

# Traffic Impact Studies: Project Traffic

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# TRAFFIC IMPACT STUDIES

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“Site transportation impact studies should be prepared under the supervision of a qualified and experienced transportation professional who has specific training in traffic and transportation engineering and planning and several years of experience related to preparing transportation studies for existing or proposed developments. The ability to forecast and analyze transportation needs both for developments and for transportation systems is essential.”

*Transportation Impact Analyses for Site Development,*  
Institute of Transportation Engineers, 2010.



# DATA COLLECTION

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**Daily Volumes** – Great for market analysis, high level planning, but not traffic analysis

**Peak Hour Volumes** (AM and PM) – This is what traffic engineers speak. This is typically the issues and where the complaints come from.

Decisions for improvements are based on this:

-Rules of thumb for traffic improvements based on Peak Hour Volume:  
Signal; Turn Lanes; Additional Lane; etc.



# DATA COLLECTION



# TRAFFIC IMPACT STUDIES

## Project traffic

- Trip Generation
- Trip Distribution
- Mode Choice
- Assignments



# PROJECT TRAFFIC

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Trip: Journey from an origin to a destination

Trip End: The portion of a trip associated with either the origin or the destination





## Project Traffic

- **Trip Generation**
- Trip Distribution
- Mode Choice
- Assignments



# TRIP GENERATION

## Data Sources

- ITE *Trip Generation*
- Local standards
- New data





# TRIP GENERATION

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## ITE *Trip Generation*

- Rates
- Equations
- Statistics
- Common sense



## Land Use: 934 Fast-Food Restaurant with Drive-Through Window

### Description

This category includes fast-food restaurants with drive-through windows. This type of restaurant is characterized by a large carry-out clientele; long hours of service (some are open for breakfast, all are open for lunch and dinner, some are open late at night or 24 hours per day); and high turnover rates for eat-in customers. These limited-service eating establishments do not provide table service. Non-drive-through patrons generally order at a cash register and pay before they eat. High-turnover (sit-down) restaurant (Land Use 932), fast-food restaurant without drive-through window (Land Use 933) and fast-food restaurant with drive-through window and no indoor seating (Land Use 935) are related uses.

### Additional Data

*Users should exercise caution when applying statistics during the a.m. peak periods, as the sites contained in the database for this land use may or may not be open for breakfast. In cases where it was confirmed that the sites were not open for breakfast, data for the a.m. peak hour of the adjacent street traffic were removed from the database.*

The outdoor seating area is not included in the overall gross floor area. Therefore, the number of seats may be a more reliable independent variable on which to establish trip generation rates for facilities having significant outdoor seating.

One site indicated that a two-story play area and video arcade were included in the gross floor area.

The sites were surveyed between the 1980s and the 2000s throughout the United States.

*It has been speculated that hamburger restaurants may generate trips at a higher rate than other types of fast-food restaurants. The database was tested in an attempt to verify this assumption; the data neither verified nor disproved it. Future research is needed in this area.*

### Source Numbers

163, 164, 168, 180, 181, 241, 245, 278, 294, 300, 301, 319, 338, 340, 342, 343, 358, 389, 438, 502, 552, 555, 577, 583, 584, 617, 640, 641

## Fast-Food Restaurant with Drive-Through Window (934)

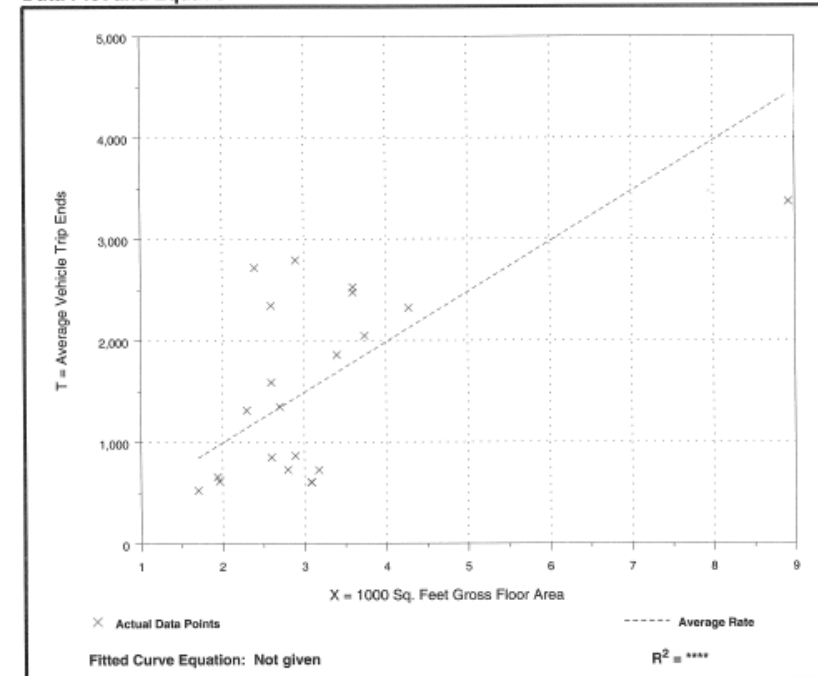
Average Vehicle Trip Ends vs: 1000 Sq. Feet Gross Floor Area  
On a: Weekday

Number of Studies: 21  
Average 1000 Sq. Feet GFA: 3  
Directional Distribution: 50% entering, 50% exiting

### Trip Generation per 1000 Sq. Feet Gross Floor Area

Average Rate	Range of Rates	Standard Deviation
496.12	195.98 - 1132.92	242.52

### Data Plot and Equation



# TRIP GENERATION

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- Choosing the appropriate land use type
  - Descriptions
  - Sample size
- Independent variable
  - Available information
  - Use the more lasting value
  - Correct scale



## **Apartment (220)**

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

Number of Studies: 88  
Avg. Number of Dwelling Units: 210  
Directional Distribution: 50% entering, 50% exiting

## **Low-Rise Apartment (221)**

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

Number of Studies: 22  
Avg. Number of Dwelling Units: 264  
Directional Distribution: 50% entering, 50% exiting

## **High-Rise Apartment (222)**

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

Number of Studies: 9  
Avg. Number of Dwelling Units: 435  
Directional Distribution: 50% entering, 50% exiting



## Supermarket (850)

**Average Vehicle Trip Ends vs: 1000 Sq. Feet Gross Floor Area**  
**On a: Weekday,**  
**P.M. Peak Hour of Generator**

Number of Studies: 7  
 Average 1000 Sq. Feet GFA: 37  
 Directional Distribution: 53% entering, 47% exiting

### Trip Generation per 1000 Sq. Feet Gross Floor Area

Average Rate	Range of Rates	Standard Deviation
11.85		

## Supermarket (850)

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

Number of Studies: 40  
 Average 1000 Sq. Feet GFA: 59  
 Directional Distribution: 51% entering, 49% exiting

### Trip Generation per 1000 Sq. Feet Gross Floor Area

Average Rate	Range of Rates	Standard Deviation
10.50	5.15 - 20.29	4.97





# TRIP GENERATION



## Pass-by capture

- Pass-by trips
  - Intermediate stops between an origin and a primary destination
  - No route diversion in order to enter site driveway



# TRIP GENERATION

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## Pass-by capture

- Magnitude
  - ITE *Trip Generation Handbook*
  - *Adjacent street traffic (10% or 15% of total)*
  - Local criteria and other limitations
- Enter / Exit based on land use



# TRIP GENERATION

## Diverted link trips

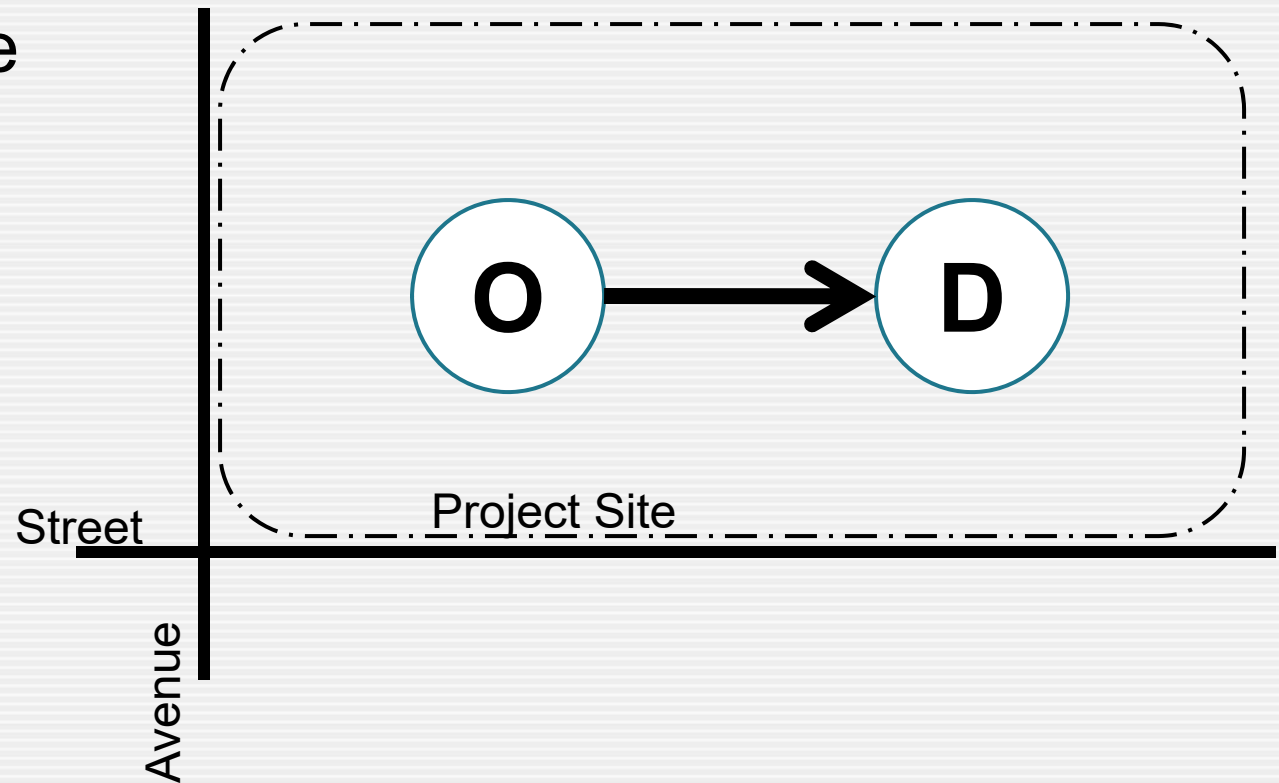
- Definition
- Magnitude



# TRIP GENERATION

Internal capture

- Definition





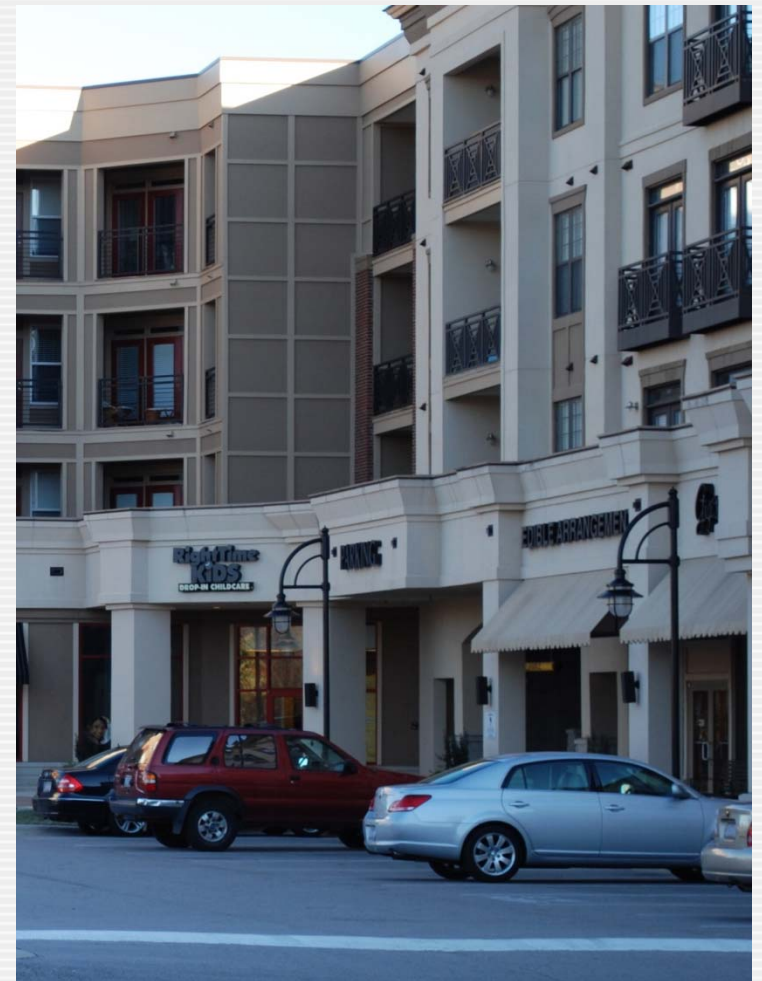




# TRIP GENERATION

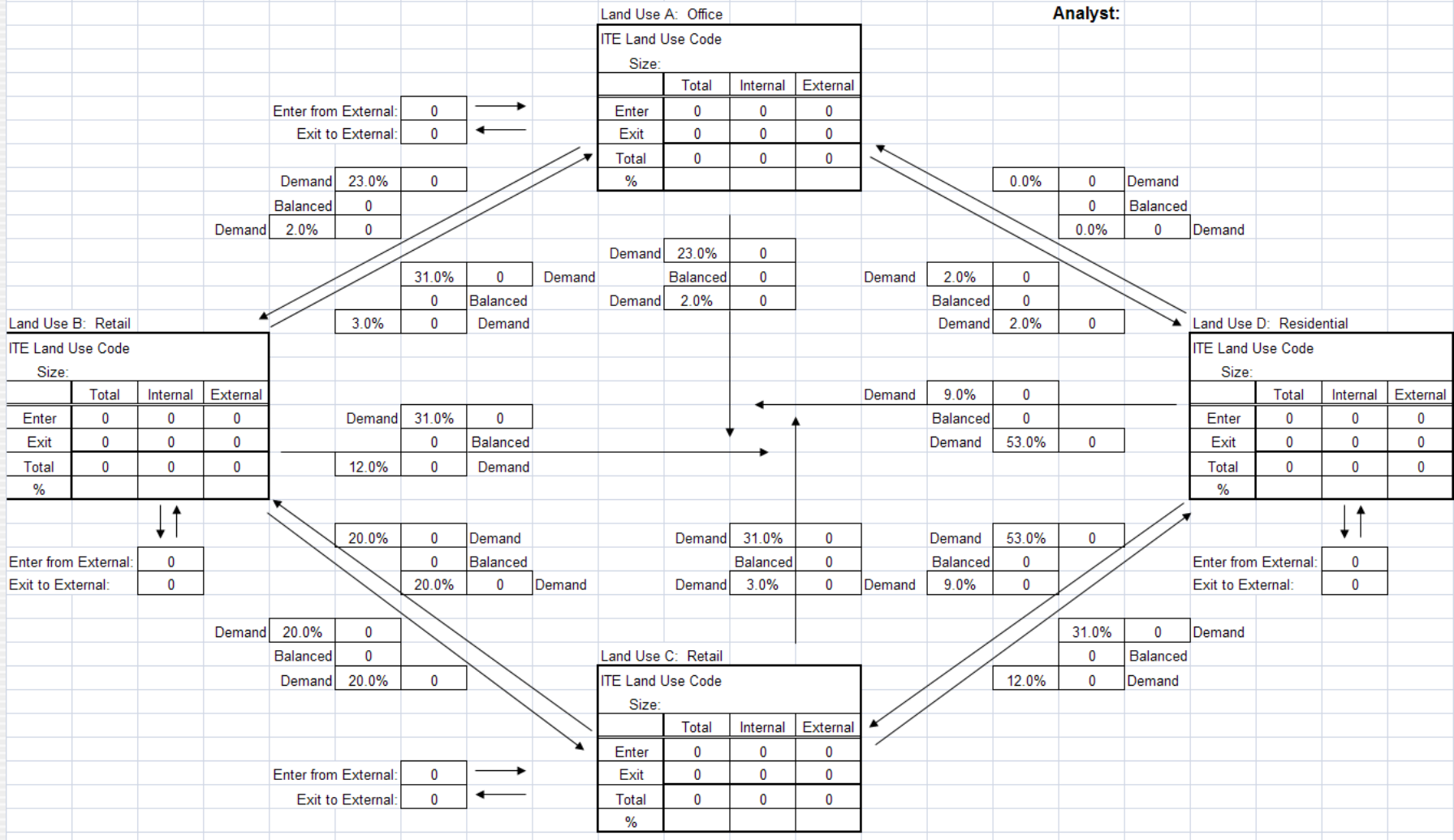
## Internal capture

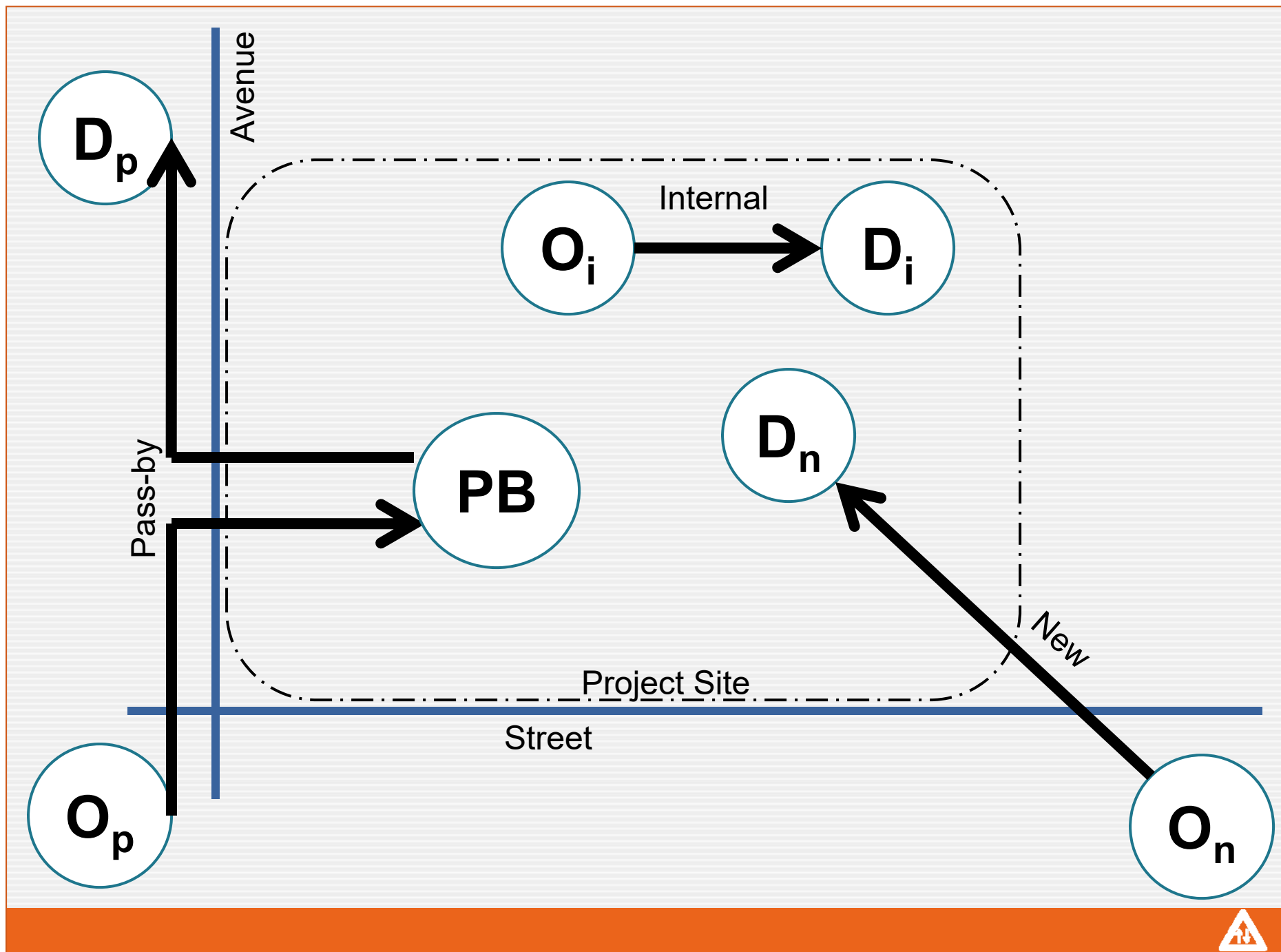
- Magnitude
  - ITE *Trip Generation Handbook*
  - Travel demand models
    - Intrazonal
    - Interzonal
- Mixed use developments



(Source: Chapter 7, *ITE Trip Generation Handbook*, June 2004)

Project Number:		
Project Name:		
Scenario:		
Analysis Period:	PM Peak	
Analyst:		





# TRIP GENERATION

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## Summary:

Driveway Volume calculated for each use

- Internal Capture

= External Trips (project driveway volumes)

- Pass-by Capture

= New External Trips



## Project Traffic

- Trip Generation
- **Trip Distribution**
- Mode Choice
- Assignments





# TRIP DISTRIBUTION

- Origins and destinations
- Productions and attractions



# TRIP DISTRIBUTION

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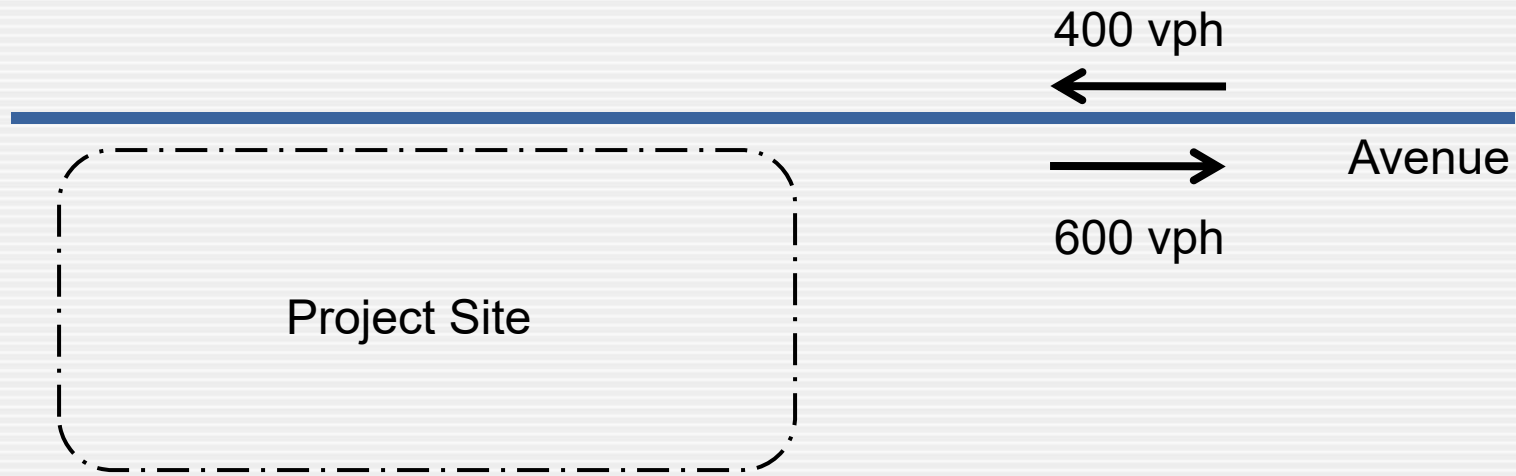
## Pass-by Trips

- Based on adjacent street traffic flow in study year

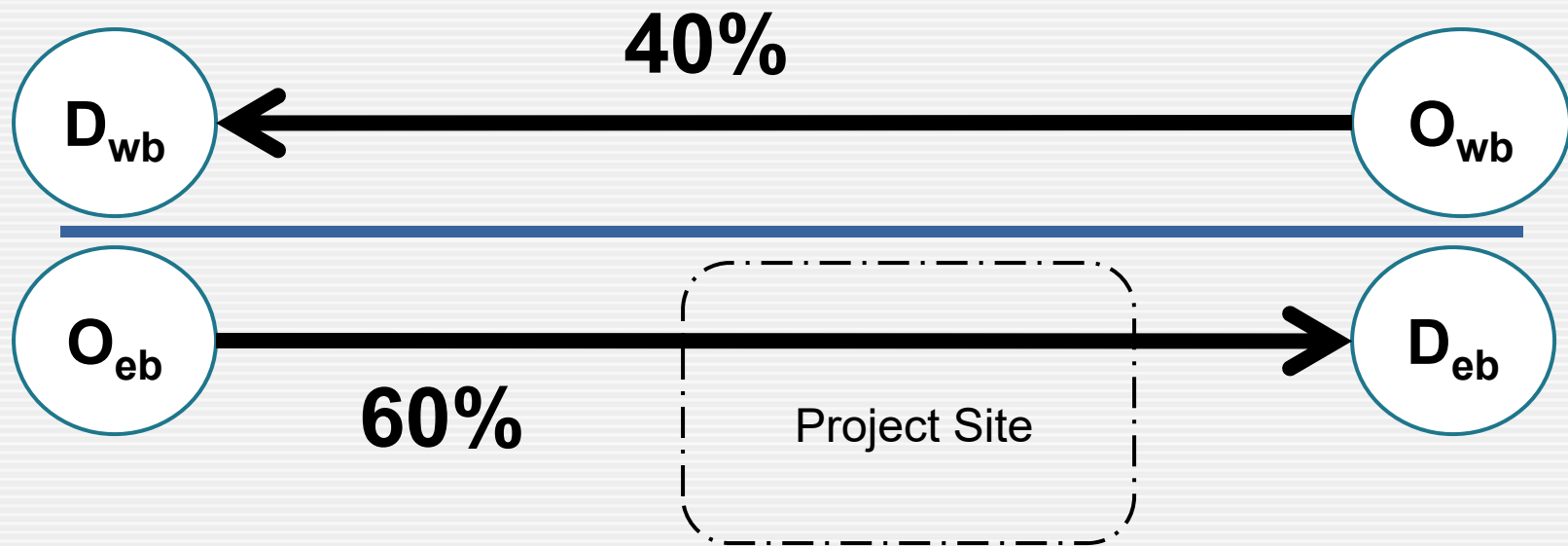
## Diverted Link Trips

- Based on flow of roads providing source of trips





## Trip Distribution Example



# TRIP DISTRIBUTION



New trips

- Manual
- Gravity model
- Travel demand forecast models



# TRIP DISTRIBUTION

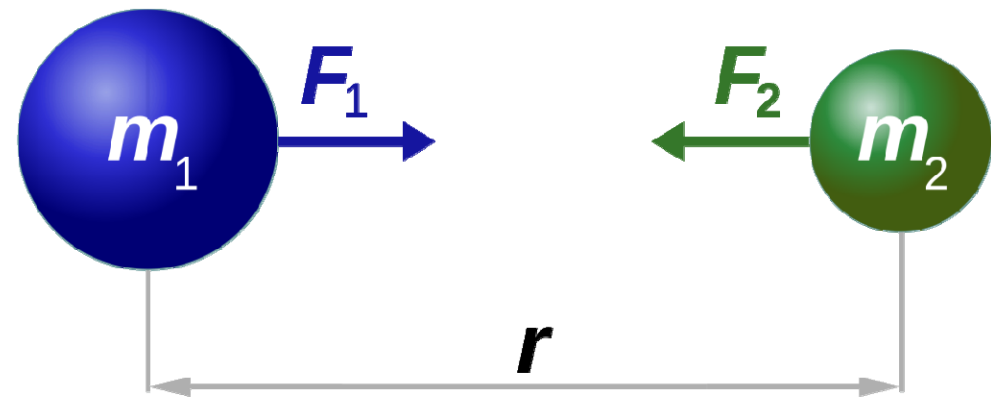
## Gravity model

- Physics lesson: Law of Universal Gravitation



“Ow!”

- Sir Isaac Newton



$$F_1 = F_2 = G \frac{m_1 \times m_2}{r^2}$$

Source: Dennis Nilsson



# TRIP DISTRIBUTION

## Gravity model for trip distribution

- From an origin to multiple possible destinations:

$$T_j = \frac{(D_j / t_j^n)}{\sum (D / t^n)}$$

D = Destination metric (population, employees, students, etc.)

t = travel time

n = calibrated variable (2 is a good default)



## Project Traffic

- Trip Generation
- Trip Distribution
- **Mode Choice**
- Assignments



# MODE CHOICE

## Modes

- Passenger cars (single and multiple occupancy)
- Bus
- Rail
- Bicycle
- Walking
- Truck
- Taxi



# MODE CHOICE

## Effective range and typical usage

Mode	Range	Suburban Usage	Urban Usage
Automobile	No limit	90% to 100%	75% to 95%
Transit (all types)	Defined routes	< 5%	5% to 25%+
Bicycle	5 miles	<1%	<2%
Walking	½ mile	<1%	<2%
Truck (freight)	No limit	<1%	<1%





## Project Traffic

- Trip Generation
- Trip Distribution
- Mode Choice
- **Assignments**



# ASSIGNMENTS

## What to assign

- Mode
- Trip type
  - Internal capture
  - Pass-by capture
  - Diverted link
  - New



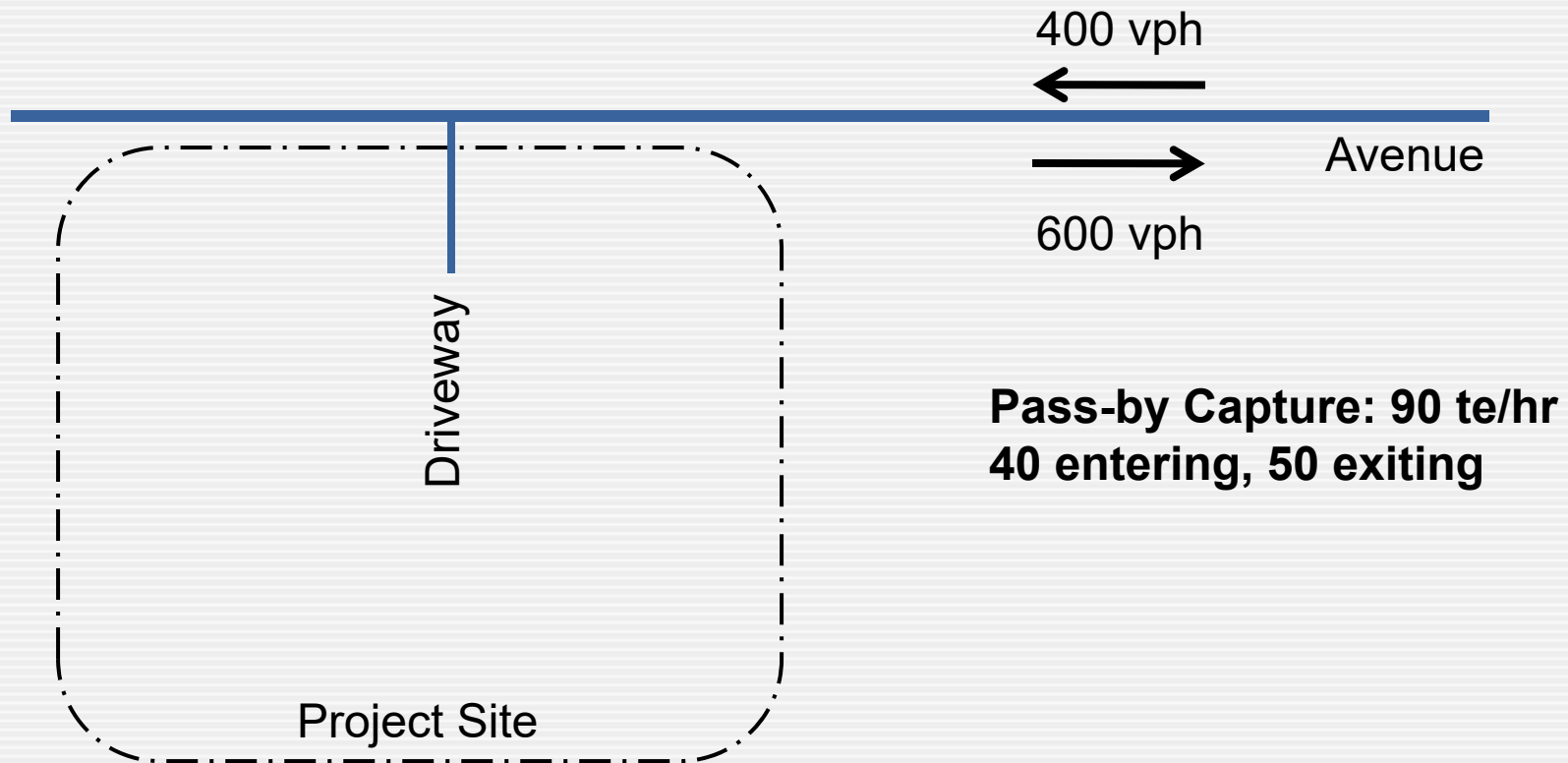


# ASSIGNMENTS

## Pass-by Capture

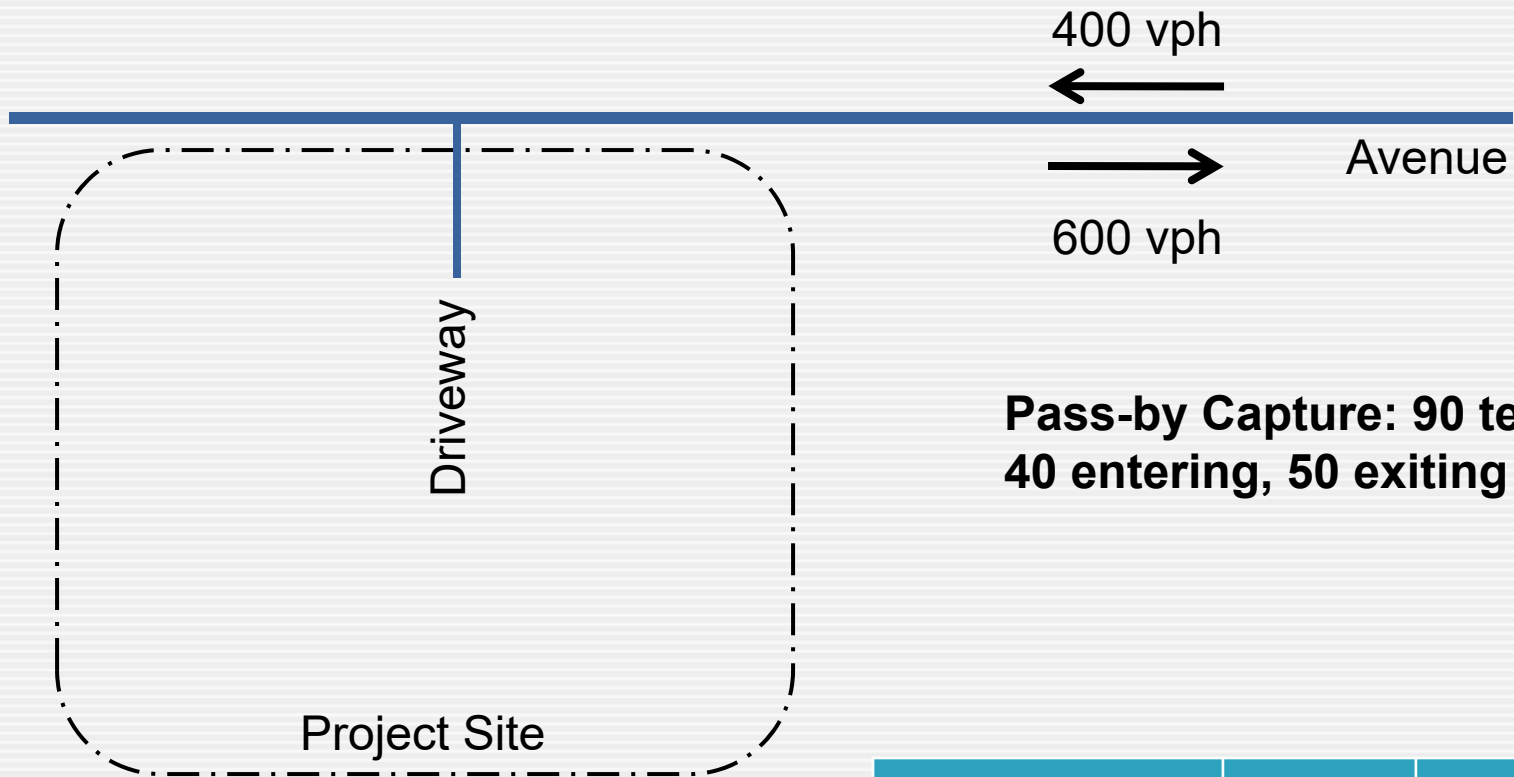
- Driveways
- Adjacent Streets





## Example #1





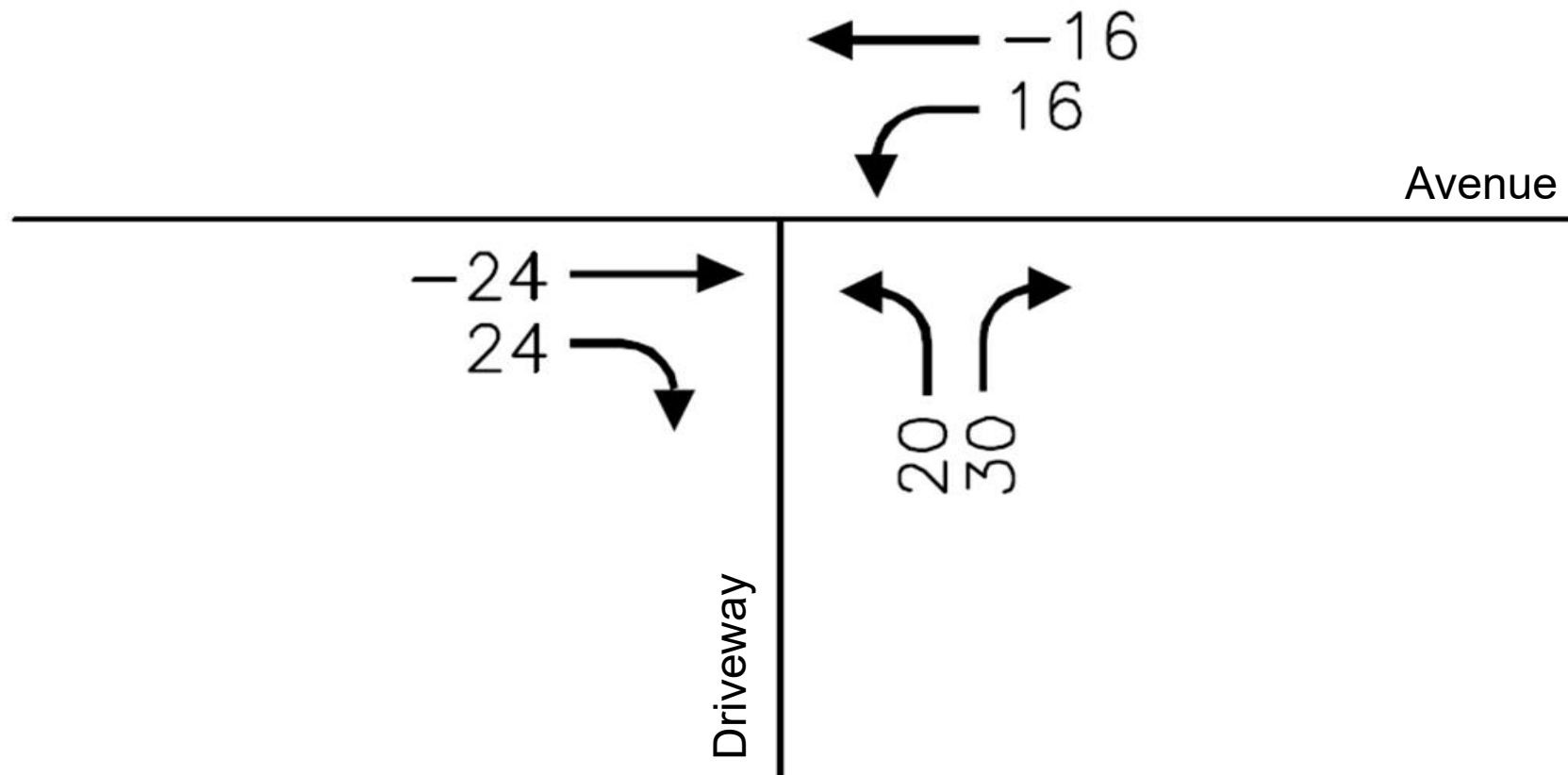
**Pass-by Capture: 90 te/hr**  
**40 entering, 50 exiting**

Direction	Enter	Exit
Eastbound		
Westbound	16	20
Total		

Example #1







Direction	Enter	Exit
Eastbound	24	30
Westbound	16	20
Total	40	50

Example #1



# ASSIGNMENTS

## New Trips

- External roads and intersections
- Site driveways



# ASSIGNMENTS

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## New Trips

- External roads and intersections
  - Start with the distribution
  - Choice
  - Travel time and equilibrium





Map courtesy of Coronado Visitor Center

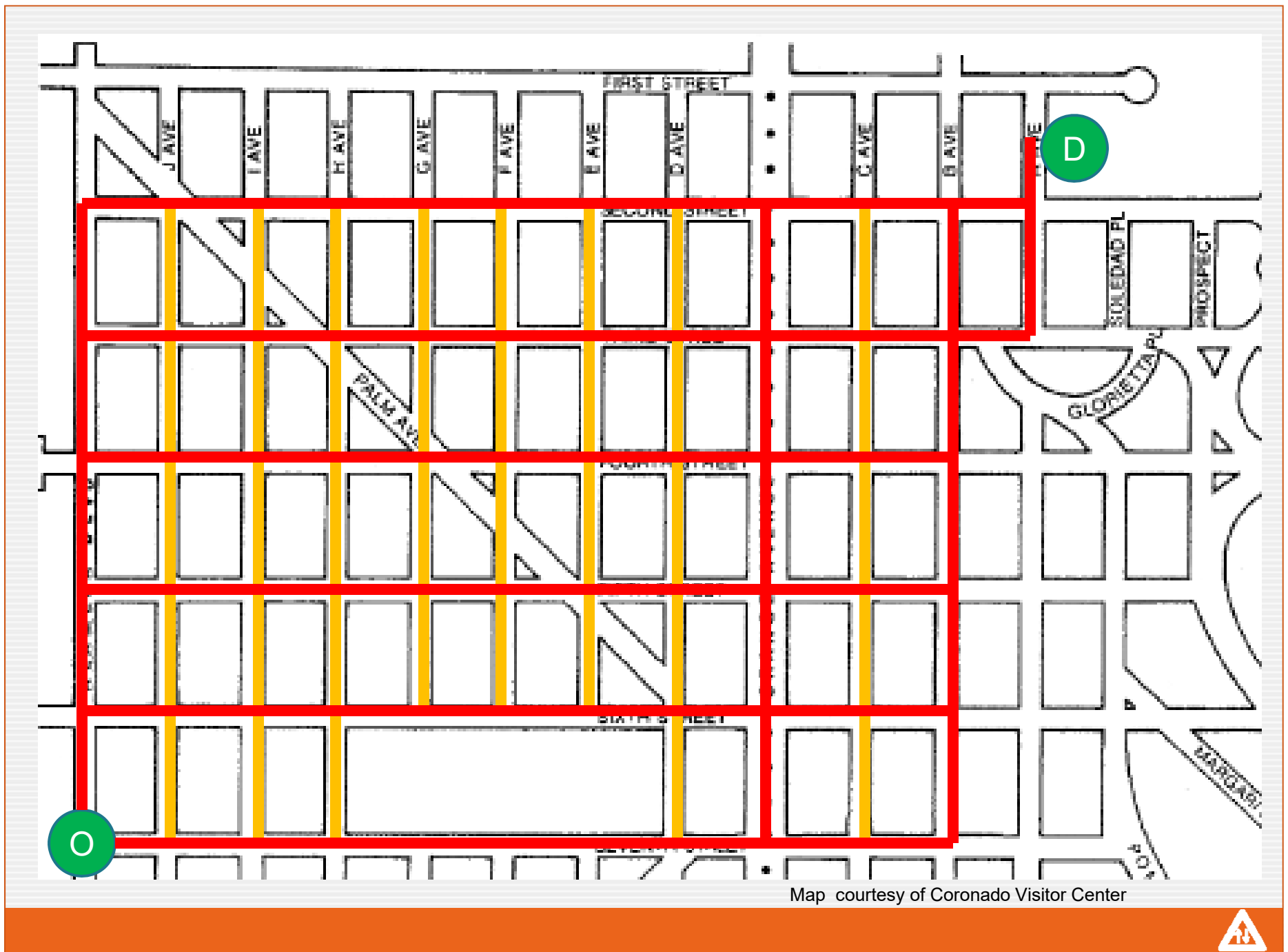


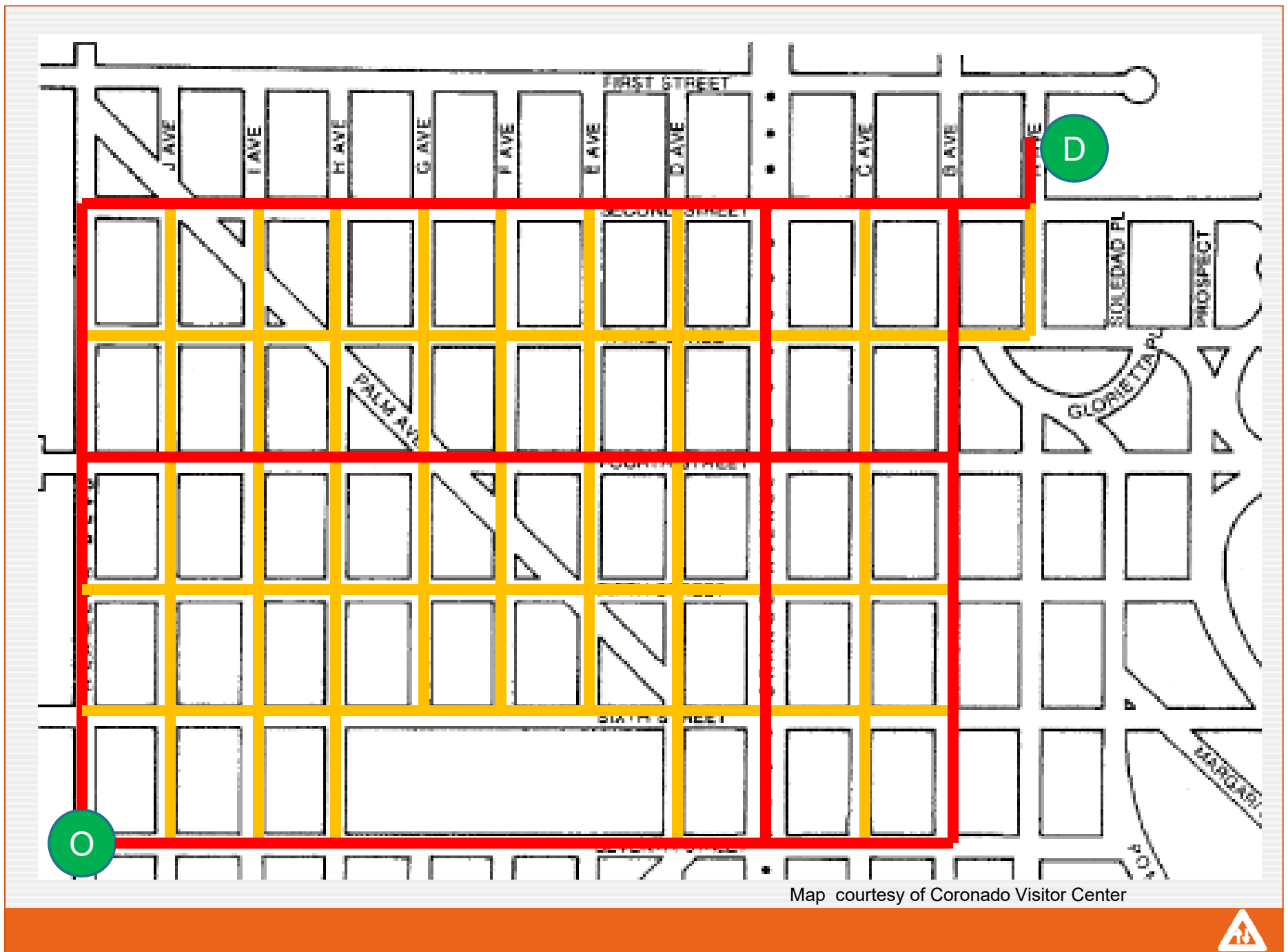


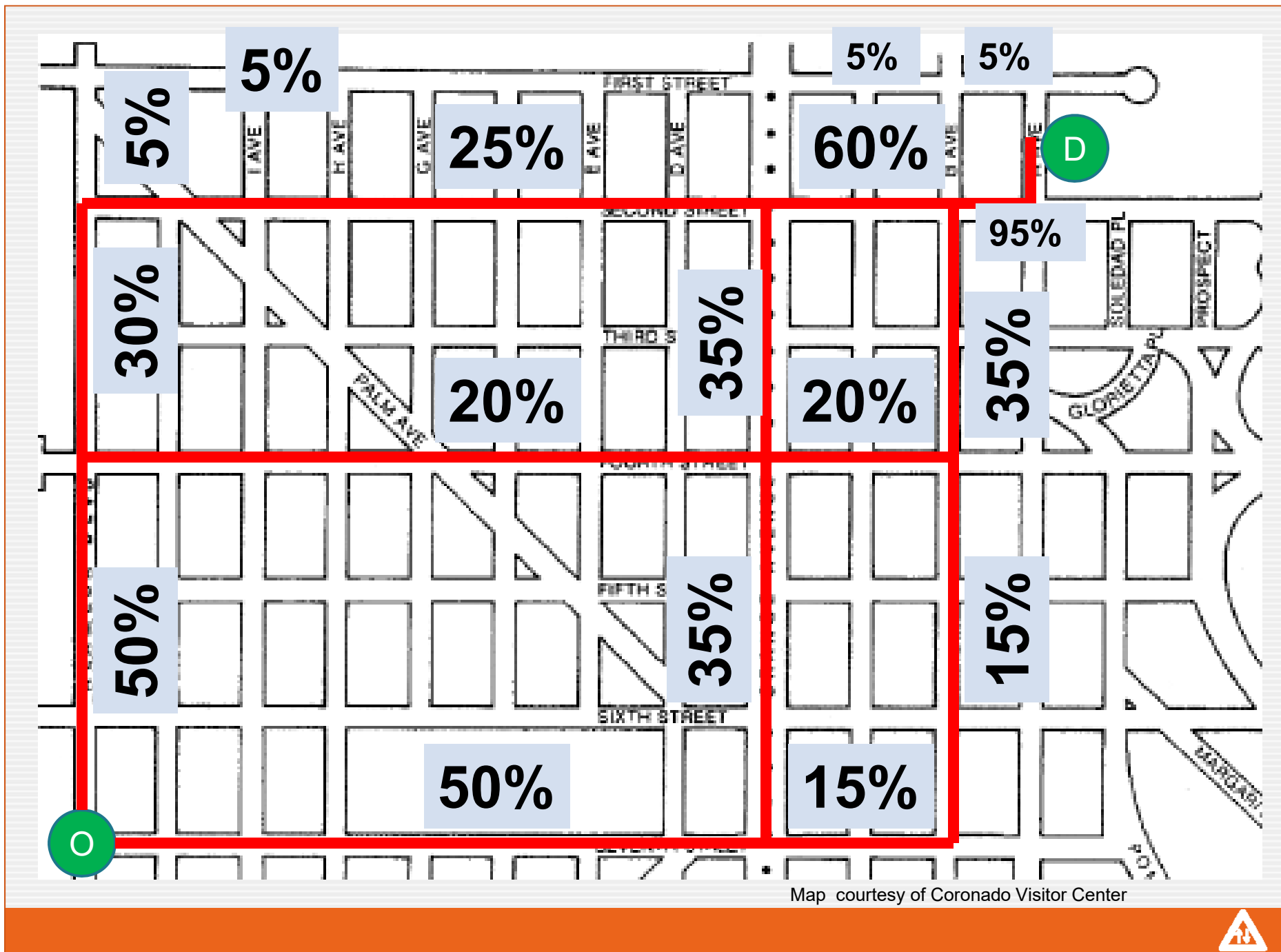
Map courtesy of Coronado Visitor Center











# ASSIGNMENTS

## New Trips

- Site driveways

- Volumes approaching the site
- Distributed across multiple driveways
- Rules of thumb:
  - For approach to
    - Two driveways: assign  $\frac{2}{3}$  to first driveway,  $\frac{1}{3}$  to second
    - Three driveways: assign  $\frac{1}{2}$  to first,  $\frac{1}{3}$  to second,  $\frac{1}{6}$  to third
  - For corner sites, assign most of the traffic to the adjacent intersection via right-turns out of the site instead of left-turns
  - Traffic does not need to exit the same driveway that it entered



# EXISTING PLANS

Scenario	Existing	Previous TIA (By Others)
Land Use	Office: 445,000 sf	Retail: 60,000 sf Office: 1,359,320 sf Restaurant: 40,844 sf Residential: 277
Daily Traffic	5,086 vehicles	19,819 vehicles
AM Peak-In (8-9)	678 vehicles	1,667 vehicles
AM Peak-Out (8-9)	84 vehicles	618 vehicles
AM Peak Total (8-9)	762 vehicles	2,285 vehicles
PM Peak-In (5-6)	92 vehicles	738 vehicles
PM-Peak-Out (5-6)	567 vehicles	1,375 vehicles
PM Peak Total (5-6)	659 vehicles	2,113 vehicles





# CODE COMPLIANT PLANS

Scenario	A	B	C
Land Use	Retail: 60,000 sf Office: 920,000 sf	Retail: 60,000 sf Office: 700,000 sf Restaurant: 15,000 sf Day Care: 10,000 sf Fitness: 20,000 sf Medical Office: 175,000 sf	Retail: 60,000 sf Office: 465,000 sf Restaurant: 15,000 sf Day Care: 10,000 sf Fitness: 20,000 sf Medical Office: 350,000 sf Grocery: 60,000 sf
Daily Traffic	12,255 vehicles	16,232 vehicles	24,005 vehicles
AM Peak-In (8-9)	1,287 vehicles	1,373 vehicles	1,424 vehicles
AM Peak-Out (8-9)	188 vehicles	269 vehicles	310 vehicles
AM Peak Total (8-9)	1,475 vehicles	1,642 vehicles	1,734 vehicles
PM Peak-In (5-6)	296 vehicles	298 vehicles	380 vehicles
PM-Peak-Out (5-6)	1,215 vehicles	1,293 vehicles	1,461 vehicles
PM Peak Total (5-6)	1,511 vehicles	1,591 vehicles	1,841 vehicles



# NEW PLANS

Scenario	A	B	C
Land Use	Retail: 24,000 sf Restaurant: 36,000 sf Office: 800,000 sf Hotel: 100 Rooms Residential: 0 units Fitness: 20,000 sf	Retail: 24,000 sf Restaurant: 36,000 sf Office: 600,000 sf Hotel: 100 Rooms Residential: 250 units Fitness: 20,000 sf	Retail: 24,000 sf Restaurant: 36,000 sf Office: 400,000 sf Hotel: 100 Rooms Residential: 500 units Fitness: 20,000 sf
Daily Traffic	12,945 vehicles	11,434 vehicles	10,298 vehicles
AM Peak-In (8-9)	1,231 vehicles	958 vehicles	685 vehicles
AM Peak-Out (8-9)	230 vehicles	269 vehicles	311 vehicles
AM Peak Total (8-9)	1,491 vehicles	1,227 vehicles	996 vehicles
PM Peak-In (5-6)	346 vehicles	354 vehicles	381 vehicles
PM-Peak-Out (5-6)	1,077 vehicles	839 vehicles	620 vehicles
PM Peak Total (5-6)	1,423 vehicles	1,193 vehicles	1,001 vehicles

