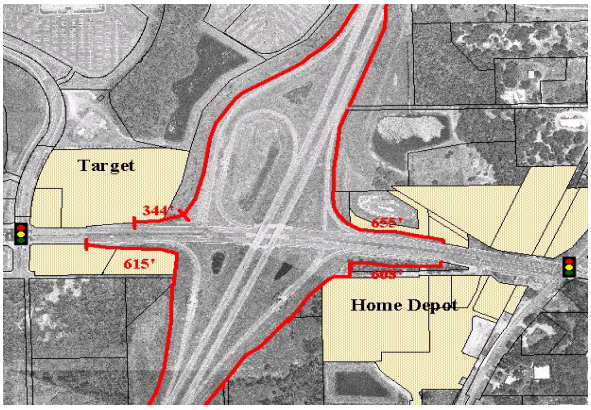
87

Additional Techniques

- Buy Abutting Property
- Deny Access to Small Frontage (Possible Compensation)
- Consolidate Existing Access – Assembled Parcels
- Designate The Number of Driveways to Each Existing Property (May Have Written Policies)

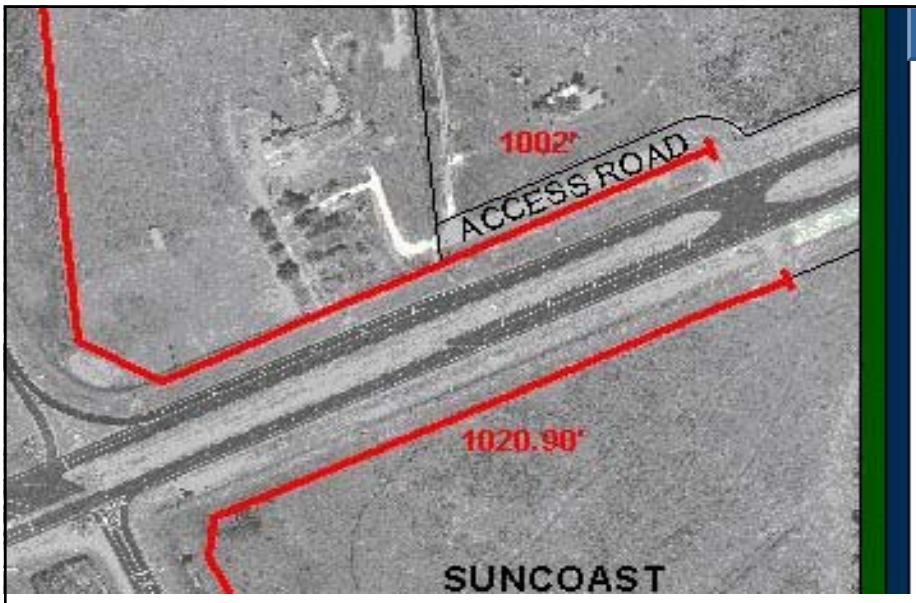
88

Acquire Limited Access Right-of-Way



- Acquire additional limited access ROW along crossroad near interchange

(Standard practice is only 100'-300' feet

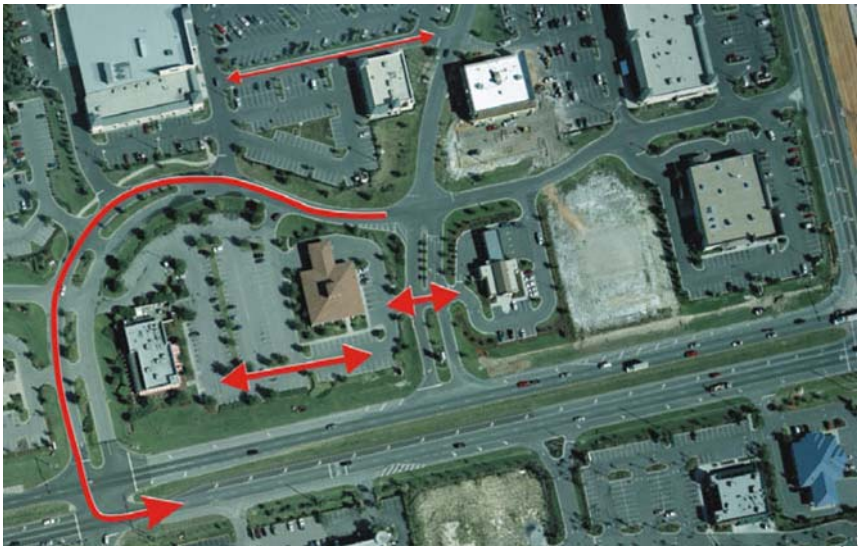


Suncoast & SR 54

Require Access On Collector Streets in Lieu of Arterial

91

Grid Network



Restrict Parking On the Roadway Next to Driveways

- Improves Turning Speed
- Improves Sight Distance

93

Install Visual Cues of the Driveway

- Sufficient to Meet AASHTO Sight Distances

94

Sight Distance

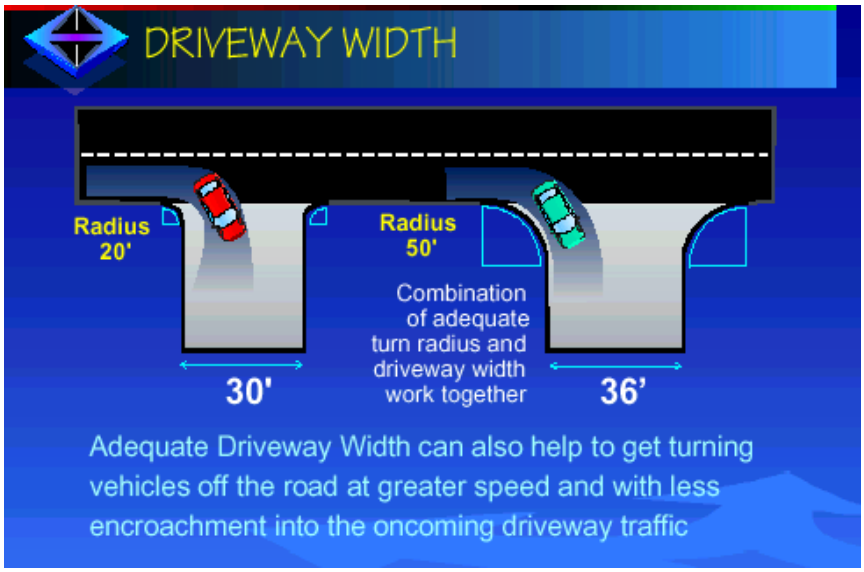
- Improve Driveway Sight Distance
- Regulate Minimum Sight Distance

95

Improve the Effective Approach Width of the Driveway

- Speed is affected by
- Driveway Width
- Return Radius
- Lateral Offset
- Approach Angle
- Approach Flare

96



97

Speeds for Turning Vehicles at Driveways

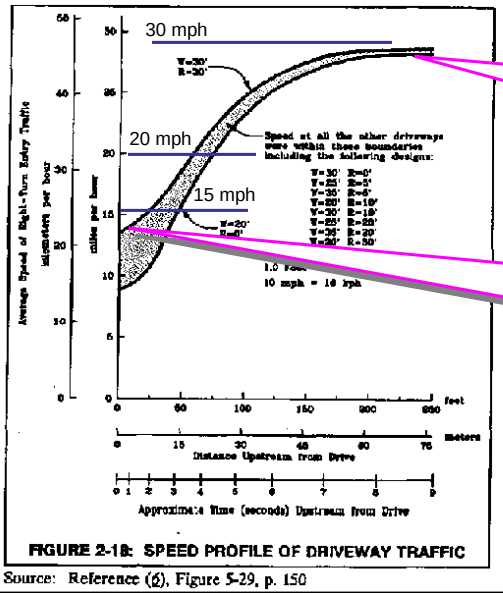


FIGURE 2-18: SPEED PROFILE OF DRIVEWAY TRAFFIC

Source: Reference (6), Figure 5-29, p. 150

200 ft away from the driveway speeds are 30 mph

Even with 30 ft Radii speeds at driveways are less than 15 mph

Source : Vergil Stover 1981 Transport. & Land Development Pg 150

98

Improve the Vertical Geometrics

- Maximum Angle Based on Roadway Classification

99

Driveway Grade

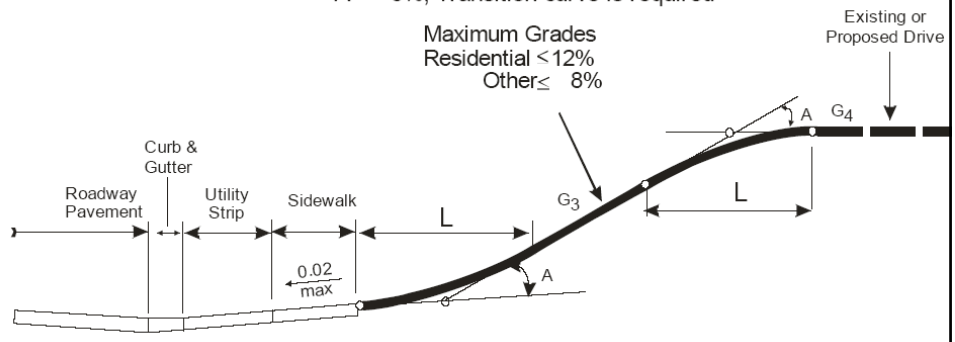
100

Source: GWSSI 2004

1

Grade

A > 6%, Transition curve is required



Utility Strip

G - Grade (%)
A - Algebraic difference in grades (%)
L - Transition

From Index 515 sheet 6

102

Driveway Requirements

- Require Driveway Paving
- Regulate Driveway Construction (Performance Bond)

103

Install Right Turn Acceleration Lane

- ADT >10,000 VPD
- Speed >35 MPH
- Peak Hour Movement >75

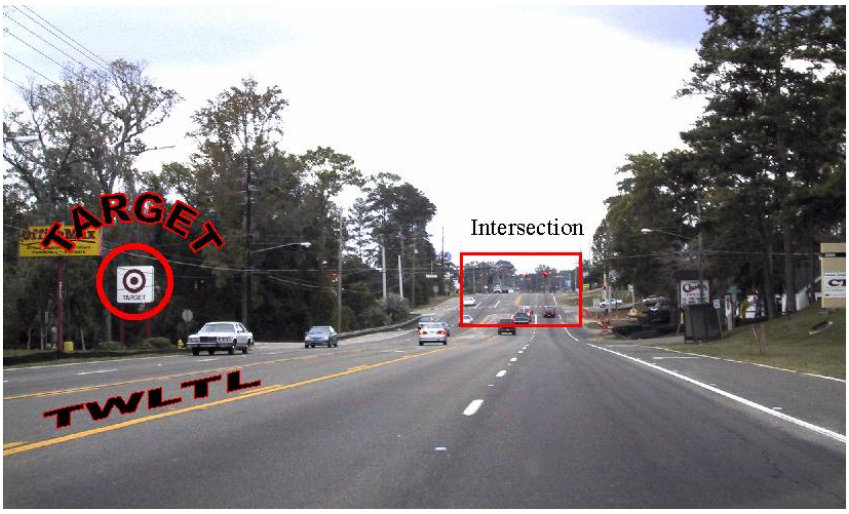
104

Install Continuous Two-Way Left Turn Lane

- May Create Severe Conflicts When High Volume Drives Are Located Downstream On Opposite Sides of Roadway
- Traffic Lane Widths Should Be 12 Feet of Greater

105

Apalachee Parkway
Tallahassee, FL
OLD



106

Apalachee Parkway Tallahassee, FL OLD

107

Source : Debbie Danton

Even Small Islands are More Visible

3

Even Small Islands are More Visible

Install Alternating Left Turn Lanes

- Perception-Reaction Time Should Establish Distances Between Left Turn Lanes

Left Turn Lanes

- Install Isolated Median and Deceleration Lane to Store Left Turn Vehicles
- Install Left Turn Deceleration to Remove Turning Vehicle From Through Lane
- Install Medial Storage For Left Turn Egress Vehicles (Requires 18 foot Median)

111

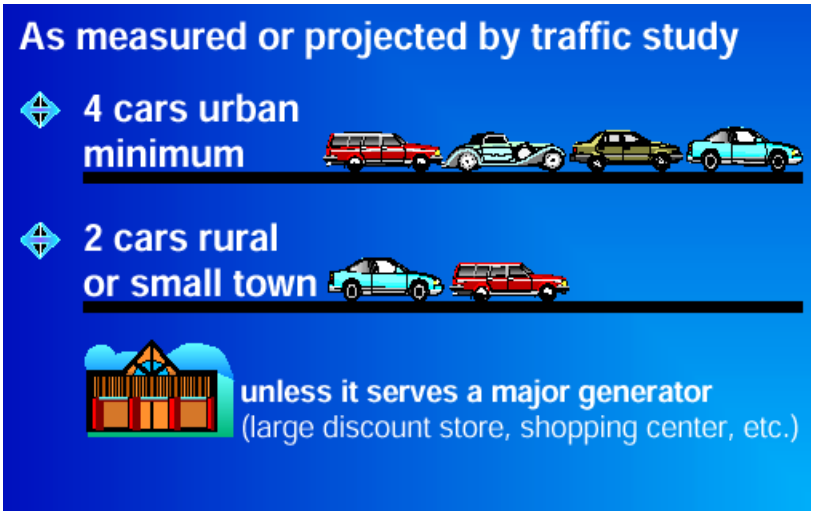
Increase Storage Capacity of Existing Left Turn Deceleration Lane

- Widen to Two Lanes
- Lengthen Existing Storage Area

112

Extensive queuing?

Recommended Queues

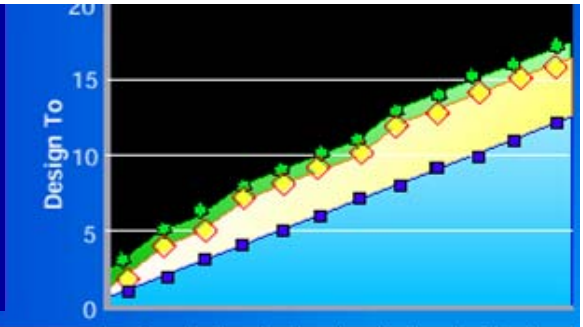


From Median Handbook Chapter 2 Page 14
Picture on Chapter 1 – Page 12

Queue Storage (Poisson Method)

Designing Left Turn Storage for Success

Remember:
You need almost twice the average queue for storage length



Average Demand Per Cycle	1	2	3	4	5	6	7	8	9	10	11	12
30-40% Failure	1	2	3	4	5	6	7	8	9	10	11	12
10% Failure	2	4	5	7	8	9	10	12	13	14	15	16
5% Failure	3	5	6	8	9	10	11	13	14	15	16	17

Source: Use of Poisson Approximation

From Median Handbook Chapter 2 Page 15

Truck Adjustments

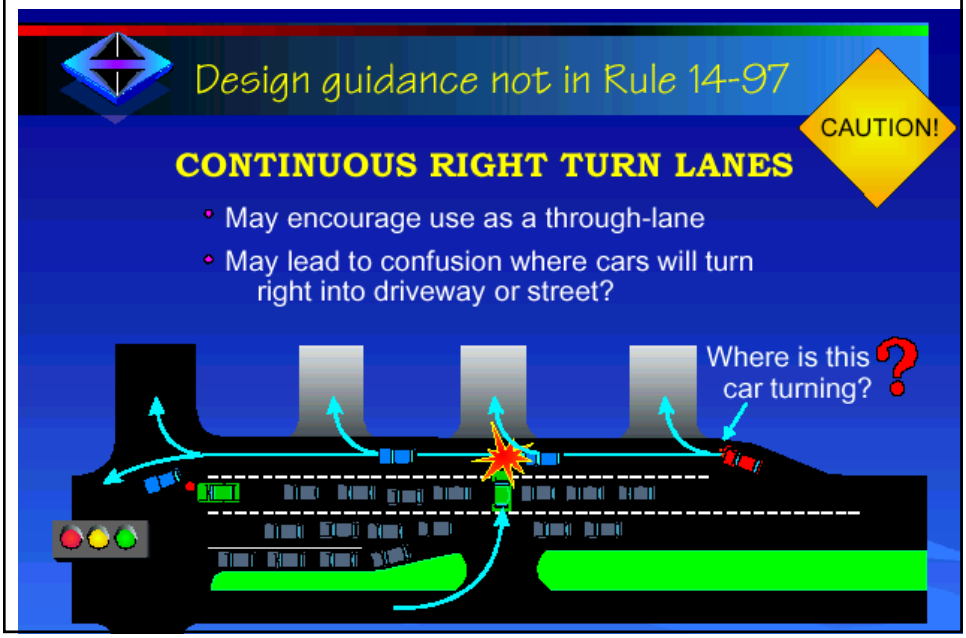
Percent Trucks	Average Storage Length per Vehicle	
<2%	25 ft	7.6m
5%	27ft	7.7m
10%	29ft	9.0m
15%	32ft	10.0m
20%	35ft	10.7m

From Median Handbook Chapter 2 Page 16

Install Continuous Right Turn Lane

- Must Be Careful About the Design

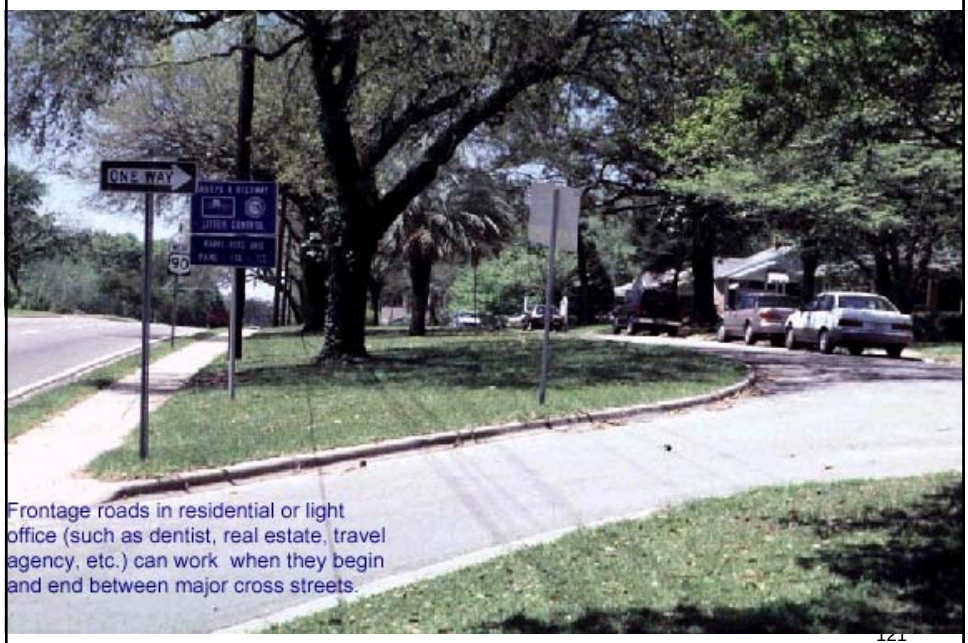
Continuous Right Turn Lanes



Construct a Local Service Road

- Frontage and Service Roads

120



Frontage roads in residential or light office (such as dentist, real estate, travel agency, etc.) can work when they begin and end between major cross streets.

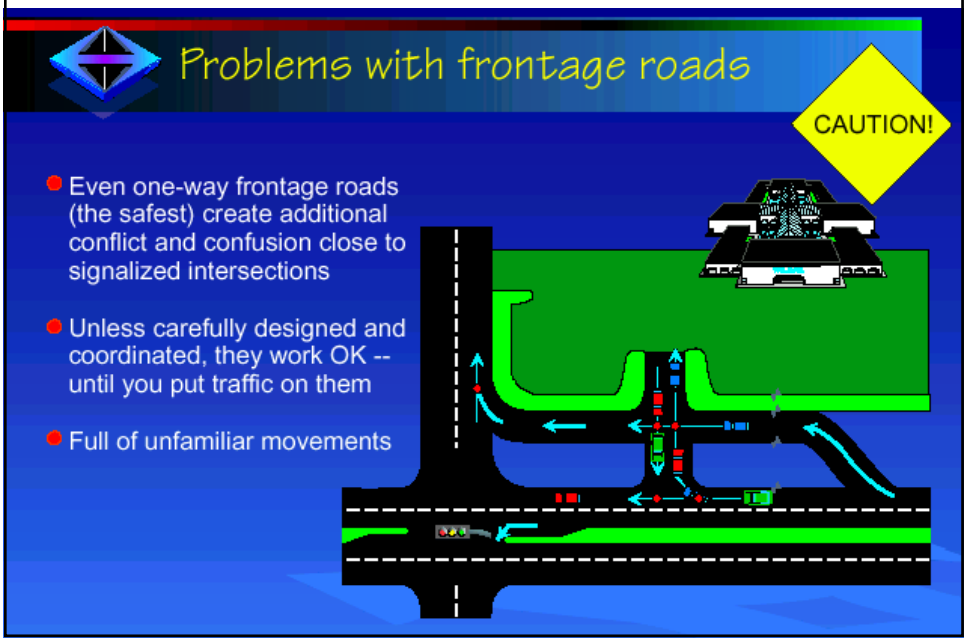
121

Backage Road

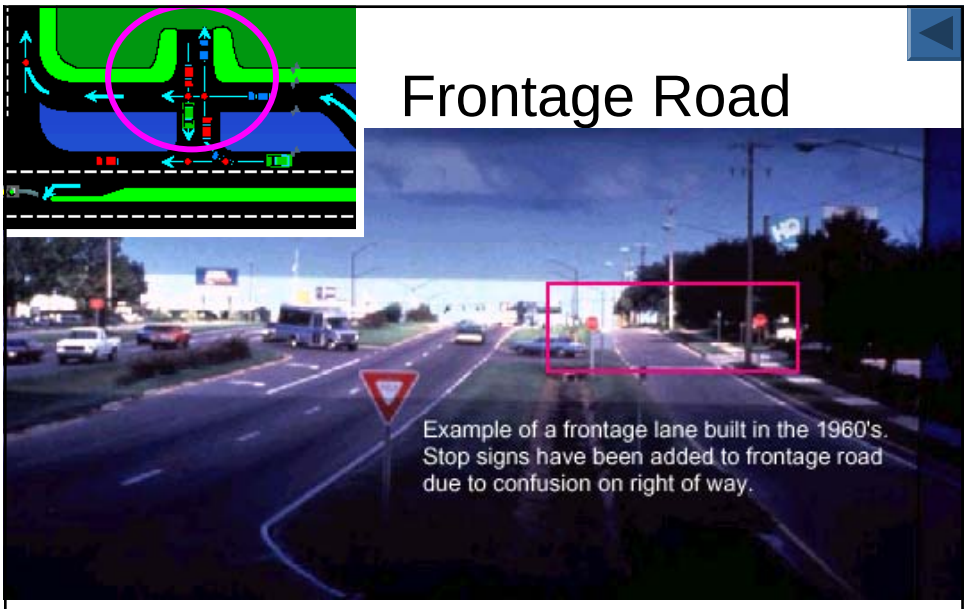
Example of "backage road." Note how the backage road flares out to provide good separation at the side street.

Source: Vergil Stover

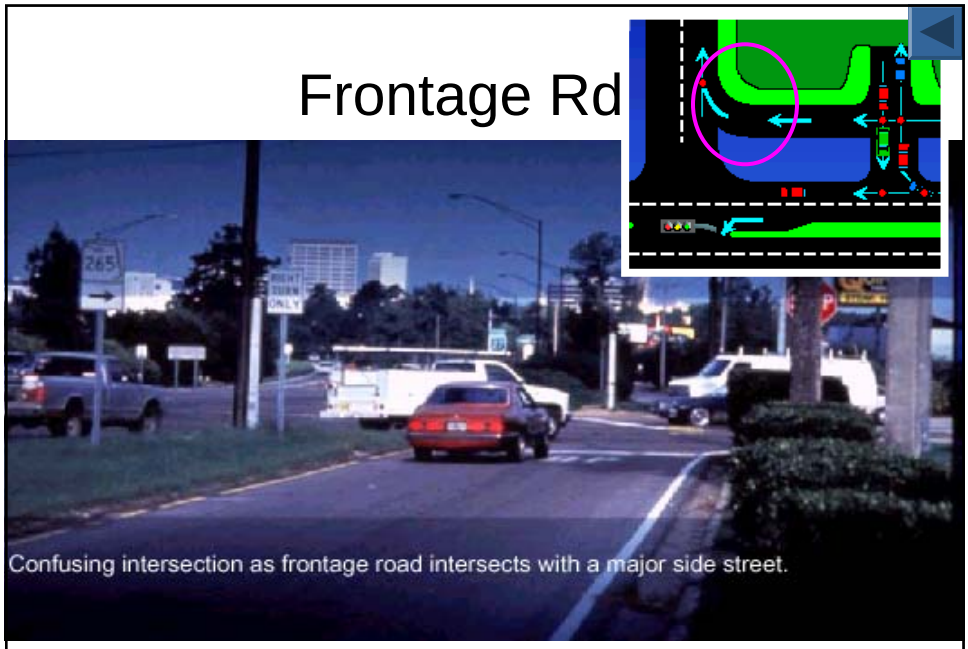
Frontage Roads



Frontage Road



Frontage Rd



Confusing intersection as frontage road intersects with a major side street.

125

126

Other Techniques

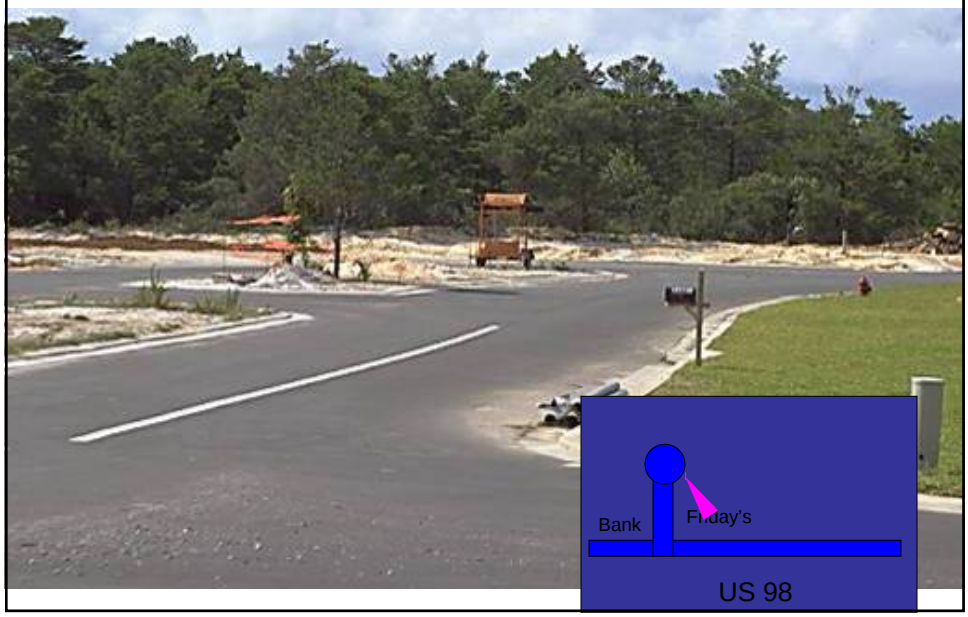
- Construct a Bypass (May Just Move the Problem to a New Area)
- Reroute Through Traffic
- Install Supplementary One-Way Right Turn Driveways to Divided Highway

127

Install Access on Collector Street When Available

128

Public Service Road with Potential



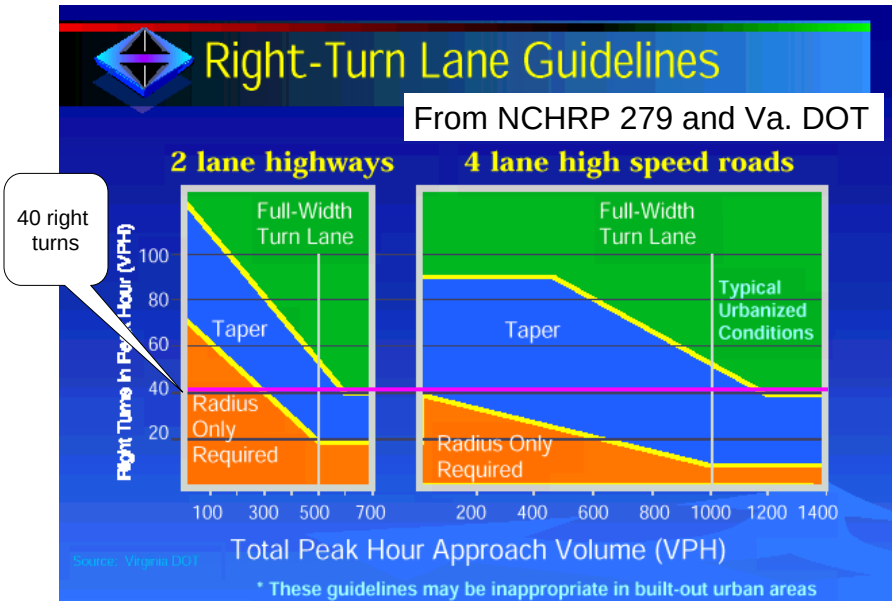
Install Right Turn Deceleration Lane

130

Some Reasons for Right Turn Lanes

- Heavy right turns and heavy through movement
- Large pedestrian presence which might conflict with right turns
- Where a drive-in facility does not have sufficient on-site circulation
  - Gated entrance
- Severe skew causes slow rights

131



132

133

Burger King's Right Turn Lane

Suggestion Volume Criteria for Exclusive Right Turn Lanes

- All highways over 45 mph posted speed limit
  - 30 - 40 rights/hour
    - 30 most "called for" on high volume* 2 lane roads
    - 40 most "called for" on multi-lane highways
    - ***Speed limit of 45 mph may use this criteria if operating speeds at the time of the peak right turn flow are over 45 mph***
- All highways 45 mph posted speed or less
  - 80 - 110 rights/hour
    - 80 more "called for" on high volume and 2 lane roads
    - 110 more "called for" on lower volume roads and multilane
  - Right turn lanes may be unnecessary for 6 lane facilities where the curb lane acts like a right turn lane

*** High Volume = 700/vehicles /hour/lane in one direction**

135

Other Conditions

- The criteria should be different for the numbers of lanes the road has
  - Lower threshold for 2 lane (Limited ability to go around slow right turn vehicle)
  - Higher threshold for 6 lane facility

136

Latest Access Management Research

- NCHRP # 420 - Impacts of Access Management Techniques

% of Through vehicles affected	Right Turns per Hour
0	0
2	10
5	30
10	60
15	85
20	110

Suggested high speed

Suggested lower speed

137

Some Trip Thresholds

- **Convenience Market w/Gas**
  - 40 Rights = 2.7K sq.ft. (many are 2K)
  - 80 Rights = 5.5K sq.ft.
  - 110 - Most are not large enough
- **Fast Food (with drive through)**
    - most are between 2.5 and 3.5K sq.ft.
  - 40 Rights = 2.2K sq.ft.
  - 80 Rights = 4.4 sq.ft.
  - 110 Rights = 6.1K sq.ft.

- Scenario = 60% of peak inbound
- Right turns will be less concentrated if it's a corner property

138

What's This Mean?

- In urbanized settings most smaller uses will not justify an exclusive right turn lane except for:
  - Shopping centers (over 50,000 sq.ft.)
  - Large office centers (over 80,000 sq.ft)
  - Very large fast food restaurants (over 5,000 sq.ft)
  - Or, small lot developments which have a potential to cause "back-out" on the highway
  - Uses with heavy peak movement in - such as
    - Stadiums - Theaters
    - Schools

139

Uses That May Require Lanes Even With Low Trip Generation

- Trucking facilities
- Bus depots
- Recreational facilities attracting boats and trailers
- Gated entrance
- Skewed angle driveway
- large pedestrian volumes crossing drives
- *Turn lanes may be required before major construction begins to make the construction traffic safer.*

140

Parts of the Right Turn Lane

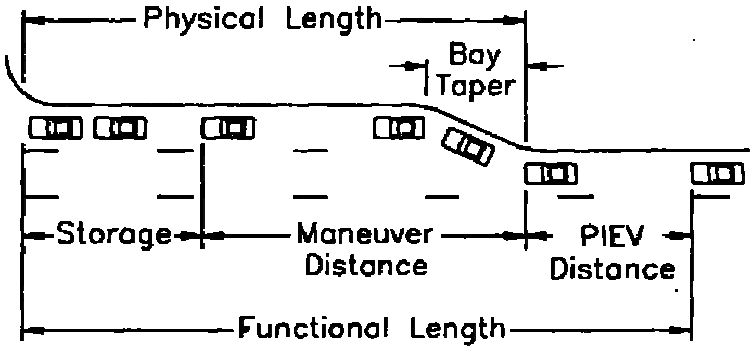


FIGURE 2-13: ELEMENTS OF THE FUNCTIONAL AREA OF AN INTERSECTION

141

Short Right Turn Lane

Install Additional Exit Lane on Driveway

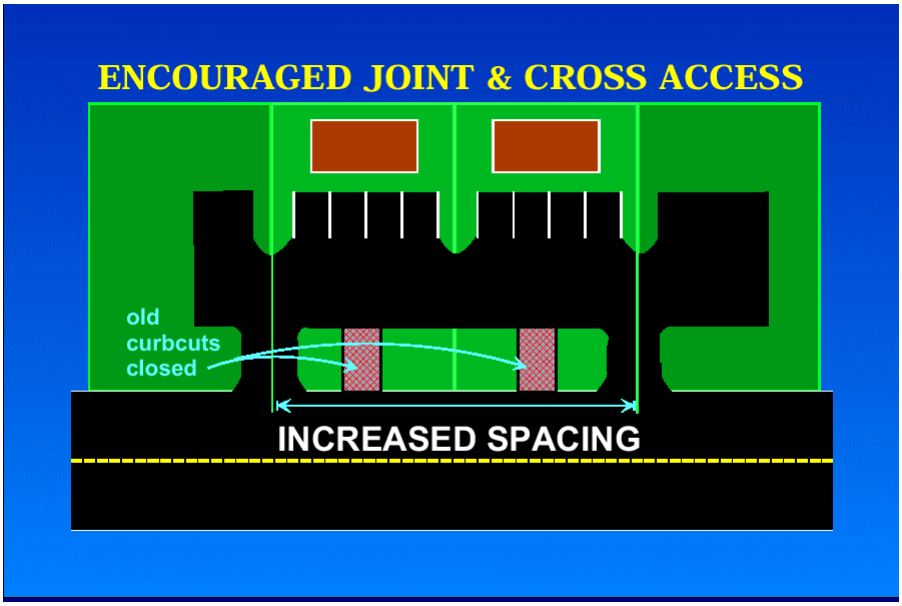
143

Pavement Markings Are Important

Clear pavement markings.

Encourage Connection Between Adjacent Properties

145



146

Require Adequate Internal Design and Circulation Plan

- Rectangular-shaped parking areas are the most efficient
- Traffic aisles should be aligned parallel to the long dimension of the parking areas
- Traffic aisles should be double loaded

147

Excessive Queues at Drive-Through

148

Bad internal design **hurts** traffic flow

Lunch hour queue. Yo quiero Taco Bell.

Drive-Thru Facility Queue Distances

Use	Observed Queue	Lane Length Required
Fast-Food (hamburger)	9	60m (198ft)*
Bank	7	47m (154ft)
Car Wash (self-service)	2	13m (44ft)
Day Care	9	60m (198ft)
Dry Cleaner	2	13m (44ft)

Source: Queuing Areas For Drive-Thru Facilities, ITE Journal, May 1995.

*Queue length per vehicle is 6.5m (22ft), which is less than the average 7.5m (25ft) used for queues on the road system.

HOW CAN WE INSTITUTE ACCESS MANAGEMENT?

DEVELOP APPROVAL PROCESS IN COOPERATION WITH LOCAL GOVERNMENTS

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

Interchange Requirements

152

INTERCHANGE SPACINGS

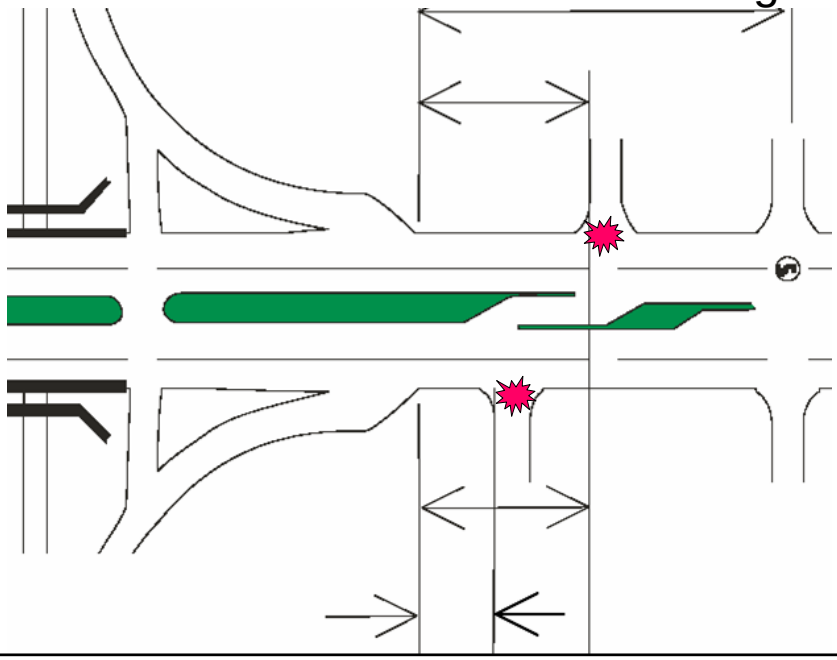
Access Class	Area Type	Segment Location	Interchange Spacing Standard
1	Area Type 1	CBD & CBD Fringe for cities in Urbanized Areas	1 MILE
	Area Type 2	Existing Urbanized Areas other than Area Type 1	2 MILES
	Area Type 3	Transitioning Urbanized Areas and Urban Areas Other than Area Type 1 or 2	3 MILES
	Area Type 4	Rural Areas	6 MILES

153

Functions of Interchange Areas

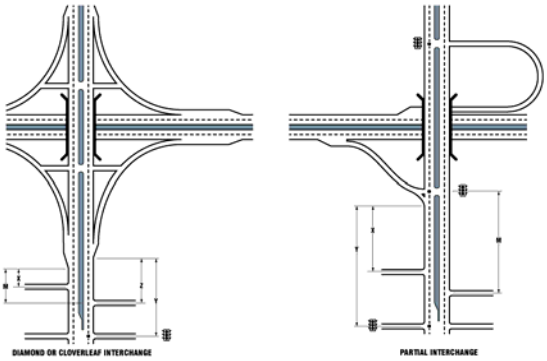
- Interface between freeways and surface streets
- Traveler service areas
- Truck stops and service areas
- Gateways to communities, tourist or recreational destinations, and employment centers
- Engines for real estate development and commerce
  - Source: Kristine Williams CUTR

Protect Areas Around Interchanges



155

Recommended Spacing at Interchange Crossroads



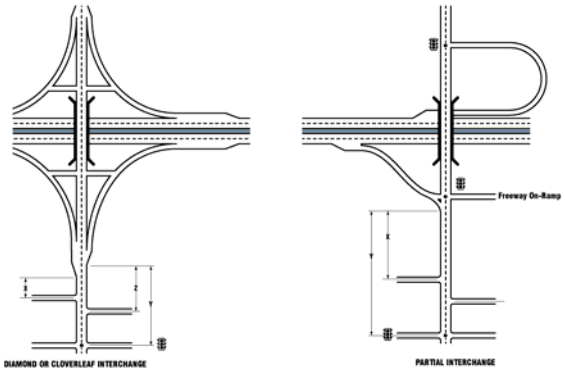
156

Recommended Spacing Dimension

TYPE OF AREA	X	Y	Z	M
Fully Developed Area	**750’**	**2640’**	**990’**	**990’**
Suburban/Urban	**990’**	**2640’**	**1320’**	**1320’**
Rural	**1320’**	**2640’**	**1320’**	**1320’**

X = distance from taper to first approach on the right; right in / right out only.
Y = distance to first major intersection.
Z = distance between the last access connection and the start of the taper for the on-ramp.
M = distance to first possible directional median opening

Recommended Spacing at Interchange Crossroads – Two Lane



Recommended Spacing

TYPE OF AREA	X OR Z	Y
Fully Developed Area	750’	1320’
Suburban/Urban	990’	1320’
Rural	1320’	1320’

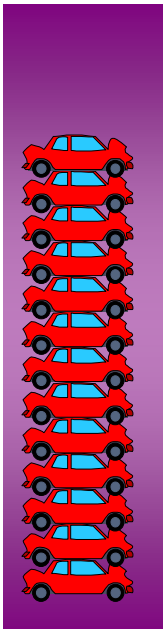
X or Z = distance to first access connection
Y = distance to first major intersection.

159

Retrofit Programs

- Limited Opportunities
- Signal Spacing
- Joint Usage
- Traffic Rerouting
- Median Treatment
- Frontage Road

160



Access Management & Safety

161

National Highway Traffic Safety Administration Study 2004

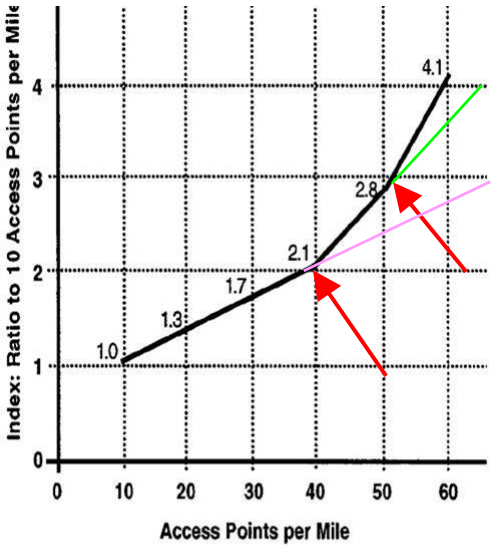
- Roadway Improvements that reduce fatalities
  - Construct Median **73%**
  - Realignment **66%**
  - Groove/Skid treatment **33%**
  - Improve Shoulder **22%**

162

More Access = More Crashes

As the number of access points per mile increase, so does the frequency of total highway collisions.

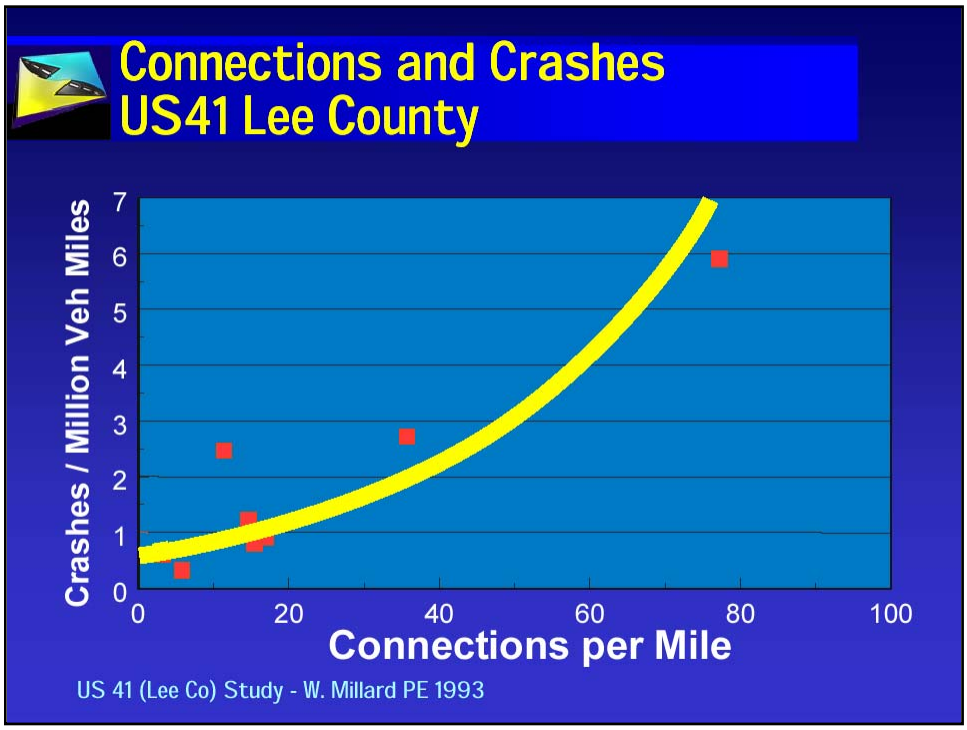
And the rate also increases



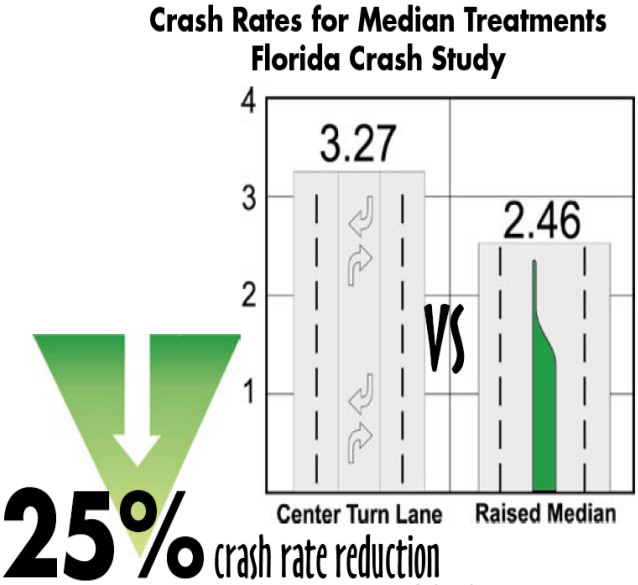
Source: Estimated from Various Sources

Figure 15. Composite accident rate indices.

Source: NCHRP 420, 2000

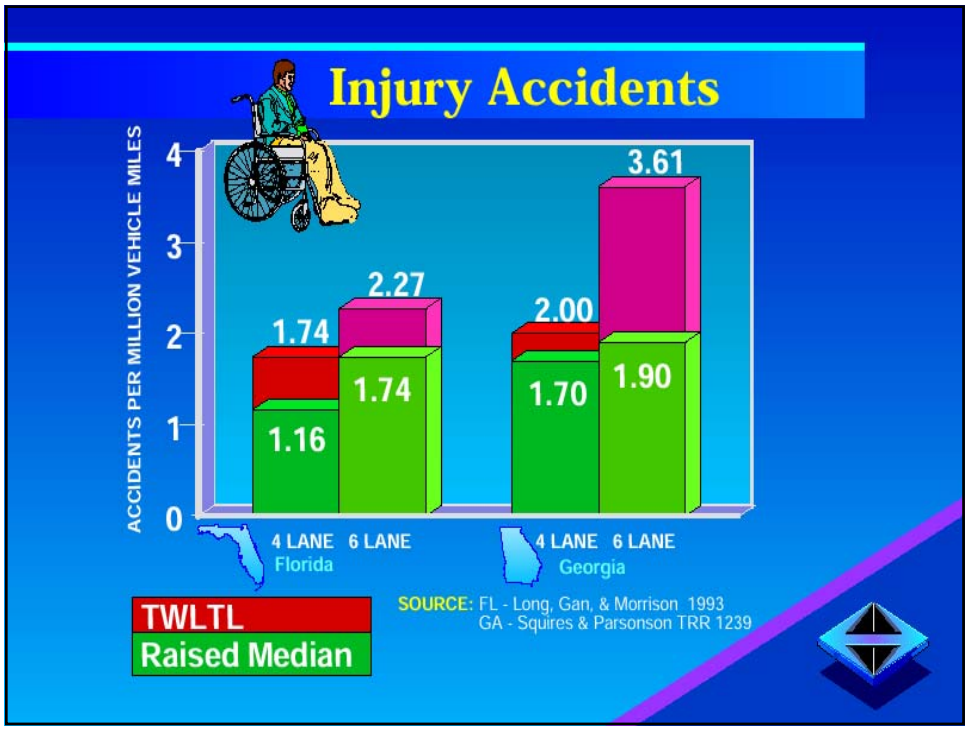


Medians Improve Safety

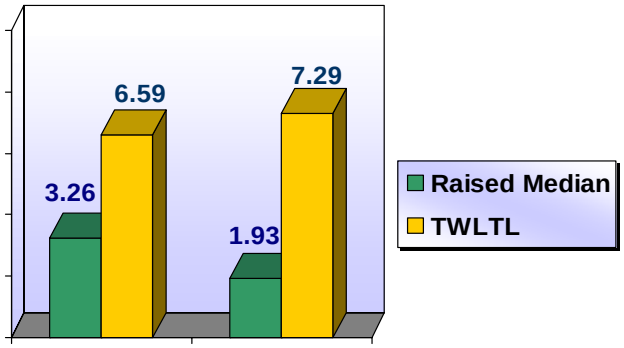


Long, Gan, Morrison, University of Florida 1993

165



Apalachee Parkway Study/Tallahassee, FL



SOURCE: Long, Gan, & Morrison, 1993

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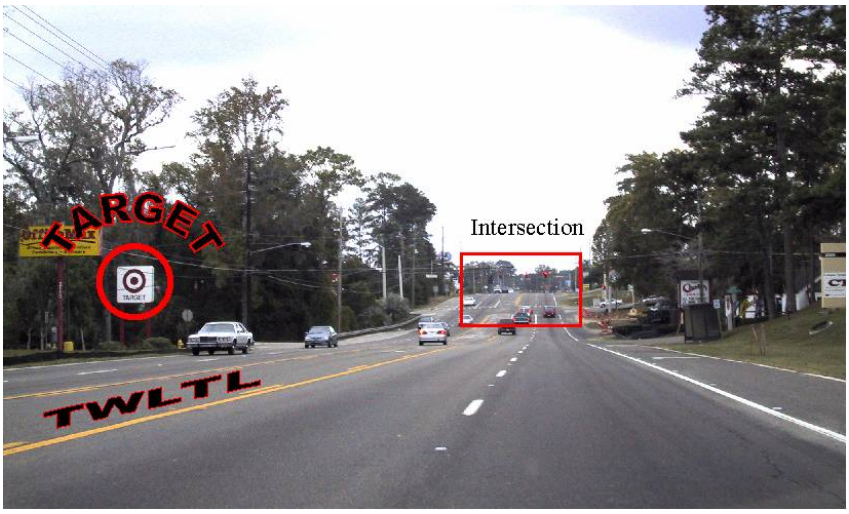
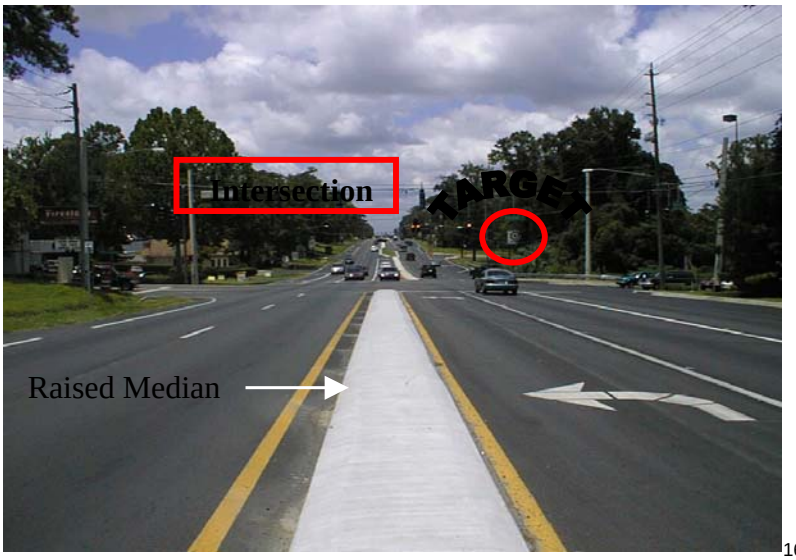
Apalachee Parkway
Tallahassee, FL
OLD



168

Apalachee Parkway
Tallahassee, FL
NEW



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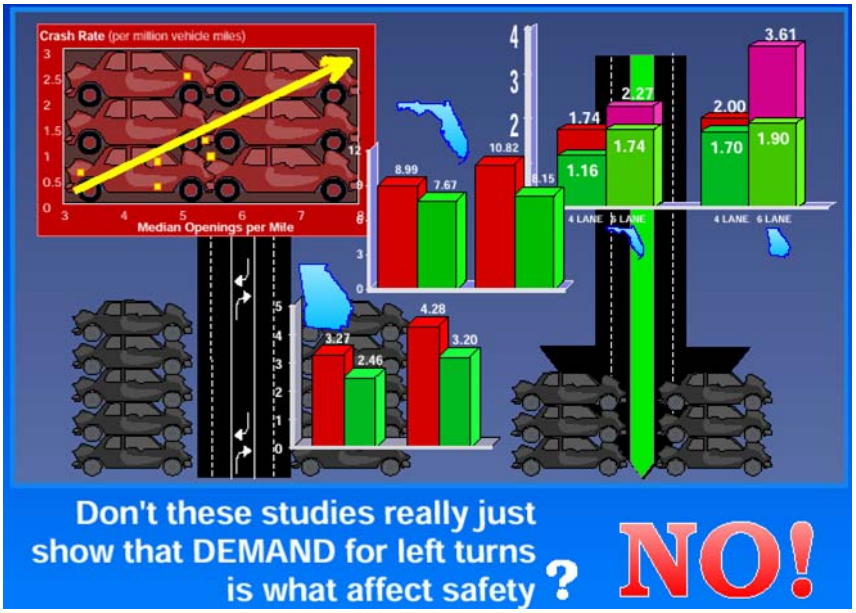


170

Atlanta's Memorial Drive

Atlanta's Memorial Drive

Data

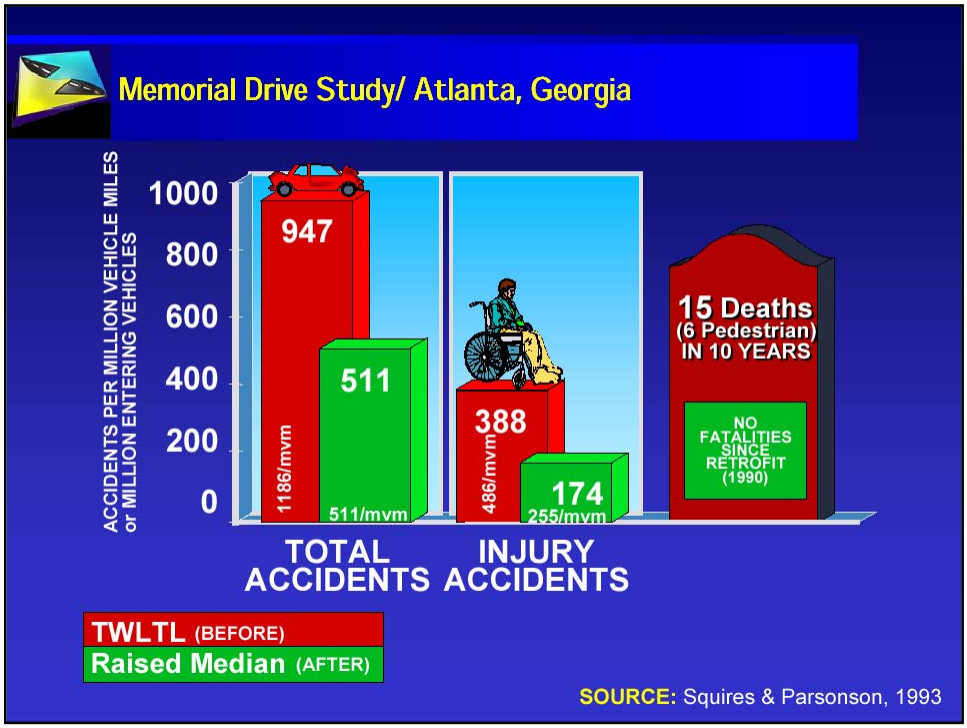
- 4.3 Miles
- 6 Lanes
- 40,000 to 48,000 Vehicles per Day
- Speed Limit 45 MPH

Before

- Two way left turn Lane

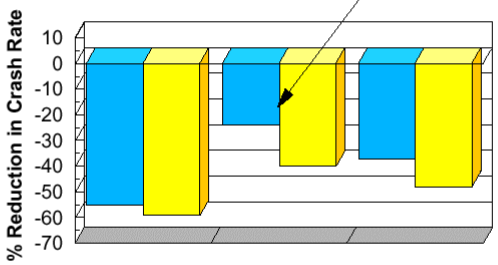
After

- Raised Median (14 ft width)
- 14 Median Openings Provided
- 7 public streets were not given median openings
- U turns allowed at all openings but one



Crash Rate Reductions Memorial Drive

Shows how driver information "load" can improve situation with even more traffic



	Midblock	Intersectio	All
Total Crash Ra	(55)	(24)	(37)
Injury Rate	(59)	(40)	(48)

174

Memorial Drive Crash Expectations

Mid-Block Crashes

Intersection Crashes

But less severe intersection crashes

175

Memorial Drive Crash Findings

Mid-Block Crashes

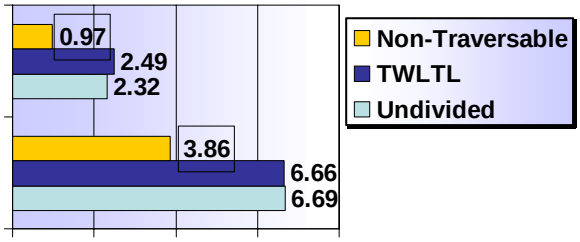
- 55%

Intersection Crashes

- 24%

Access & Pedestrian Safety

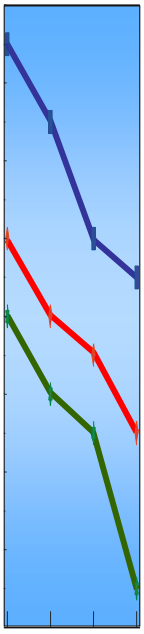
Atlanta, Phoenix, Los Angeles



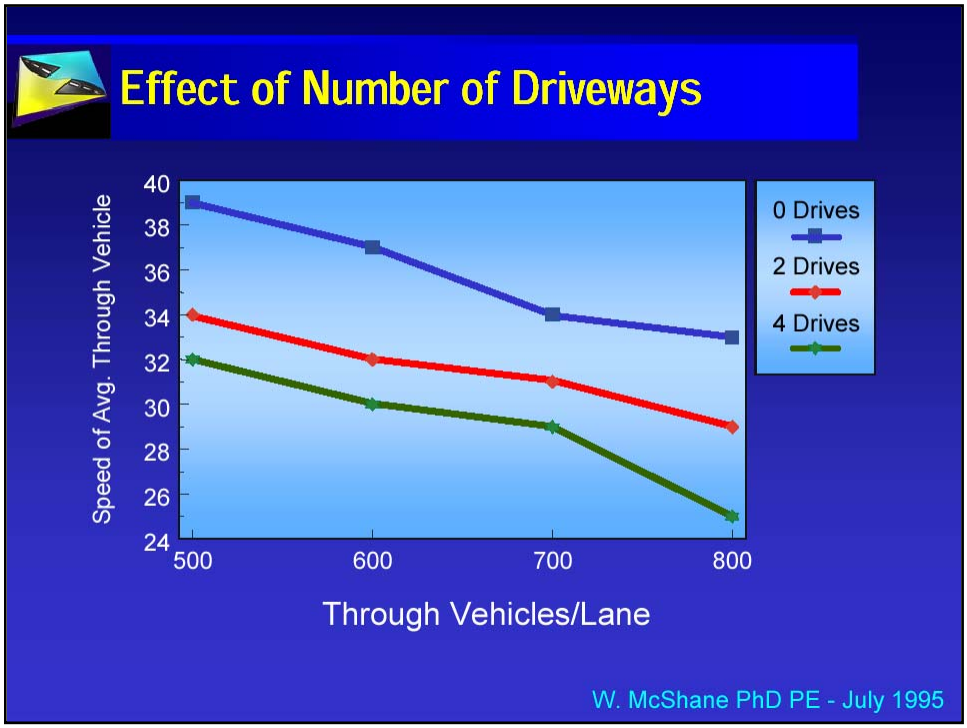
(1) Crashes per 100 million entering vehicles

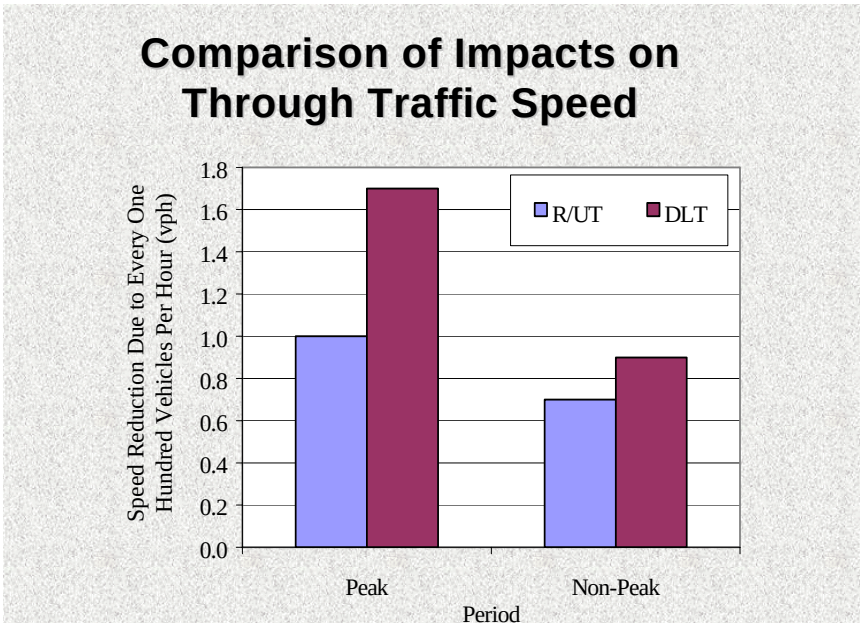
(2) Crashes per 100 million vehicle miles

SOURCE Bowman and Vecellio, 1994.

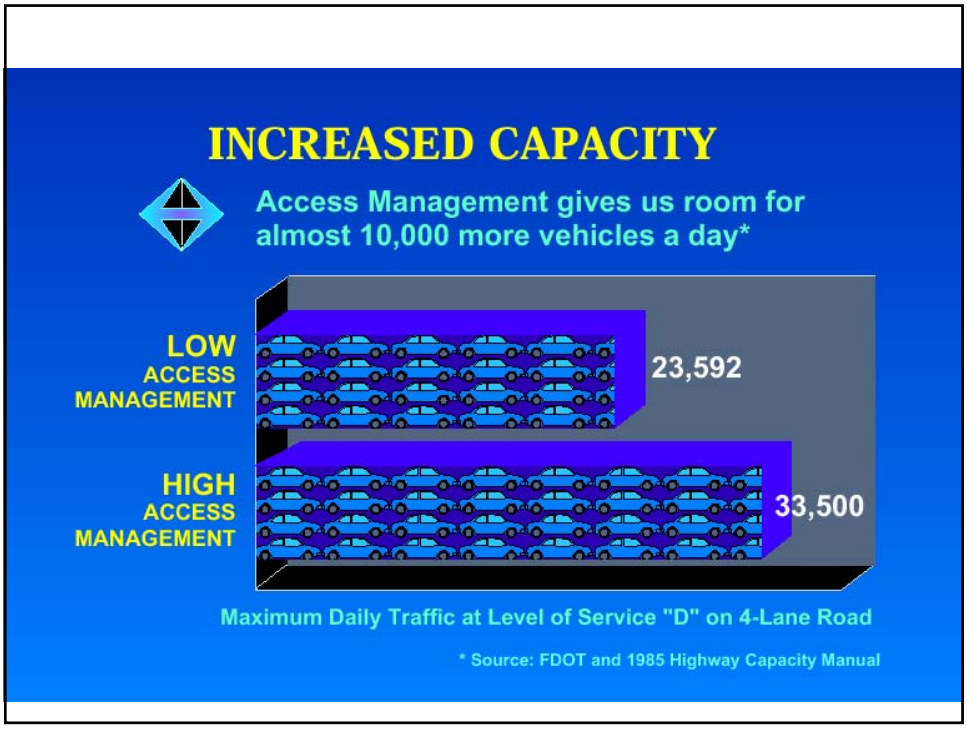


Efficiency





University of South Florida - 2001


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

Aesthetics

With Access Management
•Safety
•Aesthetics
•Efficiency
•Pedestrian/Transit friendly
US 192 – Kissimmee
Source: Glatting Jacks

STANDARD OIL COMPANY
ATLAS TIRES
solube
The old concept of good access

Evaluation of Alternatives

- Accident Reduction
- Construction Cost
- Maintenance Cost
- Capacity
- Traffic Delays
- Impact of Adjacent Properties

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- Highway Volumes
- Commercial Driveway Volumes

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Class Workshop

- Analysis Period: 4:30 – 5:30 PM
- Section Length: 0.4 Miles
- Pavement Width: 55 Feet
- Right-of-Way: 70 Feet
- Posted Speed: 35 MPH
- Bike Crossings: 50 Per Hour
- Crash Rate = 2300 per HMVM
- Scale 1 in. = 50 ft.

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Problem Checklist

- Consolidate, relocate and design driveways. Look at
- Driveway Spacing
- Corner Clearance
- Driveway Design
- Turn Prohibitions

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Problem Checklist

- Consider:
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- Signal Warrants
- Signal Spacing

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Workshop Problem

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- Estimate Collision Reduction
- Propose Bicycle Treatment
- Layout Driveway Improvements Including Closures, One-way Entrances
- Determine If ROW Should Be Purchased

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Section 1 - Introduction

PURPOSE: To establish guidance for access location determination and procedures for coordinated development between state highways and the abutting properties which they serve. The manual will provide clarification of the administrative procedures and standards as contained in Rule No. 941-7501-04002 Right of Way Encroachment Permits; Rule No. 941-7501-04013 Driveway and Street Connections, Median Openings, Frontage Roads; and Rule No. 941-7501-03001 Processing of Permit Applications.

GENERAL: Access management procedures and techniques assist the state in the following:

- Improving the overall safety of the transportation system.
- Reducing congestion on designated arterial.
- Reducing crashes.
- Improving traffic flow.
- Preserving existing system capacity.
- Improving pedestrian safety.
- Improving roadway aesthetics and property values.
- Preserving the value of adjacent business properties

The proliferation of driveways adds to the number of conflict points along a roadway and increased conflicts lead to increased crash rates and poor roadway operations. An access management program should result in a reduced number of conflict points and a reduction in the speed differentials between through and turning vehicles.

Access management techniques are relatively straightforward and based on established traffic engineering and roadway design principles. They involve: (1) limiting the number of conflict points; (2) separating conflict points; (3) reducing acceleration and deceleration impacts at access points; (4) removing turning vehicles from through travel lanes; (5) spacing of major intersections to facilitate progressive travel speeds along arteries; and (6) providing adequate site storage.

A summary of some of the typical effects of access management techniques are shown in Table 1 below:

Table 1
Summary of Research on the Effects of Access Management Techniques [1][2]

Treatment	Effects
1. Add a continuous two-way left turn lane (TWLTL)	A. 35% reduction in total crashes B. 30% decrease in delay C. 30% increase in capacity
2. Add nontraversable median	A. >55% reduction in total accidents B. >30% decrease in delay C. >30% increase in capacity
3. Replace TWLTL with a nontraversable median	A. 15%-57% reduction in crashes on 4-lane roads B. 25%-50% reduction in crashes on 6-lane roads
4. Add a left-turn bay	A. 25-50% reduction in crashes for a 4-lane road B. up to 75% reduction in total crashes at unsignalized intersections C. 25% increase in capacity
5. Type of left-turn improvement:	
(a) painted	A 32% reduction in total crashes
(b) separator or raised divider	B. 67% reduction in total crashes
6. Add a right-turn bay	A. 20% reduction in total crashes B. Limit interference with platooned traffic, increased capacity
7. Increase driveway speed from 5 mph	A. 50% reduction in delay per maneuver; less exposure time to following vehicles
8. Visual cues (e.g. signs) at driveways and driveway illumination	A. 42% reduction in crashes
9. Prohibition of on-street parking	A. 30% increase in traffic flow B. 20-40% reduction in crashes
10. Long signal spacing (1/2 mile) with limited access	A. 42% reduction in travel time B. 59% reduction in delay C. 57,800 gallons fuel saved per mile per year

It is important to remember that access management is the process of balancing the competing needs of traffic movement and land access. The primary purpose of access management programs is providing access for land development and to provide the access as part of a well managed system. An access management program includes the following:

1. A roadway classification system based upon functional criteria.
2. Defining allowable levels of access for each roadway classification, including criteria for signal spacing.
3. Geometric design criteria and traffic engineering analysis.
4. Adopting appropriate regulations and administrative procedures.

DEFINITIONS

For purposes of this guideline, the following definitions will apply. If not defined in the guidelines, words, terms, and phrases will have their commonly accepted meaning.

- *Access* – A public or private roadway used to enter or leave a public highway from adjacent land using an on-road motor vehicle. An access may be a driveway or a street.

- *Access Point* – The intersection of an existing or proposed access with the public right of way.

- *AADT* – Average annual daily traffic volume – The total two-way yearly traffic volume on a section of roadway, divided by 365; often referred to as the average daily traffic (ADT).

- *Applicant* – The person applying for a driveway permit.

- *Commission* – The Mississippi Transportation Commission.

- *Corner Clearance* – The minimum distance, measured parallel to a highway, between the nearest curb, pavement or shoulder line of an intersecting public way and the nearest edge of a driveway excluding its radii.

- *Department* – The Mississippi Department of Transportation.

- *Directional Median Opening* – An opening in a restrictive median which provides for U-turns and or left-turn ingress or egress movements.

- *Full Median Opening* – An opening in a restrictive median that allows all turning and through movements to be made.

- *Fully Developed (Type of Area)* – The land use adjacent to the roadway is less than 10% vacant.

- *ITE* – Institute of Transportation Engineers.

- *Joint Driveway* – A single access point connecting two or more contiguous sites to a public roadway that serves more than one property or development, including those in different ownership or in which access rights are provided in legal descriptions.

- *Major Intersection* – An intersection with high volumes exceeding the MUTCD warrants for signalization.

- *MDOT* – The Mississippi Department of Transportation.

- *Median* – The portion of a divided highway separating the traveled ways for traffic in opposing directions.

- *Median Opening Spacing* – The spacing between openings in a restrictive median that allow for crossing the opposing traffic to access property or U-turns. The distance is measured from centerline to centerline of the openings.

- *MPO* – Metropolitan Planning Organization.

- *MUTCD* – Manual on Uniform Traffic Control Devices.

- *Transitioning Urbanized Areas* – The area between the existing urbanized area boundary and the future projected urbanized boundaries anticipated within the next 20 years as established by the MPO and the MDOT.

- *Posted Speed* – The speed limit set and maintained by MDOT.

- *Rural (Type of Area)* – The land use adjacent to the roadway is more than 70% vacant.

- *SOP* – Standard Operating Procedures.

- *Suburban/Urban (Type of Area)* – The land use adjacent to the roadway is between 10% and 70% vacant.

- *Urban Area* – A U.S. Bureau of Census designated town with a population equal to or greater than 2,500.

- *Urbanized Area* – A U.S. Bureau of Census designated city and surrounding area with a population greater than 50,000.

Section 2 – Roadway Classifications

Under this section of the manual, the roadway classification system for the Mississippi Department of Transportation's roadway system will be defined. The roadway classification system is consistent with the definitions as contained in Rule No. 941-7501-04002 Right of Way Encroachment Permits. However, Type 3 - Conventional Highways have been subcategorized in order to reflect the effects of speed and the abutting land (urban versus rural development) on safety and operations. The recommended design standards for the number and locations of the connections, median type and openings, turn lane requirements, and traffic signal location and distance will all be affected by speed and existing land use development. Listed below are the definitions of the roadway classification types of highways.

TYPE 1 – FREEWAY

A freeway is defined as a highway or section thereof with full control of access which has been designated as such by order of the Commission. On freeways, no property abutting the through traffic lanes is permitted except at interchanges constructed at intersecting streets and highways. Frontage roads may be constructed on fully controlled access highways and, where constructed, vehicular access from the abutting property to the frontage road will be permitted. The frontage road will then carry such traffic to a cross road or street with an interchange for entry into the through traffic lanes. Pedestrians crossing on controlled access highways are not permitted. Utility lines may be located on the right of way of fully controlled access highways when such location conforms with the requirements of the Department's Rules. Freeways may be developed by stage construction.

TYPE 2 – PARTIALLY CONTROLLED ACCESS HIGHWAY

1. Highways or sections thereof designated by the Commission as TYPE 2A may have frontage roads constructed on one or both sides of the highway. Right of way may be provided for future construction of frontage roads on one or both sides of the highway. Until such frontage road or roads are constructed, vehicular access from abutting property directly to and from through traffic lanes may be permitted in the same manner as for conventional highways unless the right of access was purchased with the right of way. Upon construction of the frontage roads, vehicular access from abutting property shall be permitted into the frontage road only and then is brought into the traffic lanes over intersecting streets or highways or over approved connections of the frontage road with the through traffic lanes. The right of way of TYPE 2A highways may be used for the construction and maintenance of utility lines and other approved installations in accordance with the Department's Rules.
2. On highways or sections thereof designated by the Commission as TYPE 2B, vehicular travel from and to the through traffic lanes is permitted only at established entrances and exits. The abutter's access rights between such entrances and exits have been or are to be purchased with the right of way. Right of way purchased for access control from the abutting property may be used for the construction and maintenance of utility lines; however, such construction and maintenance must be accomplished without vehicular travel from and to the through traffic lanes or ramps and must comply with the Department's Rules.

TYPE 3 – CONVENTIONAL HIGHWAY

A conventional highway is a highway consisting of two (2) traffic lanes or divided highways with two (2) or more lanes in each direction without frontage roads on either side, and which has not been designated by the Commission as either Freeways or Partially Controlled Access Highways. On conventional highways, vehicular ingress and egress from abutting property directly to and from the through traffic lanes is permitted, except that direct access may be restricted for safety and / or as indicated in the Access Management Manual and the Department's Rules. The right of way of conventional highways may be used for the construction and maintenance of utility lines and other approved installations in accordance with the Department's Rules.

For determining levels of access and minimum standards such as driveway spacing conventional highways are subcategorized by speed and area type (rural versus urban). Urban areas are defined as those areas designated by the Bureau of the Census with a population of greater than 2,500.

Section 3 – Levels of Access

TYPE 1 - FREEWAY

For Type 1 – Freeways in urbanized areas, the minimum interchange spacing should not be less than 1 mile. Minimum spacing in urbanized areas between interchanges is necessary for drivers to have sufficient time to make lane changes for entering or exiting the freeway. For suburban areas minimum freeway interchange spacing provides for good route signing and for grade separations of the local road system. Minimum spacing for rural freeway interchanges on the Interstate System should not be less than 3 miles apart or 2 miles apart for non-Interstate facilities. Greater separation of interchanges for transitioning urbanized areas and rural areas may be desirable. Greater separation allows additional interchanges to be constructed as rural areas become urbanized.

A summary of recommended interchange spacing is shown in Table 2.

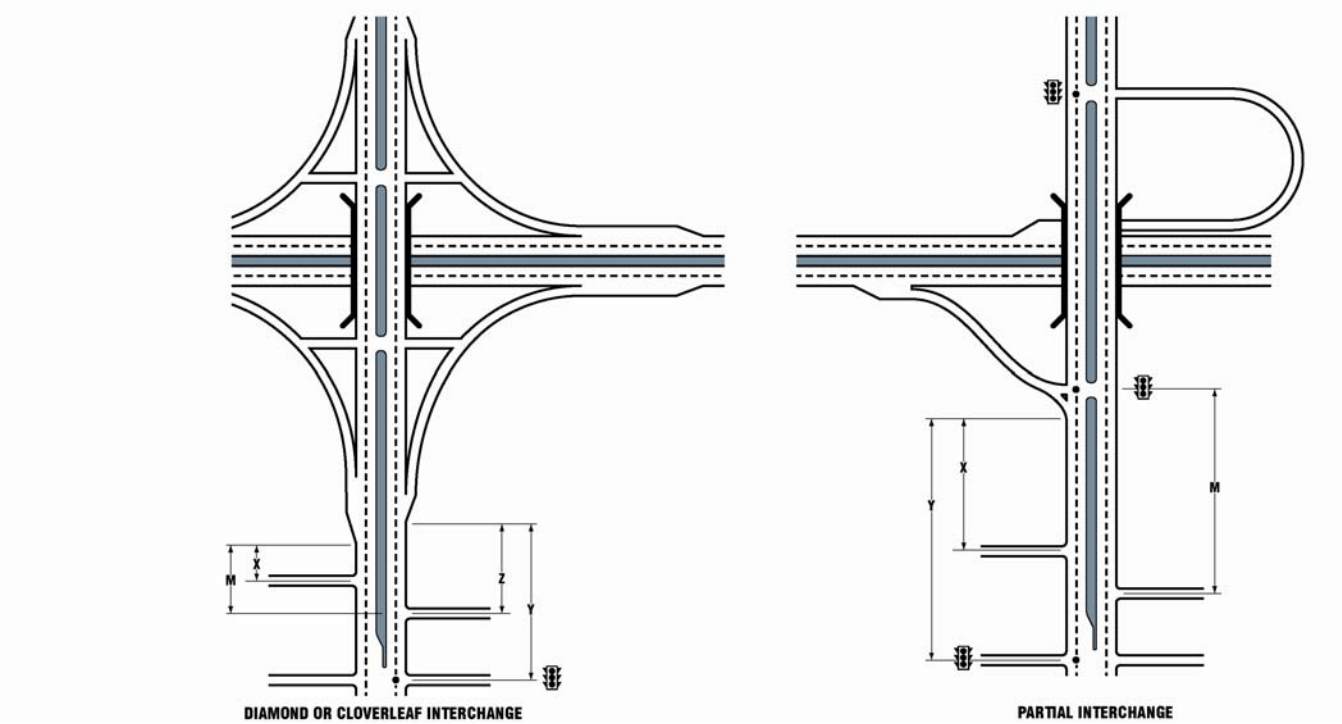
Crossroad Access Spacing at Interchanges:
Minimum access spacing on crossroads for freeway interchange areas is critical for avoiding traffic backups and providing safe maneuvering distances for turning and weaving vehicles to enter the appropriate lanes. Shown in Tables 3 and 4 are recommended spacing requirements. If the proposed distances are less than the recommended spacing then a written justification demonstrating why the recommended distances cannot be met shall be submitted to the District for approval or disapproval. Minimum spacing requirements are shown in Appendices 6 and 7.

Table 2 – Recommended Interchange Spacing [2]

Segment Location / Type	Interchange Spacing Guidance
1. Urban / Interstate	1 MILE*
2. Urban / Non-Interstate	1 MILE*
3. Rural / Interstate	3 MILES
4. Rural / Non-Interstate	2 MILES

* In urban areas, spacing of less then 1 mile may be developed by grade-separated ramps or by C-D roads, provided that a capacity analysis results in an acceptable LOS.

Table 3
Recommended Spacing for Freeway Interchange Areas with Multilane Crossroads [3]

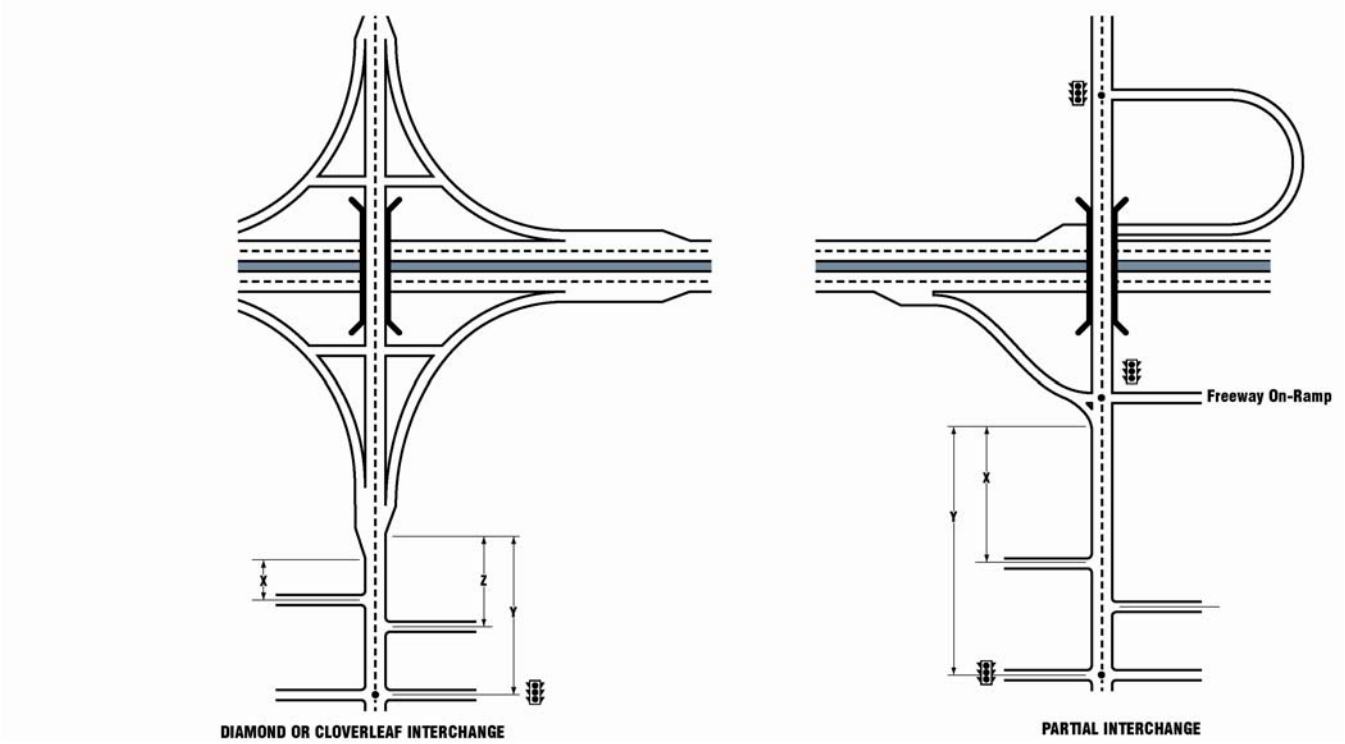


Recommended Spacing Dimension

TYPE OF AREA	X	Y	Z	M
Fully Developed Area	750’	2640’	990’	990’
Suburban/Urban	990’	2640’	1320’	1320’
Rural	1320’	2640’	1320’	1320’

X = distance from taper to first approach on the right; right in / right out only.
Y = distance to first major intersection. No four-legged intersections may be placed between ramp terminals and the first major intersection.
Z = distance between the last access connection and the start of the taper for the on-ramp.
M = distance to first possible directional median opening, provided the LOS for the weave, merge, and queue are acceptable. M applies to the tip of the taper closest to the crossover. No full median openings are allowed in nontraversable medians up to the first major intersection.
Free-flow ramps are generally discouraged in fully developed urban areas and are questionable in suburban/urban areas because pedestrian and bicycle movements are difficult.

Table 4
Recommended Spacing for Freeway Interchange Areas with Two-Lane Crossroads [3]



Recommended Spacing Dimension

TYPE OF AREA	X OR Z	Y
Fully Developed Area	750’	1320’
Suburban/Urban	990’	1320’
Rural	1320’	1320’

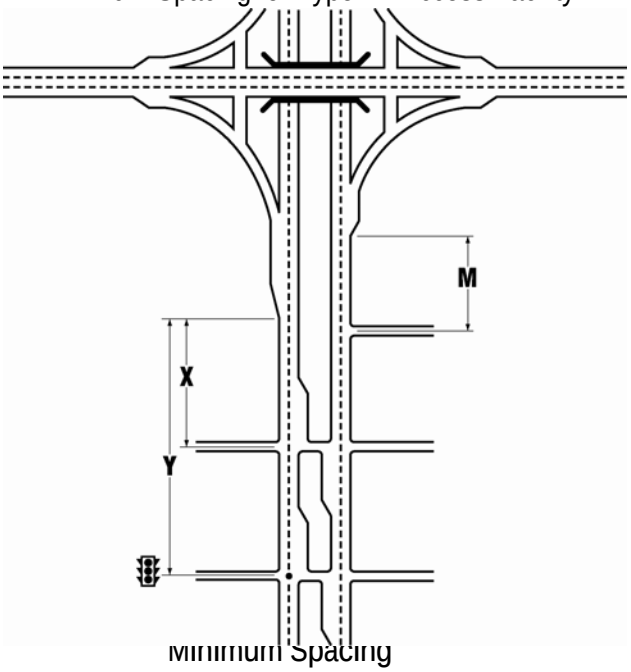
X or Z = distance to first access connection from the taper of the off-ramp or on-ramp. This dimension provides for either X or Z. However, X and Z should not be the same distance in order to avoid the creation of a four-legged intersection.

Y = distance to first major intersection. No four legged intersections may be placed between ramp terminals and the first major intersection. Y applies to the tip of the taper closest to the crossover.

TYPE 2 – PARTIALLY CONTROLLED ACCESS HIGHWAYS

For Type 2 – Partially Controlled Access Highways, the typical spacing of signalized intersections should be 1 mile. Where there is no reasonable alternative, ½ mile spacing will be permitted for rural areas and ¼ mile for urban areas. Median opening spacing requirements are defined in Appendix 1 - Median Policy. Minimum spacing requirements for freeway interchange areas with Type 2B Access Highways are shown in Table 5.

Table 5
Minimum Spacing for Type 2B Access Facility



Minimum Spacing

TYPE OF AREA	X	Y	M
Fully Developed Urban	1320’	1320’	N/A
Suburban/Urban	1320’	1320’	N/A
Rural	1320’	2640’	1320’

X = distance from taper to first approach on the right; right in / right out only.

Y = distance to first major intersection. No four-legged intersections may be placed between ramp terminals and the first major intersection.

M = distance to first possible directional median opening, provided the LOS for the weave, merge, and queue are acceptable. M applies to the tip of the taper closest to the closest crossover. No full median openings are allowed in nontraversable medians up to the first major intersection.

Free-flow ramps are generally discouraged in fully developed urban areas and are questionable in suburban/urban areas because pedestrian and bicycle movements are difficult.

TYPE 3 – CONVENTIONAL HIGHWAYS

For Type 3 – Conventional Highways, typical spacing for signalized intersections should be ½ mile. Signalized intersection spacing of ½ mile will provide enough separation to maintain high average travel speeds. Where there is no reasonable alternative the minimum spacing will be ¼ mile for urban areas and ½ mile for rural areas. Distances between signals should not vary by more than 10% in order that good progression of traffic may be maintained in both directions.

For Type 3 – Conventional Highways, the minimum driveway spacing for commercial driveways are shown in Table 6a.

Table 6a
Minimum Connection Spacing for Commercial Driveways

POSTED SPEED	DISTANCE
≤30 mph	185’
35 mph	245’
40 mph	300’
45 mph	350’
≥50 mph	425’

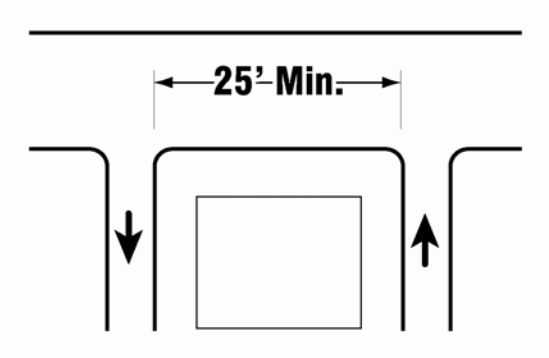
Exceptions to the minimum connection spacing shown in Table 6a are:

1. As a result of an MDOT action such as construction modifications the property would become land-locked.
2. In order to replace reasonable access that may be lost due to MDOT highway reconstruction or modification.

Table 6a lists the minimum distances between commercial driveways for sites that generate greater than 50 in or out directional trips per peak hour based on the most recent edition of the ITE Trip Generation Manual. Note in Appendix 2 there are examples of facilities generating greater than 50 trips. The commercial driveway criteria in Table 6a will apply for highways with AADT’s equal to or greater than 2,000. For commercial driveways located on highways with less than 2,000 AADT or generating 50 or less trips per peak hour, the minimum driveway spacing shall be 100 feet. The 2,000 AADT volumes should be measured based on current traffic.

Distances between adjacent one-way driveways with inbound traffic upstream from the outbound drive may have a minimum separation distance of 25 feet (Figure 1). Islands having a minimum length of 25 feet measured parallel to the highway will be built between the closely spaced driveways to form definite entrances and exits to the degree needed to channelize traffic and prevent paving of the entire frontage, thereby eliminating parking on the highway right of way directly in front of the business places and immediately adjacent to the roadway.

Figure 1
Minimum Distance Between Adjacent One-Way Driveways



For non-commercial driveways located on roads with less than 2,000 AADT the minimum distance will be 25 feet and for non-commercial driveways on roads with AADT's equal to or greater than 2,000 AADT the driveway spacing minimum will be 50 feet. These distances are shown in Table 6b.

Table 6b
Minimum Connection Spacing for Non-Commercial Driveways

AADT	DISTANCE
>2000	50'
≤2000	25'

A summary table of the commercial and non-commercial driveway spacing is shown in Appendix 5. A summary table of the levels of access for Type 2 and Type 3 highways is in Appendix 4.

Where the minimum permitted non-commercial driveway spacing is 25 feet, the driveways shall be so located within the applicant's frontage that the flared portion or return adjacent to the traveled way will not encroach on adjacent frontage. A minimum distance of 12½ feet should be reserved between driveway and boundary property line so as to preserve a 25 foot neutral area between non-commercial driveways. Applications for joint use driveways (two adjacent property owners using the same driveway) or for driveways with less than the required 25 foot neutral area between non-commercial driveways will be reviewed for approval on a case by case basis; however, in all such applications, both property owners' signatures are required on the permit.

No more than two (2) combined driveway entrances and exits shall be permitted for any parcel of property which has a frontage of 300 feet or less. Additional entrances or exits for parcels having a frontage in excess of 300 feet shall only be permitted if an additional entrance would create a safer condition. Additional entrances or exits, or if a

second entrance cannot meet the minimum connection spacing requirements as described in this Access Management Guide, must be reviewed and approved as part of the waiver and variance process.

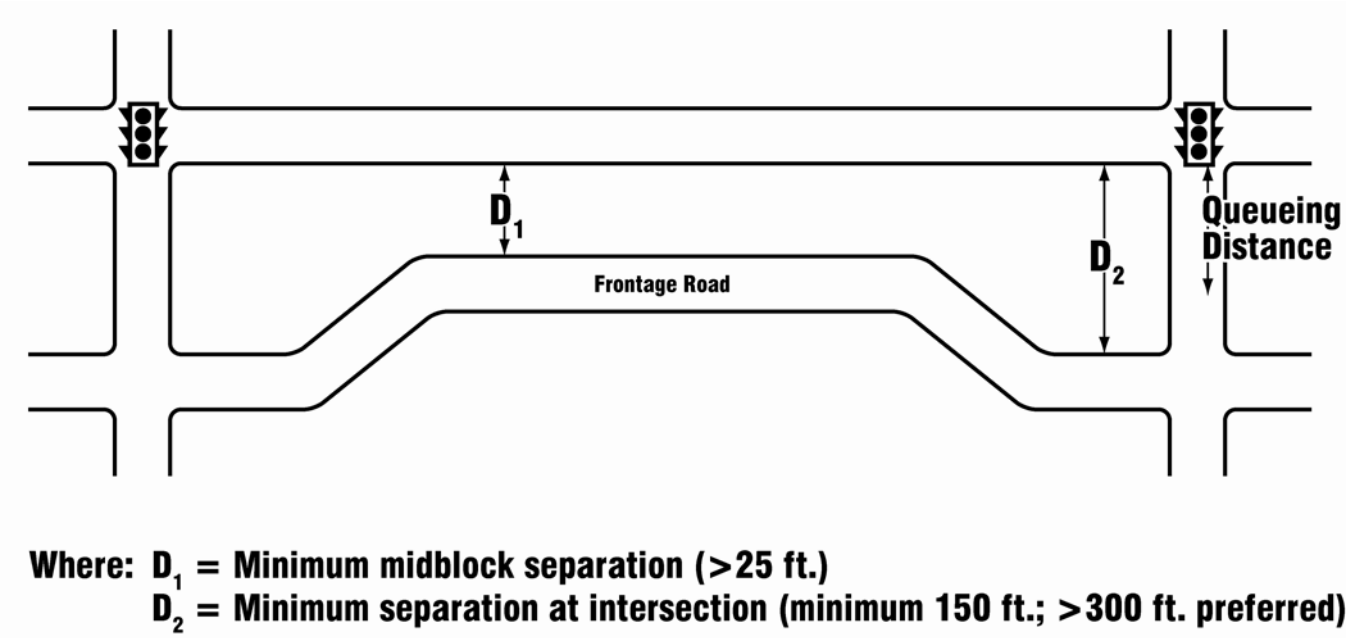
Where frontage is 50 feet or less, only one (combined) entrance and exit is permitted, the width of which shall not exceed 25 feet measured parallel to the centerline of the highway.

Spacing between driveways is measured from near edge to near edge of adjacent driveways. On undivided highways, access on both sides of the road should be aligned. Where this is not possible, driveways should be offset by at least 150 feet when two minor traffic generators are involved, and/or 300 feet when two major traffic generators (greater than 50 directional trips per peak hour) are involved.

FRONTAGE ROADS

Frontage roads for both Type 1 and Type 2 Highways shall meet the driveway access spacing requirements as specified for Type 3 highways. Minimum frontage road separation from the main highway is shown in Figure 2.

Figure 2
Minimum Frontage Road Separation



Section 4 – Geometric Requirements

The Mississippi Roadway Design Manual [4] establishes the geometric requirements for intersections/interchanges and urban arterials.

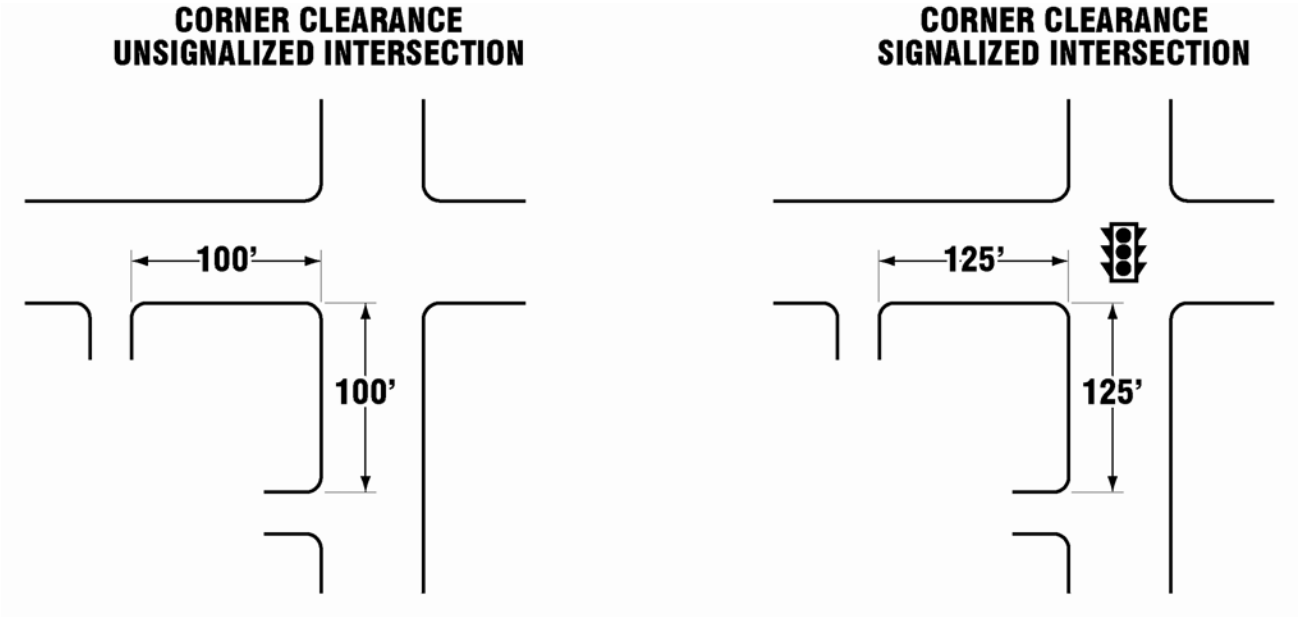
Warrants for auxiliary left-turn and right-turn lanes are shown in Chapter 6 of the Mississippi Roadway Design Manual. [4]

Driveways shall be built so that vehicles will not have to back into the roadway when exiting.

CORNER CLEARANCES

Corner clearance is the distance between an intersection and the first point of ingress or egress to a corner property's driveway. The purpose of corner clearance is to remove conflicting movements from the functional area of intersections and provide sufficient stacking space for queued vehicles at intersections so that the driveways are not blocked. No driveway will be permitted to enter directly into an intersection. Driveways must turn traffic into the traffic stream of the highway and/or intersecting road or street before it is permitted to pass through the intersection. Unless a waiver is granted, the minimum corner clearance for entrances on TYPE 2 and TYPE 3 Roads is 100 feet for unsignalized intersections and 125 feet for signalized intersections. If a waiver is requested and approved at an intersection where no provision has been made for sight distance or clear vision areas (flared right of way), no part of a driveway entrance or exit may be permitted to connect with either the highway or crossroad or street within 50 feet from the outside shoulder line of the adjacent street. No part of a driveway entrance or exit may be permitted within a corner radius.

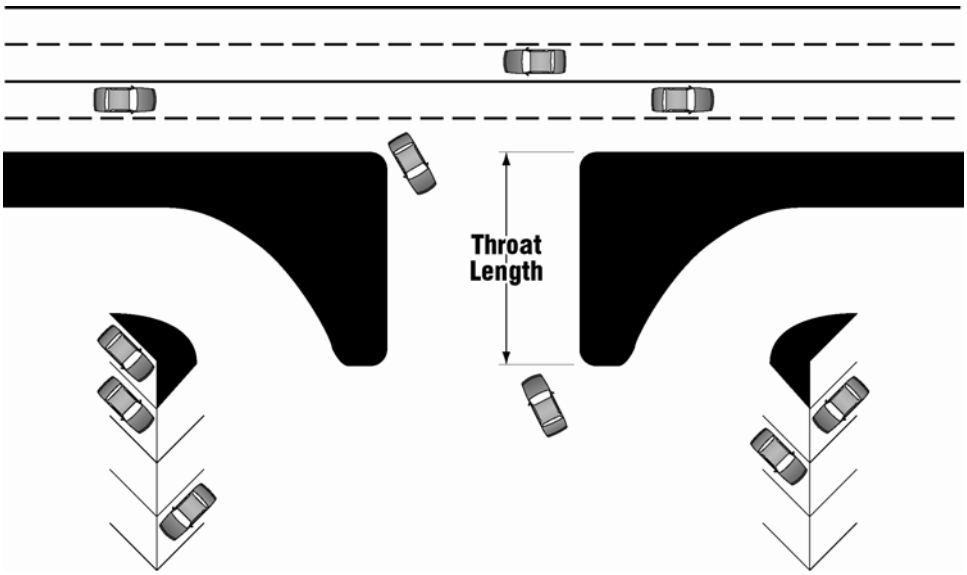
Figure 3
Corner Clearance



THROAT LENGTH DISTANCES

The connection depth of a driveway (throat length) as measured from the edge of the abutting roadway to the near edge of the internal circulation road or buffer area should be of sufficient length to allow a driver to enter the site without interfering with the mainline of traffic. Table 7 shows the recommended throat lengths based on the site activities.

Table 7
Recommended Throat Lengths [5]



SITE ACTIVITY	THROAT LENGTHS
Regional Shopping Centers (Malls)	250’
Community Shopping Center (Supermarket, Drug Store)	80’
Small Strip Shopping Center	30’
Regional Office Complex	250’
Office Center	80’
Small Commercial Developments	30’

SIGHT DISTANCE REQUIREMENTS

Driveways shall not be permitted to connect with any highway, road, street or frontage road at a location if it does not meet the minimum stopping sight distance (as outlined in the current edition of the MDOT Roadway Design Manual-using 3R Criteria), based on vertical or horizontal alignment, terrain or other reasons which will cause an undue hazard to the traveling public. Any driveway application that does not provide adequate sight distance as outlined in the above listed design manual shall be denied. In order to provide adequate sight distance in both directions when entering the highway, driveway entrances and exits should be at a 90 degree angle. Angles less than 90 degrees should not be constructed unless justified by an engineering analysis and in no case should be less than 60 degrees with the highway.

Section 5 - General Requirements

DOUBLE FRONTAGE LOTS

Where an applicant's lot has frontage on more than one public street, access shall be given from the lower functional road to the extent possible.

JOINT DRIVEWAY USAGE

If an applicant is unable to comply with the access spacing requirements shown in Tables 6a and/or 6b and requests a waiver, the applicant must attempt to obtain an access or mutual driveway easement from the adjacent property so as to allow for one egress to serve two properties. If located all or partially on the applicant's property then the adjacent property owner(s) must agree to relocate any existing access to the proposed access and the relocation must be performed in conjunction with the applicant's development of the property.

If the applicant is unable to obtain an access or mutual driveway easement from an adjacent property owner, then the access to the applicant's property shall be located on its property in an area acceptable to MDOT. Documentation of the applicant's attempt to obtain an access or mutual driveway easement from the adjacent property will be included in the submission of a waiver request.

LOCAL COORDINATION

All applications for driveways to sites that will generate more than 100 peak hour directional trips will be submitted by the applicant to the appropriate local planning agency for review and comment prior to submission to the MDOT.

Section 6 - Traffic Impact Analysis

A traffic impact study shall be required and submitted by an applicant for any proposed site that would generate 100 or more directional trips during the peak hour of the traffic generator or the peak hour of the adjacent street. A change or expansion at an existing site that results in an expected increase of 100 or more directional trips will require a traffic impact study. A traffic impact study will also be required if the resident engineer determines that the proposed development will have a significant impact on the operations at the proposed access point. The estimate of the number of directional trips for the sites will be based on the latest edition of the ITE Trip Generation Manual. Listed below in Table 8 are examples of land use size thresholds that will generate 100 peak hour directional trips.

Table 8
Typical Land Use Thresholds [6]

LAND USE	100 PEAK HOUR DIRECTIONAL TRIPS
Residential:	
Single Family	150 units
Apartments	245 units
Condominiums/Townhouses	295 units
Mobile Home Park	305 units
Shopping Center – Gross Leasable Area	15,500 sq. ft.
Fast Food Restaurant With drive-in – Gross Floor Area (GFA)	5,200 sq. ft.
Convenience Store w/gas (GFA)	1,300 sq. ft. or 5 pumps
Banks w/drive-in (GFA)	4,400 sq. ft.
Hotel/Motel	250 rooms
General Office	55,000 sq. ft.
Medical/Dental Office	37,000 sq. ft.
Research & Development	85,000 sq. ft.
Light Industrial	115,000 sq. ft.
Manufacturing	250,000 sq. ft.

The traffic impact analysis should contain the following information:

1. Description of the site surroundings and study area: Through a narrative and illustrations the characteristics of the site should be described. This would include surrounding land uses and expected development in the vicinity that would influence future traffic conditions.
2. Description of the current and proposed land use: The description would include characteristics such as the number and type of dwelling units, gross and leasable floor area, the number of employees, and schedule for construction of the development.
3. Description of existing traffic conditions: Existing conditions include existing peak-hour traffic volumes adjacent to the site and existing counts and levels of service for intersections in the vicinity which are expected to be impacted. Traffic crash data near the proposed site access point during the most recent 3 year period should be included in the analysis.
4. Estimate of background traffic growth: If the planned completion date for the project or the last phase of the project is beyond 1 year of the study an estimate of background traffic growth for the adjacent street network will be made and included in the analysis.
5. Estimate of trip generation: The site forecasted trips will be based on the most recent edition of the ITE Trip Generation Manual. Any reductions due to internal trip capture and pass-by trips will be justified and documented. Projects that will be developed in phases will calculate the trips generated by phase.
6. Estimate of trip distribution and traffic assignment: The distribution (inbound versus outbound, left turn versus right turn) of the estimated trip generation to the adjacent street network and nearby intersections will be included in the report.
7. Estimate of impact analysis: A level of service will be calculated at the access points, the arterial, and any intersection where the expected traffic generated at the site will comprise at least five percent (5%) of the intersection capacity. The levels of service will be based on the procedures in the latest edition of the Highway Capacity Manual.
8. Access Management Standards: The report shall include a map and description of the proposed access including any sight distance limitations, adjacent driveways and intersections, and a demonstration that the number of driveways proposed is the fewest necessary and they provide safe and efficient traffic operations.
9. Site circulation: A site circulation plan will be included in the report.
10. Traffic signalization: If a traffic signal is being proposed, a signal warrant analysis will be included in the study. An arterial analysis including the impact the proposed signalization will have on traffic progression will be conducted.
11. Mitigation and alternatives: The traffic impact study should include proposed improvements or access management techniques that will mitigate any changes in the levels of service.

Section 7 - Administrative Procedures

APPLICATIONS

For State Highways a permit is required for:

1. New driveways.
2. Alterations to existing drives.
3. Changes of use on the property serviced by the existing driveway/entrance that result in a daily trip increase of 10% or 100 daily trips whichever is greater.
4. Property use changes from non-commercial to commercial.

Application for a driveway permit will follow the procedures as specified in Rule Number 941-7501-04002. If the access to a site is of such a magnitude that it is expected to exceed 100 peak hour directional trips a traffic impact study must be submitted as described in the Traffic Impact Analysis section of this guide.

Should the land use for the property for which the driveway was originally permitted be changed (i.e. residential to commercial), the permit shall be revoked and a new permit must be applied for reflecting the new land use. This requirement is applicable to all permits granted by the Department prior to and after approval of this guide.

VARIANCE AND WAIVERS

If an applicant for a driveway or access permit seeks a variance from the requirements of the Department's Rules or this Access Management Guide, a request shall be attached to the permit application. The District should coordinate the variance and waiver request with Traffic Engineering, Roadway Design, and Maintenance. The request should address and provide information to address the issues listed below and to address why a variance is being requested and describe the undue hardship, if any, that will be placed on the applicant if a variance or waiver is not granted.

A variance or waiver will only be granted if it is determined that:

1. The variance will not be detrimental to public safety.
2. Denial of the variance or waiver will result in loss of reasonable access to the site.
3. The variance is reasonably necessary for the convenience and welfare of the public.
4. All reasonable alternatives that meet the access requirements have been evaluated and determined to be infeasible.
5. Reasonable alternative access cannot be provided from lower functionally classified roadways.

When a variance is approved, the reasons for granting the variance shall be clearly stated and included in the Department files. Any recommendations and actions of the Department regarding the variance shall be included in the Department files. Restrictions and conditions on the use of the permit should be imposed as necessary to keep potential safety problems to a minimum. The access permit may contain specific terms and conditions providing for an expiration date if in the future the reasons for the variance no longer exist. If the variance request is denied, the

Department shall continue to process the permit application in a standard manner and may issue a permit if it can be approved without a variance.

APPEALS

If a variance or waiver is denied by the Department, the applicant may submit within 10 days after the receipt of a notification of the adverse decision a written appeal to the Access Management Review Committee. The Committee shall consist of representatives appointed by the Chief Engineer. The Committee shall review the appeal and determine whether any means exist by which the reasons for the decision may be mitigated.

MAINTENANCE & PERMIT TRANSFER

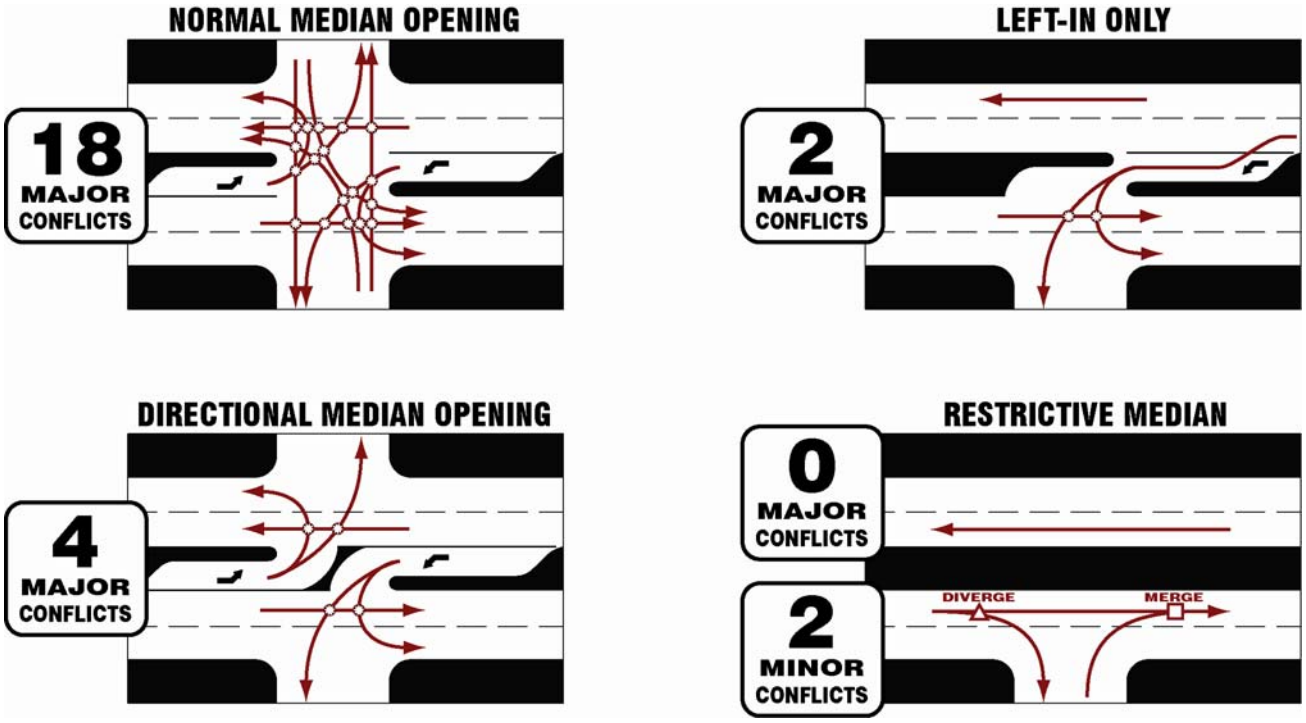
The access must be maintained according the standards and specifications at the time the permit was granted.

APPENDIX 1 – MEDIAN POLICY

Well designed medians and median openings are an important part of a safe and efficient highway system. The design and placement of these medians is an integral part of a state's access management program. The benefits of medians include:

1. Safety – fewer vehicle crashes and pedestrian accidents due to reduced conflicts and creation of refuge areas.
2. Vehicular Efficiency - reduction of conflicts and removal of turning in the through lanes increases highway speeds and reduces delays.
3. Aesthetics – creates room for landscaping and streetscaping applications.

There are four major types of raised restrictive medians as shown below:



MEDIAN PLACEMENT

In order to promote safety and preserve capacity multilane highways with design speeds greater than 40 miles per hour and annual average daily traffic exceeding 30,000 should be designed with a raised or restrictive median. Facilities having a design speed of 40 miles per hour or less and AADT's of less than 30,000 should include restrictive medians where appropriate to improve safety and traffic operations.

MEDIAN OPENINGS PRIORITY

In keeping with the principles of functional design adopted by the AASHTO "Green Book" [6], the following is a suggested hierarchy of median openings:

1. Intersection of freeway ramps and at-grade arterials.
2. Intersection of major arterial to arterial.
3. Other signalized intersections (public street or private access connection) which conform to the signalized intersection spacing standard.
4. Other intersections on major arterials which conform to the signalized intersection spacing but which are not as yet signalized.
5. Signalized intersections (public street or private access connection) which do not conform to the signalized intersection standard.
6. U-turn or left-turn/u-turn opening serving 2 or more public and/or private connections. U-turn/left turn ingress should normally be given priority over left turn out egress because ingress capacity is higher and produces less conflict than the left turn out movement.

MEDIAN OPENING PLACEMENT

The unsignalized median opening is essentially an intersection. Under most traffic conditions the median should be designed with auxiliary lanes to allow left turning vehicles to decelerate without interfering with the through movement of the leftmost through lane. To allow for safe operations and based on a queue analysis, the following provisions will apply to the construction of new and additional median openings and left turn bays on conventional or partial controlled access highways on which access rights between the median openings were not purchased with the right of way:

	MINIMUM MEDIAN OPENING SPACING (DIRECTIONAL)	MINIMUM MEDIAN OPENING SPACING (FULL)
Urban Areas:		
Speed ≥45 MPH	1320'	1320'
Speed <45 MPH	660'	1320
Rural Areas	1320'	2640'

The normal spacing between full median openings will not be less than 2640 feet in rural areas. The minimum spacing for full medians in urban areas will not be less than 1320 feet. Urban areas are defined and shown on maps published by the Department or areas which are urbanized due to heavy strip development. Strip development may be either residences or businesses that are located on either or both sides of the highway and which average 200 feet or less apart for a distance of not less than 1320 feet measured along the highway.

The normal spacing between directional median openings shall not be less than 1320 feet for rural areas. For urban roads with posted speeds equal to or greater than 45 miles per hour the minimum spacing for directional

median openings will not be less than 1320 feet and for posted speeds less than 45 miles per hour the minimum spacing is 660 feet.

Exceptions (waivers and variances) to the normal minimum spacing intervals for additional median openings will be considered for access to commercial activities and political subdivisions (city, county, school, etc.) provided all of the following criteria are met:

1. It must be documented that the additional median opening will benefit the overall safety and traffic flow of the users of the main facility and does not just serve a particular development for their own benefit.

2. Adequate distances are available for the construction of tapers, left turn bays and for turning movements of traffic based on a queue analysis.

3. Stopping sight distance meets the current edition of the MDOT Roadway Design Manual, using 3R criteria.

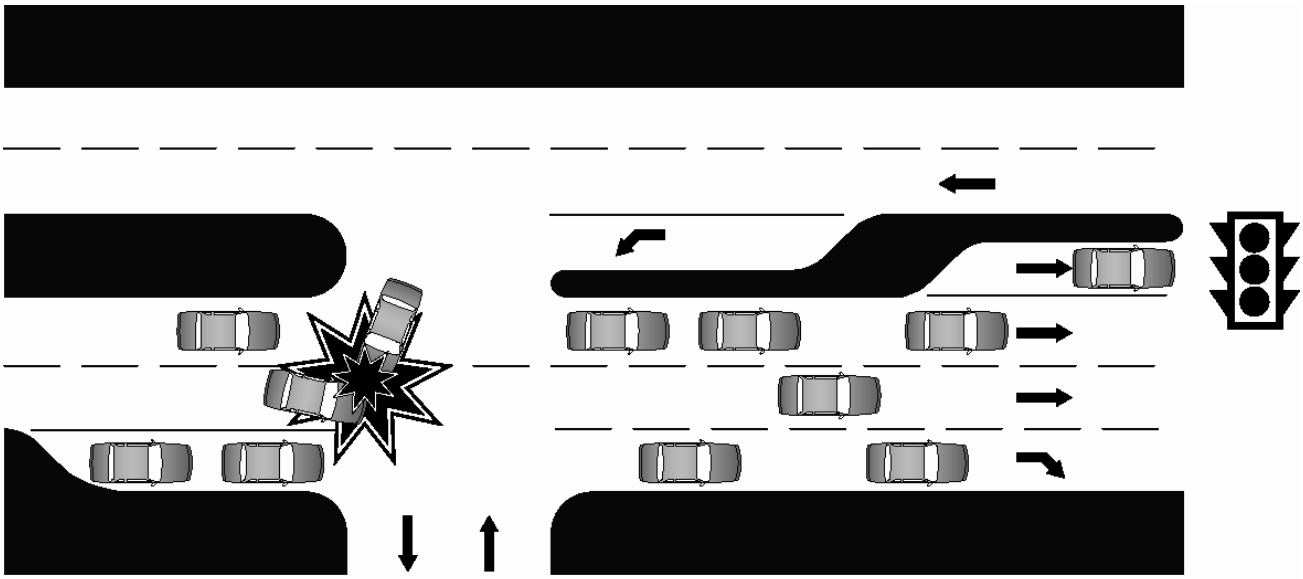
4. U-turn traffic movement restrictions for truck-class vehicles accessing adjacent properties must be addressed.

In addition to the above criteria, the variance requirements as outlined in Section 7 of this Access Management Guide must be met as well.

The State Traffic Engineer will review all requests for additional median openings. This includes the conversion of a 4-lane divided highway to a 5-lane facility. Upon completion of the review, the State Traffic Engineer will forward recommendations to the Assistant Chief Engineer- Field Operations. Additional median openings not in compliance with the median placement requirements will require approval of the Commission by order spread upon its minutes.

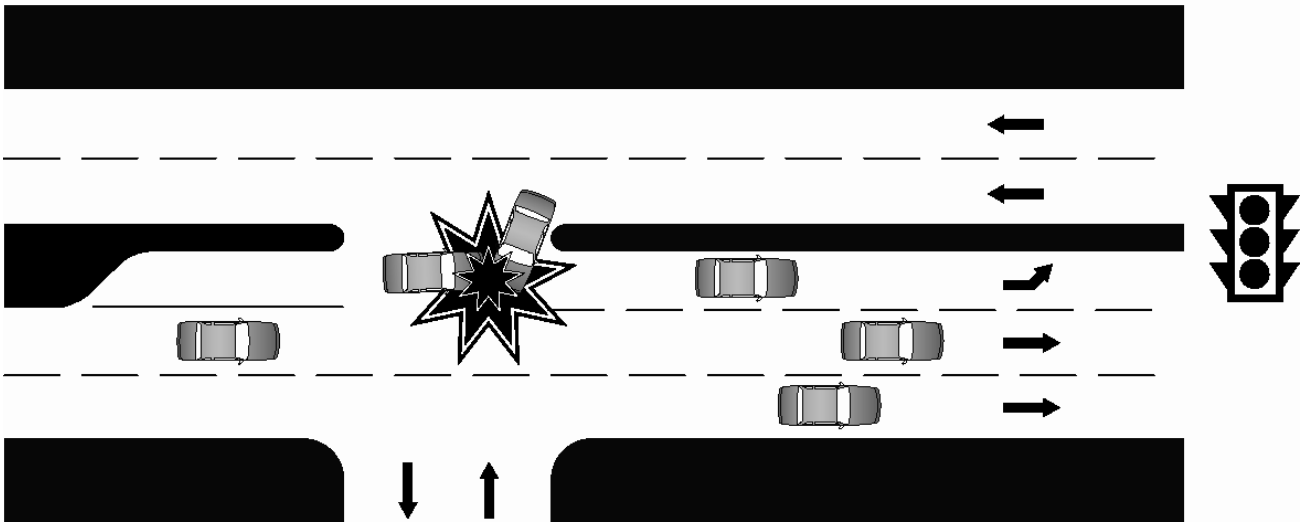
Median openings as shown in Illustration 1 that allow traffic to cross exclusive right turns or across regularly formed queues from a nearby intersection should not be permitted.

Illustration 1



Median openings as shown in Illustration 2 that allow traffic to cross exclusive left turns should not be permitted.

Illustration 2

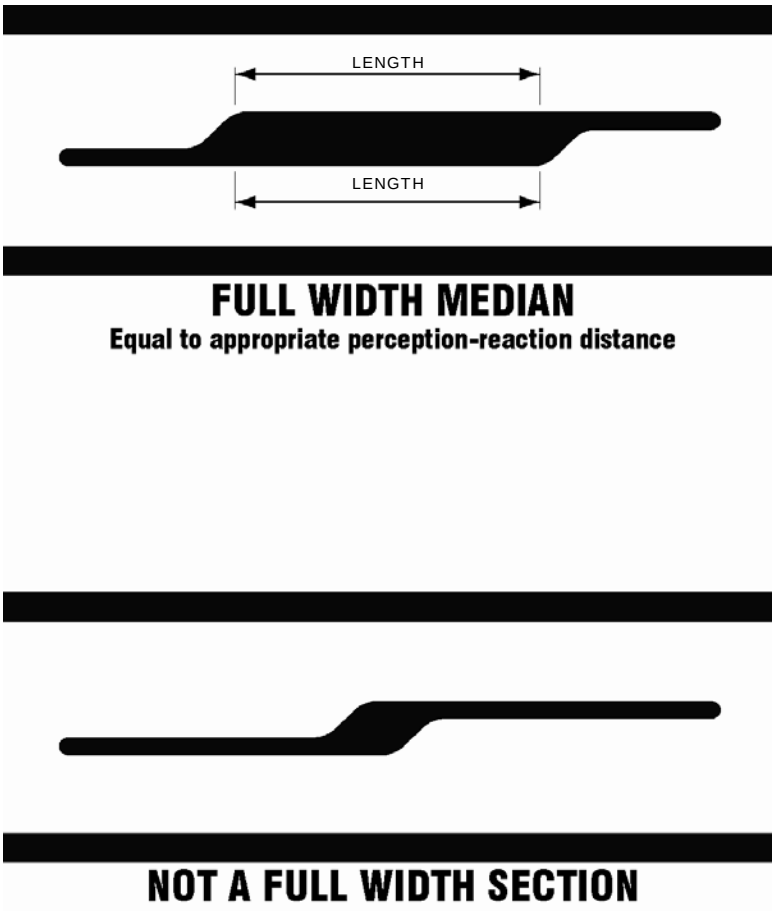


MEDIAN GEOMETRIC DESIGN

Design criteria for median openings are provided in the Department's Roadway Design Manual.

A full width median is a desirable feature that should be incorporated in the design. The length of the full median width should be equal to the perception-reaction distance. Typical perception-reaction time would be 1.5 seconds. For a 30 mph facility the full width median distance would be equal to 66 feet (1.5 x 44 fps). Full width medians provide space for signing and greater visibility to drivers. An illustration of a full width median is shown below.

Illustration 3



At a minimum for medians in urban areas, left turn lane storage areas will be 100 feet in length and for medians in rural areas the minimum will be 50 feet. These lengths will satisfy the queue storage requirements for 4 and 2 vehicles respectively. Longer left turn storage areas should be provided if needed based on a queue analysis study. In urban areas turn lane length may be determined by the queue length in the adjacent through lanes to prevent the queue from blocking access to the turn lane(s).

The type and placement of signs and traffic control devices will be based on the guidance provided in the Manual on Uniform Traffic Control Devices.

BUSINESS IMPACTS

Access management as part of site development and road projects can help businesses, even those operating on existing corridors, in numerous ways. Some of the benefits and advantages businesses experience due to access management include:

- Reduced road delays and improved speeds which will preserve and potentially expand the market area of businesses in the corridor;
- Expanded site area parking due to multiple businesses sharing access and driveways;
- Improved business community image by landscaping and other site amenities with installation of medians; and
- Easier internal circulation between businesses by construction of internal connections.

The construction of a landscaped median improves the visual appearance of a corridor and may assist in attracting new investments. In fact, access management projects have had positive impacts on property values and studies in Texas, Minnesota, Iowa, and Florida have documented either stable or increased land values for corridors after construction of access control management projects.

Where medians are constructed or median openings are closed, studies have reported relatively little effect on the number of customers making left turns into a business on congested roadways or during peak travel periods due to high volumes of opposing traffic. Other studies have reported where direct left-turns are prohibited some motorists will change their driving or shopping patterns to continue patronizing specific establishments.

An important aspect of minimizing the impact of access management projects and medians is to maintain open access to businesses during the construction phase. Potential actions to mitigate construction impacts include:

- Clearly sign business entrances from the roadway;
- Provide temporary and/or secondary business access points, where feasible:
- Schedule construction during after-business hours or during times of low usage for seasonally-oriented businesses;
- Avoid blocking business entrances with construction equipment or construction barriers;
- Provide alternative parking, if possible and avoid taking or blocking parking spaces;
- Establish a single point of contact in the agency about the construction project to communicate with property and business owners; and
- Provide regular project progress reports to business and property owners.

APPENDIX 2 – LAND USE SIZE THRESHOLDS FOR 50 PEAK HOUR DIRECTIONAL TRIPS [7]

LAND USE	50 PEAK HOUR DIRECTIONAL TRIPS
Residential:	
Single Family	70 Units
Apartments	115 Units
Condominiums/Townhouses	125 Units
Mobile Home Park	140 Units
Shopping Center (GLA)	5,200 Sq. Ft.
Fast Food Restaurant w/Drive In (GLA)	2,600 Sq. Ft
Convenience Store w/Gas (GFA)	650 Sq. Ft Or 3 Pumps
Banks w/Drive-In (GFA)	2,200 Sq. Ft.
Hotel/Motel	120 Rooms
General Office	22,000 Sq. Ft.
Medical/Dental Office	18,600 Sq. Ft.
Research And Development	37,000 Sq. Ft.
Light Industrial	58,000 Sq. Ft.
Manufacturing	125,000 Sq. Ft.

GLA – GROSS LEASABLE AREA
GFA – GROSS FLOOR AREA

APPENDIX 3 – DRIVEWAY ACCESS REVIEW CHECKLIST [7]

The following checklist is intended to be used by MDOT staff for an initial review of access permit requests. Standards to be applied are from the Mississippi Roadway Design Manual, Mississippi's Rules and this guideline.

Checklist

YES	NO	
☐	☐	The distance between driveways and adjacent intersections or other intersections meet corner clearances and spacing standards. Comment:
☐	☐	Sight distance at the proposed location is sufficient. Proposed signs and/or landscaping do not obscure sight distance. Comment:
☐	☐	Driveway grades meet standards. Comment:
☐	☐	The driveway throat length meets standards and is sufficient to provide storage for vehicles waiting to enter or exit without creating conflicts. Comment:
☐	☐	Shared driveways, frontage roads, rear service driveway or connecting driveways have been considered if appropriate. Comment:
☐	☐	Driveway radii for both inbound and outbound are sufficient to accommodate the type of vehicular traffic that is expected to enter the site. Comment:
☐	☐	Pedestrian traffic has been accommodated and ADA requirements have been met. Comment:
☐	☐	Alternative access to a side street has been considered where available. Comment:
☐	☐	Where possible the driveway is aligned with driveways across the street. Comment:
☐	☐	For driveways that meet the trip generation standards a traffic impact analysis was conducted. The need for bypass lanes, turn lanes, deceleration lanes, deceleration tapers, and width and number of ingress/egress lanes has been evaluated. Comment:

APPENDIX 4 – LEVELS OF ACCESS

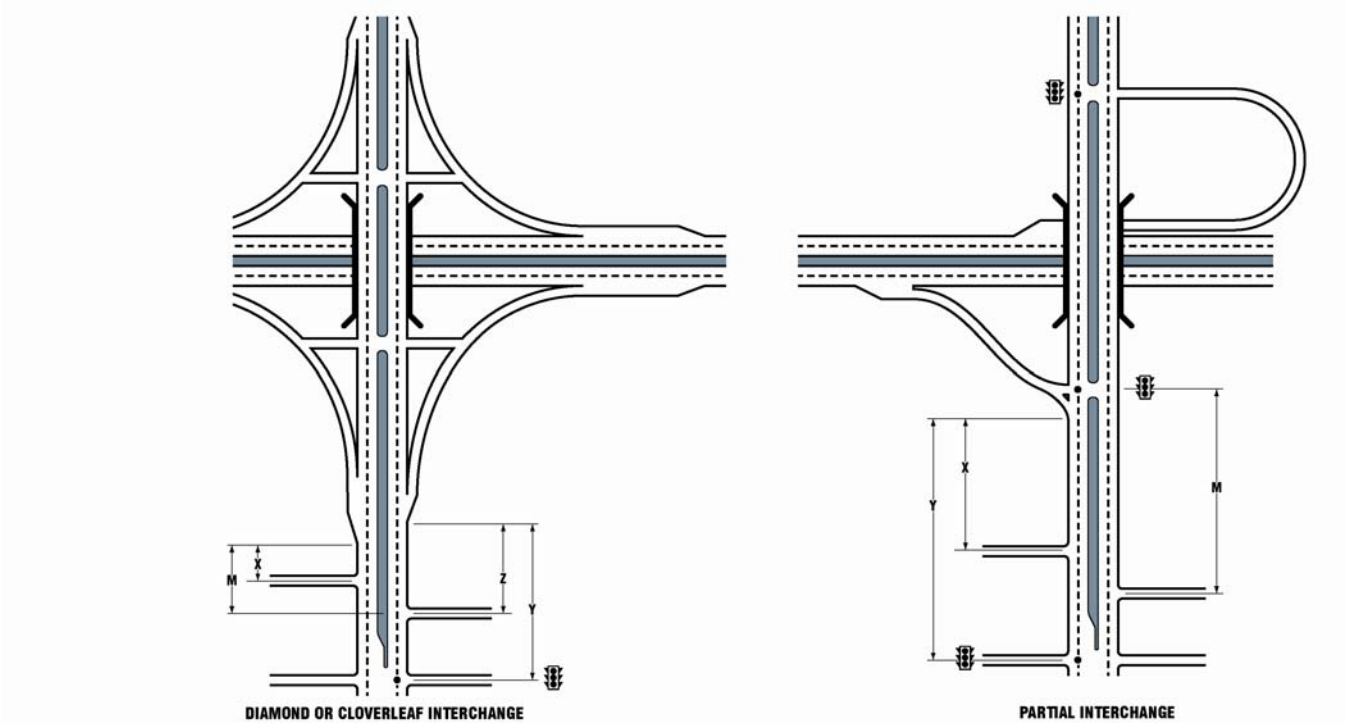
ACCESS CLASS	ARE A TYPE	MEDIAN TREATMENT	MINIMUM MEDIAN OPENING SPACING			SIGNAL SPACING
			DIRECTIONAL ACCESS		FULL ACCESS	
			≥45mph	<45mph		
TYPE 2A	URBAN	RESTRICTIVE	1320’	660’	1320’	1320’
	RURAL	RESTRICTIVE	1320’	1320’	2640’	2640’
TYPE 2B	URBAN	RESTRICTIVE	1320’	660’	1320’	1320’
	RURAL	RESTRICTIVE	1320’	1320’	2640’	2640’
TYPE 3	URBAN	NON-RESTRICTIVE	NA	NA	NA	1320’
		RESTRICTIVE	1320’	660’	1320’	1320’
	RURAL	NON-RESTRICTIVE	NA	NA	NA	2640’
		RESTRICTIVE	1320’	1320’	2640’	2640’

Note: Less than the minimum signal distance is only permitted if there is no reasonable alternative and a weave and queue analysis shows adequate spacing.

APPENDIX 5 – MINIMUM CONNECTION SPACING

		POSTED SPEED	DISTANCE
COMMERCIAL DRIVEWAY	>50 PEAK HOUR TRIPS AND >2000 AADT	≤30mph 35mph 40mph 45mph ≥50mph	185’ 245’ 300’ 350’ 425’
COMMERCIAL DRIVEWAY	≤50 PEAK HOUR TRIPS OR ≤2000 AADT	NA	100’
NON-COMMERCIAL DRIVEWAY	>2000 AADT	NA	50’
NON-COMMERCIAL DRIVEWAY	≤2000 AADT	NA	25’

APPENDIX 6 - MINIMUM SPACING FOR FREEWAY INTERCHANGE AREAS WITH MULTILANE CROSSROADS[3]



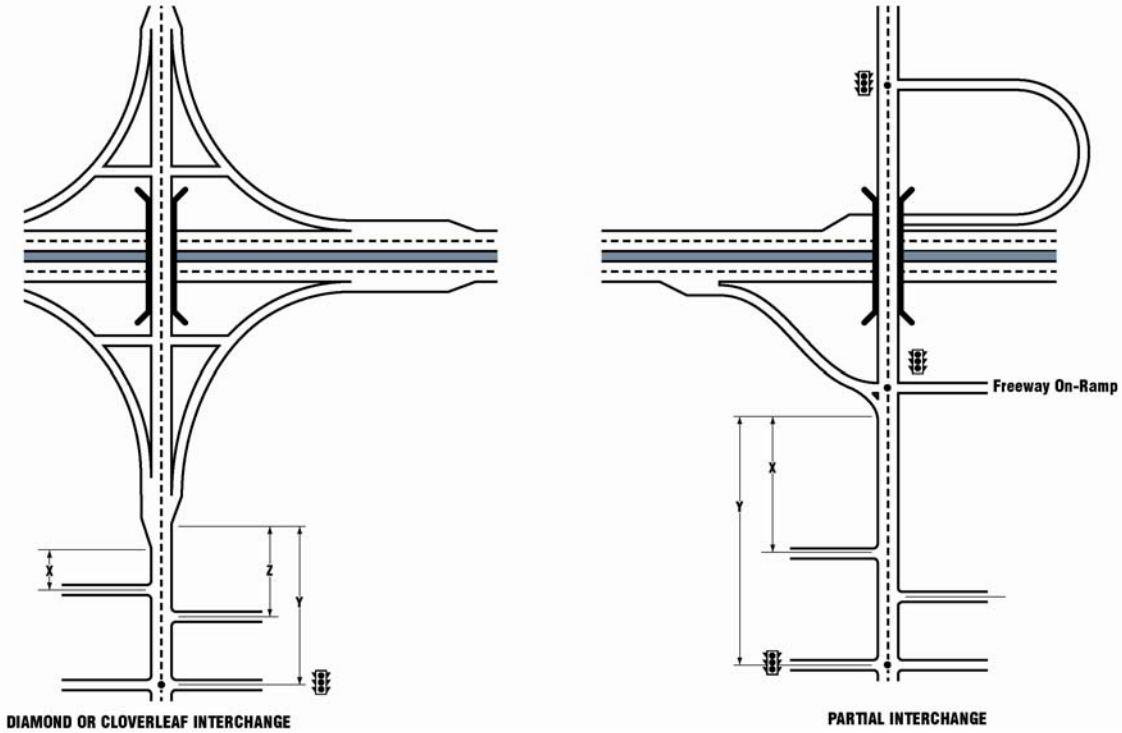
Minimum Spacing Dimension

TYPE OF AREA	X	Y	Z	M
Fully Developed Area	300’	440’	300’	300’
Suburban/Urban	440’	880’	440’	440’
Rural	880’	1760’	880’	880’

X = distance from taper to first approach on the right; right in / right out only.
Y = distance to first major intersection. Y applies to the tip of the taper closest to the crossover. No four-legged intersections may be placed between ramp terminals and the first major intersection.
Z = distance between the last access connection and the start of the taper for the on-ramp.
M = distance to first directional median opening. No full median openings are allowed in nontraversable medians up to the first major intersection.

Free-flow ramps are generally discouraged in fully developed urban areas and are questionable in suburban/urban areas because pedestrian and bicycle movements are difficult.

APPENDIX 7 - MINIMUM SPACING FOR FREEWAY INTERCHANGE AREAS WITH TWO-LANE CROSSROADS [3]



Minimum Spacing Dimension

TYPE OF AREA	X OR Z	Y
Fully Developed Area	300’	880’
Suburban/Urban	440’	880’
Rural	880’	880’

X or Z = distance to first access connection from the taper of the off-ramp or on-ramp. This dimension provides for either x or z. However, x and z should not be the same distance in order to avoid the creation of a four-legged intersection.

Y = distance to first major intersection. Y applies to the tip of the taper closest to the crossover. No four legged intersections may be placed between ramp terminals and the first major intersection.

REFERENCES

1. S&K Transportation Consultants, Inc. *Access Management, Location and Design.* Participant notebook for NHI Course 133078. Federal Highway Administration April 2000.

2. *Access Management Manual,* Transportation Research Board, Washington D. C. 2003.

3. Gluck, J., H.S. Levinson, and V. Stover. *NCHRP Report 420: Impacts of Access Management Techniques.* TRB National Research Council, Washington D.C., 1999.

4. *Mississippi Roadway Design Manual,* Mississippi Department of Transportation.

5. *Florida Site Impact Handbook,* Florida Department of Transportation.

6. *AASHTO Green Book, A Policy on Geometric Design of Highways and Streets.*

7. *Evaluating Traffic Impact Studies – A Recommended Practice for Michigan Communities* – Michigan Department of Transportation 1994.

Access Management Techniques

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INTRODUCTION

Traffic Conflicts

CHAPTER 4

ACCESS MANAGEMENT TECHNIQUES

Following adoption of a comprehensive policy, the next step in the development of an access control program is the identification of effective control measures which will enhance the safe and efficient movement of traffic. These measures include all traffic operations actions which serve to minimize the frequency and severity of traffic conflicts associated with driveways.

A traffic conflict point occurs where the paths of two traffic movements intersect. As illustrated in Figure 4-1, these maneuvers in order of increasing severity of conflict are diverge, merge, weave, and cross. In each case drivers of one or more vehicles may need to take appropriate action in order to avoid a collision. Crossing conflicts are the most serious because of the potential for high speed head-on, or nearly head-on, and right-angle collisions. Hence, these conflict points are often referred to as "major conflict points."

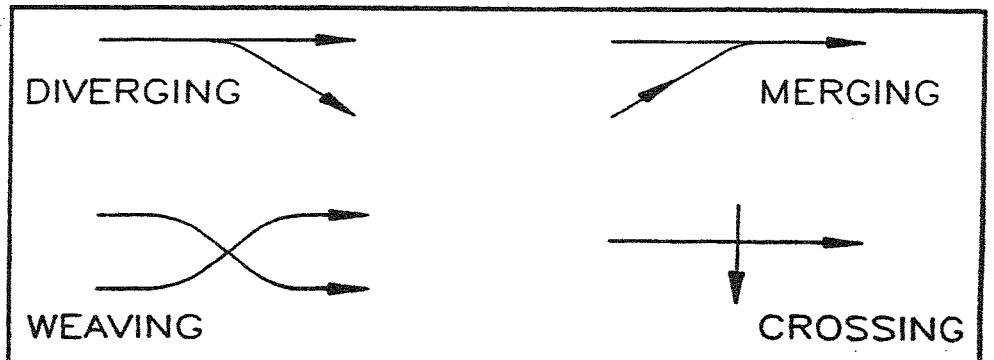


FIGURE 4-1: INTERSECTION VEHICULAR MANEUVERS INVOLVING CONFLICT

(Continued)

INTRODUCTION (Continued)

Traffic Conflicts (Continued)

Diverge and merge conflict are potentially less severe and are often referred to as "minor conflict points." Diverge conflicts occur when a driver executes a left-turn or right-turn maneuver. This often requires significant corrective action by drivers of following vehicles - especially on high speed and/or high volume roadways. Merge conflicts occur where a vehicle makes a left or right-turn and enters a through traffic stream. The burden for avoiding a collision primarily rests with the driver of the vehicle executing the turn maneuver. However, drivers in the through traffic stream are often required to take action to avoid a collision when the driver of the merging vehicle accepts a gap which is too short to accelerate to the speed of through traffic before being overtaken by on-coming vehicles.

In some cases, the conflict point covers a substantial area; as for example, when a driver executes a left-turn from a through traffic lane and a queue of vehicles forms while the left-turning driver waits for an acceptable gap in the opposing traffic stream. Defining the location and minimizing the area of such conflicts will contribute to traffic safety by reducing driver uncertainty.

The area and complexity of the crossing conflicting points are also affected by the roadway cross-section. For example, on a 2-lane roadway, each of the conflict points with the traffic stream approaching from the left and the right is only one lane wide. With a 4-lane cross-section, each conflict points is 2 lanes wide.

An example of potential conflict points at a typical four-way intersection is shown in Figure 4-2.

(Continued)

INTRODUCTION (Continued)

Traffic Conflicts (Continued)

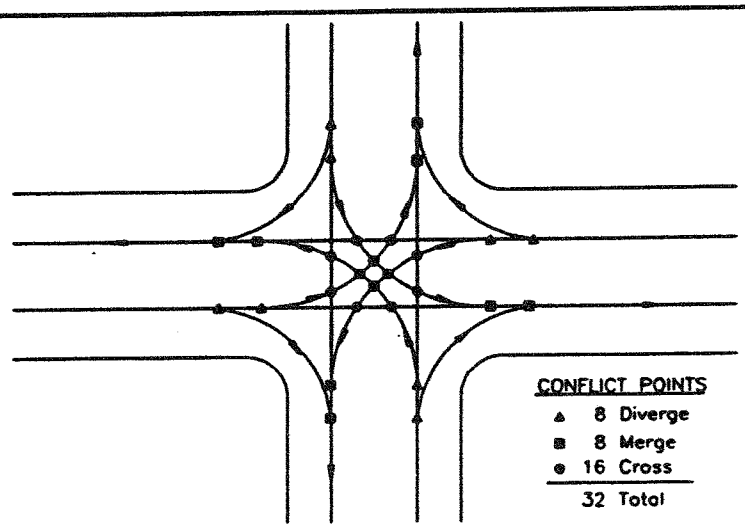


FIGURE 4-2: CONFLICT POINTS AT A TYPICAL FOUR-WAY INTERSECTION

As shown in Figure 4-3, a 3-way intersection has 9 conflict points, of which only 3 are crossing conflicts. Moreover, traffic on the "stem" of the intersection "naturally yields" to other traffic. Three-way intersections, therefore, experience fewer accidents than 4-way intersections.

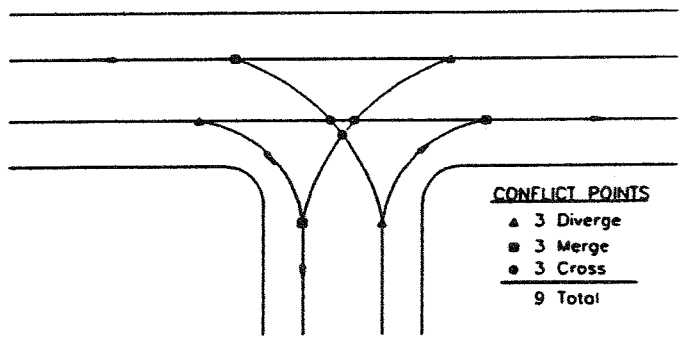


FIGURE 4-3: CONFLICT POINTS AT A TYPICAL THREE-WAY INTERSECTION

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES

Introduction

CATEGORIES OF TREATMENT FOR IMPROVING TRAFFIC FLOW

A. Limit Number of Conflict Points.

B. Separate Conflict Points.

C. Limit Deceleration.

D. Remove Turning Vehicles from Through Lanes.

The several techniques of access management that might be considered for implementation on existing roadways can be grouped into four general categories. These are as follows:

Category	Type Of Technique
A	Limit the number of points: These techniques directly reduce the frequency of either basic conflicts or encroachment conflicts, or reduce the area of conflict at some or all driveways on the highway by limiting or preventing certain kinds of maneuvers.
B	Separate basic conflict areas: These techniques either reduce the number of driveways or directly increase the spacing between driveways or between driveways and intersections. They indirectly reduce the frequency of conflicts by separating turning vehicles at adjacent access points and by increasing the decision-process time for the through driver between successive conflicts with driveway vehicles at successive driveways.
C	Reduce deceleration requirements: These techniques reduce the severity of conflicts by increasing driveway turning speeds, by decreasing through highway speeds, or by increasing driveway perception time.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

Introduction (Continued)	D	Remove turning vehicles from the through lanes: These techniques directly reduce both the frequency and severity of conflicts by providing separate paths and storage areas for turning vehicles.

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points

Introduction

CATEGORIES OF TREATMENT FOR IMPROVING TRAFFIC FLOW

A. Limit Number of Conflict Points.

B. Separate Conflict Points.

C. Limit Deceleration.

D. Remove Turning Vehicles from Through Lanes.

The number of conflict points at 4-way and 3-way intersections are shown in Figure 4-2 and 4-3 respectively. Major conflict points are defined as those where movement paths cross. Minor conflict points occur where paths diverge on merge.

As shown in Figure 4-2, there are 16 major and 16 minor conflict points at a 4-way intersection. Whereas there are only 3 major conflict points at a 3-way intersection. This, plus the fact that traffic on the "stem" of the 3-way intersection "naturally yields" to other traffic, results in accident rates being much lower at 3-way intersections.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-1: Install Median Barrier With No Left Turns At The Median Opening

A-1: Description

The physical median barrier is a route design technique for controlling access on arterial highways. The barrier, which can be the concrete safety shape median barrier (often referred to as a New Jersey Barrier) or a curbed nontraversable median. This eliminates direct left turns at all driveways and U-turns along the highway. Indirect left turns to driveways are accommodated by right-hand ramps (jughandle) and crossovers or by cloverleaf loops at cross streets.

The technique eliminates the conflict points at all driveways except at the median opening. At a 4-way intersection on a 4-lane roadway the number of conflict points are reduced from 32 (including 24 major conflicts) to only 15, of which 8 are major conflict points.

More important, the barrier totally eliminates the more hazardous crossing conflict points at all driveways. The frequency of rear-end conflicts on the through lanes is expected to decrease as a result of the elimination of direct left turns; on the other hand, the frequency of right-turn conflicts at minor driveways will probably increase proportionally to the number of indirect left turns. Some tradeoff is realized by the creation of additional basic conflict points at indirect left-turn locations.

A-1: Application

This application may be effective along highway sections where mid-block accident experience involving left-turning vehicles is excessive. In general, it may be cost effective on multi-lane arterial roadways with speeds over 40 mph, ADT's greater than 10,000, and where peak hour left-turn movements equal or exceed 150 vph per one-mile or where development levels exceeds 30 driveways per mile.

A-1: Design

Figures A-1-1 and A-1-2 indicate alternative ways of accommodating left-turns where technique A-1 is used. Critical elements to consider are ramp radius, width, and length to accommodate left-turning vehicles as per the volume, speeds, and types of vehicles expected.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-1: Design (Continued)

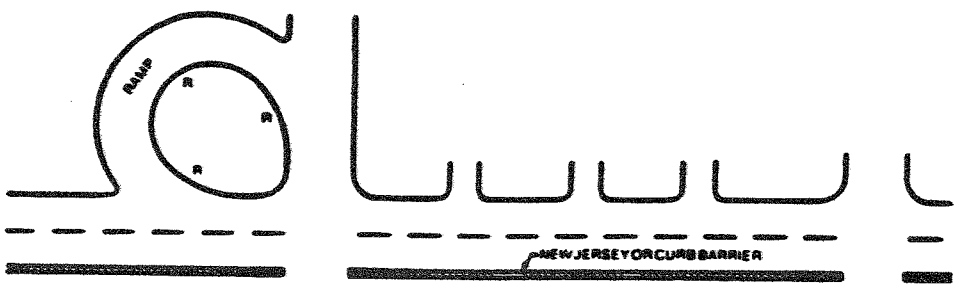


FIGURE A-1-1: MEDIAN BARRIER WITH INDIRECT LEFT TURN RAMP (CLOVERLEAF LOOP)

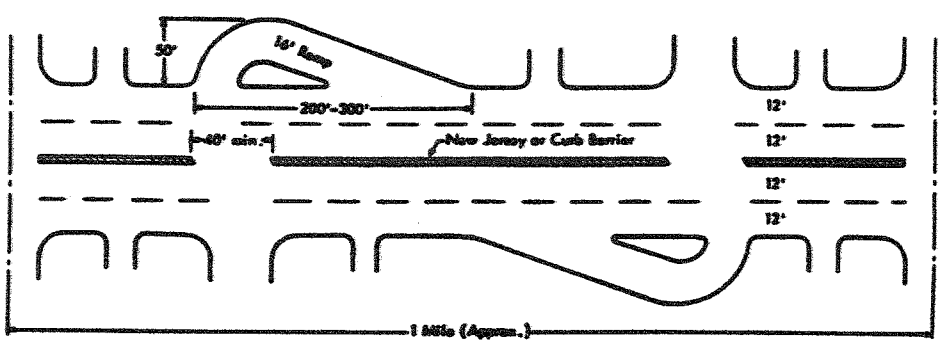


FIGURE A-1-2: MEDIAN BARRIER WITH INDIRECT LEFT TURN RAMPS (JUG-HANDLE)

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-2: Install Raised Median Divider With Left Turn Deceleration Lane

A-2: Description

This median treatment directly controls access on urban multi-lane highways by preventing left-turns and U-turns across the median except at designated locations. Access is provided with left-turn lanes at intersections and major driveways. In addition to preventing left-turns at minor driveways, the raised median divider reduces stream friction by separating opposing traffic.

This technique completely eliminates the hazardous crossing conflict points at driveways where right-turns in and out only are permitted. This reduces the conflicts to only two diverge/merge conflicts from 11 which existed on a 4-lane roadway.

For intersections and major driveways where left-turns are permitted, the frequency and severity of conflicts associated with left-turn vehicles are reduced by allowing deceleration and shadowing of these vehicles in left-turn lanes.

The median divider usually reduces the total number of driveway maneuvers. However, the maximum reduction in the frequency of conflicts is moderated by increases in right-turn volumes at minor driveways where desired left-turns are accomplished through indirect, circuitous paths.

A-2: Application

A non-traversable median with left-turn bays at all signalized intersections should be included in the design of major arterials in new locations and included in the major reconstruction of existing major arterials.

On existing multi-lane roadways, this technique may be cost effective where speeds exceed 30 mph, ADT's exceed 10,000, and levels of development exceed 30 driveways per mile or peak hour left-turn volumes exceed 150 vph per one-mile section. It should be particularly effective where there is a high accident experience involving left-turn ingress vehicles.

(Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-2: Design

The length of the turn bay will be controlled by the sum of the maneuver distance plus storage length required in the peak period or the off-peak - which ever is longer. Inadequate length presents a safety problem if excessive deceleration must take place in the through traffic lane and a high speed differential is created between the turning vehicles and traffic in the through lane. The safety problem is especially severe if the left-turn queue spills into the through traffic lane.

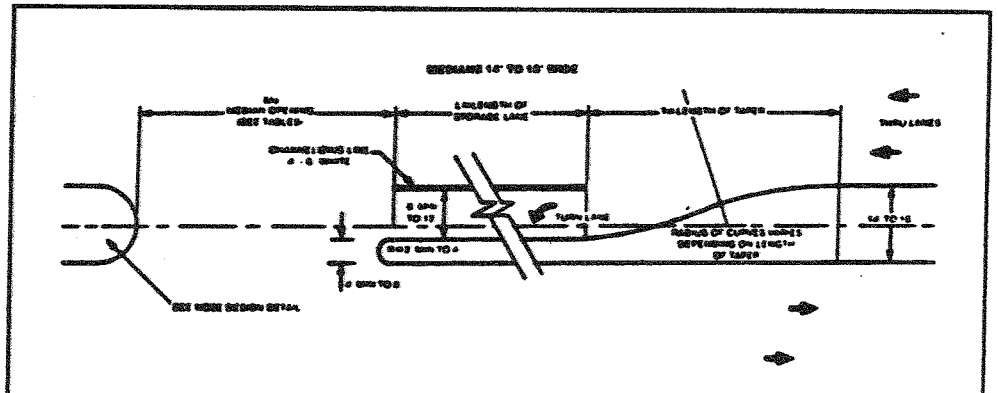


FIGURE A-2-1: SINGLE LEFT TURN LANE

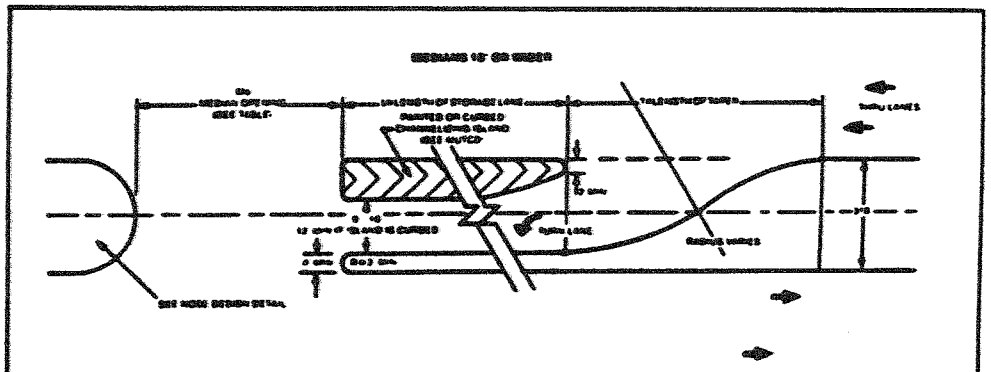


FIGURE A-2-2: DUAL LEFT TURN STRIPED FOR SINGLE LANE OPERATION

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-3: Install One-Way Operations On The Highway

A-3: Description

Converting an urban street to one-way operation eliminates the conflict between the left-turning vehicles and opposing traffic at all access drives and intersections. The number of conflicts at T-intersections and drives at the right-hand side of the street are reduced from 9 to 2 as right-turn in and right-turn out only are permitted. At the left-side of the roadway, conflicts are reduced from 9, on a 2-lane street and 11 on a 4-lane street, to 3 (the left-turn ingress diverge, left-turn egress merge and the crossing conflict between the left-turn ingress and egress maneuvers).

Capacity is increased where an odd number of lanes can be utilized. One-way streets also lend themselves to significantly improved signal progression with a resulting increase in progression speed, reduced delay, and increased capacity.

Negative considerations include increased circuity of travel (indirect or around-the-block maneuvers and impact on residential property between and along the streets which constitute the one-way pair.

A-3: Application

A two-way street can be converted to one-way operation where there is an existing parallel street. The technique is applicable on 2-way roadways experiencing high accident rates and the right-of-way is insufficient for implementing other remedial techniques. It may be cost effective as a safety measure where speeds exceed 30 mph and they are at least 30 commercial driveways per mile, or the turn maneuvers over a one-mile section is equal to 30% of the hourly volume on the section.

(Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-4: Install Traffic Signal At High Volume Driveway

A-4: Description

If properly designed, installed, and maintained, traffic signals tend to reduce right-angle collisions vehicular-pedestrian collisions, and opposing left-turn collisions. However, rear-end collisions commonly increase. Delay to the driveway traffic will be decreased; however, total delay at the intersection will be increased if the signal interferes with progression. Moreover, if the signal system has poor progression, the resulting queues can block upstream assess drives. Also, improperly located signals will increase total traffic delays through the system, cause a deterioration in the speed, and efficiency of progression, and seriously increase fuel consumption and vehicular emissions.

A-4: Application

A driveway should be considered for signalization only if installation of the signal does not interfere with traffic progression on the major arterial, or will not interfere when the major street system reaches capacity conditions when the area becomes fully urbanized. This normally means that signalization be limited to driveways which meet the uniform signalized intersection spacing which will provide maximum progression efficiency at speeds of 30 to 35 mph at the longest cycle length which is expected to be utilized in the peak periods when the area becomes fully urbanized. When the high volume access drive does not conform to the selected long, uniform spacing criteria, consideration of signalization should be based upon a traffic engineering study which demonstrates that the signal will not interfere with efficient traffic progression for peak and off-peak conditions. Different criteria for progression may be applied to different functional classes of roadways. The following are suggested.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-4:
Application
(Continued)

Functional Class	Category	Period	Minimum Progression	
			Speed (mph)	Efficiency[1] (%)
Major Arterial	A	peak	≥30	45
		off-peak	≥45	40
Major Arterial	B	peak	≥30	40
		off-peak	≥	35
Minor Arterial	C	peak	≥30	35
		off-peak	≥40	30

(1) Green phase for major street divided by cycle length.

A-4:
Design

All traffic signal installations must conform to the Manual on Uniform Traffic Control Devices (MUTCD). Installation of any signal serving an access drive, or other intersection, should not be made until the applicable volume or accident warrants are met.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-5: Channelize Median Opening To Prevent Left Turn Ingress Or Left Turn Egress

A-5: Description

This technique provides positive access control on major roadways through the design of median openings so as to allow designated movements only and the prohibition of all other movements. The crossing movement is prohibited in all cases. The number and type of conflicts which are eliminated at the intersection (access drive) at which the median opening is provided depends upon which of the 5 variations of this technique is used. The conflicts at all other drives are reduced to 2 which are the diverge and merge conflicts associated with the right-turn ingress and egress respectively. The 5 variations of this technique are:

Case 1: **Left-turn egress from one direction only, Figure A-5-1.** This design reduces the number of conflicts from 24 to 6 where access drives on opposite sides of the roadway are directly across from each other and the most dangerous crossing conflicts reduced from 16 to 1. At an existing 3-way intersection, the total conflicts are reduced from 9 to 4; the crossing conflicts are reduced from 3 to 1. Most importantly, the left-turning vehicle is removed from the through traffic lane. This greatly reduces the likelihood of rear-end collisions. Also, capacity is increased and delay to through traffic is decreased.

Case 2: **Left-turn egress from one approach only, Figure A-5-2.** The number of conflicts are reduced from 24 to 6 when installed at an existing 4-way intersection (or where driveways are opposite each other); and the serious crossing conflicts are reduced from 16 to 1. With proper design, the left-turn egress driver is able to cross the traffic stream approaching from the left and then wait in the median while selecting a suitable gap in the traffic stream approaching from the right. This significantly increases egress capacity, as well as safety, especially when the access drive is located where the traffic platoon approaching from the left arrives as the platoon from the right passes, or visa-versa.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-5: Description (Continued)

Case 3: Left-turn ingress from both directions, Figure A-5-3. The total number of conflict points is reduced from 24 to 9; the number of major conflicts (those involving crossing maneuver) is reduced from 16 to only 2. Moreover, the left-turn ingress vehicles can leave the traffic stream while creating a minimum speed differential between the turning vehicles and through traffic. This greatly reduces the chances of a rear-end collisions; it also decreases delay to through traffic.

Case 4: Left-turn ingress from one direction and left-turn egress from one approach, Figure A-5-4. While this design reduces the total number of conflicts at a 3-way intersection from 9 to 7, the three cross conflicts still remain. However, it is effective in reducing the conflicts were directly opposite drives (or public streets) results in a 4-way intersection; in this case the total number of conflicts is reduced from 24 to 9 and the serious crossing conflicts are reduced from 16 to 3.

Also, as with cases 1 and 3, the ingress vehicles is able to make the left-turn from the major roadway with minimal interference with the through traffic. However, the capacity of the left-turn egress movement from the access drive to the major roadway is very limited even under moderate traffic volumes since this maneuver must yield to through traffic approaching from the right as the left-turn ingress traffic.

Case 5: Left-turn egress from two approaches, Figure A-5-5. This design provides egress opportunities when drives are located opposite each other. The number of conflicts are reduced from 24, of which 16 are crossing conflicts, to a total of 8, of which only 2 are major conflicts. Traffic turning left from a driveway must yield to all other movements; thus, the elimination of the crossing and the left-turn ingress maneuvers greatly increases the left-turn egress capacity of both access drives.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-5: Description (Continued)

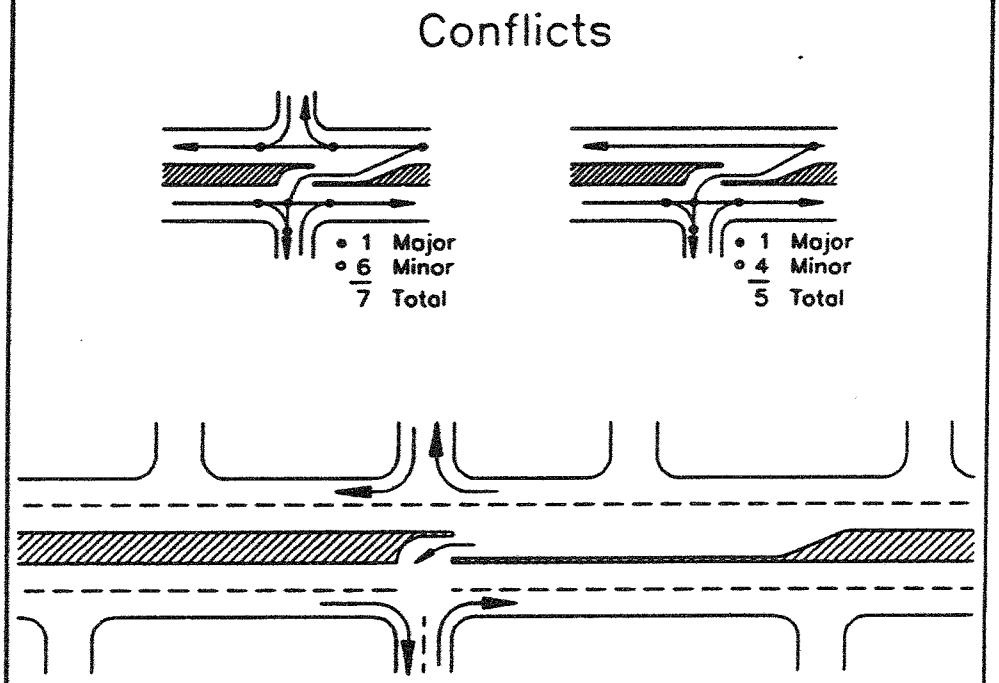


FIGURE A-5-1: LEFT TURN INGRESS FROM ONE DIRECTION ONLY

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-5:
Description
(Continued)

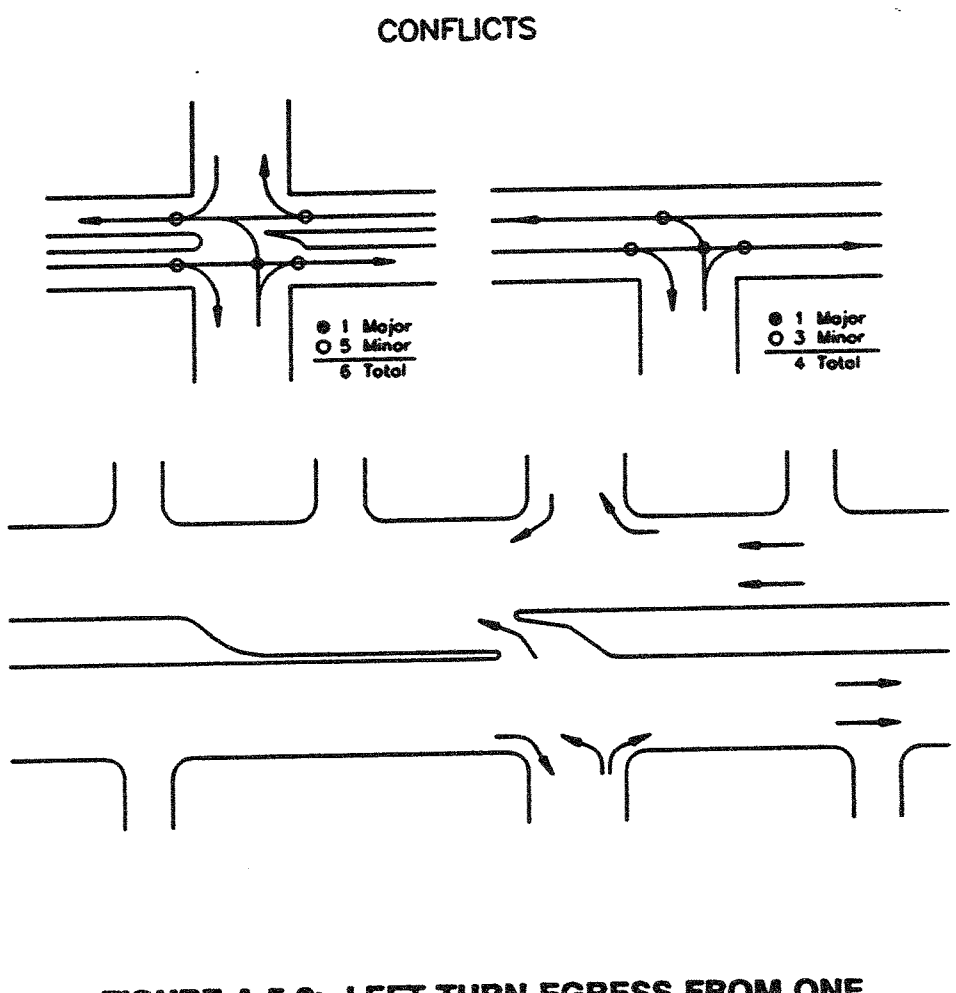


FIGURE A-5-2: LEFT TURN EGRESS FROM ONE APPROACH ONLY

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-5:
Description
(Continued)

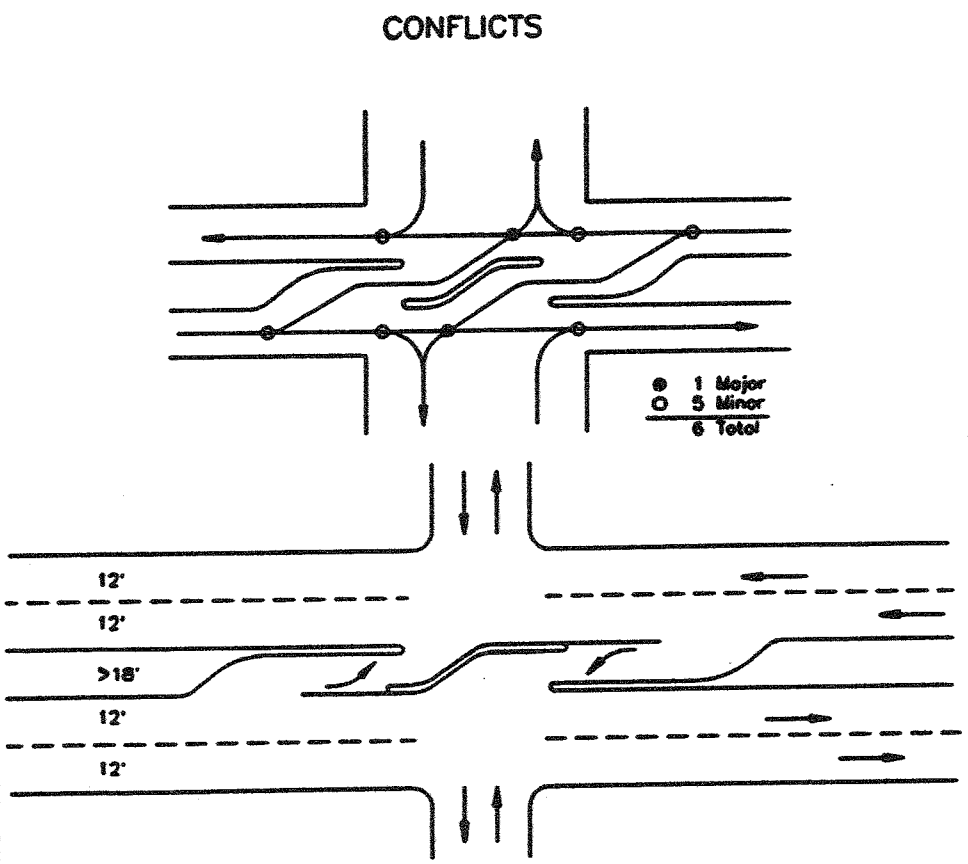


FIGURE A-5-3: LEFT TURN INGRESS FROM BOTH DIRECTIONS

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-5:
Description
(Continued)

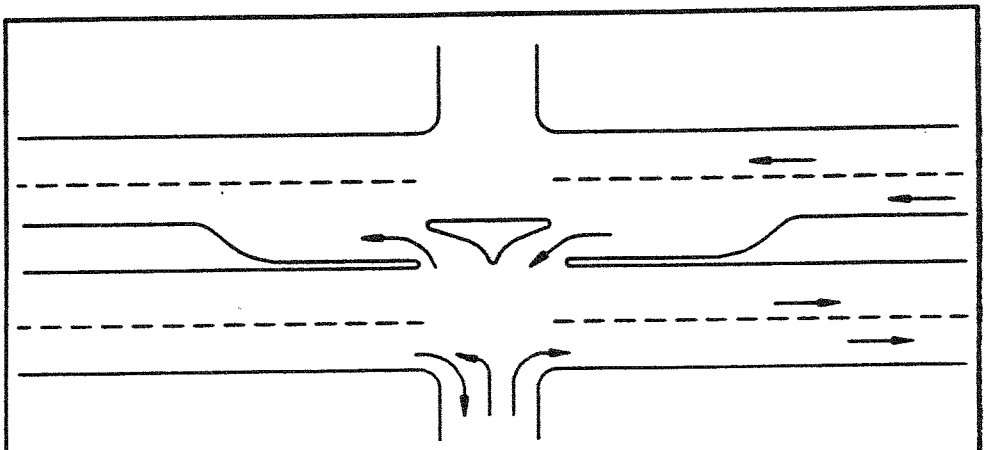


FIGURE A-5-4: LEFT TURN INGRESS FROM ONE DIRECTION AND LEFT TURN EGRESS FROM ONE APPROACH

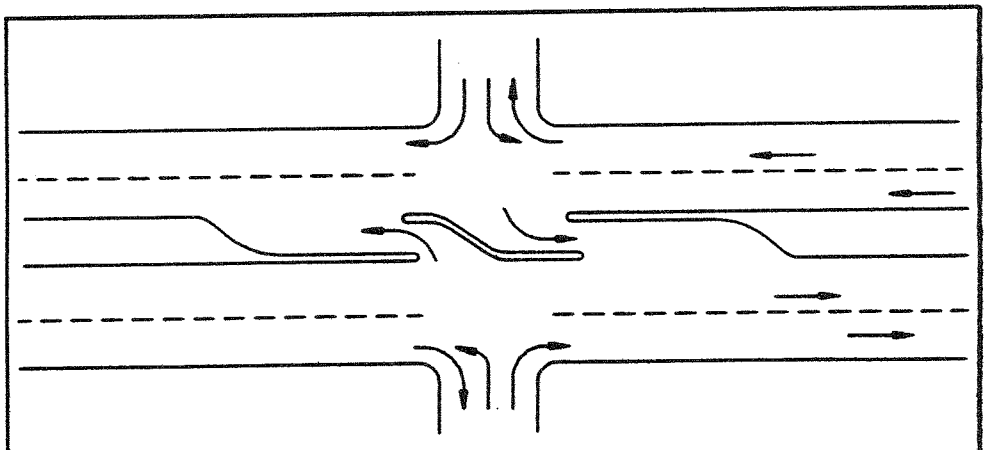


FIGURE A-5-5: LEFT TURN EGRESS FROM TWO APPROACHES

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-5: Application	The 5 variations of this technique are applicable to all major divided roadways. It has been found to have a lower accident experience than continuous left-turns lanes under the high volume conditions encountered on major urban arterials.
A-5: Design	A minimum median width, measured face-to-face of curbs of at least 18 feet is needed to accommodate the variations of this design. This width will accommodate a 12 feet turn lane with 3 feet wide non-traversable median noses at the opening. A median of 28 to 30 feet is desirable in order to provide a 12 foot turn-lane and median noses which are 7 to 8 feet wide face-to-face of curbs. This will provide 6 or 7 feet between the bulks of curbs for landscaping which will help delineate the location and the geometrics of the median opening. This landscaping will help the driver determine which maneuver(s) are and are not permitted at the particular median opening. Where right-of-way is extremely limited, a 14 foot median, face-to-face of curbs might be employed with 11 or 12 feet turn lane, this will result in median noses which are only 18, or 12 inches wide. The only treatments than can be applied to aid in making the curbs visible are reflectorized yellow paint with reflectorized yellow pavement markers and/or reflectorized 18 or 24 inch plastic pylons.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-6: Median Closure To Restrict Ingress And Egress Vehicles

A-6: Description

This technique is a limiting application of Technique A-5. It is most commonly employed where a narrow median exists and/or where there are an excessive number of closely spaced median openings in a non-traversable median. A variation of the technique involves the installation of a concrete safety barrier (New Jersey barrier) to replace a continuous 2-way left-turn lane. Closure of median openings, or installation of a barrier eliminates left-turn ingress and left-turn egress maneuvers; at a 4-way intersection it also eliminates crossing maneuvers. Thus, the total number of conflicts is reduced from 9 to 2 at a 3-way intersection and from 24 to 2 of a 4-way intersection. All of the major conflicts are eliminated. See figure A-5-6.

A-6: Application

Closure of median openings is application on multi-lane divided highways with speeds over 30 mph. It is particularly applicable on highways having medians which are too narrow to provide channelized left-turn lanes or where a small number of left-turn ingress and/or egress movements (and/or crossing movements where two access points are situated directly opposite each other to create a 4-way intersection) result in a safety problem.

Installation of a concrete safety (New Jersey) barrier may be applicable to prevent left-turns and crossing maneuvers as either a permanent solution or a temporary measure until a non-traversable median with channelized left-turns can be constructed. Typical application includes sections of continuous 2-way left-turn where speeds exceed 30 mph, the ADT exceeds 40,000 vpd and there are more than 30 access points per mile.

A-6: Design

A median of at least 4 feet, face-to-face of curbs is necessary in order to provide a landscaping treatment which will provide visibility of the median. Where a 4-way intersection (either public streets or where two drivers are located opposite each) the median treatment must clearly indicate to the driver that a right-turn only is permitted. Particular care must be given to ensure communicate this information at night.

(Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-6: Design (Continued)

The landscaping materials must be selected with so that they delineate the median but do not obscure sight distances. Special care needs to be taken in the design and choice of landscaping so that very minimal maintenance is needed since it is extremely hazardous to maintain landscaping in narrow medians. If a median of less than 4 feet must be used, reflectorized pavement markers and 18 or 24 inch reflectorized pylons should be used.

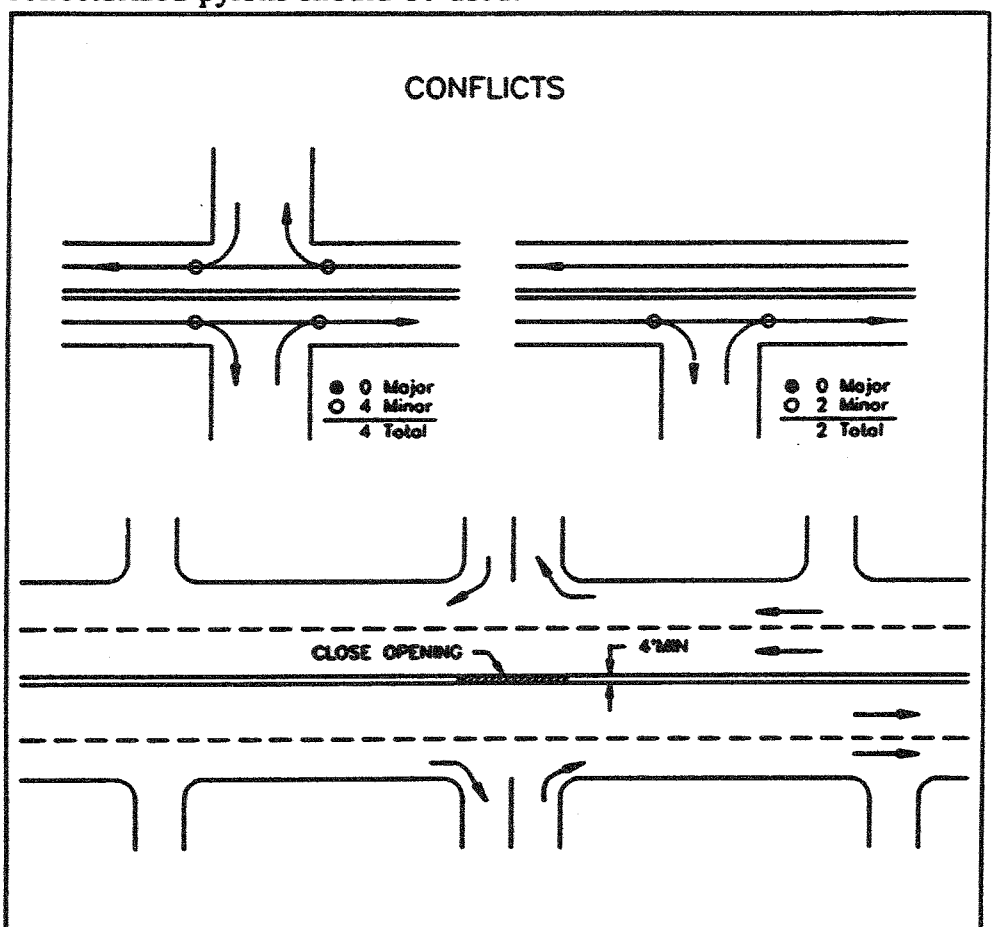


FIGURE A-6-1: MEDIAN OPENING CLOSURE TO RESTRICT INGRESS AND EGRESS VEHICLES

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-7: Install Divisional Island To Discourage Entry Into Left Turn Bay When Weave Area Is Inadequate

A-7: Description

When the location intersection of a public street, or private drive, drivers may execute a job maneuver into a left-turn bay as illustrated in Figure A-7-1. Installation of a properly designed raised barrier as illustrated in Figure A-7-2 will require drivers to make a right-turn to the outside through traffic lane and provide a positive control on access to the left-turn lane.

Implementation of this technique eliminates the dangerous conflict between the vehicles executing the jog maneuver and the through traffic lanes. It also eliminates the hazardous conflict between vehicles which have entered, or in the process of entering, the left-turn bay.

A-7: Application

This technique should be considered when a safety problem is evidenced by: (1) right-angle collisions between vehicles entering the roadway from the original marginal access; (2) collision between vehicles in the turn bay and vehicles entering downstream from the marginal access; (3) rear-end collisions in the turn bay, or; (4) Vehicles are observed to stop in the through traffic lane when attempting to enter the turn bay.

A-7: Design

Suggested minimum dimensions are given in Figure A-7-2. As illustrated in Figure A-7-3, it may be necessary to lengthen the turn bay when implementing this technique. The barrier should be at least two feet wide, preferably at least four feet, in order to give it reasonable visibility. Reflectorized pavement markers are suggested to enhance night-time visibility. A curb three or four inches in height will minimize the risk of a driver losing control of the vehicle in the event of contact with the curb and still present a positive deterrent for drivers to enter the turn bay by crossing the barrier. The leading, upstream, end of the barrier might be constructed with a 1:4, or flatter, slope to minimize the danger of the driver loosing control, or damage to the vehicle, if impact is made with the leading end.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-7: Design (Continued)

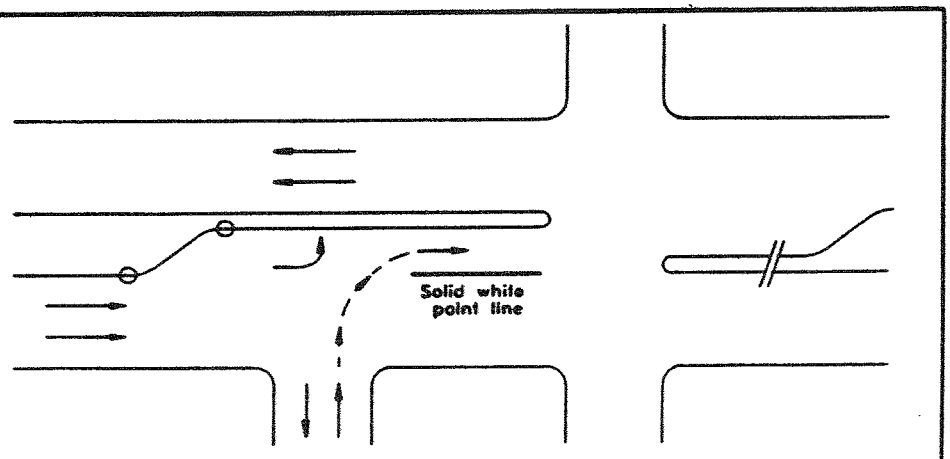
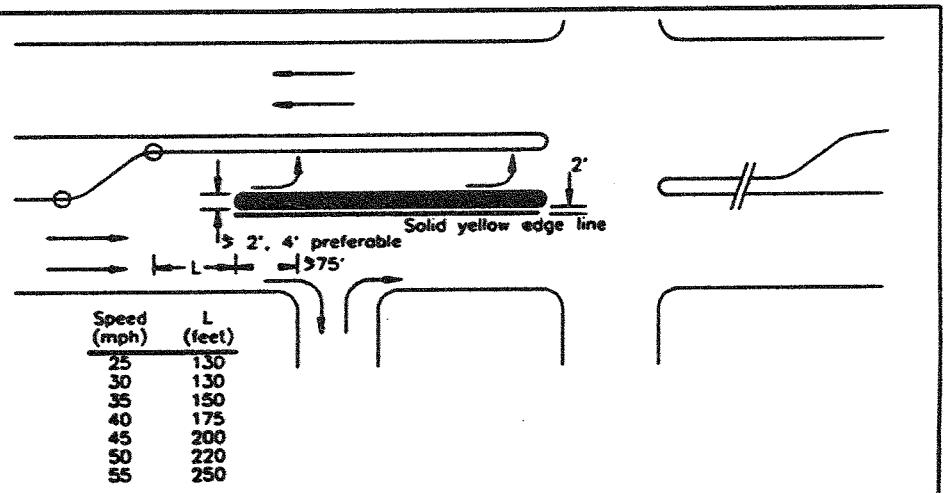


FIGURE A-7-1: SCHEMATIC ILLUSTRATION OF JOG MANEUVER WHERE WEAVE LENGTH IS INADEQUATE



Speed (mph)	L (feet)
25	130
30	130
35	150
40	175
45	200
50	220
55	250

FIGURE A-7-2: SCHEMATIC ILLUSTRATION OF RAISED BARRIER TO DISCOURAGE JOG MANEUVER WHEN WEAVING DISTANCE IS NOT ADEQUATE

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-7:
Design
(Continued)

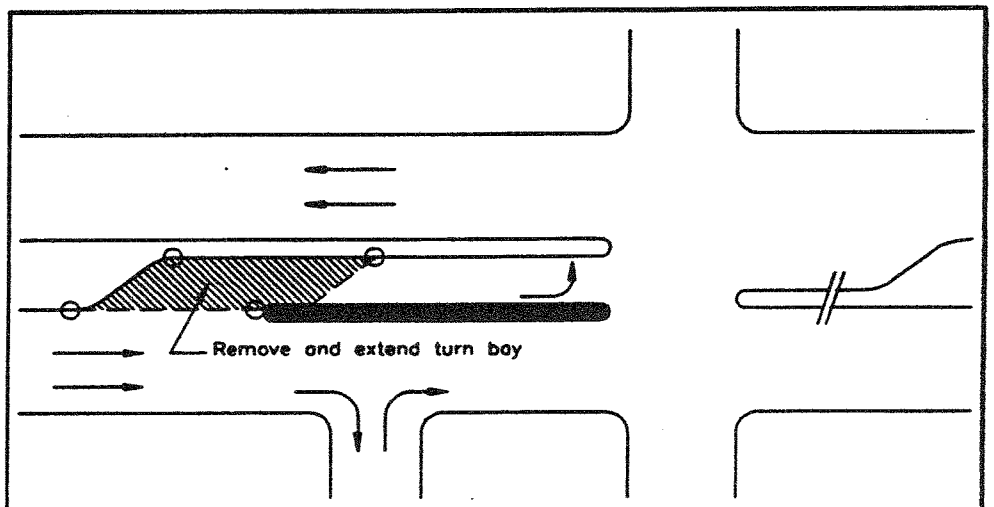


FIGURE A-7-3: IMPLEMENTING CONTROL ON ENTRY TO LEFT TURN BAY MAY REQUIRE INCREASING THE LENGTH OF THE TURN BAY

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-8: Install Physical Barrier To Prevent Uncontrolled Access Along Property Frontages

A-8: Description

The installation of a physical barrier along a single property or many adjacent frontages is a design technique for controlling access on all kinds of highways. The control of access can be accomplished by erecting fences, barriers, plantings, or curbs adjacent to the roadway or shoulder. Possibilities exist for the construction of rock walls, rail fences, or other structures that are compatible with the aesthetics of the area. Curbing, however, is the most common method.

This design technique reduces the total area of conflict by controlling and defining driveway openings. The frequency of conflicts is reduced because the number of possible conflict points is limited to the defined driveway openings.

A-8: Application

This technique is applicable on all roadways to which access is unrestricted. In general it will result in a benefit/cost ratio greater than one when the highway ADT exceeds 10,000 vpd and the level of development is greater than 45 driveways per mile, or, for individual properties, where the site traffic exceeds 500 vpd. High accident rates involving the open access situation will also warrant this technique.

A-8: Design

Regulation of uncontrolled access along property frontages can be accomplished by the following methods:

- Barrier
- Curbing
- Shrubbery
- Railing

Of the above, curbing is widely used due to: (1) ease of installation; (2) low maintenance; and (3) effectiveness. Care, however, must be exercised when placing curb to review not only the impact on control of access, but also its affect on the site and roadway drainage. A landscaped strip between the back of the curb and the on-site parking and circulation will help drivers identify the access drives by providing positive delineation of the edge of the roadway.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-9: Install Median Channelization To Control Merge Of Left Turn Egress Vehicles

A-9: Description

The installation of a channelizing island in a median opening will serve to control driveway access by channeling left-turning vehicles into and from the driveway.

This technique should reduce the frequency of conflicts associated with left-turn egress vehicles because it reduces the total area of the merge conflict. In addition, it forces the left-turn vehicle to merge at a relatively flat angle, thereby minimizing the speed differential with through vehicles.

A-9: Application

This technique is expected to produce a cost/benefit ratio greater than one on divided highways with greater than 10,000 vpd and at driveways with greater than 50 left-turn egress vehicles during the peak hour. The site should be characterized by a history of merge conflicts associated with left-turn egress vehicles.

A-9: Design

Application of this technique is best-suited for multi-lane divided highways.

Construction of the channelization island should reflect:

- Clearly-defined path for egress movement
- Adequate safety area to contain merging vehicles
- Adequate merging lane width
- Elimination of bottleneck conditions

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-9:
Design
(Continued)

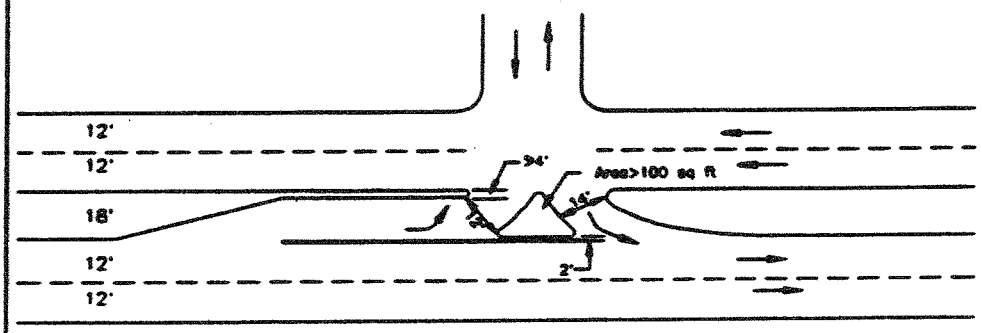


FIGURE A-9-1: CHANNELIZATION TO CONTROL LEFT TURN EGRESS

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-10: Offset Opposing Driveways

A-10: Description

This technique involves the longitudinal separation of driveways on opposite sides of the highway, and it can be implemented either at existing locations or as an optimization practice when authorizing driveway permits.

Offsetting driveways should be considered if opposing driveways are causing crossing conflict problems. The separation distance will better facilitate driveway-to-driveway maneuvers and will eliminate the concentrated conflict area that is present with opposing driveways.

The functional objective of offsetting driveways is to limit the number of conflict points. Conflict points are reduced from 32 for directly opposing driveways (4-leg intersections) to 18 for the two offsetting driveways (two 3-leg intersections). The more severe crossing conflicts decrease from 16 to 6.

Implementing this technique will cause an increase in the frequency of left-turn ingress and right-turn egress maneuvers. An increase in weaving maneuvers also results.

A-10: Application

This technique can be implemented on undivided highways having an ADT of less than 10,000 vpd and with speeds between 30 and 45 mph. Property frontage must be sufficient to accommodate the 300-ft driveway separation. Accident experience could also justify the application of this technique.

A-10: Design

Greater interference with through traffic is likely when the driveways are offset as shown in Figure A-10-1-B. The right-turn egress to left-turn egress maneuver poses a greater threat to traffic safety than does the left-turn egress to right-turn ingress maneuver. Maximum benefits are obtained when driveways are separated by at least 300 feet.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-10: Design (Continued)

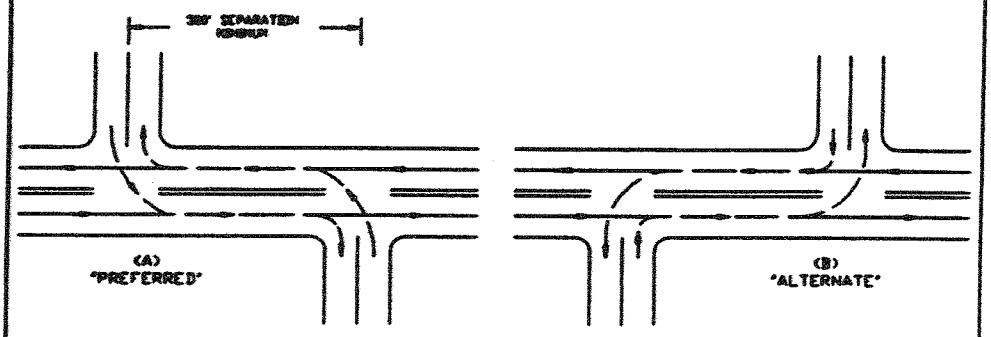


FIGURE A-10-1: DIFFERENCE IN WEAVING MANEUVERS RESULTING FROM DRIVEWAY OFFSET CONFIGURATION

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-11: Locate Driveway Opposite A Three-Leg Intersection Or Driveway And Install Traffic Signals Where Warranted

A-11: Description

This measure involves locating a driveway opposite a three-leg intersection which is suitably located for future signalization, or is already signalized. This can be accomplished either during the driveway permit authorization process or by relocating an existing driveway. Locating the driveway opposite an existing three-leg intersection rather than at a neighboring location will reduce the number of access drives and relocate the conflicts to the signalized intersection where they are separated in time.

The number of conflict points is reduced from 18 (9 each for the two separate three-leg intersections) to 10 for three-phase signalization of a 4-leg intersection. The more severe crossing conflict points are reduced from 6 to 3.

A-11: Application

This technique is applicable on all roadways where sufficient frontage is available to locate a driveway opposite a three-leg intersection or driveway.

A-11: Design

The geometric design of the intersection and the design of the signal installation should conform to the same criteria as the functional equivalent of the intersection of two public streets.

All traffic signal installations need to meet at least one of the warrants in the MUTCD.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-12: Install Two One-Way Driveways In Lieu Of One Two-Way Driveway

A-12: Description

This access control technique involves the opening of two one-way driveways (see Figure A-12-1). Although it appears that this technique may decrease the overall safety of the location by increasing access points, it actually may increase safety through the reduction in total conflict points.

The two one-way driveways, by limiting the turning maneuvers that can be made at each driveway, will have 8 conflict points, 2 of which are crossing conflict points. A two-way driveway has 9 conflict points, of which 3 are crossing conflict points. The overall benefit of implementing this technique is that 1 crossing conflict point is eliminated.

A-12: Application

This technique is applicable on undivided roadways. (Note: not applicable at point locations) Highway speeds should be less than 35 mph. Frontage widths should be at least 150 feet, to ensure that minimum driveway separation distances can be attained.

A-12: Design

Several considerations must be made in order to effectively apply this technique including: traffic volume, geometry, and roadway width. As a rule, the greater the distance between the driveways, the more efficient and safer will be traffic operations.

Chapter 3 contains minimum driveway separation distances applicable under this control measure. It is important that adequate internal circulation be provided when using this technique so that traffic, once having entered the site, does not have to exit and then re-enter in order to circulate on the property.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-12: Design (Continued)

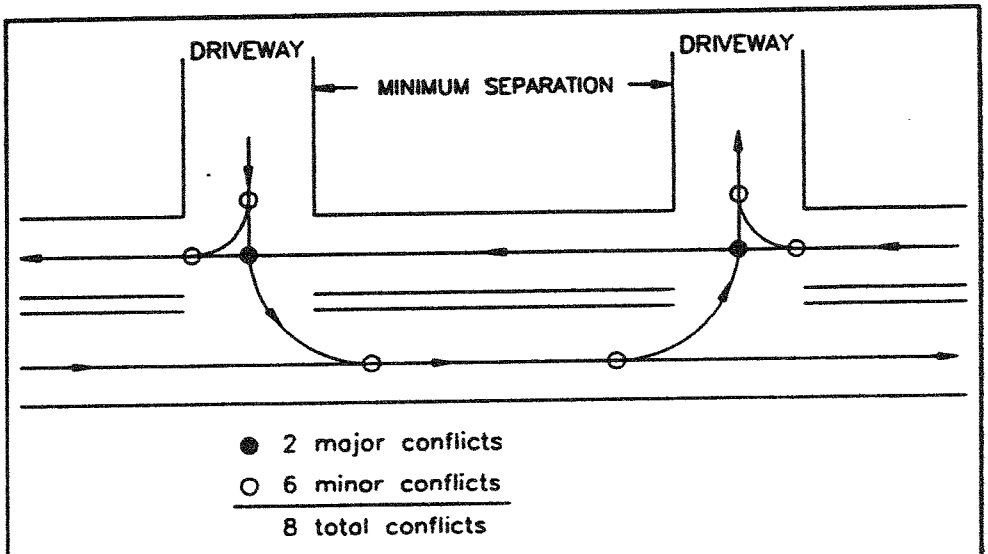


FIGURE A-12-1: MINIMUM DRIVEWAY SPACING

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-13: Install Two Two-Way Driveways With Limited Turns In Lieu Of One Standard Two-Way Driveway

A-13: Description	This access control technique is aimed at reducing conflicts at a single driveway location by replacing the single driveway with two limited-turn driveways. The immediate effect of this technique is that conflict points are reduced. A single two-way drive has 9 conflict points. The two driveways will have a total of 6 conflict points, 2 of which are crossing conflict points. A T-Intersection with two-way traffic on the driveway has 9 conflict points, 3 of which are crossing conflict points. Turning velocities can be increased by angling the driveways to receive turning vehicles.
A-13: Application	This technique is applicable at locations on divided highways with a median of sufficient width to provide for a left-turn ingress bay and to "shadow" egress vehicles. Highway ADT should be greater than 10,000 vpd, and highway speeds should be greater than 35 mph. Frontage widths should be at least 200 feet to ensure that minimum separation distances can be attained.
A-13: Design	The driveway angle with the through lanes is typically between 60° and 90° or 45° used in some cases. In urban areas the driveway angle is often nearer 90°. Careful attention must be given to the on-site circulation design to avoid conflicts which will cause traffic problems which will "spill back" to the public street.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-13:
Design
(Continued)

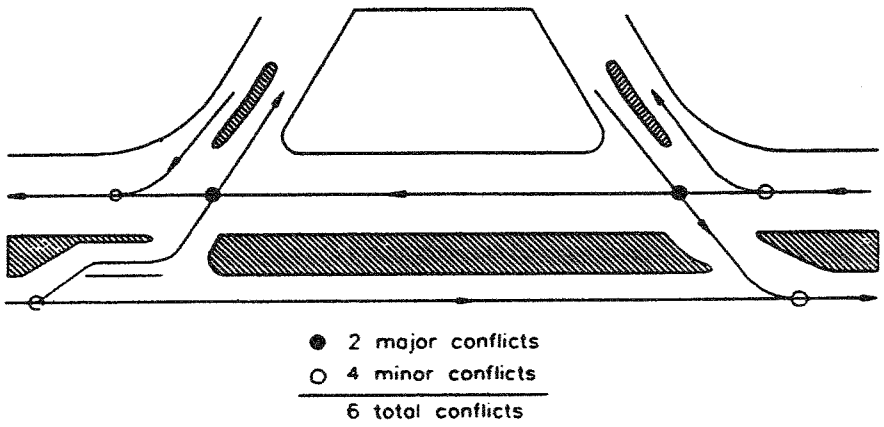


FIGURE A-13-1: CONFLICT POINTS FOR TWO-WAY DRIVEWAYS WITH LIMITED TURNS

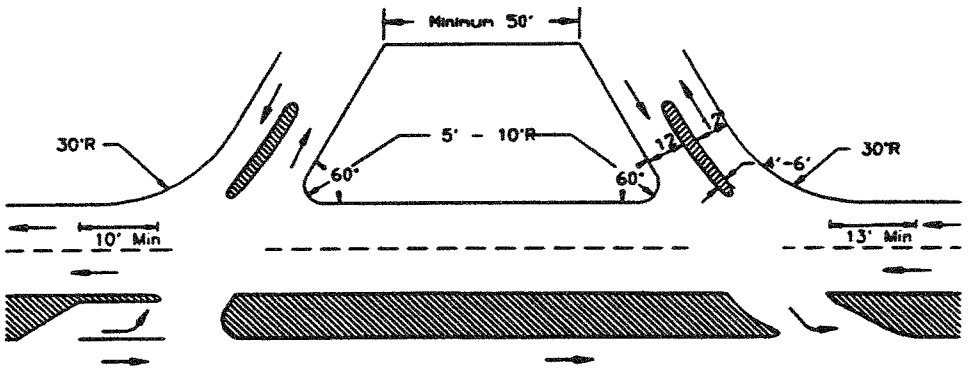


FIGURE A-13-2: TWO-WAY DRIVEWAYS WITH LIMITED TURNS

(Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-14: Install Two One-Way Driveways In Lieu Of Two Two-Way Driveways

A-14: Design (Continued)

This driveway operations technique is aimed at limiting the number of conflict points at a single property. Specifically, it reduces the number of crossing conflict points by changing driveway operations from two two-way driveways to two one-way driveways. This technique can be applied during the permit-authorization stage or at existing sites with appropriate reconstruction. The directional control accompanying one-way operations will result in improved driveway and highway operations by allowing a smaller variety of maneuvers to be made at each driveway.

Accident frequencies are expected to decrease because the total number of conflicting points will be reduced from 18 to 8. Four crossing, three merge, and three diverge conflict points are eliminated at the two driveways. Accident severities are not expected to substantially decrease.

Possible detrimental effects may occur because turns made into, or from, the wrong driveway may initiate a severe conflict. Also, if a vehicle misses the intended entrance driveway, no other opportunity will exist to enter the other driveway.

A-14: Application

This technique is applicable at point locations on all types of highways where highway speeds are less than 50 mph and traffic volumes greater than 10,000 vpd. Driveway volumes should be greater than 300 vpd. Frontage width requirements are determined by the driveway separation and highway speed. The minimum acceptable frontage width is 120 feet, for a highway speed of 20 mph.

A-14: Design

The driveways should be operationally arranged so that the one-way directions are egress and then ingress proceeding downstream. This does not conform to driver expectation. It also places weaving on the street. Table A-14-1 lists the recommended driveway separation distances to be used with this technique.

(Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-14:
Design
(Continued)

TABLE A-14-1: RECOMMENDED DRIVEWAY SPACING DISTANCES

Speed (mph)	Minimum Spacing	
	Eliminate Right Turn Conflict Overlap[a]	Minimum Maneuver Distance[b]
30	185	325
35	245	425
40	300	525
45	350	630

a) Values from Table 3-14
b) Values from Table 3-3

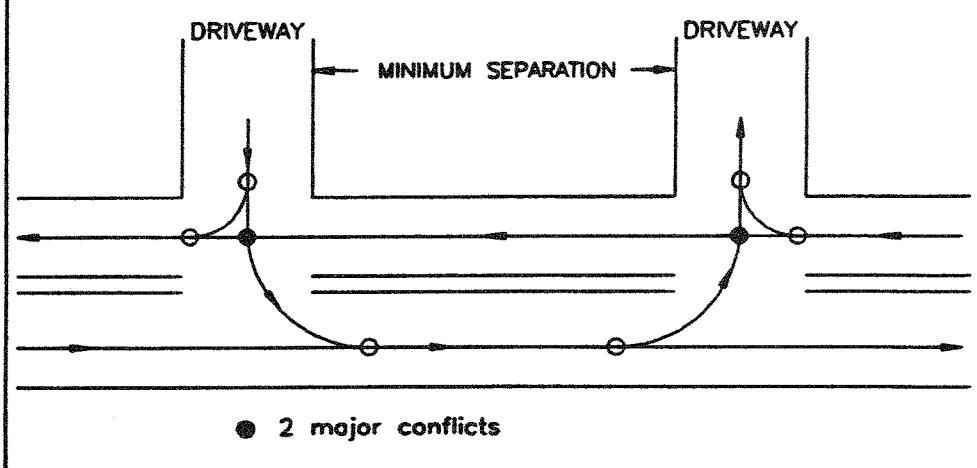


FIGURE A-14-1: TWO ONE-WAY DRIVEWAYS IN LIEU OF TWO TWO-WAY DRIVEWAYS

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-15: Install Two Two-Way Driveways With Limited Turns In Lieu Of Two Standard Two-Way Driveways

A-15: Description

This technique can be implemented during the permit authorization stage or at an existing location with appropriate reconstruction.

The technique reduces the frequency of conflicts at a single property from 18 to 6 by eliminating 4 crossing, 4 merge, and 4 diverge conflict points. Accident severities and vehicular delays are not expected to change substantially. Turning velocities can be increased by angling the driveway to receive turning vehicles.

A-15: Application

This technique is applicable at point locations on all types of highways. It is not applicable at point locations. It may be expected to be cost effective where the highway ADT exceeds 10,000 vpd, and highway speeds should be greater than 35 mph, and where at least 40 vph should turn left across through traffic to enter the driveway during peak periods. Frontage widths should be at least 200 feet to ensure that minimum separation distances can be attained.

A-15: Design

In the design of this technique, consideration should be given to limiting the number of conflict points between ingress/egress vehicles and through movements. Access driveway approaches preferably should be positioned between 90°-60° to the highway, and 45° in special cases. On high speed roads, an angle of 60° is preferred to facilitate a higher speed ingress maneuver. This will increase the deceleration distance that must be provided on site. The design is the same as Technique A-13 and special attention must be given to the site circulation design so that on-site conflicts do not result in problems on the public street.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-15:
Design
(Continued)

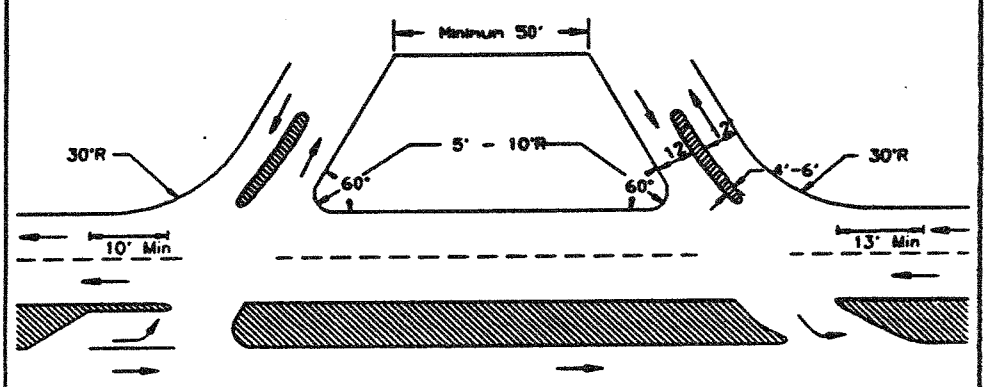


FIGURE A-15-1: ANGLED TWO-WAY DRIVEWAYS WITH LIMITED TURNS

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-16: Install Channelizing Island To Discourage Left Turn Maneuvers

A-16: Description

This driveway attempts to discourage left-turn ingress maneuvers. The left-turn maneuvers are restricted by a channelizing island in the driveway throat.

There are three variations of this technique. They are:

Case 1: Discourage left-turn ingress, Figure A-16-1. The number of conflicts are reduced from 9 to 4.

Case 2: Discourage left-turn egress, Figure A-16-2. Conflicts are reduced to 5, one of which occurs on-site.

Case 3: Discourage left-turn ingress and left-turn egress, Figure A-16-3. This design eliminates all but 2 of the conflicts.

However, the reduction in conflicts is moderated by a possible increase in right-turn and indirect left-turn maneuvers. Travel time may increase to vehicles denied the opportunity to make left turns.

A-16: Application

This technique is applicable as a point control on undivided highways with speeds of 30-45 mph and ADT's greater than 5,000 vpd. High left-turn accident rates will also warrant this technique.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-16: Design

The island construction should be offset a minimum of 2 to 4 feet from the traveled throughway and be of sufficient width to effectively deter unwanted maneuvers.

A radius of between 75 feet and 100 feet should be used in order to make it more difficult for a driver to make a maneuver which the design is intended to discourage. Radii larger than 100 feet should not be used on egress (cases 2 and 3) unless an acceleration lane is provided because of the large angle a driver must rotate one's head in order to see vehicles approaching from the left. The acceleration lane allows the driver to use the rear view mirror to select a gap. This will also provide an island that exceeds the minimum 75 square feet area for triangular islands. A mountable curb, preferably no more than 4 inches high should be used. This curb design and the 2 foot to 4 foot offset will minimize the chances of the curb being hit and, if hit, reduces the chance of the driver losing control of the vehicle. The island should be landscaped with materials appropriate for the local in order to enhance the visibility of the island.

In addition, turn prohibition signs (R3-1, R3-2) as outlined in the MUTCD should be installed.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-16: Design (Continued)

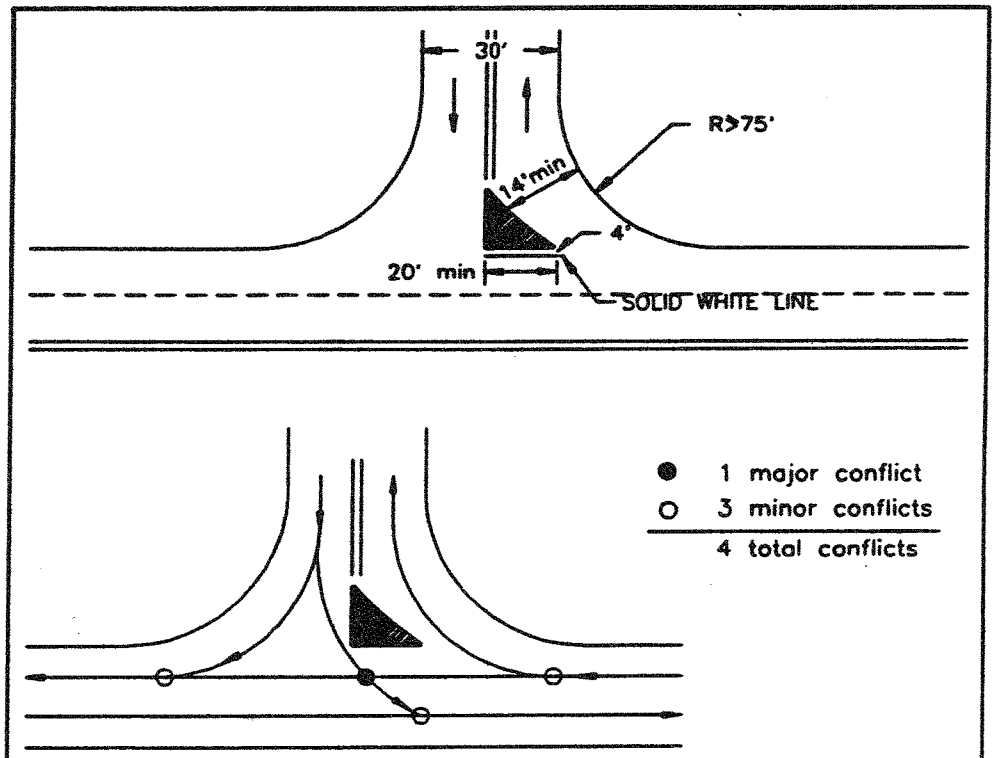


FIGURE A-16-1: DRIVEWAY CHANNELIZING ISLAND TO DISCOURAGE LEFT TURN INGRESS MANEUVERS

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-16:
Design
(Continued)

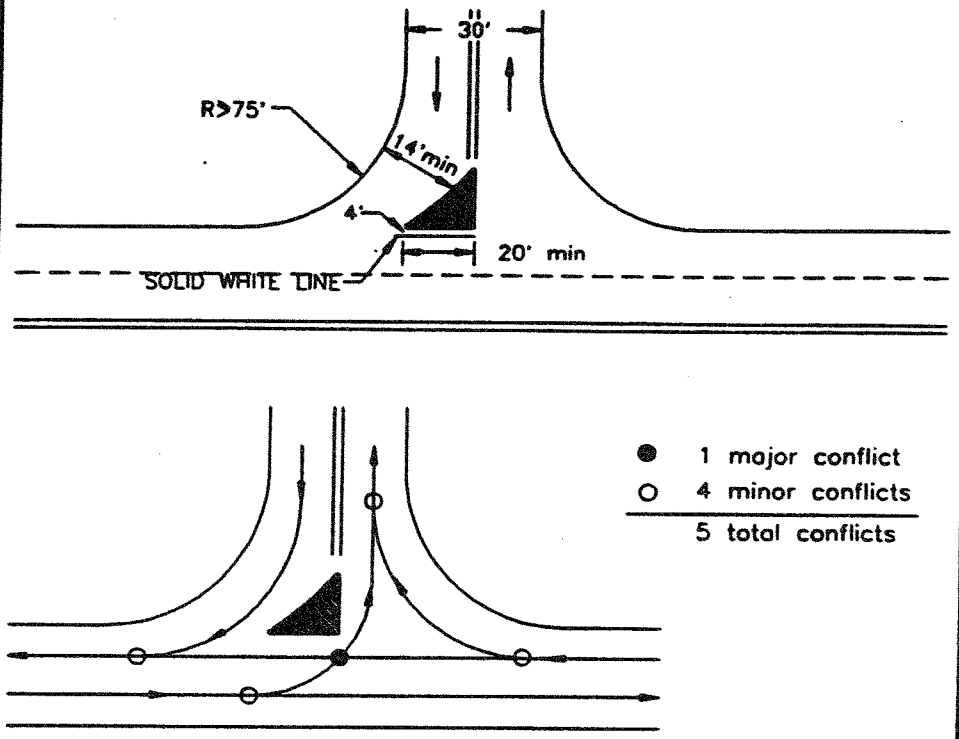


FIGURE A-16-2: DRIVEWAY CHANNELIZING ISLAND TO DISCOURAGE LEFT TURN EGRESS MANEUVERS

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-16:
Design
(Continued)

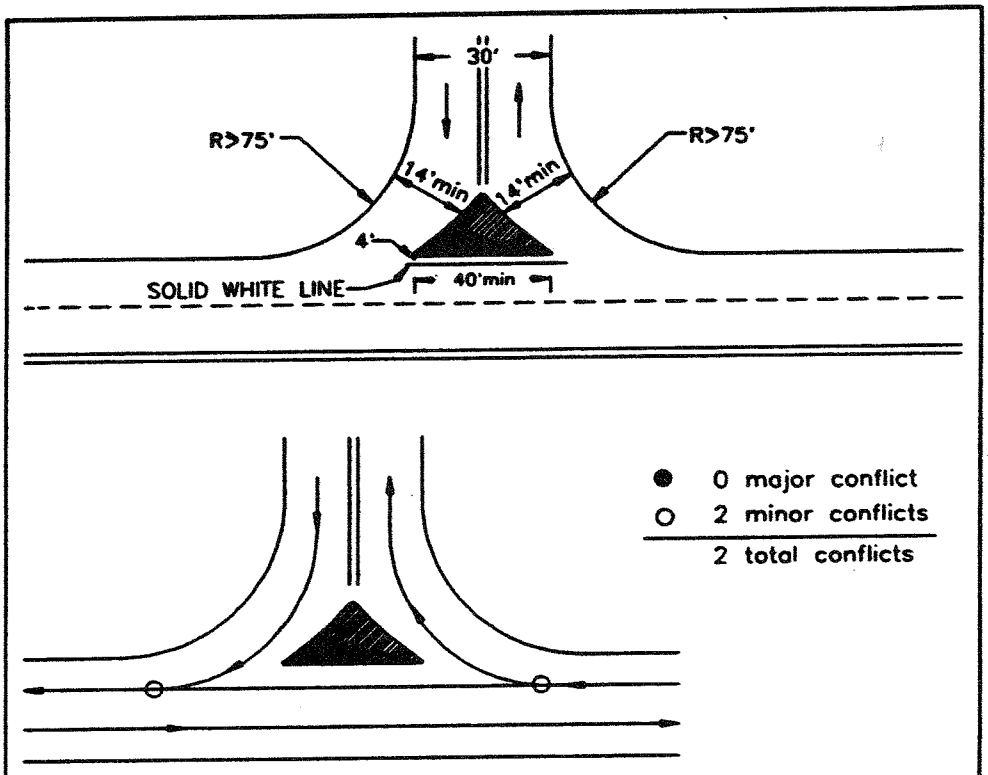


FIGURE A-16-3: DRIVEWAY CHANNELIZING ISLAND TO DISCOURAGE LEFT TURN EGRESS AND INGRESS MANEUVERS

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-17: Install Driveway Divisional Island To Prevent Driveway Encroachment Conflicts

A-17: Description

This access control measure involves the construction of a driveway median island to control ingress and egress vehicle maneuvers. The technique can be applied either to existing driveways or in the permit authorization stage.

The technique will reduce head-on encroachment conflicts between driveway ingress and egress vehicles. Ingress and egress traffic will be directed to separate sides of the driveway median island. Some increases in single-vehicle accidents can be expected due to driveway vehicles striking the island.

A-17: Application

This technique is applicable for driveways with two-way operations on all types of highways. It is particularly applicable to two-way driveways where the throat width is designed to accommodate left-turn and right-turn egress movements from separate lanes and there is a history of driveway head-on accidents between opposing vehicles or between entering and parking vehicles would justify reconstruction to add this treatment.

A-17: Design

Installation of a divisional island driveway should be made to prohibit encroachment by opposing vehicles. The width of the median should be from 4 feet to 10 feet; the length from 25 feet to 120 feet. The offset of the island with respect to the through lanes should be at least 5 feet. If the divisional island is at least 8 feet wide and 100 feet long it should be curbed (4" mountable). Landscaping should be used to provide visibility. Narrow and shorter islands should not be curbed. Instead, these islands should be flush or slightly raised with a contrasting surface. Reflectorized yellow pavement markers help provide delineation and are recommended on high volume driveways. Standard yellow edge lines should be used at the divisional island. Also, white pavement markings should be used to delineate traffic lanes when there are two, or more, lanes in the same direction. Where there is the possibility that truck wheel paths may track over a flush or slightly raised divisional island, a "full strength" pavement should be provided.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-17:
Design
(Continued)

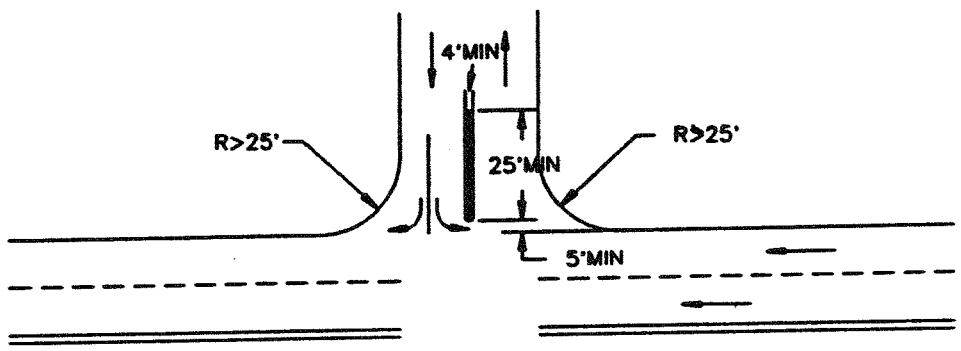


FIGURE A-17-1: DRIVEWAY MEDIAN CHANNELIZING ISLAND

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-19: Install Channelizing Island To Control The Merge Area Of Right Turn Egress Vehicles

A-19: Description

This driveway design technique reduces the frequency of conflicts by reducing conflict areas. The channelizing island will designate the correct right-turn egress path and more clearly define the merge area.

The merge conflict is relocated longitudinally downstream from the immediate driveway intersection. Delay is not expected to change.

A-19: Application

This technique is applicable at driveways serving large development having access to major highways where long curb return radii (≥ 50 ft) are used and/or where it is desired to operate the right-turns under separate traffic control.

A-19: Design

The intent of this design is to control egress movements by directing flow to desired path. Island size and position must be such that presence and function are clearly delineated to the motorist. If the island is less than 75 square feet in area, it should not be curbed. Islands of 50 square feet or less should be delineated by paint (and perhaps reflectorized pavement markers). Islands between 50 and 75 square feet might be designed with a flush or slightly raised (≤ 1 1/2 inches) and contrasting surface; reflectorized pavement markers will help provide night-time delineation. Islands of at least 75 square feet may be curbed. Curb height should not exceed four inches to minimize loss of control in the event it is hit by a vehicle. Landscaping should be used to enhance visibility.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY A: Limit The Number Of Conflict Points (Continued)

A-20: Regulate The Maximum Width Of Driveways

A-20: Description

This is a regulatory practice aimed at reducing conflict areas by defining the maximum width of driveway openings on the highway. The maximum width is a function of the types of vehicles using a facility as well as the nature of the development to be served. This technique is applicable at a point location or as a standard for all driveways. Curbing is usually used to define the extent of a driveway opening.

The reduction in potential conflict areas is expected to be accompanied by a reduction in accident frequencies and severities. No tradeoffs are anticipated by regulating maximum driveway widths.

A-20: Application

This technique is warranted on all highways.

A-20: Design

Maximum driveway widths a function of design parameters appropriate to the expectant vehicle usage. Consideration must be given to highway operating conditions, volume, geometry, sight distance, angle of intersection, and alignment (vertical and horizontal).

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY B: Separate Basic Conflict Areas

Introduction

CATEGORIES OF TREATMENT FOR IMPROVING TRAFFIC FLOW

A. Limit Number of Conflict Points.

B. Separate Conflict Points.

C. Limit Deceleration.

D. Remove Turning Vehicles from Through Lanes.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY B: Separate Basic Conflict Areas (Continued)

B-1: Regulate Minimum Spacing Of Driveways

B-1: Description

The minimum spacing of driveways is a regulatory method used by many agencies to regulate the frequency of access points along highways. This technique can be implemented at existing locations or during the driveway permit authorization stage. Strategies for achieving this objective at existing driveways include closing of driveways or closing and relocating driveways.

This technique indirectly reduces frequency of conflict by separating adjacent, basic conflict areas and limiting the number of basic conflicts points per length of highway. The technique is expected to reduce the severity of rear-end conflicts as it allows more deceleration distance and perception time for motorists. Some tradeoffs may be realized by increasing average delay and rear-end conflicts at driveways as a result of increasing the average volume per access point.

B-1: Application

This access control technique is generally applicable for all types of arterials where conflict areas overlap and delays are excessive. Highways with volumes greater than 5,000 vpd and speed greater than 25 mph are candidates for consideration.

B-1: Design

Table B-1-1 contains desirable separation distances applicable to driveways on all types of roadways.

TABLE B-1-1: DESIRABLE SEPARATION OF ADJACENT DRIVEWAYS

Speed (mph)	Minimum Spacing	
	Eliminate Right Turn Conflict Overlap[a]	Minimum Maneuver Distance[b]
30	185	325
35	245	425
40	300	525
45	350	630

a) Values from Table 3-14
b) Values from Table 3-3

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY B: Separate Basic Conflict Areas (Continued)

B-2: Regulate Minimum Corner Clearance

B-2: Description

This access control standard regulates the distance between a crossroad intersection and the nearest driveway location. In this text, corner clearance is defined as the distance, measured along the back of the arterial curb, from the nearest edge of the intersection.

This technique moves the basic driveway conflict area away from the vicinity of an intersection by regulating the distance from the driveway to the intersection. The major effect is that the minimum spacing of access points is increased, resulting in larger stopping sight distances and driver perception times. An additional effect is that driveway vehicles will be delayed less by standing queues at signal-controlled intersections. A possible tradeoff is that access to some corner commercial properties may be partially or totally denied.

B-2: Application

This technique may be applied on all types of highways where corner lot driveways create conflict and delay problems to through and driveway traffic.

B-2: Design

This technique is aimed at preventing the location of driveways within the functional area of an intersection. It will also minimize driveway/intersection conflicts by preventing blockage of driveways upstream of an intersection due to standing traffic queues. Minimum driveway setback distances should take into consideration typical traffic queue lengths while permitting sufficient movement to driveway vehicles.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY B: Separate Basic Conflict Areas (Continued)

B-3: Regulate Minimum Property Clearance

B-3: Description	The regulation of minimum property clearance distances is an access control standard that helps increase the minimum spacing of access points. Property clearance is the distance, measured along the arterial curb, from the extended property line to the nearest edge of the driveway. Conflicts will be at adjacent driveways at properties having a common property line.
B-3: Application	This technique may be applied on all highway types in the permit authorization stage.
B-3: Design	On local and minor collector roadways the minimum property clearance will be the curb return radii. If no radius (a "dustpan design") is used, the minimum clearance should be at least 25 feet. On major arterials, the property clearance should be at least equal to the deceleration distance needed for the operating speed of the roadway.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY B: Separate Basic Conflict Areas (Continued)

B-4: Optimize Driveway Spacing In The Permit Authorizing Stage

B-4: Description	This is a general operating practice that maximizes the spacing of adjacent driveways during the permit authorization stage. The technique is intended to supplement the operational benefits expected from Technique B-1, "Regulate Minimum Spacing of Driveways." This technique indirectly reduces the frequency of conflicts by separating adjacent conflict areas and limiting the number of basic conflict points per length of highway. The implementation of this technique is expected to reduce the severity of conflicts as it allows more deceleration distance and perception time between driveways.
B-4: Application	This technique is applicable on arterial and collective roadways. Application is limited to the permit authorization stage.
B-4: Design	This technique is aimed at maximizing the spacing between adjacent driveways along an arterial. Application of this technique is intended to supplement the information contained in Technique B-1. Figure B-4-1 contains two arrangements: (a) minimum non-optimized driveway spacing, and (b) optimized driveway spacing.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY B: Separate Basic Conflict Areas (Continued)

B-4: Design (Continued)

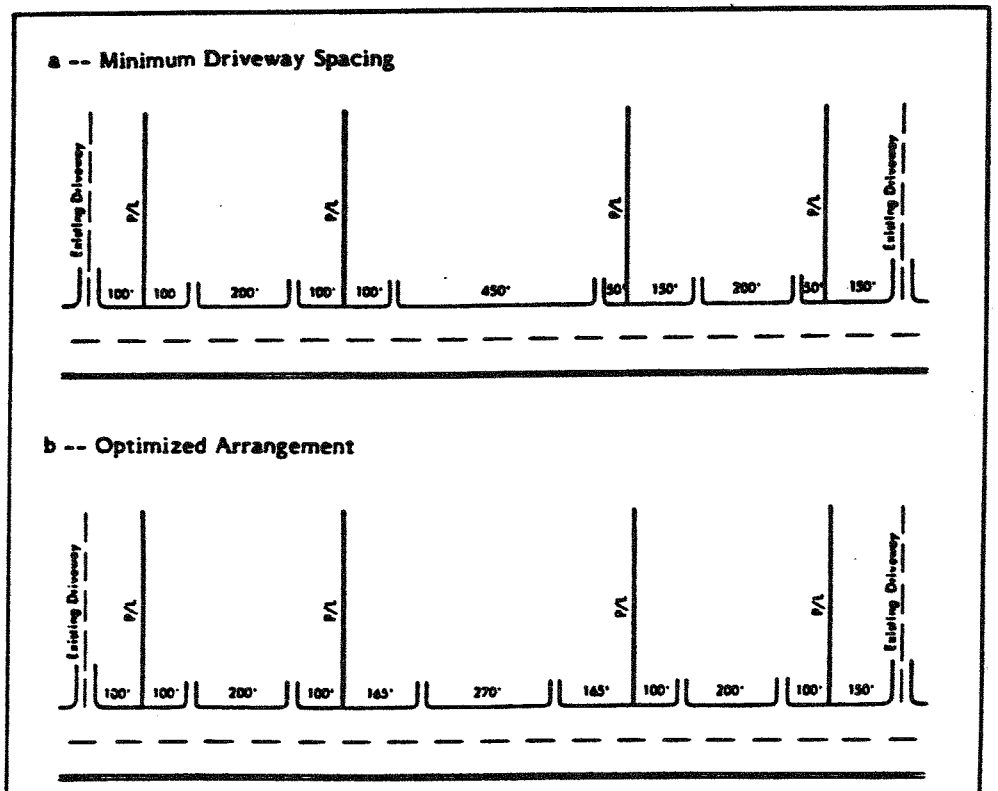


FIGURE B-4-1: OPTIMIZED DRIVEWAY PLACEMENTS

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY B: Separate Basic Conflict Areas (Continued)

B-5: Regulate Maximum Number Of Driveways Per Property Frontage

B-5: Description

This general access control standard limits the number of driveways per property relative to the length of available frontage. It is a route alternative that minimizes the number of driveways per length of highway.

Generally, regulating the maximum number of driveways per property frontage limits the number of conflict areas and provides turning drivers more time and distance to execute their maneuvers.

Basic conflict points will be reduced proportionately to the reduction in driveways. This results in a reduction in the frequency of conflicts. The severity of conflicts should also decrease because deceleration requirements are lessened.

If, because of the application of this technique, traffic volume increases significantly at existing driveway locations, an increase in the frequency of conflicts at these locations is likely. Also, regulating the number of driveways permitted for specific frontage length could have significant impact on the business activity at that location. These problems should be considered before denial for an additional driveway is given or before an existing driveway is closed.

B-5: Application

The application of this access control measure is applicable on all existing arterial highways or as a standard for all new facilities.

B-5: Design

- Neighborhood commercial development located on the corner of an arterial and collector should be restricted to access on the collector only.
- On major arterial roadways, access should be limited to a single drive unless the frontage exceeds 1/4 mile.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY B: Separate Basic Conflict Areas (Continued)

B-6: Consolidate Access For Adjacent Properties

B-6: Description

This general operating practice encourages adjacent property owners to construct joint-use driveways in lieu of separate driveways. Strategies for implementing this technique include closing existing driveways or encouraging joint-use driveways.

The feasibility of this technique is viewed primarily at the permit-authorization stage. The joint driveway will cause a reduction in the concentration of driveways along an arterial. The reduction in driveway concentrations is expected to be accompanied by a reduction in the frequency and severity of conflicts.

B-6: Application

This technique is applicable on all major roadways with speeds greater than 35 mph. Driveway pairs with more than 50 vehicles using each driveway per hour will be good candidates for this technique.

B-6: Design

The physical means by which access can be consolidated between two adjacent properties involves construction of a joint use driveway between the two properties. It is recommended that both owners have property rights in a joint-use driveway. That is, the drive should be located straddling the property line with each having a permanent easement on the other. This practice will not enable either owner the opportunity to deny or restrict access to his neighbor's property.

The resulting parking area should have an efficient internal circulation plan.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY B: Separate Basic Conflict Areas (Continued)

B-6: Design (Continued)

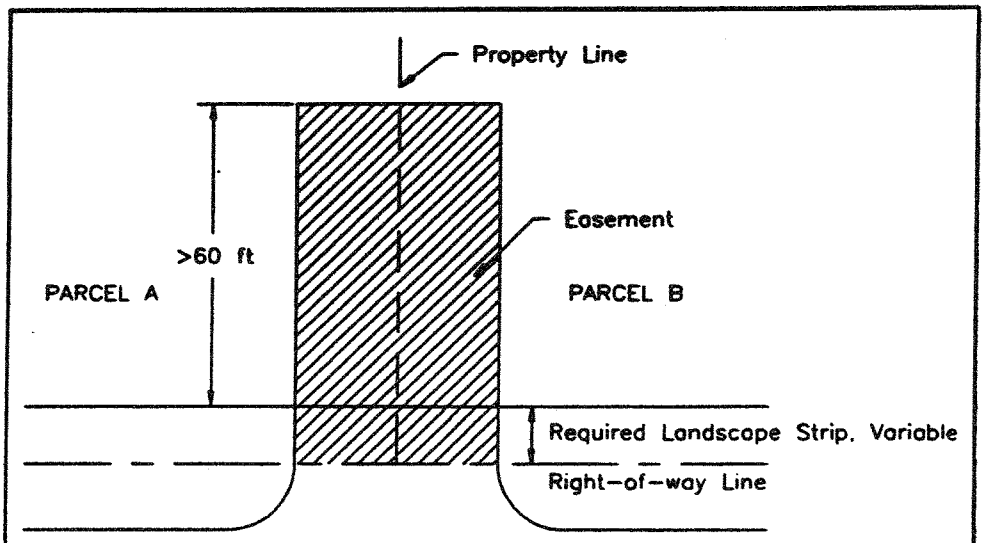


FIGURE B-6-1: SHARED ACCESS DRIVE

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY B: Separate Basic Conflict Areas (Continued)

B-8: Buy Abutting Properties

B-8: Description	This access control measure is aimed at reducing the frequency of access points by purchasing small parcels that remain after a highway improvement. The several parcels can be consolidated into large tracts and sold with access deed reservations or as a single parcel with only one access drive. This elimination of potential access points can aid substantially in protecting the functional integrity of the highway by minimizing the frequency and severity of conflict points.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY B: Separate Basic Conflict Areas (Continued)

B-9: Deny Access To Small Frontage

B-9: Description	The denial of access to small frontages is a regulatory policy that prohibits direct access to the arterial highway. legal problems are usually encountered and are concerned with the availability of suitable and sufficient access. Compensation will be required if suitable and sufficient access cannot be provided. This technique, as in other regulatory driveway location techniques, separates basic conflict areas by limiting the number of access points. The frequency and severity of conflicts will be reduced because conflict areas are further separated, and driver perception times and distances are increased. The number of frontages which are denied access affects the degree to which the frequency and severity of conflicts is changed.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY B: Separate Basic Conflict Areas (Continued)

B-10: Consolidate Existing Access Whenever Separate Parcels Are Assembled Under One Purpose, Plan, Entity, Or Usage

B-10: Description

This is a general operating practice that requires specific changes on commercial sites when they are assembled for development or redevelopment. The consolidation is accomplished by voiding existing driveway permits upon alteration of the property functions. The new permit authorization depends on the developer's plans to use some existing driveways and close or relocate other driveways.

The objective of this technique is to increase average spacing of access points along the highway. The consolidation of driveways reduces the number of access points and thereby increases the spacing of driveways. The increase in driveway spacing provides motorists of turning vehicles more time and distance to properly execute their maneuvers. The severity of conflicts should decrease because deceleration requirements are lessened.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY B: Separate Basic Conflict Areas (Continued)

B-11: Designate The Number Of Driveways To Each Existing Property And Deny Additional Driveways Regardless Of Future Subdivision Of That Property

B-11: Description

This is a general regulatory policy which designates the maximum number of driveways permitted to each existing property before development. The implementation of this technique requires an advance planning policy with a formal planning document made readily available to abutters. Such policy denies additional driveways regardless of future subdivision of that property.

The objective of this technique is to maintain average spacing of access points along the highway. This objective is achieved by regulating the maximum number of driveways per property frontage. The increase in average driveway spacing provides motorists turning into driveways with more time and distance to properly execute their maneuvers.

This access control measure increases the minimum spacing of access points. This results in a reduction in the frequency of conflicts. The severity of conflicts should also decrease because deceleration requirements are lessened.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY B: Separate Basic Conflict Areas (Continued)

B-12: Require Access On Collector Street (When Available) In Lieu Of Driveways On Major Highway

B-12: Description	This access control technique is aimed at maintaining the movement function of the major roadway by locating additional driveways on collector streets instead of on the arterial highway. This technique will reduce conflict frequency and severity by diverting some driveway vehicles to the collector street location where traffic volumes and speed are lower.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY C: Limit Deceleration Requirements

Introduction

CATEGORIES OF TREATMENT FOR IMPROVING TRAFFIC FLOW

A. Limit Number of Conflict Points.

B. Separate Conflict Points.

C. Limit Deceleration.

D. Remove Turning Vehicles from Through Lanes.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY C: Limit Deceleration Requirements (Continued)

C-2: Restrict Parking On The Roadway Next To Driveways To Increase Driveway Turning Speeds

C-2: Description

This technique increases the turning speed by removing constraining obstacles, specifically parked vehicles, from areas adjacent to driveways. Parked vehicles may indirectly contribute to driveway accidents by limiting the sight distance or influencing the turning paths of driveway vehicles. This technique is intended as a point measure, although route applications are also feasible.

This technique will reduce the severity and frequency of conflicts by removing, and merging, driveway vehicles at higher speeds. Severity is reduced because the speed differential between turning and through vehicles is reduced. Conflict frequency also benefits from the increase in turning velocity. One possible tradeoff that accompanies this technique is a reduction in parking capacity.

C-2: Application

This technique is applicable at any driveway location where parking is permitted.

C-2: Design

Drivers in the outside through traffic lane must have adequate stopping sight distance. Driveway traffic must have adequate intersection sight distance to safely select a gap and to accelerate to the speed of through traffic.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY C: Limit Deceleration Requirements (Continued)

C-3: Install Visual Cues Of The Driveway

C-3: Description

Adequate sight distance and visual realization of the driveway location are very important factors to the safe and efficient operation of driveways and highways. Many existing driveways, however, lack adequate visual cues and are the scene of many vehicular and pedestrian conflicts.

Visual cues of driveways serve to limit maximum deceleration requirements of highway vehicles by increasing driver perception time. Consequently, the severity of conflicts should be lessened. Rear-end conflicts are expected to decrease the most.

C-3: Application

Driveways should be highly visible to the approaching drivers in the through traffic lanes. Visual clues should provide information as to both the location and the geometrics of the driveway to the driver. On major roadways, the driver should be able to locate and identify the driveway at a distance at least equal to the decision sight distance (the perception-reaction distance plus the distance required to maneuver to a turn at a speed of 10 mph or less).

Visual clues should be provided to the presence of any driveway where sight distances equal to or exceeding AASHTO minimums and the sight distance problem cannot be corrected.

C-3: Design

Contrasting surfaces (or materials) are the best method of providing visual clues as to driveway location and geometrics. On major roadways, a landscaped strip should be required between the back of the curb and any paved area, including sidewalks. In no case should the paved site parking and circulation be allowed to extend to the back of the curb. The minimum width of the landscaped area along a major roadway should be at least 25 feet. On major collectors, locating the sidewalk one foot from the property line, and not permitting paving of the right-of-way, will provide visual clues as to a driveway. on minor collectors, a strip 2 to 4 feet wide, between the curb and sidewalk will provide adequate visual clue; if the sidewalk is contiguous with the back of the curb, landscaping at least 4 feet wide should be used.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY C: Limit Deceleration Requirements (Continued)

C-3: Design (Continued)	If circumstances exist such that adequate sight distance can not be provided by removing obstructions or relocating the drive, advanced warning will be required. Consideration must be given to the geometric and grade layout, traffic level, and roadway type. Recommended visual cues include: flashing beacons, warning signs, contrasting pavements, reflectorized treatments, driveway lighting, or any combination of the above mentioned. Installation of warning devices must adhere to recommendations outlined in the MUTCD.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY C: Limit Deceleration Requirements (Continued)

C-4: Improve Driveway Sight Distance

C-4: Description

Adequate sight distance at driveway entrances is required to allow driveway egress drivers a sufficient view of the highway for acceptable gaps, and to provide through drivers the necessary perception, reaction, and braking distances to avoid collision with a driveway-egress vehicle that has entered the highway.

There are numerous causes of reduced sight distance including horizontal and/or vertical alignment, topography, foliage and/or other landscaping, parked vehicles, and physical structures. Statutes should be adopted which authorize the governing jurisdiction to maintain a clear-visibility triangle which has the driveway and main street as two of its legs with the hypotenuse between these two enclosing a prescribed area.

Improved sight distance requires altering existing site conditions to increase the available sight distance at the driveway. The terrain can be altered by cutting down hillsides, removing walls and fences, or moving signs and billboards. Alterations to the roadway include flattening horizontal and vertical curves.

Often commercial establishments with insufficient setback distances and internal parking problems will use the unpaved highway right-of-way for parking. This should be discouraged by municipal or state authorities. If encroachment on public land has contributed to accidents on or off the traveled way, steps should be taken to prohibit and prevent the practice. Stepped-up enforcement of regulations may be an effective deterrent. Other remedies should be tried if more critical problems occupy police time.

C-4: Application

This technique is applicable at all existing driveways where adequate sight distance is not available.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY C: Limit Deceleration Requirements (Continued)

C-4: Design (Continued)	In addition to utilization of information contained in Techniques C-2 and C-3 to increase driveway sight distance, elimination or alteration of physical and geometric barriers should be considered as an enhancement to driveway sight distances. Improved sight distance can result from altering roadway alignment (horizontal and vertical curves) and eliminating physical obstructions (shrubbery, fencing, walls, etc.).

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY C: Limit Deceleration Requirements (Continued)

C-5: Regulate Minimum Sight Distance

C-5: Description	This regulatory policy is designed to control driveway location by imposing minimum sight distance standards for driveways. The policy takes effect by closing and relocating existing driveways or by regulating new driveways in the permit authorization stage. Regulation of sight distance is generally more applicable to suburban-rural locations. The technique enables the driver of a vehicle, which is on the driveway, to see a sufficient distance in both directions along the highway and to enter the highway without creating a hazardous situation. The increased sight distance also decreases the speed differential between highway and driveway vehicles by allowing the through drivers more perception time which helps to reduce maximum deceleration requirements.
C-5: Application	Insuring that adequate sight distance is provided must always be considered in the permit authorization stage. At existing access locations where sight distance is found to be inadequate, corrective action needs to be taken immediately.
C-5: Design	Minimum sight distances should exceed the AASHTO minimums - especially on high volume and/or high speed major roadways.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY C: Limit Deceleration Requirements (Continued)

C-6: Optimize Driveway Location In The Permit Authorization Stage

C-6: Description	This is a regulating reserve policy which considers driveway location through review of the site plan. The review enables the driveway to be located where maximum sight distance is available, consistent with other locational controls and to minimize impact on the public street. Careful location of the driveway enables the driver of a vehicle, which is stopped on the driveway outside the edge of the traveled way, to see a sufficient distance in both directions along the highway to enter the highway without creating a hazardous situation. Drivers in the through traffic lanes are afforded more perception time which helps to reduce maximum deceleration requirements. These conditions lead to a reduction in the severity of conflicts.
C-6: Application	Requests for driveway permits in the authorization stage warrant this access control treatment. All highway types are candidates with particular attention to major roadways.
C-6: Design	Although frontage widths pose some limitations on the actual location, driveways should be located at the point of optimum sight distance along the frontage. This technique attempts to achieve sight distances greater than AASHTO minimums.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY C: Limit Deceleration Requirements (Continued)

C-7: Increase The Effective Approach Width Of The Driveway

C-7: Description

This technique is a driveway design technique aimed at limiting the maximum deceleration requirements on the highway. The technique affects driveway operations by decreasing the time required for the turning vehicle to clear the through traffic lane.

Conflict severity will be reduced with this technique by decreasing the maximum deceleration requirements for following vehicles. This will decrease the severity of the "shock wave" which is created by the turning vehicle.

C-7: Application

This technique has general application to all driveways. It should always be a part of the design process for all planned or reconstructed driveways. Also, it should be considered as a general accident countermeasure for medium-to-high volume existing driveways.

C-7: Design

The speed at which vehicles can safely and effectively negotiate turning maneuvers is governed by several design parameters including: driveway width, return radius, lateral offset, approach angle, and approach flare.

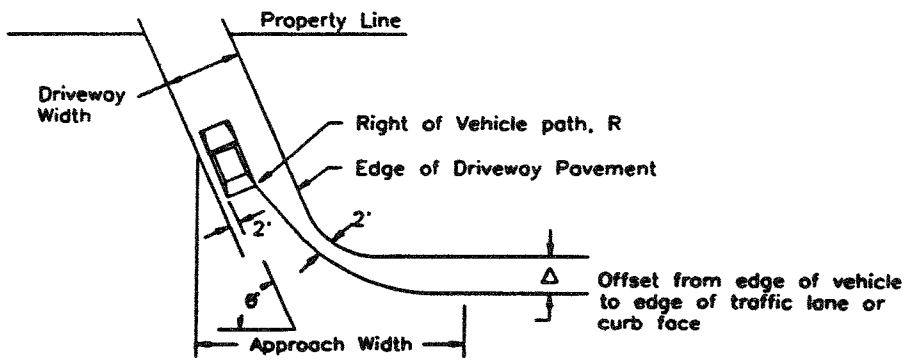


FIGURE C-7-1: DRIVEWAY DESIGN ELEMENTS

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY C: Limit Deceleration Requirements (Continued)

C-8: Improve The Vertical Geometrics Of The Driveway

C-8: Description

This technique is a general design standard for new and existing driveways in which driveway profile guidelines are specified. These guidelines allow vehicles to efficiently execute driveway maneuvers without the vehicle experiencing severe bouncing. Providing adequate driveway profiles will result in desirable driveway operation only when the other driveway geometric characteristics will permit such speeds.

Improving the driveway maneuver will decrease the duration and severity of the conflicts between vehicles in the following traffic which is caused by the turning vehicle.

C-8: Application

Application of this technique is desirable on existing driveways and should be mandatory on all newly constructed or reconstructed driveways and on existing facilities where the driveway profile is adversely affecting traffic operations.

C-8: Design

Adequate design of driveway grades should reflect consideration for basic functions of the highway and the site which the driveway serves. Generally, in order to safely perform ingress/egress maneuvers, driveway profiles should provide for sufficient clearance between the vehicle and driveway surface.

Design guidelines often limit the change in grade that is permitted without the use of a vertical curve.

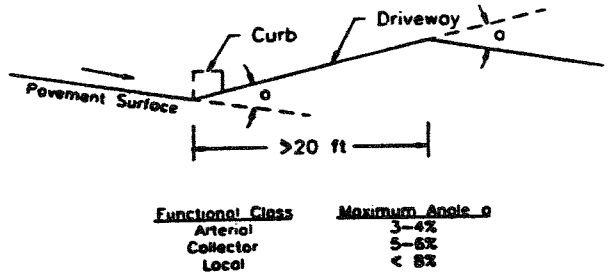


FIGURE C-8-1: VERTICAL DRIVEWAY GEOMETRY

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY C: Limit Deceleration Requirements (Continued)

C-9: Require Driveway Paving

C-9: Description

This technique is a general access control standard in which the structural integrity of the driveway is ensured by using a hard-surface treatment.

Without driveway paving, desired driveway speeds are difficult to maintain because of potholes, ponding, and ill-defined maneuver paths. Also, loose material from the driveway causes a hazardous condition on the through traffic lanes. With paving, interference to through vehicles and conflict severity are reduced because the maximum deceleration requirement is limited.

C-9: Application

Paving should be required for all driveways intersecting major roadways.

C-9: Design

Appropriate driveway thicknesses and surfaces shall be installed to withstand expected driveway usage; and be applied to extend the entire length necessary for a smooth transition between the highway and driveway. Minimum recommended thickness for commercial usage should be based on soil conditions and type and volume of traffic. Typical guidelines include:

- 6" base stone plus 1 1/2" asphalt, or
- 4" reinforced concrete

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY C: Limit Deceleration Requirements (Continued)

C-10: Regulate Driveway Construction (Performance Bond) And Maintenance

C-10: Description	This technique is an access management policy that ensures a permanent and structurally adequate driveway surface. The strategy used in regulating construction is a performance bond that is required prior to construction. Maintenance is regulated by specifications included in the driveway permit, and regular enforcement of these regulations is needed to ensure adequate operations. The functional objective of the technique is to increase driveway speeds which in turn limits the deceleration requirements of through vehicles. A reduction in the severity of conflicts is the anticipated result.
C-10: Application	This technique is applicable for all driveways during the driveway permit process. This policy is most applicable to urban-suburban areas.
C-10: Design	In order to ensure that the construction of a driveway is sound and structurally adequate, a performance bond should be required from the contractor. This bond should be requested prior to construction and be of adequate value to cover any warranty period. Driveway maintenance is typically outlined in the permit-granting stage and plays a necessary function in maintaining adequate driveway operation and service life.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY C: Limit Deceleration Requirements (Continued)

C-11: Install Right Turn Acceleration Lane

C-11: Description

This design technique reduces through-lane deceleration requirements by facilitating higher speed driveway merge maneuvers. The merge maneuver is facilitated by a right-turn acceleration lane for use by right-turn egress driveway vehicles. This technique can be applied both during the permit-authorization stage or at existing facilities.

The speed of driveway to highway merges is increased by allowing driveway vehicles the necessary length to accelerate. The merge maneuver can be accomplished more safely when the speed is more compatible with highway running speeds.

Merge and rear-end conflicts are expected to decrease because of a reduction in the deceleration requirement of through vehicles. Increased perception times will also result.

C-11: Application

This technique is applicable on all highway types. Highway volumes should exceed 10,000 vpd, and speeds should be greater than 35 mph. The technique should be implemented only at driveways that have at least 75 right-turn egress movements during peak demand periods. Property frontages should exceed the recommended length of the acceleration lane. high accident rates involving right-turn egress vehicles will also warrant this technique.

C-11: Design

A right-turn acceleration lane should be of sufficient width and length to allow safe, efficient merging maneuvers to occur (see Figure C-11-1).

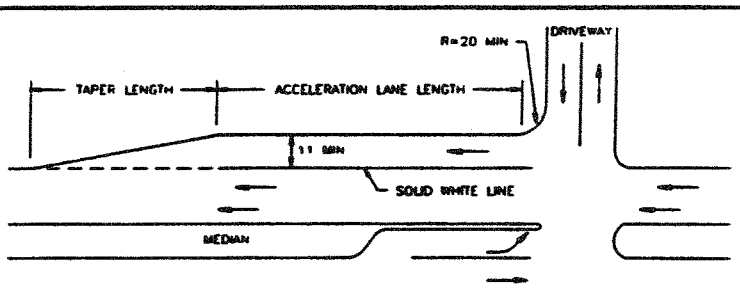


FIGURE C-11-1: RIGHT TURN ACCELERATION LANE

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY C: Limit Deceleration Requirements (Continued)

C-12: Install Channelizing Islands To Prevent Driveway Vehicles From Backing Onto The Highway

C-12: Description

This driveway design technique is aimed at reducing through-lane deceleration requirements by preventing driveway vehicles from backing onto the highway from a parking area. The strategy for achieving this objective is to construct channelizing islands at existing locations to prohibit this maneuver. The islands can be located either on the right-of-way or inside commercial properties. Candidate locations for this technique are characterized by commercial parking areas paved to the edge of pavement in back of curb, with no physical distinction between the two areas. This method will define where access to a property should be made.

The technique will reduce the total area of conflict by controlling and defining driveway openings. Conflict severity will be reduced by prohibiting uncontrolled access along property frontages. Possible detrimental effects may include an increase in through vehicle conflicts with the installed island.

C-12: Application

This technique is warranted on all highways where open access exists.

C-12: Design

The design of islands to accomplish this technique is dependent upon geometric layout and highway speeds. Islands should be of adequate size to discourage undesirable maneuvers but clearly define intent and direction for the turning vehicle.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes

Introduction

CATEGORIES OF TREATMENT FOR IMPROVING TRAFFIC FLOW

A. Limit Number of Conflict Points.

B. Separate Conflict Points.

C. Limit Deceleration.

D. Remove Turning Vehicles from Through Lanes.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-1: Install Continuous Two-Way Left Turn Lane

D-1: Description

A two-way left-turn lane is provided to remove left-turning vehicles from the through lanes and store those vehicles in a median area until an acceptable gap in opposing traffic appears. The two-way left-turn lane completely shadows turning vehicles from both through lane traffic streams. Thus, accident severity and frequency reductions will result. Frequency is reduced by removing stopped or slow left-turning vehicles from the through lanes and severity is reduced by allowing additional perception time to reduce left-turn crossing conflicts. Delay to through vehicles will also be reduced because left-turning vehicles and queues will not block the through lanes.

D-1: Application

This technique is applicable on roadways with existing strip development which has frequent, but low volume driveways. Two moderate to high volume driveways should not be located in close proximity to each other. Continuous two-way left-turn lanes are compatible with the function of collective streets, and some minor arterials, serving commercial and industrial and multi-functional residential areas. Special care needs to be taken in the permit phase to ensure that moderate to high volume access points are NOT arranged as illustrated in Figure D-1-1. Continuous two-way left-turn lanes provide a level of access which is incompatible with the movement function of arterial roadways.

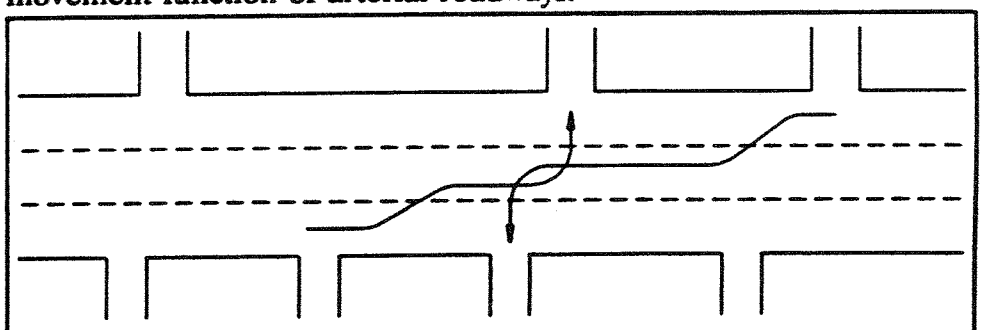


FIGURE D-1-1: SEVERE CONFLICT CREATED WHEN HIGH VOLUME DRIVES ARE LOCATED DOWNSTREAM ON OPPOSITE SIDES OF ROADWAY

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-1: Design

Figure D-1-2 illustrates the major design considerations applicable under this Technique. Traffic lane widths of 12 feet are desirable, however, existing conditions, particularly in urban settings may dictate lane width modifications.

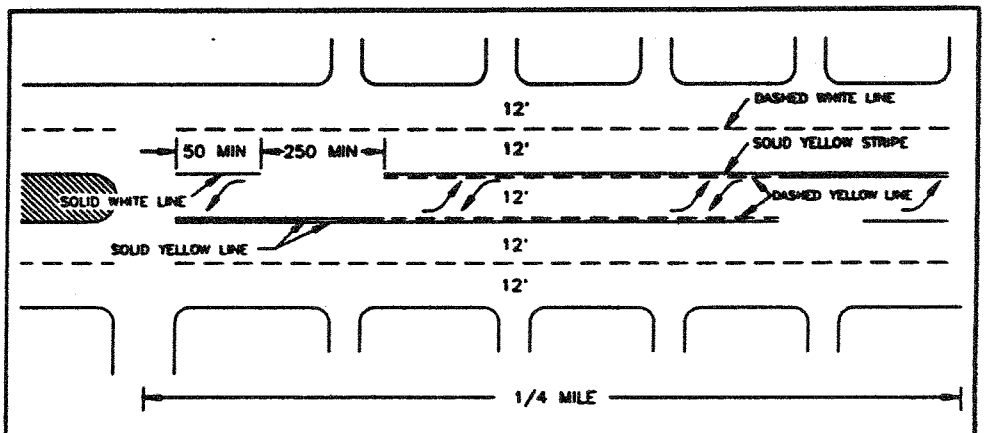


FIGURE D-1-2: CONTINUOUS TWO-WAY LEFT TURN LANE

(Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-3: Install Alternating Left Turn Lane

D-3: Description

The alternating left-turn lane will allow one traffic direction to have the opportunity to cross the median into driveways, and after a determined distance, the left-turn lane is physically opened to the opposing direction traffic. Thus, both traffic directions have a unique left-turn lane available for continuous left-turn maneuvers over a limited section of highway. Left-turn access to some driveways is prevented because when the left-turn lane is available to one traffic direction, the opposing traffic cannot attempt a left turn.

Accident frequency and severity reductions will result from the implementation of this technique. Frequency is reduced by removing stopped or slow-moving vehicles and queues from the through lanes, and severity is reduced by allowing through vehicles additional perception time to avoid left-turn crossing conflicts. Delay to through vehicles will also be reduced because left-turning vehicles will not block the through lanes.

D-3: Application

This technique is applicable on all types of highways where sufficient space is available for construction of medial turn lanes. Median widths 12 feet or greater are necessary. Multi-lane undivided highways where the curb-to-curb width will accommodate an odd number of lanes can be achieved by removing parking or restriping the through traffic lanes are candidates for these techniques. Application is particularly appropriate where concentrations of driveways alternate from one side of the highway to the other.

D-3: Design

Alternating left-turn lanes can be used when property access is required and roadway width is limited. Figure D-3-1 exhibits typical usage.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-3: Design (Continued)

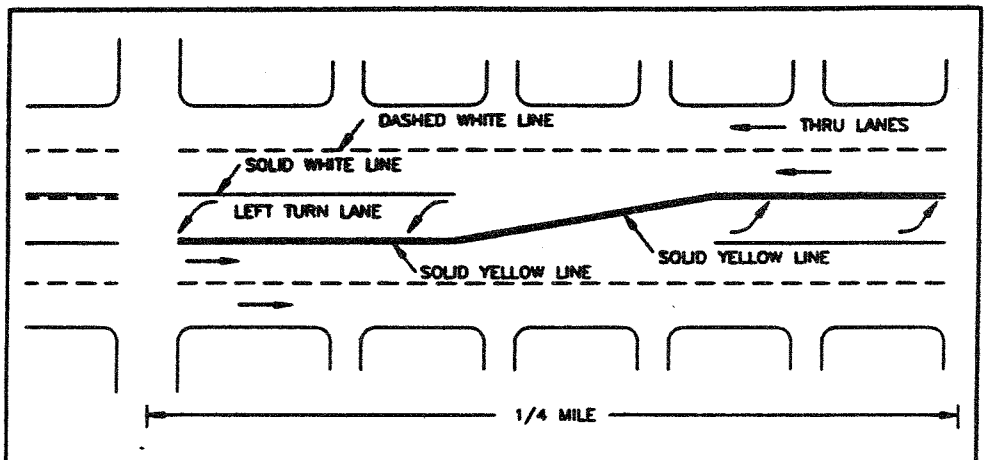


FIGURE D-3-1: ALTERNATING LEFT TURN LANE

(Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-4: Install Isolated Median And Deceleration Lane To Shadow And Store Left Turn Vehicles

D-4: Description

The functional objective of this technique is to remove turning vehicles or queues from the through lanes at a major driveway. Improvements in left-turning operations result from the isolated median and deceleration lane which shadows and stores the left-turning vehicles.

By providing higher diverging speeds and removing the stopped left-turning vehicles from the through lanes, a reduction in the frequency and severity of rear-end conflicts at the driveway should occur. Also, the severity of left-turn crossing conflicts should be reduced because the turning drivers are allowed additional perception time. Some tradeoffs may occur because of through vehicles colliding with the channelizing islands.

D-4: Application

Installation of an isolated median left-turn is applicable on all undivided high speed roadways where an individual public road, or private driveway, has moderate to high volume left-turns in one or both directions.

Suggested applications are:

Speed (mph)	Left-Turn Volume (vpd)
35	200
45	150
≥ 55	100

D-4: Design

The decision components of this technique are the deceleration lanes (taper and storage), median islands, and the tapering length of the highway. The taper rates are a function of speed; suggested taper rates are shown in Table D-4-1. In many cases, additional rights-of-way will be needed to facilitate construction of needed deceleration lanes and median islands. Figures D-4-1 and D-4-2 provide design guidelines.

(Cor.tinued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-4: Design (Continued)

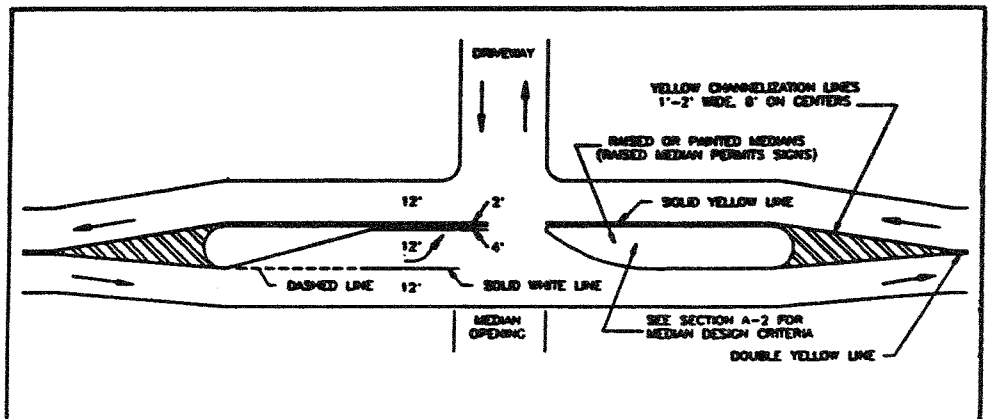


FIGURE D-4-1: ISOLATED DECELERATION LANE DESIGN

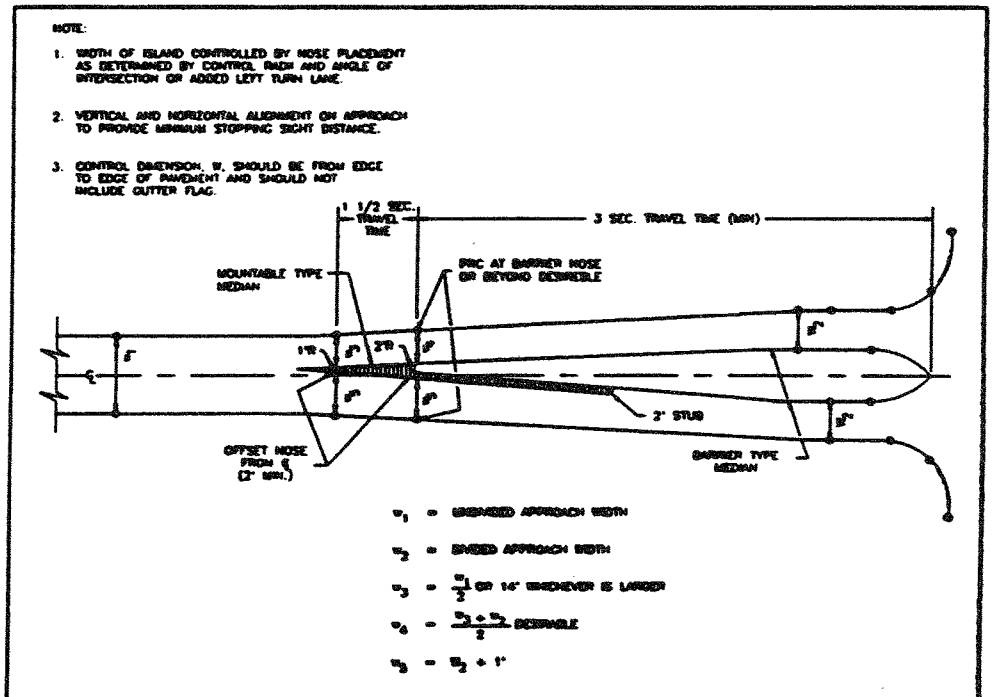


FIGURE D-4-2: DESIGN CRITERIA FOR CHANNELIZATION APPROACHES

(Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-4:
Design
(Continued)

TABLE D-4-1: SUGGESTED TAPER RATES FOR ISOLATED LEFT TURN LANES

Posted Speed (mph)	Ratio for Straight Taper for Acceleration and Deceleration Lanes	Minimum Ratio for Deceleration Lane
20	7.5:1	7.5:1
25	7.5:1	7.5:1
30	10:1	8:1
35	12.5:1	10:1
40	15:1	11.5:1
45	15:1	13:1
50	20:1	15:1
55	22.5:1	18.5:1
60	50:1	25:1
65	50:1	25:1

Source: Reference (6)
Note: Colorado code includes speeds up to and including 55 mph.
Source: Reference (7)
Note: New Mexico regulations contain the same ratios through 55 mph but also includes ratios for 60 and 65 mph.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-5: Install Left Turn Deceleration Lane To Remove Turning Vehicle From Through Lane

D-5: Description

This median treatment facilitates left-turn access to a driveway by providing a left-turn deceleration lane in place of a right-angle crossover. The principal objective is to remove turning vehicles or queues from the through lanes, thereby improving the left-turn operations.

The frequency and severity of rear-end conflicts is reduced because turning vehicles can diverge at higher speeds and because stopped vehicles or queues are removed from the through lanes. The severity of left-turn opposing conflicts should decrease because the left-turning drivers will have more perception time in which to make their decisions.

This technique should only be considered where a median opening exists and there is sufficient median width for a deceleration lane.

D-5: Application

All multi-lane divided highways with median widths of 14 feet or greater are potential locations for this application. A median opening must exist in order to provide for turning maneuvers.

D-5: Design

In rural areas the length of the taper should be a function of roadway speeds (see Table D-4-1). In urban areas a standard taper length of 120 feet is suggested for major arterials and 90 feet for streets of lower functional classification. The total length of the left-turn deceleration lane, including the taper, should be sufficient to allow the turning vehicle to decelerate from the speed of through traffic to a stop plus queue storage if a minimum length of the full-width lane must be sufficient to store the largest expected queue.

The width of the turn lane should be 12 feet. Where street width is limited, a 10-foot lane might be used. The minimum width of the median nose is four feet. Where pedestrians are present a minimum of 6 feet should be used.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-5:
Design
(Continued)

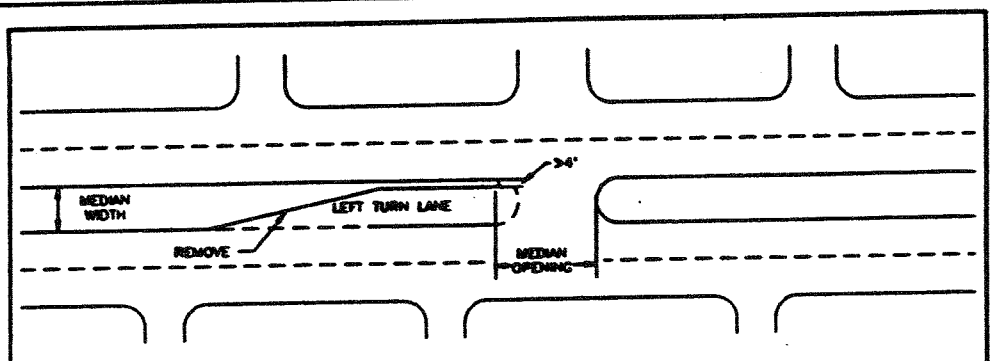


FIGURE D-5-1: LEFT TURN DECELERATION LANE

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-6: Install Medial Storage For Left Turn Egress Vehicles

D-6: Description

The installation of medial storage for left-turn driveway egress vehicles on multi-lane divided highways improves left-turn operations by removing those turning vehicles from the through lanes of the highway. This allows left-turn egress drivers additional perception time, which in turn reduces the severity of left-turn egress merge conflicts.

D-6: Application

All multi-lane divided highways with median widths of at least 18 feet are applicable locations. A median opening has to exist in order to provide for the turning maneuvers.

D-6: Design

A minimum median width of 18 feet is needed for this treatment. Also, a lane width of at least 14 feet must be maintained between the channelizing island and the median end. The island should occupy at least 100 square feet in order that the path of left-turning vehicles is well defined. The island should be offset from the through lanes by a 2 foot safety area.

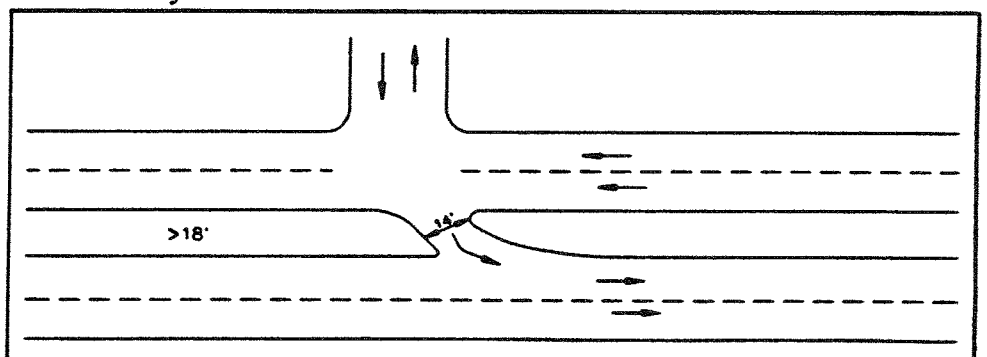


FIGURE D-6-1: MEDIAN STORAGE FOR LEFT TURN EGRESS VEHICLES

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-7: Increase Storage Capacity Of Existing Left Turn Deceleration Lane

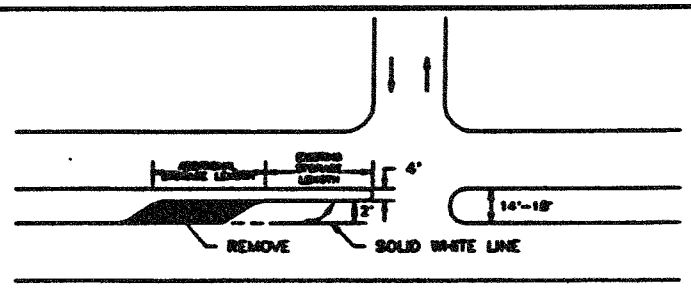
D-7: Description	The deceleration lane shadows and stores left-turning vehicles from the main stream of traffic. When the storage capacity becomes insufficient to handle the turning volume, the safety and capacity of the through lanes is adversely affected. An acceptable solution involves increasing the storage capacity of the deceleration lane to accommodate most peak-period turning vehicles. The effects on operation are reductions in the frequency and severity of rear-end conflicts.
D-7: Application	All multi-lane divided highways with existing deceleration lanes and insufficient storage lengths are applicable locations.
D-7: Design	The design of this technique involves two alternatives. These alternatives are: (1) increasing the length of an existing storage lane where sufficient median length is available; or (2) widening the highway to facilitate left-turning maneuvers from two lanes. The second condition considers the possibility of right-of-way acquisition. Several construction options exist under each of these conditions.

(Continued)

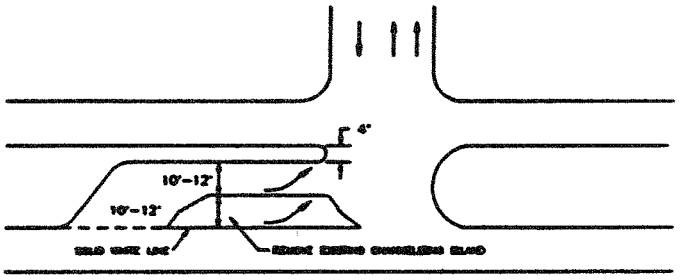
CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

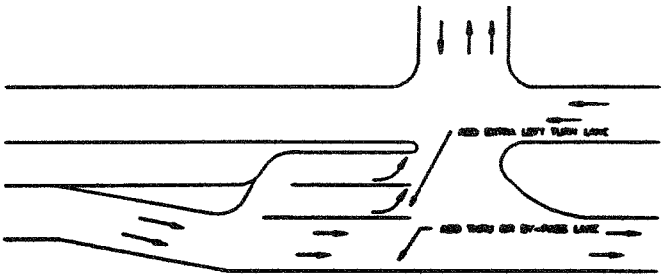
D-7: Design (Continued)



INCREASE STORAGE CAPACITY
EXTEND LEFT TURN LANE
(FOR MEDIAN WIDTHS 14'-18')



INCREASE STORAGE CAPACITY
ADD SECOND LEFT TURN LANE
(FOR MEDIANS 24' AND GREATER)



INCREASE STORAGE CAPACITY
WHERE EXISTING LANE CANNOT BE EXTENDED
(FOR MEDIAN WIDTHS 14'-18')

FIGURE D-7-1: INCREASE LEFT TURN STORAGE

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-9: Install Continuous Right Turn Lane

D-9: Description

A continuous right-turn lane is essentially a combination of a right-turn acceleration and deceleration lane that is extended to accommodate several nearby driveways. It is used along a section of highway where driveways cannot otherwise accommodate right-turning queues and/or high enough right-turn speeds. This technique reduces the frequency and severity of rear-end conflicts by removing turning vehicles at higher speeds and by shadowing right-turn queues.

D-9: Application

This technique is warranted on all types of highways with existing driveways.

D-9: Design

Application of this technique is appropriate where access to driveways cannot be achieved at safe right-turn speeds. Figure D-9-1 exhibits typical guidelines. Left-turns should be prohibited where a continuous right-turn lane is used, preferably by a non-traversable median.

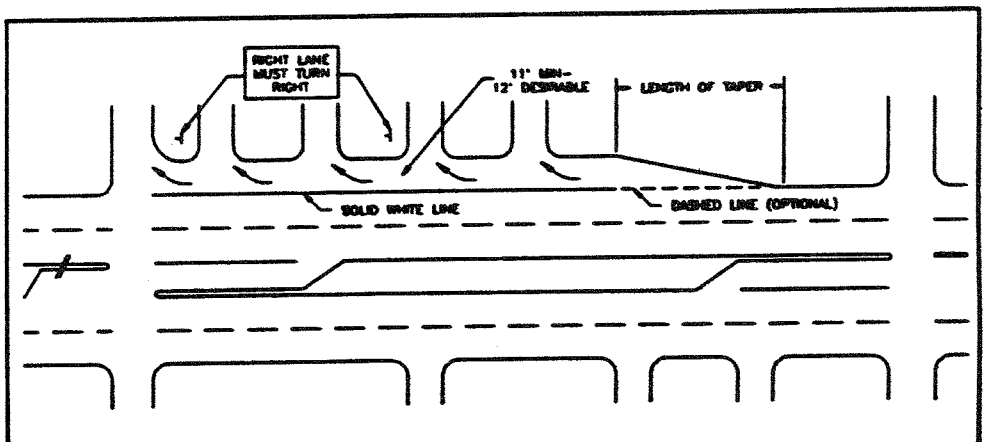


FIGURE D-9-1: CONTINUOUS RIGHT TURN LANE

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-10: Construct A Local Service Road

D-10: Description

Frontage roads are access control measures that have numerous functions, depending on the kind of arterial highway they serve and the character of the surrounding commercial area. They segregate local traffic from the higher-speed through traffic, and intercept driveways of abutting commercial establishments. Cross connections between the through traffic lanes and frontage roads, usually provided in conjunction with crossroads or intersections, furnish the means of access between through roads and adjacent property. Thus, the through character of the highway is preserved and is unaffected by subsequent development of the roadside.

The frontage road system can add tremendous flexibility to the operation of a highway when utilized as an auxiliary facility. A continuous frontage road system provides maximum land service to properties abutting the highway facility. Also, during periods of saturated flow on urban highways, frontage roads provide the operational flexibility often required to alleviate congestion on the system.

The frontage road, as an access control measure, reduces the frequency and severity of conflicts along the highway by preventing direct left turns and removing slower-turning vehicles from the through lanes. This technique decreases delay on the highway for through vehicles as a result of the elimination of marginal stream friction. Some tradeoffs are realized by increasing the frequency of conflicts and delay by indirect routing for some maneuvers.

D-10: Application

Frontage roads are applicable in the planning stage for primary divided arterials with speeds high of and a high level of development (greater than 60 driveways/mile). Usually traffic volumes exceeding 20,000 vpd are associated with this type of development.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-11: Construct A Bypass Road

D-11: Description

The continued growth of commercial strips along major arterials has magnified the problem of access control. Many highway agencies have been unable to alleviate congestion occurring in the vicinity of such commercial developments.

Bypasses provide motorists with the opportunity to avoid heavily developed or congested areas without conflicting with local traffic. As a result, this technique reduces the frequency and severity of conflicts on both facilities by separating longer-distance and faster-moving through traffic (including trucks) from slower local traffic. Removal of the intercity traffic from the existing roadway makes it more convenient for local traffic to enter and exit the business sites.

D-11: Application

Bypasses are applicable on major intercity routes where development along the existing route makes it impractical to reconstruct the facility or the existing location.

D-11: Design

Design and construction of a bypass route is subjected to the same standards applicable to major highways. Appropriate design standards based on intended use should be followed. Established documents such as "A Policy on Geometric Design for Rural Highways", "A Policy on Design of Urban Highways and Arterial Streets", "Design Standards for the Interstate System", "Geometric Design Standards for Highways Other Than Freeways", and "Geometric Design Guide for Local Roads and Streets" should be consulted.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-12: Reroute Through Traffic

D-12: Description	In this technique, the separation of through traffic from local traffic is achieved by using other adjacent facilities to reroute through traffic. The technique helps to reduce congestion and the frequency and severity of conflicts by separating and rerouting higher-speed through vehicles to where they have less potential of conflict with slower-speed local traffic.
D-12: Application	Rerouting through traffic is applicable where it is impractical to reconstruct the existing roadway and an alternative route having fewer access drives is available.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-13: Install Supplementary One-Way Right Turn Driveways To Divided Highway

D-13: Description

This driveway location technique is aimed at removing turning vehicles and queues from sections of the through lanes. Strategies for achieving this objective involve installing supplementary one-way right-turn driveways to an existing T-driveway on divided highways. The supplementary driveways can be installed to serve both egress or ingress vehicles.

This technique is intended at high-volume driveways to eliminate conflicts on the driveway and secondary rear-end conflicts on the highway associated with right-turn maneuvers. Where the T-driveway has only one lane, each for ingress and egress, this technique will add substantially to the total driveway capacity.

D-13: Application

This technique is warranted at high-volume driveways on multi-lane highways where a property has a very long frontage.

D-13: Design

This control measure is particularly applicable at large commercial or industrial complexes such as regional shopping centers and industrial parks. Sufficient frontage area is required to construct safe, adequate driveways, which do not present undue interference with through-moving vehicles. Figure D-13-1 presents a typical layout recommended for this technique.

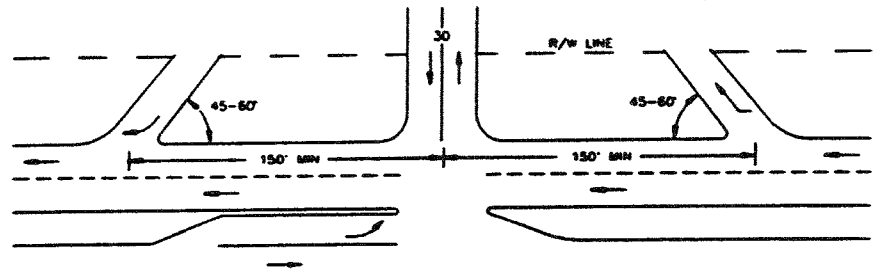


FIGURE D-13-1: SUPPLEMENTARY ONE-WAY RIGHT TURN DRIVEWAYS

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-14: Install Access On Collector Street When Available

D-14: Description	This driveway location technique is aimed at removing turning vehicles or queues from sections of the through lanes. The strategy for achieving this objective is to provide supplementary access to a single property at a collector street location. The technique provides an additional access point for vehicles to use when entering or exiting a property. The average volume of all driveways to a property will decrease after the supplementary driveway absorbs some of the total volume. Conflict frequency will be reduced on the highway, and total conflict severity should be reduced by moving some of the conflicts to the lower speed collector. Delay to arterial and driveway vehicles will be reduced because the individual driveway volumes are smaller.
D-14: Application	This technique is applicable at all corner parcels having frontage on a major roadway and a collector.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-16: Install Right Turn Deceleration Lane

D-16: Description	This driveway design technique is aimed at removing turning vehicles or queues from sections of the through lanes. The deceleration lane will reduce the severity of rear-end conflicts on the highway by allowing right-turn vehicles to leave the through lanes at a high speed.
D-16: Application	This technique is applicable on all major roadways.
D-16: Design	The length of the right-turn lane, including taper, should be sufficient to allow vehicles to decelerate from the through traffic speed to a stop plus any necessary queue storage.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-17: Install Additional Exit Lane On Driveway

D-17: Description

This technique involves construction on an additional driveway exit lane to better facilitate egress maneuvers. Right-turn and left-turn egress maneuvers are made more efficiently because drivers are not delayed by egress vehicles wanting to turn in the opposite direction. The egress capacity of the driveway is also significantly increased.

Total driveway delay should decrease significantly because of the increased capacity due to the separation of egress-turning maneuvers. However, if insufficient approach length is available, a reduction in the capacity potential may result because of internal conflicts associated with considerable weaving at the exit.

D-17: Application

This technique is applicable for all highway types and at driveway locations where both left-turn and right-turn egress maneuvers are permitted.

D-17: Design

In the design of the technique, consideration must be given to driveway width, traffic volumes, internal circulation and highway operation. The additional lane should be sufficiently wide to safely accommodate turning vehicles and long enough to provide adequate storage with minimal impact to internal circulation. If the additional lane services left-turning vehicles, adequate signalization is necessary to facilitate traffic operation.

(Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-17:
Design
(Continued)

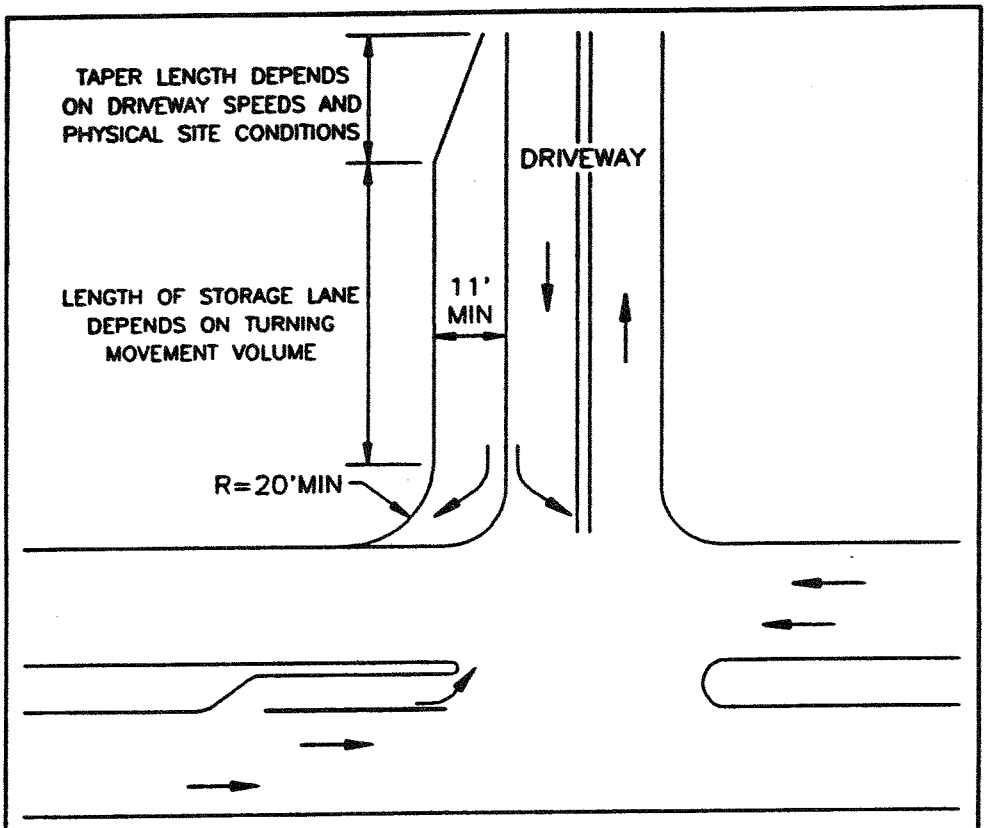


FIGURE D-17-1: INSTALLATION OF ADDITIONAL EXIT LANE ON DRIVEWAY

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-18: Encourage Connections Between Adjacent Properties

D-18: Description	This driveway operation technique is aimed at removing turning vehicles or queues from the through lanes. The strategy for achieving this objective is to encourage adjacent property owners to permit property-to-property movements away from the highway. A prime example of this access control measure is the neighborhood shopping center, where several adjacent properties are served by one open parking lot area. The patrons frequenting nearby establishments do not need to exit onto the highway and then enter the neighboring driveway. Highway conflicts will be reduced because the highway will no longer be used in traversing from one property to the next.
D-18: Application	This technique is applicable on all highway types. Of particular interest are adjacent properties with small frontage widths.
D-18: Design	This technique is intended to serve adjacent properties through use of common access points. Thought must be given to internal circulation and storage space for driveway vehicles as well as geometric layout and existing highway operation.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-20: Require Adequate Internal Design And Circulation Plan

D-20: Description

This is a general access control policy that may be utilized on existing facilities or in the driveway permit stage. An adequate internal design and circulation plan is intended to ensure harmony between highway, driveway, and internal operations. Driveway and internal operations will be improved by providing adequate internal property design and controls. Through traffic will experience a decrease in interference because the internal design will minimize queuing on the highway and vehicles searching for parking places are able to circulate internally. Conflict frequency and severity are expected to decrease because deceleration requirements are lessened.

D-20: Application

This technique is applicable to all types of highways. Implementation is feasible on existing facilities but primary consideration should be given this policy during site plan approval.

D-20: Design

Internal circulation designs should provide adequate handling of limited parking and maneuvering areas; minimize internal interference by supplying storage areas to egressing movements; and distribute ingressing vehicles into the main circulation pattern with minimal hesitation and confusion. The following list reflects recommendations by which this technique can be properly applied.

1. General location of driveway entrances should be approved by code authorities before the major effort toward maximum capacity planning begins.

2. Rectangular-shaped parking areas are the most efficient.

3. Wherever possible, the long sides of parking areas should be parallel.

4. Curved, triangular, and other irregularly shaped parking areas should be avoided.

(Continued)

CATEGORIES OF ACCESS MANAGEMENT TECHNIQUES (Continued)

CATEGORY D: Remove Turning Vehicles From The Through Lanes (Continued)

D-20: Design (Continued)

5. Traffic aisles should be aligned parallel to the long dimension of the parking areas where feasible.

6. Irregularly shaped areas should be designed with the traffic aisles parallel to the longest side.

7. Traffic aisles should serve two rows for stalls; that is, they should be double-loaded.

8. The perimeter of the parking area should be lined with parking stalls to the maximum extent.

9. Parking areas serving combined parking-use functions, such as combined customer and employee parking, should be designed to provide distinctly separate areas and traffic control for each use function.

10. Traffic flow and control should be analyzed carefully for optimum efficiency.

11. Landscaping and lighting should be designed after the optimum maximum capacity design has been achieved. If the maximum capacity design is altered to suit other criteria (such as an owner's request for greater stall width, changes in direction of traffic aisles, etc.), lighting fixtures should be located so the parking area may be converted to the maximum capacity design without requiring relocation of the lighting standards. Where feasible, landscaping should be planned in the same manner, especially where irrigation and sprinkler systems with underground water piping are included.

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CHAPTER 8 - EVALUATION OF IMPROVEMENTS

INTRODUCTION

Implementation Constraints

CHAPTER 8

EVALUATION OF IMPROVEMENTS

Implementation of access control techniques on an existing roadway may be constrained by existing physical situations. Major constraints include small property frontages, major intersection spacing, median design or the absence of a median, right-of-way width, building setbacks, and existing driveway spacings and corner clearance. Table 8-1 summarizes the major physical constraints which might influence the implementation of various techniques on an existing roadway.

Evaluation Of Improvements

- Accident Reduction
- Construction Cost
- Maintenance Costs
- Capacity
- Traffic Delays
- Impact On Adjacent Properties

Other considerations involved in the evaluation of possible access improvements on existing roadways include the following: potential accident reduction, cost of constructing the improvement, maintenance costs, capacity, traffic delays, and the impact on adjacent properties.

IMPLEMENTATION ON EXISTING ROADWAYS

Background

The access management techniques included in Categories A, B, C, and D in Chapter 4 were identified in research reported by the Midwest Research Institute in 1975 (*1, 2, 3*). "The scope of research was limited to control of direct access to commercial properties on two-lane and multi-lane highways with unlimited access, where traffic volumes are high enough to produce a hazardous situation. The emphasis was on the control of direct access on existing urban and suburban routes under state highway department jurisdiction." (*1*)

Operational Evaluation Parameters

- Level Of Development
- Highway Volume
- Commercial Driveway Volume

A major effort of this research was to evaluate the potential benefit/cost ratio of the various techniques based upon the following three operational parameters: (1) level of development, (2) highway volume, and (3) commercial driveway volume.

Each of the operational parameters was grouped according to "low", "medium", and "high" as indicated in Table 8-1.

(Continued)

IMPLEMENTATION ON EXISTING ROADWAYS (Continued)

Background (Continued)

TABLE 8-1: OPERATIONAL EVALUATION PARAMETERS

Level of Development	Number of Commercial Driveways per Mile	Average
Low	0-30	15
Medium	31-60	45
High	>60	75
Highway Volume	**ADT Range**	**ADT Average**
Low	0-5,000	3,000
Medium	5,001-15,000	10,000
High	>15,000	20,000
Commercial Driveway Volume	**ADT Range**	**ADT Average**
Low	0-500	250
Medium	501-1,500	1,000
High	>1,500	2,000

Source: Reference (*1*), pp. 100-101

Because of limited data on high volume roadways, the "high" level for the parameter for roadway (average annual daily traffic or ADT) is > 15,000 vpd. This is obviously an inappropriate value for urban/suburban conditions. However, the value levels given in Table 8-1 may not be inappropriate for rural conditions.

The research used reduced accidents as a measure of benefits. Costs used in calculating the benefit/cost ratios for the various alternatives included such elements as construction cost, effect on businesses, and maintenance costs. In this regard, it might be noted that current (1992) dollar values for traffic accidents are substantially higher than the dollar amounts used in the mid-1970's. While construction and other costs have also increased, the escalation is probably less than for accidents.

(Continued)

IMPLEMENTATION ON EXISTING ROADWAYS (Continued)

Background (Continued)

It is also pertinent to note that the evaluation/implementation guidelines presented in these reports are for modification of existing highways. This is reflected by the following statement:

"Consideration for implementation include: (1) comprehensive policy development; and (2) the selection of techniques to counteract operational problems on existing highways."

Most of the access management techniques should be included in the design of major roadways on new locations and in the major reconstruction of existing roadways. Such practices include the incorporation of long and uniform signal spacings, provision of left-turn and right-turn deceleration lanes at all intersections (including medial or marginal driveway access) limiting medial access at unsignalized locations to designate a movement(s) only, with the elimination of crossing movements at all unsignalized locations, and insuring that all driveways are suitably located and designed.

Application Of Techniques

Situations will vary in different locations and among the various public agencies administering the program, however, the general elements involved in the approach to an access-related problem usually include:

Application Of Techniques

- Definition Of Problem
- Inventory Of Operational And Physical Characteristics Of Facility And Surrounding Area
- Identification Of Alternative Solutions Using Warrants
- Evaluation Of Alternative Solutions
- Selection Of Alternative To Be Implemented

(Continued)

Application Of Techniques (Continued)

These steps are further defined in the following recommended procedure.

Step 1: Definition of problem. This step implies recognition that operational or safety conditions are not within parameters acceptable to the affected community. These obviously vary with the roadway character, urban or rural setting, type and volume of traffic, and community values. Many jurisdictions set theoretical accident rates and/or delay levels (or levels of service) beyond which they institute investigation.

Step 2: As a minimum, identify the operational and physical characteristics of the roadway segment to be studied including:

- Highway volume
- Driveway volume
- Level of development

These should be classified as high, medium, or low as per Table 8-1. The roadway segment should be physically identified as:

- Multi-lane divided
- Multi-lane undivided
- Two-lane

Step 3: Select the alternative techniques that may be applicable to the problem(s). This is accomplished through the use of Table 8-2.

- Select the segment of Table 8-2 (A, B, or C) which corresponds to the highway volume (high, medium, low).
- Find the horizontal section of that table that corresponds to the physical definition of the roadway (multi-lane divided, two-way, etc.).

(Continued)

IMPLEMENTATION ON EXISTING ROADWAYS (Continued)

Application Of Techniques (Continued)	• Enter that portion of the table within the column that describes the operational parameters of the roadway segment (level of development or driveway volume-high, medium, low). The techniques listed in this square are those which may be applicable to this particular situation. • Evaluate each of these techniques. • Select the technique (or group of techniques) which provides the greatest cost-effective solution in achieving the community's goals.

(Continued)

IMPLEMENTATION ON EXISTING ROADWAYS (Continued)

Application Of Techniques (Continued)

TABLE 8-2-A: APPLICATIONS OF TECHNIQUES

HIGH HIGHWAY VOLUME (MORE THAN 15,000)

OPERATIONAL PARAMETERS

LOW				MEDIUM				HIGH			
Multilane Divided											
A	B	C	D	A	B	C	D	A	B	C	D
9	2	2	5	1	1	2	3	2	2	2	1
11	3	3	6	2	2	3	6	4	3	3	3
12	5	4	7	5	3	4	8	5	4	4	5
13	6	5	14	6	4	5	7	6	5	5	7
14	8	6	16	9	5	6	14	9	6	6	9
15	9	7	17	11	6	7	16	11	8	7	10
18	10	8	18	12	8	8	17	14	9	8	11
19	11	9	20	13	9	9	18	17	10	9	12
20	12	10		14	10	10	20	18	11	10	13
		11		15	11	11		20	12	11	14
		12		17	12	12				12	16
				18							17
				19							18
				20							20
Multilane Undivided											
A	B	C	D	A	B	C	D	A	B	C	D
11	2	2	4	1	1	2	3	2	2	2	1
14	3	3	16	2	2	3	4	3	3	3	
15	5	4	17	3	3	4	14	4	4	4	3
18	6	5	18	8	4	5	16	8	5	5	4
19	8	6	20	11	5	6	17	11	6	6	9
20	9	7		12	6	7	18	12	7	7	11
	10	8		14	7	8	20	14	8	8	12
	11	9		15	8	9		16	9	9	13
	12	10		16	9	10		17	10	10	14
		11		17	10	11		18	11	11	16
		12		18	11	12		20	12	12	17
				19	12						18
				20							20
Two-Lane											
A	B	C	D	A	B	C	D	A	B	C	D
11	2	2	4	3	1	2	3	3	2	2	3
14	3	3	14	6	2	3	4	4	3	3	4
15	5	4	16	11	3	4	14	8	4	4	9
18	6	5	17	12	4	5	16	11	5	5	11
19	8	6	18	14	5	6	17	12	6	6	12
20	9	7	20	15	6	7	19	14		7	14
	10	8		16	8	8	20	16	8	8	15
	11	9		17	9	9		17	9	9	16
	12	10		18	10	10		18	10	10	17
		11		19	11	11		20	11	11	18
		12		20	12	12			12	12	20

Source: Reference (4), p. 89

(Continued)

IMPLEMENTATION ON EXISTING ROADWAYS (Continued)

Application Of Techniques (Continued)

TABLE 8-2-B: APPLICATIONS OF TECHNIQUES

MEDIUM HIGHWAY VOLUME
(5,000 - 15,000)

OPERATIONAL PARAMETERS

LOW				MEDIUM				HIGH			
Multilane Divided											
A	B	C	D	A	B	C	D	A	B	C	D
9	2	2	5	1	1	2	3	2	2	2	1
11	3	3	6	2	2	3	5	4	3	3	3
12	5	4	7	5	3	4	6	5	4	4	5
13	6	5	14	8	4	5	7	8	5	5	7
14	8	6	16	9	5	6	14	9	6	6	13
15	9	7	17	11	6	7	16	11	8	7	14
18	10	8	18	12	8	8	17	14	9	8	16
19	11	9	20	13	9	9	18	17	10	9	17
20	12	10		14	10	10	20	18	11	10	18
		11		15	11	11		20	12	11	20
		12		17	12	12				12	
				18							
				19							
				20							
Multilane Undivided											
A	B	C	D	A	B	C	D	A	B	C	D
10	5	2	4	1	1	2	3	2	4	2	1
11	6	3	14	2	4	3	4	3	5	3	3
12	8	4	16	3	5	4	14	4	6	4	5
14	9	5	17	8	6	5	16	8	8	5	7
15	10	6	18	10	8	6	17	10	9	6	13
18	11	7	20	11	9	7	18	11	10	7	14
19	12	8		12	10	8	20	14	11	8	16
20		9		14	11	9		16	12	9	17
		10		16	12	10		17		10	18
		11		17		11		18		11	20
		12		18		12		20		12	
				19							
				20							
Two-Lane											
A	B	C	D	A	B	C	D	A	B	C	D
10	5	2	4	3	1	2	3	3	4	2	3
11	6	3	14	8	4	3	4	4	5	3	4
12	8	4	16	10	5	4	14	8	6	4	14
14	9	5	17	11	6	5	16	10	8	5	16
15	10	6	18	12	8	6	17	11	9	6	17
18	11	7	20	14	9	7	18	14	10	7	18
19	12	8		15	10	8	20	16	11	8	20
20		9		16	11	9		17	12	9	
		10		17	12	10		18		10	
		11		18		11		20		11	
		12		19		12				12	
				20							

Source: Reference (4), p. 88

(Continued)

IMPLEMENTATION ON EXISTING ROADWAYS (Continued)

Application Of Techniques (Continued)

TABLE 8-2-C: APPLICATIONS OF TECHNIQUES

LOW HIGHWAY VOLUME
(LESS THAN 8,000)

OPERATIONAL PARAMETERS

LOW (a)				MEDIUM (b)				HIGH (c)			
Multilane Divided											
A(d)	B	C	D	A	B	C	D	A	B	C	D
(e)	8	2	14		8	2	14		8	2	14
	9	3	18		9	3	18		9	3	18
	10	4			10	4			10	4	
	11	5			11	5			11	5	
	12	6			12	6			12	6	
		7				7				7	
		8				8				8	
		9				9				9	
		10				10				10	
Multilane Undivided											
A	B	C	D	A	B	C	D	A	B	C	D
10	8	2	14	10	8	2	14	4	8	2	14
	9	3	18		9	3	18	10	9	3	18
	10	4			10	4	19		10	4	
	11	5			11	5			11	5	
	12	6			12	6			12	6	
		7				7				7	
		8				8				8	
		9				9				9	
		10				10				10	
Two-Lane											
A	B	C	D	A	B	C	D	A	B	C	D
10	8	2	14	10	8	2	14	4	8	2	14
	9	3	18		9	3	18	10	9	3	18
	10	4			10	4			10	4	
	11	5			11	5			11	5	
	12	6			12	6			12	6	
		7				7				7	
		8				8				8	
		9				9				9	
		10				10				10	

(a) Low = <30 driveways per mile
(b) Medium = 30 - 60 driveways per mile
(c) High = >60 driveways per mile
(d) Category of techniques
A= Limit number of conflict points
B= Separate conflict points
C= Limit deceleration requirement
D= Remove turning vehicle from through lane
(e) Numbers in each column identify individual treatments in each category

Source: Reference (4), p. 87

(Continued)

IMPLEMENTATION ON EXISTING ROADWAYS (Continued)

Application of Techniques (Continued)

TABLE 8-3: GENERAL PHYSICAL CONSTRAINTS TO IMPLEMENTATION ON EXISTING ROADWAY

Technique	Possible Major Physical Constraints to Implementation									
	No Constraint	Available ROW for Widening	Median Width	Property Frontage Width	Setback to Buildings and Parking Areas	Driveway Spacing	Corner Clearance	Major Intersection Spacing	Spacing of Median Openings	Other
[illegible]		●			●			●		●
[illegible]			●				●			
[illegible]			●		●					
[illegible]				●	●	●	●	●		
[illegible]				●	●	●	●		●	
[illegible]		●		●	●	●			●	
[illegible]		●		●	●	●	●			
[illegible]				●						
[illegible]				●						
[illegible]	●					●				
[illegible]	●			●		●				
[illegible]	●				●				●	
[illegible]	●									
[illegible]	●				●					
[illegible]	●									
[illegible]	●									
[illegible]	●									
[illegible]	●									
[illegible]	●									
[illegible]	●									
[illegible]	●									
[illegible]	●									
[illegible]	●									
[illegible]	●									
[illegible]		●			●					
[illegible]		●			●					
[illegible]		●	●						●	
[illegible]					●					
[illegible]		●			●			●		
[illegible]				●	●					●
[illegible]		●		●	●	●	●			
[illegible]										●
[illegible]										●

Source: Reference (*1*), p. 68

(Continued)

IMPLEMENTATION ON EXISTING ROADWAYS (Continued)

Application
of Techniques
(Continued)

TABLE 8-4: PREDICTION OF DELAY AND ACCIDENT REDUCTION

Techniques with Quantified Benefits

Technique	Group	Operational Parameter (a)	Annual Accident Reduction and/or (Annual Hours of Delay Reduction) — Highway Volume: Low — Operational Parameter Level: Low	Low — Medium	Low — High	Medium — Low	Medium — Medium	Medium — High	High — Low	High — Medium	High — High
A-1	*	2	-2.7	1.8	6.3	-0.0	0.7	13.6	-3.0	0.1	21.3
A-2	*	2	2.2	3.5	10.7	0.1	11.3(2.3)	20.7(0.9)	6.3	17.2(0.9)	31.3(17.0)
A-3	*	2	---	---	---	---	9.9(30.0)	13.6(10.3)	---	10.9(7.3)	20.0(12.3)
A-4	1	3	0.12(-.35)	0.20(-.35)	0.63(-.35)	0.30(-.37)	0.49(-.37)	0.76(-.37)	0.20(-.157)	0.67(-.157)	1.02(-.157)
	2	3	0.17(-.35)	0.42(-.35)	0.63(-.35)	0.30(-.37)	0.76(-.37)	1.16(-.37)	0.42(-.157)	1.08(-.157)	1.91(-.157)
A-5	1	1	0.08	0.19	0.39	0.14	0.33	0.51	0.10	0.03	0.69
	2	1	0.05	0.13	0.19	0.09	0.22	0.34	0.12	0.30	0.46
	3	1	0.13	0.31	0.69	0.23	0.55	0.85	0.31	0.73	1.15
A-8		1	---	---	---	---	0.4	0.4	---	0.4	0.4
A-10		1	0.40	0.90	1.60	0.7	1.7	2.6	1.0	2.3	3.6
A-11		1	-0.50	-0.60	-0.60	-1.0	-1.0	-0.5	-1.0	-1.0	-1.2
A-12		1	0.02	0.07	0.11	0.03	0.12	0.18	0.06	0.16	0.26
A-13		1	0.09	0.21	0.32	0.13	0.37	0.57	0.21	0.50	0.77
A-14		1	0.38	0.70	1.08	0.38	1.22	1.88	0.68	1.64	2.96
A-15		1	0.36	0.84	1.30	0.60	1.46	2.26	0.82	2.00	3.06
A-16	1	1	0.05	0.13	0.19	0.09	0.22	0.34	0.12	0.30	0.46
	2	1	0.08	0.19	0.29	0.14	0.33	0.51	0.19	0.45	0.69
	3	1	0.13	0.31	0.49	0.23	0.55	0.85	0.31	0.75	1.15
A-17	1	1	0.040	0.025	0.090	0.010	0.006	0.060	0.025	0.060	0.092
	2	1	0.058	0.019	0.027	0.014	0.033	0.031	0.019	0.045	0.069
	3	1	0.013	0.032	0.049	0.023	0.055	0.085	0.031	0.075	0.115
A-19		1	0.08	0.19	0.29	0.014	0.033	0.051	0.019	0.045	0.069
A-20		1	---	---	---	---	0.4	0.4	---	0.4	0.4

* Note: All benefits expressed as benefits per establishment except those marked "---" indicating benefits per mile of improvement.

a. Operational Parameter Code
1. Driveway volume
2. Level of development (commercial driveways per mile)
3. Accidents dependent on driveway volume and delay dependent only on highway volume

FUNCTIONAL OBJECTIVE B -- SEPARATE BASIC CONFLICT AREAS

Techniques with Quantified Benefits

Technique	Group	Operational Parameter (a)	Annual Accident Reduction and/or (Annual Hours of Delay Reduction) — Highway Volume: Low — Operational Parameter Level: Low	Low — Medium	Low — High	Medium — Low	Medium — Medium	Medium — High	High — Low	High — Medium	High — High
B-5		2	0.25	0.25	0.25	0.60	0.60	0.60	0.75	0.75	0.75
B-6		1 (c)	0.60	0.35	---	0.17	0.30	---	0.30	0.70	---
B-9		1	0.36	---	---	0.65	---	---	0.62	---	---
B-10		2	0.25	0.25	0.25	0.60	0.60	0.60	0.75	0.75	0.75
B-12		1	---	---	---	0.19	0.47	0.75	0.36	0.87	1.31

* Note: All benefits expressed as benefits per arterial driveway eliminated, or collector driveway added.

a. Operational Parameter Code
1. Driveway Volume
2. Accidents dependent only on highway volume

Source: Reference (4), pp. 72-73

(Continued)

IMPLEMENTATION ON EXISTING ROADWAYS (Continued)

Application of Techniques (Continued)

TABLE 8-4: PREDICTION OF DELAY AND ACCIDENT REDUCTION (Continued)

FUNCTIONAL OBJECTIVE C -- LIMIT MAXIMUM DECELERATION REQUIREMENTS

Techniques with Quantified Benefits

			Annual Accident Reduction and/or (Annual Hours of Delay Reduction)								
			Highway Volume								
			Low			Medium			High		
		Operational Parameter (a)	Operational Parameter Level			Operational Parameter Level			Operational Parameter Level		
Technique	Option		Low	Medium	High	Low	Medium	High	Low	Medium	High
C-2		1	0.016	0.030	0.056	0.027(23)	0.046(91)	0.102(182)	0.037(30)	0.098(122)	0.110(204)
C-3	1	1	0.05	0.13	0.20	0.09	0.23	0.36	0.13	0.32	0.60
	2	1	0.02	0.04	0.09	0.04	0.11	0.16	0.06	0.16	0.27
	3	1	0.04	0.11	0.16	0.08	0.18	0.29	0.10	0.25	0.39
C-6		2	1.9	3.0	4.2	3.6	6.0	8.7	5.7	9.0	12.3
C-7		1	0.016	0.036	0.056	0.027(23)	0.046(91)	0.102(182)	0.037(30)	0.098(122)	0.110(204)
C-8		1	(25.3)	(101.4)	(202.8)	(20.4)	(202.8)	(403.4)	(73.9)	(406.2)	(808.4)
C-9		1	(25.3)	(101.4)	(202.8)	(20.4)	(202.8)	(403.4)	(73.9)	(406.2)	(808.4)
C-10		1	(25.3)	(101.4)	(202.8)	(20.4)	(202.8)	(403.4)	(73.9)	(406.2)	(808.4)
C-11		1	0.02	0.05	0.07	0.03	0.08	0.13	0.05	0.11	0.17
C-12		1	---	---	---	---	0.0	0.0	---	0.0	0.0

* Note: All benefits expressed as benefits per driveway except for C-4, which is in benefits per mile of parking removed.

a. Operational Parameter Code
1. Driveway volume
2. Level of development (commercial driveways per mile)

FUNCTIONAL OBJECTIVE D -- REMOVE TURNING VEHICLES OR QUEUES FROM SECTIONS OF THE THROUGH LANES

Techniques with Quantified Benefits

			Annual Accident Reduction and/or (Annual Hours of Delay Reduction)								
			Highway Volume								
			Low			Medium			High		
		Operational Parameter (a)	Operational Parameter Level			Operational Parameter Level			Operational Parameter Level		
Technique	Option		Low	Medium	High	Low	Medium	High	Low	Medium	High
D-1	•	2	6.6	7.1	9.7	8.5	13.9(1638)	19.8(6699)	13.5	28.9(6935)	28.6(17066)
D-2	•	2	6.6	7.1	9.7	8.5	13.9(1638)	19.8(6699)	13.5	28.9(6935)	28.6(17066)
D-3		2	1.7	3.5	6.6	3.2	7.1(1638)	13.3(6699)	5.1	11.4(6935)	21.6(17066)
D-4		1	0.13	0.32	0.69	0.23	0.52(1638)	0.93(6699)	0.31	0.72(6935)	1.3(17066)
D-5		1	---	0.13	0.19	---	0.22	0.34	1.2	3.0	4.3
D-6		1	0.02	0.06	0.07	0.03	0.07	0.11	0.06	0.10	0.16
D-7		1	0.036	0.063	0.067	0.063	0.10(1638)	0.17(6699)	0.042	0.15(6935)	0.23(17066)
D-8		1	0.01	0.03	0.04	0.02	0.04	0.07	0.03	0.06	0.09
D-9	•	2	---	1.4	2.1	---	1.6	3.6	---	3.3	6.9
D-10		1 (c)	---	---	---	---	-0.13	-0.03	---	-0.03	-0.03
D-14		1	0.02	0.05	0.07	0.03(23)	0.08(91)	0.13(182)	0.05(30)	0.11(122)	0.17(204)

* Note: All benefits are expressed as benefits per installation except those marked "*", indicating benefits per mile of improvement.

a. Operational Parameter Code
1. Driveway Volume
2. Antilocks dependent only on highway volume

Source: Reference (4), pp. 73-74